ICES WGNSDS REPORT 2006

ICES ADVISORY COMMITTEE ON FISHERY MANAGEMENT

ACFM:30

REPORT OF THE WORKING GROUP ON THE ASSESSMENT OF NORTHERN SHELF DEMERSAL STOCKS (WGNSDS)

9-18 MAY 2006

ICES HEADQUARTERS, DENMARK

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

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Recommended format for purposes of citation:

ICES. 2006. Report of the Working Group on the Assessment of Northern Shelf Demersal Stocks (WGNSDS), 9-18 May 2006, ICES Headquarters, Denmark. ACFM:30. 870 pp.

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1 GENERAL INTRODUCTION

1.1 Participants

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1.2 Terms of reference

2ACFM10: The ***Working Group on the Assessment of Northern Shelf Demersal Stocks*** *[WGNSDS] (Chair: R. Scott, UK(E&W)) will meet at ICES, Copenhagen from 9–18 May 2006 to:*

a) *assess the status of and provide management options for 2006 for the stocks of cod, haddock, whiting, anglerfish, and megrim in Subarea VI, for cod, haddock, whiting, plaice, sole in Division VIIa, and* <u>*Nephrops*</u> *Functional Units 11, 12, 13, 14, and 15, and for anglerfish stocks in Subarea IV and Divisions IIa, IIIa and VIa;*

b) *for the stocks mentioned in a) perform the tasks described in C. Res. 2ACFM01.*

Terms of Reference *a)* is considered within the individual stock sections which give the results of attempts to assess each stock. Term of Reference *b)* (C. Res. 2ACFM01) requires that several tasks be undertaken in 2006 for each of the stocks mentioned in Term of Reference *a)*. These tasks are listed below, and henceforth referred to as Terms of Reference *c)* to *m)*:

c) *based on input from e.g. WGRED and for the North Sea NORSEPP, consider existing knowledge on important environmental drivers for stock productivity and management and if such drivers are considered important for management advice incorporate such knowledge into assessment and prediction, and important impacts of fisheries on the ecosystem;*

d) *Evaluate existing management plans to the extent that they have not yet been evaluated. Develop options for management strategies including target reference points if management has not already agreed strategies or target reference points (or HCRs) and where it is considered relevant review limit reference points (and come forward with new ones where none exist) – following the guidelines from SGMAS (2005, 2006), AGLTA (2005) and AMAWGC (2004, 2005, and 2006); If mixed fisheries are considered important consider the consistence of options for target reference points and management strategies. If the WG is not in a position to perform this evaluation then identify the problems involved and suggest and initiate a process to perform the management evaluation;*

e) *where mixed catches are an important feature of the fisheries assess the influence of individual fleet activities on the stocks and the technical interactions;*

f) *update the description of fisheries exploiting the stocks, including major regulatory changes and their potential effects. Comment on the outcome of existing management measures including technical measures, TACs, effort control and management plans. The description of the fisheries should include an enumeration of the number, capacity and effort of vessels prosecuting the fishery by country;*

g) *where misreporting is considered significant provide qualitative and where possible quantitative information, for example from inspection schemes, on its distribution on fisheries and the methods used to obtain the information; document the nature of the information and its influence on the assessment and predictions.*

h) *provide for each stock and fishery information on discards (its composition and distribution in time and space) and the method used to obtain it. Describe how it has been considered in the assessments;*

i) *report as prescribed by the Secretariat on a national basis an overview of the sampling of the basic assessment data for the stocks considered;*

j) *provide specific information on possible deficiencies in the 2006 assessments including, at least, any major inadequacies in the data on landings, effort or discards; any major inadequacies in research vessel surveys data, and any major difficulties in model formulation; including inadequacies in available software. The consequences of these deficiencies for both the assessment of the status of the stocks and the projection should be clarified.*

k) *Further develop and implement the roadmap for medium and long term strategy of the group as developed by AMAWGC.*

l) *Working Group Chairs will set appropriate deadlines for submission of the basic assessment data. Data submitted after the deadline will be considered at a later meeting at the discretion of the WG Chair*

m) *The NEAFC Commission requests ICES to provide information on the effect of the Rockall box:*

Point no.	*Latitude*	*Longitude*
1	*57° 000 N*	*15° 000 W*
2	*57° 000 N*	*14° 700 W*
3	*56° 575 N*	*14° 327 W*
4	*56° 500 N*	*14° 450 W*
5	*56° 500 N*	*15° 000 W*

in protecting juvenile haddock and possible revisions of the boundary of the box.

1.3 Stock Assignments in 2006

In accordance with the established system of identifying different assessment types C.Res. 2ACFM01 outlined a plan for WGNSDS stocks in 2006. The plan listed Cod stocks in VIa and VIIa as being on the Observation list and placed all other stocks as Experimental with the exception of Megrim for which it was recommended that no assessment be attempted. No stocks were listed as having either Benchmark or Update status

Based on its reviews of each individual assessment, the RGNSDS suggested an alternative classification of stock status in 2006, as listed below. The additional category Monitoring allows for inter-sessional work to be done and signifies that the WGNSDS should continue compiling and presenting, for example, catch and survey data, but that it should not feel obliged to attempt an analytical assessment.

Observation list	Benchmark	Update	Experimental	Monitoring
Cod VIa	Haddock VIa		Haddock VIb	Megrim VIa
Cod VIIa	Haddock VIIa		Whiting VIa	Megrim VIb
	Plaice VIIa		*Nephrops FU11/12/13/15*	*Nephrops FU14*
	Sole VIIa			Anglerfish II/IIIa/IV/VI
				Whiting VIIa

Stock assessments conducted by WGNSDS in 2006 are in accordance with the recommendations of RGNSDS. The assessment approach adopted for each stock is introduced at the beginning of the individual stock chapter.

The stocks considered by WGNSDS are tabulated in Table 1.1, along with the type of assessment carried out, and an indication of whether the approach in 2006 reflects a change to previous practice.

1.4 Environmental and Ecosystem Information

Term of reference *c)* asks the WG to incorporate existing knowledge on important environmental drivers for stock productivity and management into assessment and predictions, based on input from $WGRED_{2006}$ (ICES 2006). The WG was further asked to consider important impacts of fisheries on the ecosystem noted by WGRED.

The areas of most interest to WGNSDS comprise the waters to the west of Great Britain and Ireland but the area extends (for some stocks) into the Norwegian Sea and northern North Sea. This area is largely defined by WGRED as regional ecosystem E (Celtic Seas). WGRED did not identify any obvious environmental signals that should be considered in assessment or management in this area, but stated that the major trends in the ecosystem are the steady warming of the area, particularly in the context of slope current, and the general and continuing reduction of copepod abundance. It was noted that these factors are likely to have an impact on many species but will particularly affect migratory pelagic species.

WGRED notes that eco-region E has attracted less attention than other areas, such as the North Sea. The report states that environment and ecosystem information are collected by numerous organisations but that there is little or no central co-ordination of the data series. Environmental and ecosystem information for the Norwegian Sea was provided to WGRED by WGNSDS in 2005. WGNSDS continues to provide selected information on data and data sources regarding environmental drivers in the Celtic Seas eco-region and has, this year, focussed attention on the potential relationship between sea surface temperature and cod recruitment in the Irish Sea.

1.4.1 Environmental Drivers of Productivity

A long term trend of increasing sea temperature has been recorded over a large area of the NE Atlantic, particularly since the 1990s. This has been accompanied by an increasing occurrence of more southerly warm-water species such as red mullet and anchovy in the North Sea and Celtic Seas. The effect on productivity of changes in temperature and other climate-related variables such as freshwater input is less well understood, both in terms of trophic dynamics as well as the more direct effects on physiology, survival and behaviour of individuals. Data-rich sea areas such as the North Sea and Baltic are the subject of large-scale co-ordinated studies (e.g. WGREGNS), but the Irish Sea and west-of Scotland areas have generally been the subject of more localised national programmes.

The effect of sea temperature on recruitment of cod in the Irish Sea has been examined by Planque and Fox (1998), and the effects of changing climate and sea temperature on North Sea cod have also been considered by Clark *et al* (2003) and Kell *et al* (2005). Several series of SST values are available for the Irish Sea. These include a long time-series of approximately fortnightly physical records from a fixed station off the SW coast of the Isle of Man (the “Cypris” station), a more recent shorter series from a mooring in the western Irish Sea (Gowen, AFBI, Belfast), and two series of combined satellite and ship-recorded data compiled by the Climate Diagnostics Center, National Oceanographic and Atmospheric Administration of the US Department of Commerce. ERSST version 2 is an extended reconstructed SST time series based on interpolation of ICOADS data, which is itself a blend of satellite and ship based observations from (1960 through spring 2003). The OISST series are optimally interpolated time-series based on ICOADS data from 1960 through to spring 2006. ERSST and OISST use slightly different interpolation routines and grid sizes.

The satellite/ship data were extracted from a box bounded by latitudes 52 and 56 degrees north and longitudes 2 and 6 degrees west for the period 1960 to the latest record in the datasets. Areas of land were excluded using the supplied land/sea mask. The yearly arithmetic mean SSTs for the whole boxed region for the period January – April were computed. Data from the Cypris station, OISST and ERSST datasets for January – April, covering the cod spawning period, show similar trends (Fig. 1.4.1.1). The moorings data from the western Irish Sea also follow very similar trends to the Cypris station data. Since all the datasets (point locations and larger area measurements) are in agreement for this period of time, the Cypis station data were used for an examination of any linkage between cod recruitment and sea temperature during the spawning and larval drift period

The time series of Irish Sea cod recruitment shows a decline in the 1990s, coincident with an increase in SST (Fig. 1.4.1.2). A simple correlation of SST and cod recruitment (e.g. Fig. 1.4.1.6 c) will be confounded by coincidental long-term trends in both series, and it is necessary to de-trend at least one of the data series to allow an examination of the relationship between recruitment anomalies and SST or SST anomalies. This was achieved for recruitment by fitting a Ricker S-R curve (Fig. 1.4.1.3) and calculating the standardised recruitment residuals as $(R_{obs} – R_{pred})/R_{pred}$. The SST data were smoothed using a Loess smoother (Fig. 1.4.1.4), and the residuals calculated. There is a clear tendency for strong recruitment residuals to coincide with prominent negative SST residuals, and for weak recruitment to coincide with strong positive SST residuals (Fig. 1.4.1.5). This is reflected in a highly significant negative correlation between recruitment residuals and either SST or SST residuals (Fig. 1.4.1.6 a&b). Regression statistics for recruitment residuals vs SST residuals are given in Table 1.4.1.1. The relationship between absolute recruitment and SST residuals was weaker. Further biological studies are needed to establish the causal mechanisms for any association between cod recruitment residuals and SST, before such an association could be considered to have any predictive power in the future. If causal mechanisms were established, the consequence would be an expectation of a continued high probability of very weak year classes occurring whilst SSB remains low and SST continues to vary around the elevated values observed since the

1990s. This does not preclude the possibility of strong recruitment occurring in any year, but the probability is likely to be much lower than was the case in the 1960s – 1980s when SST was lower and SSB (and consequently egg production) was relatively high. Although not backed up by mechanistic understanding, the relationship between cod recruitment and SST could be used to produce likely stock changes under varying climate and fishing trends as has been done for North Sea cod.

Table 1.4.1.1. Irish Sea cod: Parameters of linear least-squares regression of standardised recruitment residuals (from S-R curve) against SST residuals from Loess smoother fitted to Cypris Station data for 1969 – 2005.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.658867431
R Square	0.434106292
Adjusted R Square	0.418387022
Standard Error	0.528687665
Observations	38

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	7.7190183	7.719018	27.61619	6.8763E-06
Residual	36	10.06238328	0.279511		
Total	37	17.78140158			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.219764904	0.085932328	2.557418	0.014903	0.04548607	0.39404374	0.045486068	0.394043741
X Variable 1	-1.01056746	0.192301846	-5.255111	6.88E-06	-1.4005737	-0.62056124	-1.40057368	-0.62056124

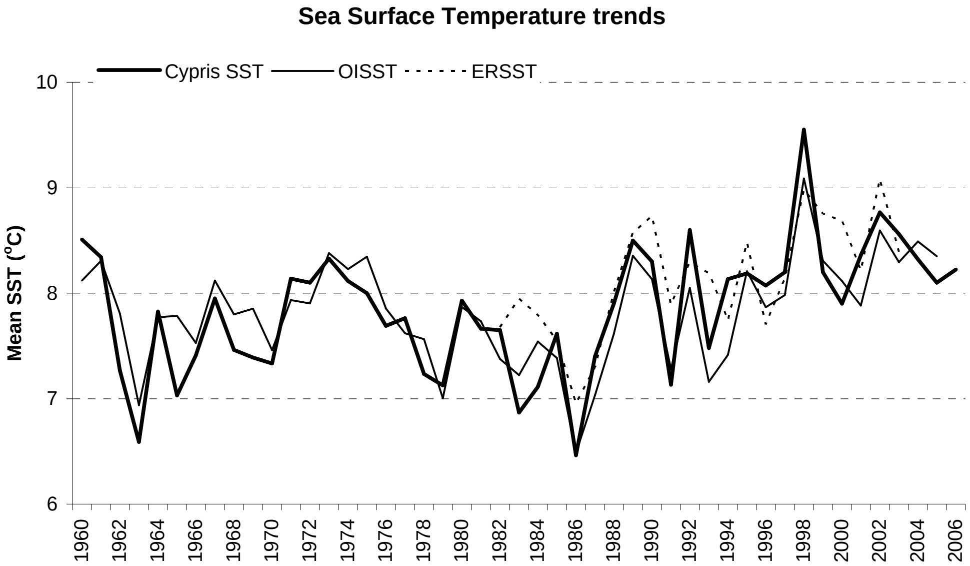

Fig. 1.4.1.1. Trends in Sea Surface Temperature from three sources described in the text.

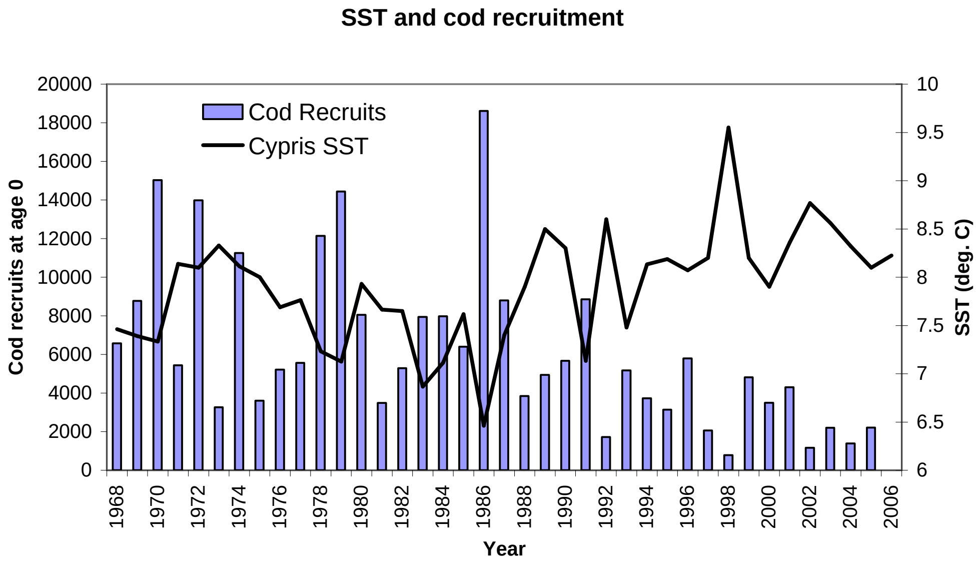

Fig. 1.4.1.2. Time series of cod recruits (age 0) and SSB from the B-ADAPT assessment carried out by this year's WG.

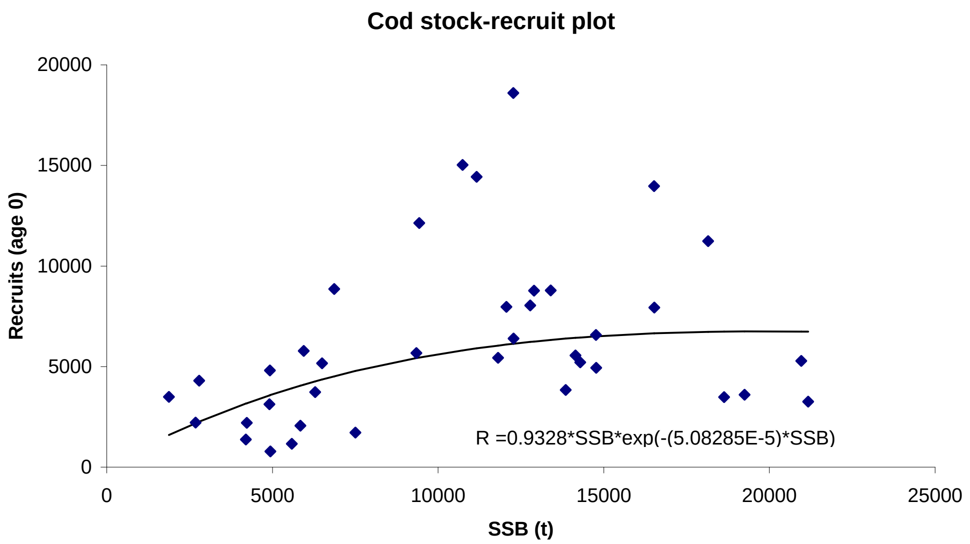

Fig. 1.4.1.3. Stock-recruit plot for Irish Sea cod, with fitted Ricker curve

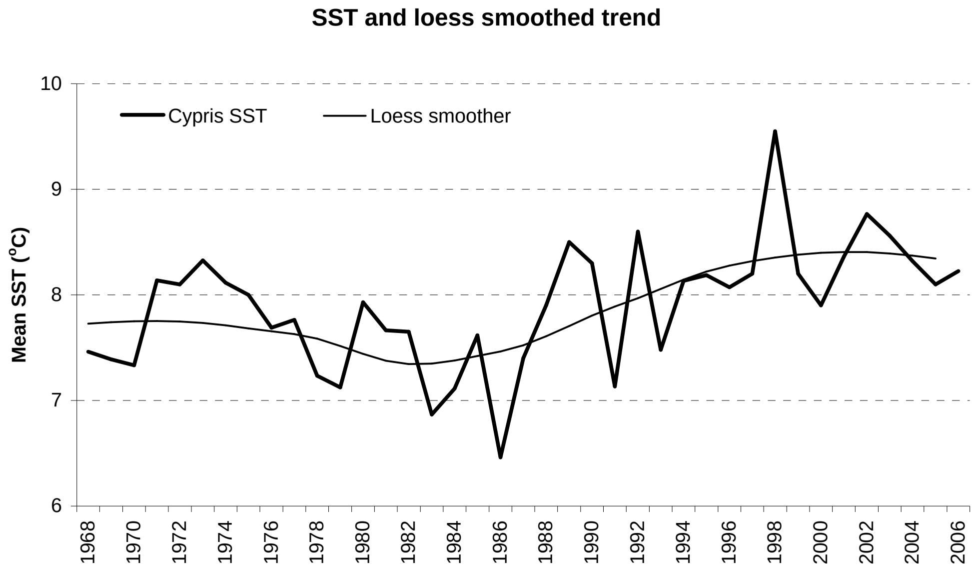

Fig. 1.4.1.4. Cypris station SST with Loess smoother fitted to 1968-2005 data.

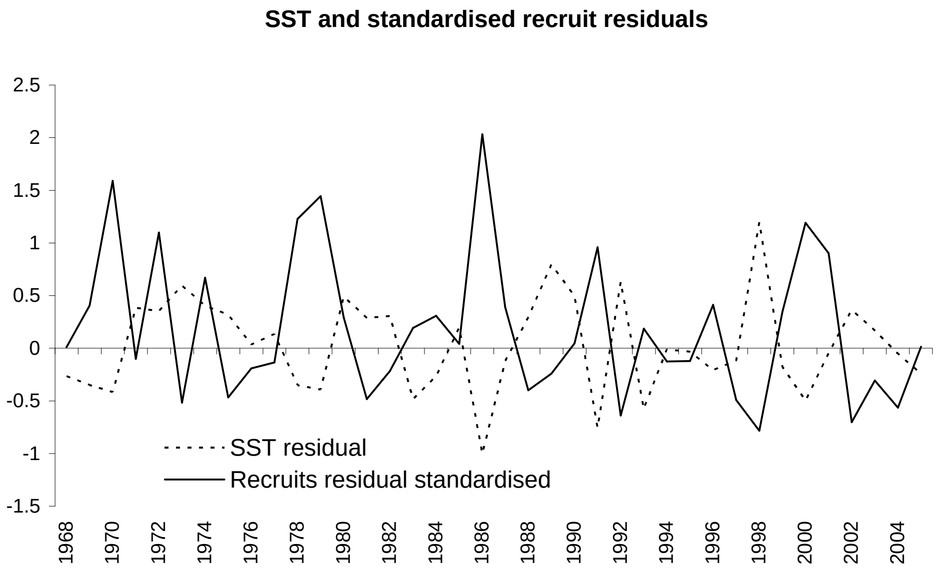

Fig. 1.4.1.5. Residuals of Cypris station SST from Loess smoother, and standardised recruitment residuals from fitted Ricker S-R curve for Irish Sea cod..

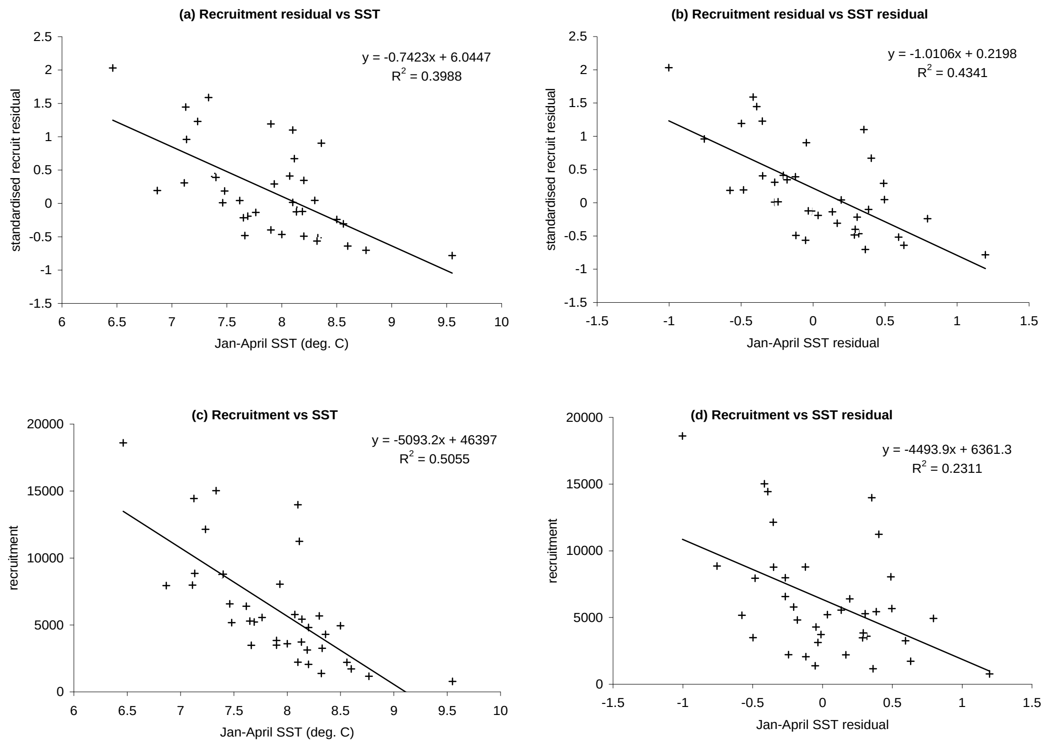

Fig. 1.4.1.6. Plot of recruitment or standardised recruitment residuals (from S-R curve) for Irish Sea cod vs SST or SST residuals from Loess smoother.

1.5 Description of Fisheries

$AMAWGC_{2006}$ (ICES 2006) concluded that further discussions between WGFTFB and ACFM were required before descriptions of mixed fisheries and fishing practices could be revised and reviewed by working groups. The descriptions of the fisheries, provided below, are therefore largely unchanged from last year. Section 17 of this report provides further information on fleet activities in recent years. Information provided to WGNSDS by WGFTFB regarding fishing practices in 2005 has been included in the relevant stock sections.

1.5.1 Fisheries to the West of Scotland and Rockall

The main fleets operating in Division VIa include the mixed roundfish otter trawl fleet, the *Nephrops* otter trawl fleet, the otter trawl fleet targeting anglerfish, megrim, and hake, and the fleet targeting saithe and/or deep-sea species. To a large extent, the roundfish fishery in Division VIa is an extension of the similar fishery in the North Sea. The demersal fisheries in Division VIa are predominantly conducted by otter trawlers fishing for cod, haddock, anglerfish, and whiting, with bycatches of saithe, megrim, and lemon sole.

The majority of the vessels in the demersal fishery are locally-based Scottish trawlers using light-trawls, but trawlers from Ireland, Northern Ireland, England, France, and Germany also participate in this fishery. The importance of Scottish seiners targeted mainly at haddock has been declining in recent years as many of these vessels have been converted to trawlers. Part of the fleet of light trawlers has diversified into a fishery for anglerfish that has been expanding into deeper water off the northern coast of Scotland. Bycatches in this fishery include megrim, ling, and tusk.

About 200 Scottish trawlers also take part in the fisheries for *Nephrops* on inshore grounds. In recent years Irish vessels have also been targeting *Nephrops* in Division VIa, mainly on offshore grounds. These *Nephrops* vessels also land smaller quantities of haddock, cod, whiting, and small saithe, but discard large amounts of whiting and haddock.

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; effort in the roundfish fisheries has shifted away from the traditional 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. These vessels mainly use large twin-rig otter trawls with >100-mm mesh. A smaller Irish fleet also targets anglerfish, megrim, and hake on the Stanton bank with 90-mm to 100-mm mesh. This fleet has declined in numbers in recent years.

The fishery for anglerfish has expanded into deeper waters with an associated increase in catches. The expansion of this fishery has been further accelerated by the diversion of fishing effort from other stocks subject to more restrictive quotas in recent years and by market opportunities. A gillnet fishery has developed on the continental slopes to the West of the British Isles, North of Shetland, at Rockall and the Hatton Bank. A preliminary investigation of this fishery suggests high levels of gear loss, widespread dumping of netting, high catch & discarding levels (particularly of monkfish), and a lack of effective management. These fisheries are occurring in areas believed to have been a refuge for adult anglerfish, increasing the vulnerability of the stock to over-exploitation. Immature fish are subjected to exploitation for a number of years prior to first maturity.

The larger Scottish and Irish trawlers fish for haddock at Rockall when opportunities arise for good catches from the Division VIb stock. Vessels from the Russian Federation have fished for haddock and other demersal species at Rockall since 1999 when part of the Bank was designated as being in international waters. Although young saithe are caught by coastal trawlers in Subarea VI, the fishery for saithe essentially takes place on the shelf edge to the west and northwest of Scotland. Traditionally, this fishery has largely been operated by the larger deep-sea French trawlers. However, the number of these vessels has declined in recent years. Since the late 1980s, some of these vessels diverted their activity toward deep-sea species, notably orange roughy, and some medium-sized trawlers also participate in the fishery for deep-sea species during summer in some years.

The pelagic fishery for herring is mainly operated by UK, Dutch, and German vessels in the north, and by Irish vessels in the south. Substantial misreporting of catches from the North Sea and between the northern and southern stocks occurred in the past, but UK licensing regulations are thought to have reduced misreporting since 1997. In recent years TACs for the northern stock have not been restrictive, presumably because of low effort and a weak market. The Clyde herring fishery has declined sharply in recent years as the stock has suffered from a series of low recruitments. Recent TACs have not been taken and the catches have been less than 1 000 t since 1991.

There is a directed trawl fishery for mackerel and horse mackerel in the area. The mackerel fishery mainly takes place in the fourth and first quarter of the year, when the mackerel is returning from the feeding area to the spawning area. The horse mackerel is mainly fished in the second half of the year. In addition, there are fisheries for blue whiting in the area.

The industrial fisheries in Division VIa are much smaller than in the North Sea. The Scottish sandeel fishery started in the early 1980s, peaking in 1986 and 1988. It is irregular, depending on the availability of the resource and of processing facilities at Shetland, Denmark, and the Faroes. Bycatches in this fishery are very small. The Norway pout fishery is conducted mainly by Danish vessels.

Fisheries interactions to the West of Scotland and Rockall

Demersal fisheries in the area are mixed fisheries, with many stocks exploited together in various combinations in different fisheries. Roundfish are caught in otter trawl and seine fisheries, with a 120-mm minimum mesh size that comprises mixed demersal fisheries with more specific targeting of individual species in some areas and/or seasons. Cod, haddock, and whiting form the predominant roundfish catch in the mixed fisheries, although there can be important bycatches of other species, notably saithe and anglerfish in the deeper water and of *Nephrops* on the more inshore *Nephrops* grounds. Static gear fisheries with mesh sizes generally in excess of 140 mm are also used to target cod. Saithe are mainly taken in a directed trawl fishery in deeper water along the shelf in Subarea VI. There is thought to be little bycatch of other demersal species associated with the directed fishery.

Large *Nephrops* fisheries take place in discrete areas that comprise appropriate muddy seabed sediment. Targeted *Nephrops* fisheries on these grounds are taken predominantly in trawls with mesh sizes of less than 100 mm using single- or multiple-rig trawls. *Nephrops* fishing grounds are mainly inshore grounds although there are smaller offshore fisheries at Stanton Bank and west of the Hebrides. The bycatch and discarding of other demersal species in the *Nephrops* fisheries is highly variable.

There are trawl and gillnet fisheries targeting hake and anglerfish and otter trawl fisheries targeting hake, megrim, and anglerfish in Subarea VI. The catch of other demersal species associated in these fisheries is uncertain.

There is an international fishery targeting haddock, grey gurnards, and other species at Rockall using small mesh. Successful application of TACs for this stock would require that there is a simple relationship between recorded landings and effort exerted. This assumption is unlikely to be true for Rockall haddock especially when coupled with ways of evading TACs including misreporting, high-grading, and discarding. In the case of Rockall haddock these may occur to a large extent due to the remote nature of the fishery and the processing of catches at sea by some fleets. Direct effort regulation is therefore suggested as a means of controlling fishing mortality on Rockall haddock.

1.5.2 Fisheries in the Irish Sea

The majority of vessels in the Irish Sea target *Nephrops* with either single- or twin-rig otter trawls. These vessels use either 70-mm diamond mesh with an 80-mm square mesh panel or an 80-mm diamond mesh in their codends, and (by regulation) their landings must consist of at least 35% *Nephrops* by live weight. These vessels have bycatches of whiting (most of which are discarded) and haddock, cod, and plaice. Twin-rig otter trawl were first introduced in the early 1990s. Recent studies show that the use of twin-rigs increases the proportion of roundfish bycatch in *Nephrops* fisheries compared with single-rig otter trawls. *Nephrops* catches are highly seasonal with the highest *Nephrops* catches in the summer months. Catch rates are also dependent on tidal conditions, with higher catches during periods of weak tide.

The roundfish fisheries in the Irish Sea are conducted primarily by vessels from the UK and Ireland. A Northern Irish semi-pelagic trawling for cod and whiting developed in the early 1980s. As the availability of whiting declined this fleet switched to mainly targeting cod and haddock. Irish, Northern Irish, and English and Welsh otter trawlers target plaice, haddock, whiting, and cod, with smaller bycatches of anglerfish, hake, and sole. Some Irish vessels participate in a fishery for rays in the southern Irish Sea. Since 2001, these trawlers have adopted mesh sizes of 100 120 mm and other gear modifications, depending on the requirements of recent EU technical conservation regulations and national legislation.

Fishing effort in the semi-pelagic effort increased rapidly between the early 1980s and early 1990s before decreasing somewhat in the mid-1990s. Fishing effort in the England and Wales otter trawl vessels longer than 12m declined rapidly after 1989, and from 1992 to 1995 was about 40% of the effort reported in the 1980s, although it has increased slightly in recent years. There has been a declining trend in fishing effort for Northern Irish otter trawlers also since the early 1990s. Fishing effort for Irish otter trawlers has declined in recent years as many vessels switched from targeting roundfish to *Nephrops*.

There is also a beam trawl fishery which takes place mainly in the eastern Irish Sea with vessels from Belgium, Ireland, and the UK. This fishery mainly catches sole with important bycatches of plaice, rays, brill, turbot, anglerfish, and cod. The fishing effort of the Belgian beam-trawl fleet varies in response to the catch-rates of sole in the Irish Sea relative to catch-rates in other areas in which the fleet operates. Fishing effort peaked in the late 1980s following a series of strong year classes of sole, but is presently only about 60% of the peak value.

The other gears employed to catch demersal species are gillnets and tangle nets, notably by inshore boats targeting cod, bass, grey mullet, sole, and plaice.

The main pelagic fishery in the Irish Sea is for herring. In recent years, it has been predominantly operated by one pair of trawlers from Northern Ireland. The size of this fleet has declined to a very low level in recent years.

There are also a number of inshore fisheries in the Irish Sea that target stocks not currently assessed by ICES. These include pot fisheries for crab, lobster, and whelk, hydraulic dredge fisheries for razor clams, and dredge fisheries for scallops.

Decommissioning at the end of 2003 permanently removed 19 out of 237 UK demersal 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 had used demersal trawls with mesh size >=100mm and had more than 5% cod in their reported landings. The previous round of decommissioning in 2001 removed 29 UK(NI) *Nephrops* and whitefish vessels and 4 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 >=100mm and had more than 5% cod in their reported landings.

1.5.3 Fisheries in other areas covered by the WGNSDS

The fisheries in other areas covered by the WG are described in the relevant stock sections.

1.6 Enumeration of Capacity and Effort

An analysis of effort trends in divisions VI and VIIa is presented in Section 17 of this report

1.7 Regulations

1.7.1 TAC Regulations

The Regulations specifying Total Allowable Catches (TAC) by species and management area for stocks assessed by WGNSDS are as follows:

Stock	Council Regulation (EC) No: / Management Area	2848 / 2000 2001 TAC	2555 / 2001 2002 TAC	2341 / 2002 2003 TAC	2287 / 2003 2004 TAC	27 / 2005 2005 TAC	51 / 2006 2006 TAC
Cod	Vb $^{\alpha}$, VI, XII, XIV	3,700	4,600	1,808	848	721	613
	VIIa	2,100	3,200	1,950	2,150	2,150	1,828
Megrim	Vb $^{\alpha}$, VI, XII, XIV	4,360	4,360	4,360	3,600	2,880	2,880
Anglerfish	IIa $^{\alpha}$, IV $^{\alpha}$	14,130	10,500	7,000	7,000	10,314	10,314
	Vb $^{\alpha}$, VI, XII, XIV	6,400	4,770	3,180	3,180	4,686	4,686
Haddock	Vb, VI $^{\alpha}$, XII, XIV	13,900	14,100	8,675	~	~	
	Vb, VIa	~	~	~	6,503	7,600	
	VIb $^{\alpha}$, XII, XIV	~	~	~	702	702	597
	VII, VIII, IX, X, CECAF 34.1.1.1 $^{\alpha}$	12,000	9,300	8,185	9,600	11,520	11,520
	VIIa $^{\beta}$	2,700	1,300	585	1,500	1,500	1,275
Whiting	Vb $^{\alpha}$, VI, XII, XIV	4,000	3,500	2,000	1,600	1,600	1,360
	VIIa	1,390	1,000	500	514	514	437
Plaice	VIIa	2,000	2,400	1,675	1,340	1,608	1,608
Sole	VIIa	1,100	1,100	1,010	800	960	960
Nephrops	VI, Vb $^{\alpha}$	11,340	11,340	11,340	11,300	12,700	17,675
Nephrops	VII	18,900	17,790	17,790	17,450	19,544	21,498

$^{\alpha}$: European Community waters, $^{\beta}$: Within the limits of the VII, VIII, IX, X and CECAF 34.1.1.1 TAC, no more than the quantity stated may be taken in Division VIIa.

1.7.2 Other Regulations

Area Closures

Due to the depleted state of the stock and following the advice from ICES, a recovery plan for cod in the Irish Sea was introduced in 2000. Commission Regulation (EC) No 304/2000 established emergency closed areas to fishing for cod between 14 February and 30 April in the western and eastern Irish Sea to protect spawning adults at spawning time (Figure 1.1). Council Regulation (EC) 2549/2000, which came into force on 1 January 2001, with amendments in Council Regulation (EC) No 1456/2001, of 16 July 2001, established additional technical measures for the protection of juveniles.

The closed area in the Irish Sea and additional technical regulations were extended to 2001 in Council Regulation (EC) 300/2001 and to 2002 in Council Regulation (EC) 254/2002. The main difference in the recovery measures for 2002, 2003 and 2004 from those of 2001 is that a closed area remained only in the western Irish Sea time (Figure 1.1). Derogations have existed for fleets targeting *Nephrops* in all years.

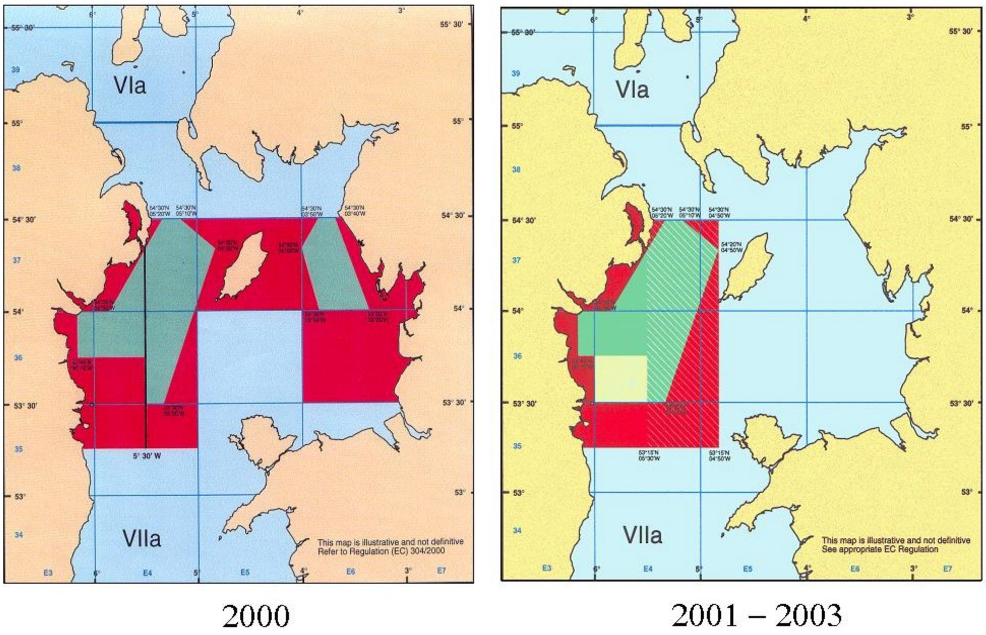

Figure 1.1. Maps of the Irish Sea (VIIa) closed areas for 2000 – 2003. The closed area is shaded red and the area open to Nephrops derogations is shaded green.

Emergency measures were enacted in 2001 for the west of Scotland, consisting of area closures from 6 March–30 April, in an attempt to maximise cod egg production. These measures were retained into 2003 and 2004. A new closed area was implemented to the west of Scotland in 2004 under Council Regulation (EC) No 2287/2003.

In the west of Scotland there have been unilateral closures by Ireland of a traditional fishery for juvenile cod off Greencastle, Co. Donegal (Figure 1.3). From mid-September 2003 to mid-February 2004 (Irish Statutory Instrument (SI) No. 431 of 2003) closed the area. In December 2003 the closed area was extended along its eastern edge by amendment to the Statutory Instrument (SI No. 664 of 2003). Whilst the initial closure period officially ended in mid-February 2004, fishermen in the local trawl fleet imposed a voluntary exclusion to trawling within the boundaries of the closed area as described in SI 664 of 2003. These fishermen submitted signed declarations effectively banning trawling in the area from February 15th to July 1st 2004. A new Statutory Instrument (SI No. 670 of 2004) reinstated the closed area from 1st November 2004 until 14th February 2005. At a stakeholder meeting in October 2005 another official closure of the Cape grounds for the 2005-2006 season was agreed. A new Statutory Instrument (SI No. 700 of 2005) re-instated the closure of the Cape to all fishing methods from 14th November 2005 until 14th February 2006. Another period of tagging and recapture of cod on the Cape Grounds was undertaken in December 2005 – January 2006.

These closures were instigated by the local fishing industry to allow an assessment of seasonal closure as a potential management measure. Over 13,000 cod have been tagged and released during the closures. Most of the cod catch during the closed period is normally taken in the fourth quarter. During 2000-2002 50% of the Irish catch weight of cod in VIa (61% by number) was taken in the fourth quarter. The closure is expected to have reduced the Irish fishing mortality on cod that would otherwise have occurred in 2003-2005. As the Greencastle codling fishery is a mixed demersal fishery, any benefits Flowing from the closure are likely to extend to other demersal stocks.

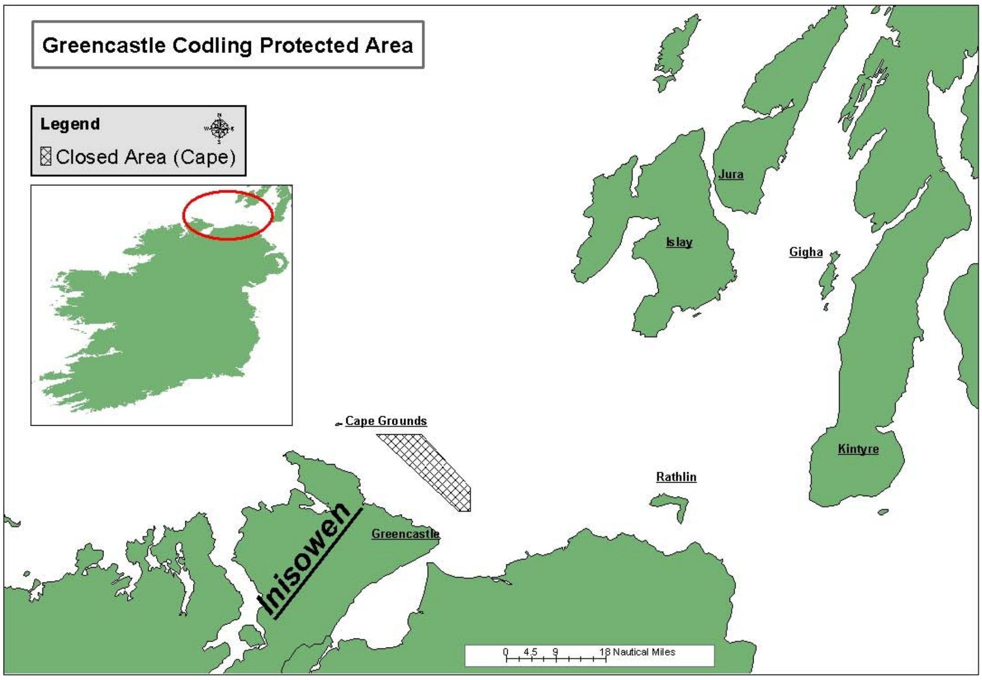

Figure 1.2. Location of the area closed by Irish Statutory Instrument in 2003-4 and 2004-5.

Effort Limitation

Annex XVII to Council Regulation (EC) No 2341/2002 regulated fishing effort to the West of Scotland. The extent of effort limitation varied for particular gears. The maximum number of days in any calendar month for which a fishing vessel may be absent from port to the West of Scotland in 2003 was:

- 9 days for demersal trawls, seines or similar towed gears of mesh size ≥ 100 mm except beam trawls,
- 25 days for demersal trawls, seines or similar towed gears of mesh size between 70 mm and 99mm except beam trawls, and,
- 23 days for demersal trawls, seines or similar towed gears of mesh size between 16 mm and 31 mm except beam trawls.

The Regulation included a provision for additional days to be allocated on the basis of the achieved results of decommissioning programmes. A Commission Decision (C(2003) 762) in March 2003 allocated additional days absent from port to particular vessels and Member States. United Kingdom vessels were granted 4 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 ≥ 100mm, 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.

Monthly effort limitation was extended to the Irish Sea (and other “cod recovery” areas) under Annex V to Council Regulation (EC) No 2287/2003. The restrictions for the West of Scotland and Irish Sea (per month) in 2004 were:

- 10 days for demersal trawls, seines and similar towed gears with mesh size >= 100mm,
- 14 days for beam trawls of mesh size >= 80mm and static demersal nets,

- 17 days for demersal longlines,
- 22 days for demersal trawls, seines and similar towed gears with mesh size 70-99mm, and,
- 20 days for demersal trawls, seines or similar towed gears of mesh size between 16 mm and 31 mm except beam trawls.

Additional days were available for vessels meeting certain conditions such as track record of low cod catches. In particular, an additional two days were available for whitefish trawlers (mesh >= 100mm) and beam trawlers (mesh >=80mm) which spent 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.

Council Regulation (EC) No 27/2005 further limited effort in the Irish Sea and West of Scotland (and other "cod recovery" areas). The restrictions for the West of Scotland and Irish Sea (per month) in 2005 were:

- 9 days for demersal trawls, seines and similar towed gears with mesh size >= 100mm,
- 13 days for beam trawls of mesh size >= 80mm and static demersal nets,
- 16 days for demersal longlines,
- 21 days for demersal trawls, seines and similar towed gears with mesh size 70-99mm, and,
- 19 days for demersal trawls, seines or similar towed gears of mesh size between 16 mm and 31 mm except beam trawls.

The maximum number of days per month for which demersal trawlers (mesh >= 100mm) may be absent from port was further restricted to 8 days for the West of Scotland, and 10 days for the Irish Sea. The additional effort available to Irish Sea demersal trawlers (mesh >= 100mm) and beam trawlers (mesh >=80mm) was reduced to one day.

The effort regulations have provided an incentive for some vessels previously using >100-mm mesh in otter trawls to switch to smaller mesh gears, thus claiming a higher number of days-at-sea. After the implementation of EC Regulation No. 850/98 these vessels will also be required to target either *Nephrops* or anglerfish, megrim, and whiting, with various catch and bycatch composition limits. No detailed information is available to quantify how many vessels have switched to using smaller meshes as a result of effort regulation as this information is not reliably recorded in the logbook information for some countries.

Recovery Plans

Council Regulation (EC) No 423/2004, of 26 February 2004, established measures for the recovery of cod stocks. These include: Multi-Annual processes for selection of TAC's, restriction of fishing effort, technical measures, control and enforcement, accompanying structural measures and market measures. Council Regulation (EC) No 423/2004 formulated harvest control rules with reference to limit and precautionary reference points. For stocks above $\mathbf{B}_{\mathrm{lim}}$, the harvest control rule 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 $\mathbf{F}_{\mathrm{pa}}$.

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.

Gear Regulation and Other Technical Measures

New technical regulations for EU waters came into force on 1 January 2000 (Council Regulation (EC) 850/1998 and its amendments). The regulation prescribes the minimum target species' composition for different mesh size ranges. Since 2001, cod in Division VIIa have been a legitimate target species for towed gears with a minimum codend mesh size of 100 mm.

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. 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. Cod are a by-catch in *Nephrops* and anglerfish fisheries in Division VIa. These fisheries use a smaller mesh size of 80mm, but landings are restricted through by-catch regulations. 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.

Regulation (EC) No 423/2004 required that fishing vessels give prior notification of their landing of more than one tonne of cod. Vessels carrying more than two tonnes of cod were also required to land only in designated ports. The permitted margin of tolerance in the estimation of quantities reported in the logbook was reduced to 8 % of the logbook figure.

Council Regulation (EC) No 1928/2004, of 25 October 2004, amended Regulation (EC) No 2287/2003 in order to align the provisions for effort limitation, monitoring, inspection and surveillance with those in Regulation (EC) No 423/2004.

A corrigendum to Council Regulation (EC) No 867/2004 amended restrictions on fishing for cod in the West of Scotland in order to avoid unnecessary social and economic hardship. Fishing activities that do not catch cod were permitted within the area closed for cod fishing to the west of Scotland, with the provisions that these activities were clearly defined (shellfish, crustacean and pelagic fishing), enforceable, and did not cause an additional risk to the remaining stock of cod.

Other Regulations specific to particular stocks are described in the relevant Stock Sections.

1.8 Recent ICES Advice in the Context of Mixed Fisheries

1.8.1 Mixed fisheries advice for 2005:

For West of Scotland mixed-species fisheries ICES gave the following advice for 2005 (ACFM report, October 2004):

> *"Demersal fisheries in Subarea VI should in 2005 be managed according to the following rules, which should be applied simultaneously:*
>
> *They should fish:*
>
> - *without catch and discards of cod in Subarea VI;*
> - *in accordance with a recovery plan for northern hake or within an effectively implemented TAC of less than 33,000 t covering all areas where northern hake is caught;*
> - *no directed fishery for haddock in Division VIb;*
> - *concerning deepwater stocks fished in Subarea VI;*
> - *within the biological exploitation limits for all other stocks.*
>
> *Furthermore, unless ways can be found to harvest species caught in mixed fisheries within precautionary limits for* all *those species individually, then fishing should not be permitted."*

For Irish Sea mixed-species fisheries ICES gave the following advice for 2005 (ACFM report, October 2004):

> *Fisheries in the Irish Sea should in 2005 be managed according to the following rules, which should be applied simultaneously:*
>
> *They should fish:*
>
> - *without bycatch or discards of cod and minimal catch of whiting;*
> - *without jeopardizing the recommended reduction in fishing mortality of haddock and plaice;*
> - *within the biological exploitation limits for all other stocks.*

Furthermore, unless ways can be found to harvest species caught in a mixed fisheries within precautionary limits for all those species individually, then fishing should not be permitted."

1.8.2 Mixed fisheries advice for 2006:

For West of Scotland mixed-species fisheries ICES gave the following advice for 2006 (ACFM report, October 2005):

> *"Demersal fisheries in Subarea VI should in 2006 be managed according to the following rules, which should be applied simultaneously:*
>
> *They should fish:*
>
> - *without catch or discards of cod in Subarea VI;*
> - *without catch or discards of spurdog;*
> - *no directed fishery for haddock in Division VIb;*
> - *concerning deepwater stocks fished in Subarea VI;*
> - *within the biological exploitation limits for all other stocks.*

Furthermore, unless ways can be found to harvest species caught in mixed fisheries within precautionary limits for <u>all</u> those species individually, then fishing should not be permitted."

For Irish Sea mixed-species fisheries ICES gave the following advice for 2006 (ACFM report, October 2005):

Fisheries in the Irish Sea should in 2006 be managed according to the following rules, which should be applied simultaneously:

They should fish:

- *without bycatch or discards of cod and spurdog, and minimal catch of whiting;*
- *without jeopardizing the recommended reduction in fishing mortality of haddock;*
- *within the biological exploitation limits for all other stocks.*

Furthermore, unless ways can be found to harvest species caught in mixed fisheries within precautionary limits for <u>all</u> those species individually, then fishing should not be permitted."

1.9 Recommendations

In consideration of the state of current assessments of WGNSDS stocks the Working Group recommends the following Stock Assignments for WGNSDS in 2007:

OBSERVATION LIST	BENCHMARK	UPDATE	EXPERIMENTAL	MONITORING
Cod VIa	Haddock VIa		Haddock VIb	Megrim VIa
Cod VIIa	Sole VIIa		Haddock VIIa	Megrim VIb
	Plaice VIIa		Whiting VIa	Whiting VIIa
			Nephrops FU 11/12/13/15	*NephropFU14*
				Anglerfish IIa, IIIa, IV & VI

1.9.1 WGNSDS response and recommendations to WGMethods

The working group found it difficult to ascertain aspects of model behaviour for a number of the assessment methods that were used during the meeting. Whilst some methods have undergone some simulation testing there is a clear need for further work in this area as well as the provision of improved diagnostic tools and comprehensive documentation.

Particular issues in 2006 related to the quality of the model fit, which, in SURBA for example, is currently determined largely from consideration of the log residuals from the fitted model and the considerations listed in section 2.7. In a multi-fleet SURBA analysis it is difficult to determine whether the addition of an extra fleet provides an improved model fit. The inclusion of an AIC or similar statistic in the diagnostic output may provide additional information with this respect although it is noted that the use of an AIC becomes invalid when data set being examined is not fixed.

Parameter estimates from TSA analyses are presented in the report with little information to indicate their individual relevance and importance. Comment is made on the degree of change in parameter estimates from runs conducted in previous years but there is little information to indicate how well the parameter has been estimated or how significant the change may be. Diagnostic plots showing the likelihood profile of each parameter estimate would provide useful information on the ability of the model to estimate individual parameters.

1.9.2 WGNSDS response and recommendations to SGFTFB

A draft copy of the 2006 SGFTFB report was made available to WGNSDS during the meeting this year. Information provided by SGFTFB has been included, where appropriate, in the fishery descriptions section and in the management considerations section of the individual stock sections of the report.

Members of the WGNSDS found the structure of the report very helpful with the information provided being clearly presented for each management area.

1.9.3 WGNSDS response and recommendations to IBTSWG and survey groups

WGNSDS is aware of the proposed format of survey information to be provided by IBTSWG which includes distribution maps of the survey stations and specific information relating to the most recent survey results. WGNSDS welcomes the provision of such information as well as the provision of estimates of precision for some surveys, which, it is understood will extend to all surveys in due course.

Whilst this information is very useful and should assist the working group considerably in making choices regarding the appropriateness of particular models and model settings, the information can, currently, only be used in a largely qualitative manner. Although some methods, such as ICA, allow a user defined weighting to be applied to individual tuning indices, many methods do not and none of the methods used by this group specifically incorporate sample-based precision estimates for survey indices.

Whilst the provision of methods that are capable of incorporating such information should not necessarily be a concern for IBTSWG, WGNSDS recommends that members of IBTSWG apply current survey based assessment methods (eg. SURBA) to the data that they provide so as to increase understanding of how such information is being used by assessment working groups. With regards the development of appropriate methods, WGNSDS recommends that WKSAD be re-convened with a specific term of reference to investigate and apply methods for incorporating survey variance in stock assessment models.

WGNSDS meets relatively early in the year (May). For information supplied by IBTSWG to be effectively incorporated into the assessments, data should ideally be supplied 2 to 3 weeks prior to the working group meeting, as is required of other data providers, thus allowing sufficient time for data collation and preliminary analyses to be conducted.

An assessment approach using UW TV survey information has been employed again for stocks of Nehphrops in Via and has also been applied, this year, to nephrops in VIIa. WGNSDS recommends that a TV survey workshop be held in 2006/7 to further investigate the application of this approach to nephrops stocks and also the potential for applying the method to other demersal species.

2 DATA AND METHODS

The stocks within the remit of this Working Group are tabulated in Table 2.1 along with the type of assessment carried out and an indication of whether this reflects a change to previous practices.

Table 2.1 2006 Working Group on the Assessment of Northern Shelf Demersal Stocks. Summary of past and current practices for stock assessment. SPALY denotes that the Same Procedure As Last Year was used.

Stock:	Working Group: 2002	2003	2004	2005	2006
Division IIa, III, IV and VI					
Anglerfish	Catch-at-size analysis	SPALY	No assessment	No assessment	No assessment
Division Via (FU 11, 12 & 13 for *Nephrops*)					
Cod	TSA, short- & medium-term predictions	SPALY	Modified TSA & XSA assessments	SURBA	TSA, no catch 1995-
Haddock	TSA, short- & medium-term predictions (& discards)	SPALY	Modified TSA & XSA assessments	SURBA (compared to update of XSA, TSA)	TSA, no catch 1995-
Whiting	TSA, short- & medium-term predictions (& discards)	SPALY	Modified TSA & XSA assessments	SURBA (compared to update of TSA)	SURBA
Megrim	Separable VPA	SPALY	Collie-Sissenwine Analysis	No assessment	No assessment
Nephrops	XSA, Trend analysis	SPALY	No assessment	TV Survey	TV Survey
Division VIb					
Haddock	XSA, short-term predictions	No assessment	No assessment	XSA including discards	SPALY
Division VIIa (FU 14 & 15 for *Nephrops)*					
Cod	XSA, short- & medium-term predictions	SPALY	XSA & TSA assessment	SURBA	B-Adapt
Whiting	XSA, short-term predictions (& discards)	SPALY	No assessment	No assessment	No assessment
Haddock	XSA, short-term predictions	SPALY	XSA, TSA, SURBA assessments	SURBA	SURBA
Plaice	XSA, short- & medium-term predictions	SPALY	ICA, short-term projections	SPALY	SPALY
Sole	XSA, short- & medium-term predictions	SPALY	SPALY	SURBA, FSSSPS for forecast	XSA? tbc
Nephrops	XSA, Trend analysis	SPALY	No assessment	No assessment	TV Survey

2.1 Catch Data

2.1.1 Official Landings

The Coordinating Working Party on Fishery Statistics (CWP) coordinates collection of nominally reported catch statistics under the STATLANT programme. The website was accessed through http://www.ices.dk/fish/statlant.asp and used to obtain 2005 official catch statistics.

2.1.2 Misreported Landings

The WG has included misreported landings within the "unallocated" landings figures reported for each stock. These unallocated landings represent adjustments to nominal landings figures to correct either for misreporting or for differences between official statistics and data obtained by national scientists. The general term misreporting is used throughout this report to include misreporting by area, misreporting of landings by species and under- or over-reporting of landings.

The main inadequacy in landings data available to WGNSDS is the unknown level of misreporting. Anecdotal information provided by fishermen from several countries indicates that under-reporting of landings of some species is widespread and significant, particularly for stocks with restrictive TACs. Furthermore there is evidence of over-reporting of landings of some species for which TACs are not set, or are not restrictive. Mis-allocation of landings into other TAC areas is also known, although the WG has attempted to correct for this where possible: for example Irish Sea cod and Celtic Sea cod.

Previous assessments of some WGNSDS stock have included estimates of landings by one country based on a quayside survey of landings rather than official log-book data. This resulted in substantial unallocated catches implying significant misreporting, and this was identified by ACFM as a major concern. The Annual Meeting of Assessment Working Group Chairs (AMAWGC) (ICES 2005) advised that it is no longer acceptable to make estimates of mis- and non-reporting and make corrections to catch data without revealing the sources of both the data and the problems. Term of Reference *g)* asks the WG to provide information on the distribution of misreporting and the methods used to obtain information on misreporting.

As the misreporting estimates used previously by WGNSDS are for one country only, and there is evidence that the practice is more widespread, the WG cannot provide the transparency requested by AMAWGC. However, the absolute values of landings and landings at age, based on reported catches, are considered too biased in recent years to allow an analytical catch-based assessment without a procedure to allow for the potential bias. As the bias can be manifest in apparent trends in survey catchability, WGNSDS has this year adopted assessment methods for west of Scotland and Irish Sea cod, and west of Scotland haddock, that combine the full time series of survey data with fishery data from an earlier period (also covered by the surveys) when the landings data are considered relatively unbiased. The methods (B-ADAPT and TSA) effectively scale the survey indices to the absolute population estimates derived from the period of un-biased fishery data. The TSA method applied to VIa stocks excluded all fishery data from the estimation from 1995 onwards, whereas the B-ADAPT method applied to Irish Sea cod estimated the bias in total removals from 2000 onwards, but retained the relative age composition data from the fishery. Both methods provide estimates of the total annual removals for a recent period (in excess of the assumed M) consistent with removing any trends in survey catchability. However, the figures may include additional discards or natural mortality as well as any misreported landings.

The history of WG attempts to quantify misreporting is given in the 2000 WG report (ICES CM:2001/ACFM:01). A summary of past practices is given below.

Stocks in Sub-Area VI

Previous Working Groups had expressed a view that misreporting of area VI gadoids had not been significant because of low availability of fish relative to quotas. However, recent Working Groups have not been able to make an informed judgement on misreporting of area VI gadoids. Values for misreported landings of VIa haddock in 1992 – 1994, inferred from survey data, are given in ICES CM 1996/Assess:1 and ICES CM 1997/Assess:2.

For anglerfish and megrim in Division VIa the existence of a restrictive precautionary TAC in Division VIa but no catch restrictions in the adjacent areas of the North Sea up until 1998 is suspected to have led to extensive reporting of catches from VIa into IVa. Such an effect is apparent in the reported distribution of catches by one nation where catches of anglerfish and megrim reported from the statistical rectangles immediately east of the 4°W boundary (the E6 squares) have accounted for a disproportionate part of the combined VIa/North Sea catches of these species. This proportion has reached up to 57% in the case of anglerfish and 75% in the case of megrim. As it is strongly suspected that the large majority of catches reported from the E6 squares are actually taken in Division VIa the landings totals used in previous assessments of these stocks had been corrected for this effect. The correction was 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 were estimated by replacing the reported values by the mean of the catches in the adjacent squares to the east and west. This mean was calculated iteratively to account for increases in catches in the VIa squares resulting from reallocation from the E6 squares.

Stocks in Division VIIa

Misreporting of cod, haddock and whiting in the Irish Sea has occurred during the 1990s due to restrictive quotas. This has mainly taken the form of misreporting between VIIa and surrounding regions (mainly from the Celtic Sea into the Irish Sea), and misreporting of species compositions (both over- and under-reporting). Reported (official) landings data from one country taking a significant part of the international catch have in the past been adjusted at source for area-misreporting based on local knowledge of fleet activities. Landings at three ports have been estimated since 1991 using a sampling method based on observations made by scientists taking length measurements in the ports. The total landings are estimated either by raising the mean observed catch per landing to total number of landings (by port and gear type) where at least one of the species was reported, or (in some earlier years) adjusting the reported landings by the ratio of observed to reported landings. Further details are given in ICES CM 1999/ACFM:1.

The sample-based estimates of landings at official fish markets exclude any "black" landings made at non-designated ports or times and correct only for misreporting of species compositions. Possible increases in black landings may have occurred in the more recent years when some TACs have been set to achieve substantial reductions in fishing mortality without effective mechanisms for controlling fishing effort to the necessary extent. This is of concern not only for the accuracy of the assessments, but also for the appropriateness of assessment methods such as XSA in which survey and commercial CPUE data are evaluated against population numbers reconstructed from commercial catch data (see also Casey, J: Working Document 5; 2002 meeting of WGNSSK ICES CM 2003/ACFM:02). Concerns about the incompleteness of the sample-based landings estimates has resulted this year in the landings of cod from 2000 onwards being treated as biased in a B-ADAPT analysis, although the relative age composition data are retained.

2.1.3 Discards

Implementation of the EU Data Collection Regulation (Commission Regulation (EC) No 1639/2001) has resulted in some discard data being available for most stocks within the scope of WGNSDS. High grading is suspected in some stocks, although its significance has not been possible to estimate.

Unfortunately, the inclusion of new series of discard data in stock assessments is not straightforward. Available discard data are highly variable. The discarding behaviour can change according to fleet, areas, time and importance of a year class. Raising protocols to estimate the total volume of discards in a given stock differ between countries. Sampling and raising procedures therefore need to minimise bias and maximise precision. Unfortunately, it is still difficult to determine the accuracy (or bias) in most discard estimations as raising procedures still rely upon commercial logbook information which suffers from misreporting.

Several methods have been developed to estimate discards of young commercial fish species. These can be considered in two groups; direct and indirect methods of estimation (Sokolov, 2003). Direct methods are based on the measurement of fish directly onboard the fishing vessels (Hylen, 1967; Hylen and Smedstad, 1974; Jermyn and Robb, 1981; Tamsett, 1999). Indirect methods use other data sources and assumptions to calculate discards:

- quantitative estimation of small fish discards can be done on the basis of comparison of length measurements by onboard observers and shore-based sampling of landings (Palsson et al., 2002; Palsson, 2003, Sokolov, 2003),
- results from studies of fishing gear selectivity followed by recalculation of the reported catch (DingsOr, 2001, Matsushita and Ali, 1997),
- analysis of catch length frequencies on the assumption that all fish shorter than a certain length are discarded (Sokolov, 2001),
- interviewing of skippers on their return to harbour and analysis of their reports,
- data provide by skippers directly at sea for a small consideration (Jermyn and Hall, 1978).

The choice of one or another method to estimate discards depends on the availability and completeness of initial data. Each stock section includes further comments on available discard data.

2.2 Biological Sampling

Table 2.2 shows which countries provided assessment data to the Working Group for the year 2004, and the form of data provided. An increased amount of discard data was provided to the $WGNSDS_{2005}$ for several stocks. The level of sampling in 2004 for core assessment data (numbers of samples, length measurements and age-length keys) is indicated in table 2.3, where data were available for individual countries. Unfortunately estimation of the intensity of sampling (through comparison with the total international landings) was not possible for most stocks at $WGNSDS_{2005}$. Deficiencies in sampling (if any) are discussed in the relevant stock Section.

Table 2.2 2006 Working Group on the Assessment of Northern Shelf Demersal Stocks. A summary of countries from which 2005 assessment data was provided for the stocks covered by WGNSDS.

Data	Cod			Haddock			Whiting			Plaice	Sole	Megrim		Anglerfish					*Nephrops*				
	VIa	VIb*	VIIa	VIa	VIb	VIIa	VIa	VIb*	VIIa	VIIa	VIIa	VIa	VIb	VIa	VIb	IIa	IIIa	IV	FU11	FU12	FU13	FU14	FU15
Catch weight	E&W	E&W	B	E&W	E&W	B	Sc	E&W	B	B	B	Fr	Fr	E&W	IR	No	Dk	B	Sc	Sc	Sc	E&W	E&W
(main exploiters)	NI	IR	E&W	Fr	IR	E&W	E&W	IR	E&W	E&W	E&W	IR	IR	Fr	Sc		G	Dk				IR	IR
	No	Sc	Fr	IR	No	IR	Fr	Sc	IR	Fr	Fr	NI		G	Fr		No	E&W				NI	NI
	Sc	Fr	IR	NI	R	NI	IR		NI	IR	IR	B		IR	B		Sw	No					
	IR		IoM	No	Sc	Sc	NI		Sc	NI	NI	Sc		NI				Sc					
	F		NI	Sc		Fr				Sc	Sc			Sc				G,NL					
			Sc	Sp										Sp				Sw					
Catch length	IR		E&W	IR	IR	IR	IR		E&W	E&W	B	IR	IR	IR		No		Dk	Sc	Sc	Sc	E&W	IR
	Sc		IR	Sc	R	NI	Sc		IR	IR	E&W							No					
			NI		Sc				NI	NI	IR												
Catch ALK	IR		E&W	IR	IR	IR	IR		IR	E&W	B	IR	IR	IR									
	Sc		IR	Sc	R	NI	Sc			IR	E&W												
			NI		Sc						IR												
Catch wt-at-age	IR		E&W	IR	IR	IR	IR		IR	E&W	B	IR	IR	Sc	Sc			Sc					
	Sc		IR	Sc	R	NI	Sc			IR	E&W			IR									
			NI		Sc						IR												

Table 2.2.1 (continued).

Data	Cod			Haddock			Whiting			Plaice	Sole	Megrim		Anglerfish					*Nephrops*				
	VIa	VIb	VIIa	VIa	VIb	VIIa	VIa	Vib	VIIa	VIIa	VIIa	VIa	VIb	VIa	VIb	IIa	IIIa	IV	FU11	FU12	FU13	FU14	FU15
Discard weight	Sc IR		E&W	Sc IR		IR	Sc IR		IR	IR E&W	B	IR							Sc	Sc	Sc	E&W	IR
Discard length	Sc IR		E&W	Sc IR		IR	Sc IR		IR	B IR E&W	B	IR							Sc	Sc	Sc	E&W	IR
Discard ALK	Sc IR		E&W	Sc IR		IR	Sc IR		IR			IR											
Effort	IR Sc		E&W IR NI	IR Sc	R IR Sc	IR NI	IR Sc		E&W IR NI	B E&W IR	B E&W IR	IR	IR	Sc NI E&W	Sc E&W			E&W Sc	Sc	Sc	Sc	E&W IR	E&W IR NI
CPUE	IR Sc		E&W IR NI	IR Sc	R IR Sc	IR NI	IR Sc		E&W IR	B E&W IR	B E&W IR	IR	IR						Sc	Sc	Sc	E&W IR	E&W IR NI
Survey indices	IR Sc		E&W IR NI Sc	IR Sc	Sc R	IR NI Sc	IR Sc		E&W IR NI Sc	E&W	E&W	IR							Sc	Sc	Sc		NI/IR

*=No assessment

B: Belgium, Dk: Denmark, E&W: England and Wales, Fr: France, G: Germany, IBTS: Combined IBTS data, IR: Republic of Ireland, IoM: Isle of Man, NI: Northern Ireland, No: Norway, NL: Netherlands, Sc: Scotland, Sp: Spain, Sw: Sweden, R: Russian Federation

Table 2.3 2006 Working Group on the Assessment of Northern Shelf Demersal Stocks.
Biological sampling levels by stock and country:
Number of fish measured (Length) and aged (Age) from catches in 2005.
Number of samples is shown beneath the sample type in (brackets).
Data submitted by fleet/fishery are shown in **bold** type.

	Belgium		Denmark		England and Wales		Norway [a]		Northern Ireland		Republic of Ireland		Russian Federation [b]		Scotland	
	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age
Cod:																
VIa (landings)									**182 (3)**	**51 (1)**	**1,203 (18)**	**754 (30)**			4,686	2,334
VIa (discards)											46 (7)	37			180	152
VIb (landings)																
VIIa (landings)	**325 (4)**	**285 (4)**			**2,513 (22)**	**319**			**8,182 (157)**	**622 (14)**	**2,632 (68)**	**763 (29)**				
VIIa (discards)	**470 (4)**	**235 (4)**			S						445 (8)	71				
Haddock:																
VIa (landings)									**403 (4)**		**1,856 (16)**	**600 (18)**			13,235	2,941
VIa (discards)											1,705 (7)	169			8,721	1,297
VIb (landings)											**1,795 (10)**	**553 (13)**	**56,806 (278)**	**563**	1,587	264
VIb (discards)																
VIIa (landings)	**560 (4)**	**185 (4)**							**7,341 (102)**	**510 (16)**	**1,015 (18)**	540 (22)				
VIIa (discards)	**3,135 (4)**	**265 (4)**									2,812 (8)	228				
Whiting:																
VIa (landings)											**1,724 (9)**	**421 (8)**			6,154	1,391
VIa (discards)											920	114			10,506	1,129
VIIa (landings)	**210 (4)**	**80 (4)**			**755 (9)**				**9 (3)**		**513 (4)**	**113 (3)**				
VIIa (discards)	**3,995 (4)**	**225 (4)**			S						3,465 (8)	303				
Plaice:																
VIIa (landings)	**7,350 (8)**	**450 (6)**			**6,881 (39)**	**1,108**			**611 (8)**		**5,681 (54)**	**650 (21)**				
VIIa (discards)	**7,680 (8)**	**230 (6)**			S	S					1,954 (8)	207				
Sole:																
VIIa (landings)	**9,340 (8)**	**660 (6)**			**6,099 (44)**	**1,037**					**2,215 (28)**	**284 (5)**				
VIIa (discards)	**6,270 (8)**	**90 (6)**			S	S					4 (8)	2				

Table 2.2.2 (continued).

	Belgium		Denmark		England and Wales		Norway [a]		Northern Ireland		Republic of Ireland		Russian Federation [b]		Scotland	
	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age	Length	Age
Megrim:																
VIa (landings)											**542 (3)**	**329 (4)**			*8,101*	*352*
VIa (discards)											1,083 (7)	188				
VIb (landings)											**778 (5)**	**445 (5)**				
VIb (discards)																
Anglerfish [c]:																
IIa (landings)							**440 (51)**				0	0				
IVa & IIIa (landings)			**1,648 (23)**				**497[IV] (80)**				0	0			*16,985* [IV]	*955* [IV]
IVa & IIIa (discards)			**636 (7)**								0	0			*1250* [IV]	*0*
VIa (landings)											**1,552 (19)**	**572 (13)**			*10,083*	*689*
VIa (discards)											183 (7)	131			*58*	*0*
VIb (landings)																
VIb (discards)																
Nephrops																
FU11 (landings)															**30,054 (39)**	
FU11 (discards)															**18,605 (23)**	
FU12 (landings)															**19,501 (30)**	
FU12 (discards)															**7,112 (11)**	
FU13 (landings)															**32,284 (46)**	
FU13 (discards)															**5,869 (6)**	
FU14 (landings)					**1,920 (8)**											
FU14 **(catches)**					**2,646 (14)**											
FU15 (landings)											**30,018 (27)**					
FU15 (discards)											**59,745 (31)**					

[a]: Norwegian sampling is carried out at sea, sampling the catch. Includes samples from Danish vessels operating in Norwegian EZ.

[b]: Russian sampling is carried out at sea, sampling the catch. Survey data included

[c]: Only *Lophius piscatorius* are aged.

S: Samples were collected and data was presented to the WG, but information on numbers of age & length samples was not available.

[IV]: Samples from the North sea (Sub-area IV) only.

2.2.1 Compilation and Aggregation of Catch Data

Institutes submitted data to the $WGNSDS_{2006}$ in similar formats to that previously provided. Increasingly formats that may better support mixed-fisheries analyses and assessments are used. For stocks in Divisions VIa and VIIa catch-at-age data have been provided by most countries by fleet/fishery and species rather than by stock. The fleet/fishery groupings used are consistent with those agreed by the $SGDFF_{2004}$ for demersal fisheries in VIa and VIIa. Institutes sometimes did not have sufficient sampling to support dis-aggregation into fleet specific catch-at-age datasets. In such cases the data co-ordinators allocated the most appropriate alternative age compositions and weights-at-age to the unsampled catch.

The assessment data files are retained on the ICES network in the ASCII format used by the stand-alone assessment packages. All revisions to these files for individual stocks are discussed in the separate stock sections.

The stocks assessed by WGNSDS can be split into groups for which different data compilation and aggregation procedures are used. These groups are the Area VI gadoids, the Irish Sea gadoids, the Irish Sea flatfish, and the *Nephrops* stocks. For the other stocks assessed by this WG, assessments are generally at a more preliminary stage and data compilation had been on a more *ad hoc* basis.

UK (Scotland) Data Issues – 2005

Two important developments occurred in 2005 that have strongly influenced the availability of Scottish fisheries data relating to that year. These developments and their implications for Scottish data for 2005 are discussed below:

<u>Log book database</u>

Fisheries log-book data for Scotland are collected via local fishery offices which populate the Scottish Fishery Information Network database (FIN) electronically FIN is a system operated by Scotland's fishery protection agency and central fisheries administration. Partially-aggregated information from FIN is routinely transmitted to the FRS Marine Laboratory for entry into its own database.

The introduction into Scotland of Statutory Instrument 2005 No. 286 (The Registration of Fish Sellers and Buyers and Designation of Auction Sites (Scotland) Regulations 2005) meant that FIN had to be modified to account for the enhanced statutory fish-landing reporting requirements under the new regulation. The updated version of FIN went live on 1 September 2005, coinciding with the formal commencement of the enhanced reporting requirements.

It became apparent that under the new version of FIN, not all fishing landings records within FIN were being transmitted to FRS with ICES rectangle data associated with them (but only for data from 1 September onwards). On transfer to the FRS database system, records without this information were rejected. Consequently the Scottish market and discard sampling data could only be applied directly to those records that were accepted by the FRS system. FRS was in a position to know the quantity of landings that were rejected (by species and ICES Division), and so, with the exception of *Nephrops* data, the overall Scottish age compositions have been inflated by these amounts when compiling the international datasets for use by the working group. It was not possible to account for such discrepancies for *Nephrops* because of the multiple functional units that exist within ICES Divisions.

FRS has been assured that the FIN 'problem' will be addressed shortly and in a way that should permit revisions of the data supplied to FRS since 1 September 2005. When this happens, Scottish age compositions *etc* will be revised.

FRS database

The FIN 'issues' arose in the first operational year of a new fishery database (FMD) within FRS. FRS's old VAX system had been semi-withdrawn from service and a new SQL server database replaced it. It was not possible to run both systems in parallel during the first year of FMD operations, so 2005 fisheries and biological data were entered solely into the new system.

This resulted, as was anticipated, in a great deal of checking of outputs and the reporting and fixing of bugs through 2005 and into 2006. This process has continued up to the release of data for this working group. Checks are continuing, and these may result in further (albeit likely small) revisions to 2005 age compositions etc.

IIa, IIIa, IV & VI Anglerfish

Data are supplied to the stock co-ordinators electronically. Data handling and aggregation is handled by standard spreadsheets that incorporate SOP checks at each stage. The files retain the full seasonal and gear disaggregation of the supplied data. Length compositions for landings where no length data are supplied are estimated using user-specified fill-in rules. Assessment files are updated manually and data are stored in spreadsheets with one worksheet per year.

Area VI Gadoids

Data are requested by the stock co-ordinator in electronic form in a specific format, although the format is not always adhered to by the Institutes submitting data. The data are then stored in ASCII files that retain the quarterly and gear disaggregation in which the data are supplied. At present the file handling and data aggregation are done by a series of BASIC programs. The programs do not perform any checks on the data. SOP-correction is optional, but is usually applied to ensure consistency given SOP discrepancies in some fleets in the early years of the data. Age compositions for landings where no age data are supplied, are normally estimated using the total age composition across all fleets for which age data are available. More appropriate age compositions and weights-at-age can be allocated to the unsampled catch but this process has to be done externally to the data aggregation program. The programs writes a complete set of assessment data files so it is straightforward to update the assessment data each year.

Irish Sea Gadoids and Area VI Megrim

Data are supplied to the stock co-ordinators electronically. Data handling and aggregation is handled by standard spreadsheets which incorporate SOP checks at each stage. The files retain the full seasonal and gear disaggregation of the supplied data. Age compositions for landings where no age data are supplied are estimated using user-specified fill-in rules. Assessment data files are updated manually. Data are stored in spreadsheets, with one worksheet per year.

Irish Sea Flatfish

Data are supplied to co-ordinators electronically, and the data handling and aggregation is handled by a series of spreadsheet macros. Some SOP checking is included in these macros. Raw data are not routinely SOP corrected, although SOP corrections are applied to the combined and smoothed total international weights at age. The files retain the full seasonal and gear disaggregation of the supplied data. Age compositions for landings where no age data are supplied are estimated using user-specified fill-in rules. The data for one year are stored in an individual spreadsheet file, making it less straightforward to update data for all years. The process includes independent checking of the data by two people.

<u>Nephrops</u> in Management Area C (West of Scotland)

These fisheries are conducted predominantly by Scotland, and catch data is not provided by other countries. Quarterly length distributions by sex (raised to Scottish *Nephrops* trawler landings) are compiled, and stored in an annual data sheet. These are combined with quarterly discard files in an in-house data aggregation programme, to generate annual length distributions of removals in a single file. For catch-at-age analysis this data file is then sliced with the WGNEPH programme L2AGE, which generates the Lowestoft input files.

<u>Nephrops</u> in Management Area J (Irish Sea)

Irish Sea *Nephrops* fisheries are conducted mainly by Ireland and the United Kingdom with Northern Ireland taking over 60% of the catch from the western fishery (FU15). A lack of co-operation by the Northern Ireland industry prevented sampling during 2003 and 2004. Quarterly length distributions by sex from Ireland were therefore raised to the international *Nephrops* trawler landings and stored in an annual data sheet. These were combined with quarterly discard files, to generate annual length distributions of removals in a single file. For catch at age analysis this data file was then sliced with the WGNEPH programme L2AGE, which generates the Lowestoft input files.

2.3 Biological Parameters of Stocks

Previous ACFM reviewers have commented on the different methods used by the WG to estimate stock weights, and have been particularly concerned at using catch weights as the proxy for stock weights. The declining abundance and age composition in heavily exploited gadoids means that weights at age may be poorly estimated for the older ages where few fish may be represented in the age length keys for the catches. This adds un-necessarily to the uncertainties in mean weight at age in the forecast, both for catch and stock. In cases where catch (or even worse, landings weights) for partially recruited ages are used as stock weights, the biomass will be over-estimated for these ages. This can lead to incorrect total biomass estimates.

There is a need for this (and presumably other WGs) to develop a consistent methodology for (a) dealing with the variability introduced by small numbers of fish at the older ages in ALKs and (b) to develop robust and consistent methods for estimating stock weights that are not influenced unduly by sampling error and that track real changes in growth of different year classes.

The interaction between maturity ogives and stock weights influences the estimation of reference points for spawning stock biomass. The maturity ogives for some of the stocks assessed by the WG have remained unchanged for many years and may no longer be appropriate. The ogives for Irish Sea cod, plaice and sole were revised following sampling carried out as part of an EU contract to estimate SSB using the annual egg production method. However, the use of these ogives for the full historic series may not be appropriate, particularly in view of the large changes in stock size over time.

Biological data collected under the EU Data Collection Regulation (Comm. Reg. (EC) No 1639/2001) is now being submitted to the WGNSDS Biological data on stocks only partially within EU waters is also being provided. The WG recommends that a comprehensive review of the biological parameters of the stocks should be carried out, including analysis of recent survey data and an evaluation of the information (if available) on which historic estimates have been based.

Biological parameters may be poorly estimated when the declining abundance and contracting age composition of heavily exploited stocks means that few fish could be sampled. The WGNSDS considers that this problem may be alleviated through co-ordinating sampling of fisheries Institutes. WGNSDS notes that a provision exists within the Data Collection

Regulation encouraging an improvement in the precision of the estimation of biological parameters through co-operation between EU Member States.

2.4 Fleet Catch per Unit Effort Data

Most of the Commercial CPUE fleet data provided to the Working Group are described in Appendix 1 and 2 of the report of the 1999 Northern Shelf Demersal Working Group. Some new series were described in the 2002 WG Report (ICES CM 2003/ACFM:04). The geographical areas covered by these fleets in relation to the stock assessment areas are presently being incorporated into the Stock Annexes. These annexes will eventually include descriptions of commercial fleet tuning series, including areas covered, sampling protocols and a time series of commercial vessel effort distribution for the main gears used in the fishery.

2.5 Fishery-Independent Surveys

The poor quality of catch information has forced an increased reliance on fishery-independent data at WGNSDS. Some of the survey-based assessments rely heavily on estimates of year-class strength from survey data with relatively high variance. The low number of young cod caught by surveys in Division VIa indicates very low catchability of small recruiting year-classes on these surveys. At such levels of catchability the survey estimates are highly variable and heavily influence survey-based assessments.

Most surveys providing data to the Working Group are described in Appendix 1 and 2 of the report of the 1999 Northern Shelf Demersal Working Group. The first two years of a new survey series for the Irish Sea (cod, haddock, whiting, plaice and sole) and West of Scotland (Cod, Haddock, Megrim and Whiting) were provided to the WG this year from the Irish (RV *Celtic Explorer*) Quarter 4 IBTS survey. A description of the Underwater Television surveys (UWTV) used for *Nephrops* stocks is given in Section 2.5.1.

The geographical areas covered by the surveys in relation to the stock assessment areas are presently being incorporated into the Stock Annexes. These annexes will eventually include descriptions of the surveys, including their spatial coverage, sampling protocols and the temporal and spatial trends in distribution and abundance of target species.

2.5.1 Underwater TV surveys for Nephrops

Nephrops is a mud-burrowing species that is protected from trawling while within its burrow. Burrow emergence is known to vary with environmental (ambient light level, tidal strength) and biological (moult cycle, females reproductive condition) factors. This means that trawl catch rates may bear little resemblance to population abundance.

Underwater television (UWTV) surveys have been developed to estimate stock size from burrow densities (Bailey et al., 1993; Marrs et al., 1996; Froglia et al., 1997; Tuck et al., 1997). Annual surveys started at the Fladen Ground in the North Sea in 1992, and began to the west of Scotland in 1994.

Scottish Underwater Survey methodology

An underwater colour TV camera (Kongsberg-Simrad OE1364) is mounted on an aluminium sledge (Shand and Priestly, 1999), towed slowly (< 1kt) astern of the survey vessel. The camera is arranged on the sledge to view obliquely forwards between the runners of the sledge, with a width of view of approximately 1m. Lighting for the camera is provided by underwater lights mounted on the sledge, and powered from the vessel through the umbilical. A micro-range finder is mounted vertically on the sledge to provide information on the height of the camera above the seabed, and the degree of sinking of the sledge runners into the mud sediment. These data, together with camera lens angle specifications, are used to calculate the dimensions of the camera field of view. An odometer wheel is used to measure the distance travelled along the seabed during a TV run, typically lasting for 10 minutes. Data on the vessel location, elapsed time, sledge depth, range finder and odometer readings are recorded during a TV run with ‘in-house’ data logging software.

Recordings are made of each TV run, and burrow counts made both at the time of recording, and subsequently by at least two experienced observers under controlled conditions. Discrepancies between counts are investigated. The counts are converted into densities using information on the width of view of the camera and length of the tow. Burrow occupancy is assumed to be 100% in estimating total stock abundance. Field studies using SCUBA have shown that *Nephrops* regularly maintain and repair their burrows, and that trawling fills in burrow openings. Multiple occupancy of burrows has also been observed. Overall animal abundance is estimated by raising the mean densities to the appropriate strata area. Total survey abundance variance and confidence limits are calculated from strata abundance variances.

UWTV surveys use a random stratified design, with the basis of stratification varying between stocks on the west coast of Scotland. Seabed sediment information is used to stratify the Firth of Clyde and South Minch surveys, while a regular grid is used for the North Minch stock.

Surveys have been conducted in June in most years, but occasionally have been delayed until September owing to other vessel commitments. However, since the survey counts burrows rather than animals, there are no behavioural implications of small changes in survey timing.

Irish/Northern Ireland Underwater Survey methodology

The methods used during the survey were similar to those employed for UWTV surveys of *Nephrops* stocks around Scotland. The main difference between these Irish surveys and Scottish surveys is that the area observed is estimated rather than directly measured. This is because the field of view of the camera is not corrected using the range finder data and to date vessel distance over ground rather sledge distance over ground from an odometer has been used. There are minor differences in sledge design, camera equipment and recording media used which are detailed in Lordan et al. (2003).

The Irish/Northern Ireland survey is timed such that it occurs after the main summer fishery in August-September and during a period of neap tides. Stations are on a fixed regularly spaced grid approximately 3.5 nautical miles apart with has been off set randomly each year. This design was chosen since it is more appropriate for later geostatistical analysis.

Advice from TV data

At the 1999 meeting of WGNEPH, concern was expressed that the TAC set at the time was unrealistically low for the Fladen Ground stock, given its large size and the expanding fishery (ICES, 1999). It was feared that this would encourage misreporting and lead to deterioration of the information for the stock, and ultimately the chance of not detecting future problems that might arise. As a consequence, the advice moved away from the previous reliance on the historical landings data as a basis for providing a TAC recommendation. Instead, the independent estimates of stock abundance provided by the TV survey were used to estimate a likely landings level. This estimate was based on a 'harvest ratio' (defined here as catch in numbers/stock abundance) from the lower end of the harvest ratios observed across a range of other *Nephrops* stocks, as calculated during the 1998 *Nephrops* Study Group (ICES, 1998). This approach was also adopted at the 2001 and 2003 meetings of the WGNEPH. Given the generally low density of *Nephrops* at the Fladen Ground, and greater uncertainty over the reliability of recruitment compared to more intensively studied inshore stocks, a conservative harvest ratio of 7.5% of the abundance was considered appropriate by WGNEPH, and accepted by ACFM. Estimated harvest ratio’s for other *Nephrops* stocks range from 9.7 – 33%

of the biomass, based on reported landings and stock sizes from analytical assessments (ICES, 1998).

Average length frequency distributions (calculated over the three most recent years) for the two sexes from monthly market samples are raised to annual removals (landings + dead discards) using discard estimates from quarterly observer trips (with 25% discard survival) and reported landings figures. This provides an indication of the length structure of the animals of each sex removed from the population. The TV abundance estimate is multiplied by the harvest ratio to estimate a suitable limit on the number of animals removed (harvest abundance). The length structure of removals is then raised to the harvest abundance, and the weight of the landed component estimated to provide TAC advice.

Uncertainties in the approach include the extent to which the area of coverage of the survey reflects the distribution of the stock and fishery, and the sensitivity of the outcome to potential differences in the selectivity of the fisheries and the survey.

2.6 Sequential Population Analysis and Recruit Estimation: Catch-at-Age Assessments

Where a full analytical assessment was possible, the WG implemented either Extended Survivor's Analysis (XSA) with shrinkage and recruit calibration, Time Series Analysis (TSA) or Integrated Catch-at-Age analysis (ICA) as the baseline method. This follows the practices adopted at the 1993–2003 Working Group meetings. B-ADAPT has also been employed in the assessment of the stock of cod in Division VIIa and the application of this method to other stocks has been explored. Details of the B-ADAPT method are provided below.

At $WGNSDS_{2006}$ age-based analytical assessments were attempted for stocks of cod and haddock in Via; cod, plaice and sole in VIIa, and for Rockall haddock. Despite the inability to conduct analytical catch-at-age assessments for some stocks (VIIa Haddock, Via Whiting, VIIa Sole) the full sequence of analysis for application of catch-at-age assessments is given here as an indication of the normal practice the WG would adopt for benchmark catch-at-age assessments. Following the recommendations of RGNSDS2005 no analytical assessment has been attempted for stocks of whiting in VIIa; megrim in area VI and anglerfish in the Northern Shelf:

a) The age above which catchability can be assumed fixed (the *q*-plateau) is generally the same as that determined for each stock in previous Working Groups. A complete exploratory analysis to determine *q*-plateau and/or appropriate level of shrinkage is only carried out if the values used at previous Working Groups are no longer considered appropriate, or if new tuning series are included. In such cases, the choice of catchability model for the younger age classes is reviewed as the youngest age class cannot automatically be treated as recruits, particularly when the time series is short.

b) A separable VPA is carried out to screen the catch at age data in order to detect if large residuals or unusual patterns reveal anomalies in the data from year to year. The separable VPA was used to select the range of ages over which to run XSA, and to investigate the exploitation pattern.

c) Tuning series are scrutinised in detail independently of the assessment model as follows:

   - The WG first considers if the survey or commercial CPUE series are potentially capable of providing an unbiased series of population indices for a given range of fish age classes. This is evaluated based on the distribution of fishing or survey stations relative to the known distribution of the stock; the type of fishing gear; the timing of a survey; whether or not changes in survey design or fishing gear over time, or in efficiency of fishing fleets, have been examined and their effect quantified; quality of sampling for length or age; and, in the case of commercial fleets, the absence of discards in the CPUE data at any age, the accuracy of the catch and effort data, and the targeting practices of the vessels. Where such evaluations were carried out in previous WG meetings, they are generally not repeated and any fleets previously excluded are not re-considered unless there has been a significant change in the data.

- The internal consistency of the data for each fleet is evaluated by examining the coherence of year-class effects at each age. For surveys with multiple ages, the separable model SURBA (survey based assessment) developed at the FRS Marine Laboratory in Aberdeen was run to examine how well the data conform to a simple model of separable year and age effects on mortality.

- The similarity of trends in the indices at each age is examined to check for consistency between fleets.

- The consistency between the tuning data and the commercial catch at age data is examined by inspecting catchability residuals from single-fleet Laurec-Shepherd runs, or in some cases weakly-shrunk XSA (usually S.E. = 2.5), without taper and using the constant-catchability model for all ages. Age- and year- effects in log-catchability residuals over the entire time-series of data are examined. Based on the independent examination of tuning fleets, and the single-fleet L-S or XSA runs, a choice is then made on which fleets and age classes may be included in the multi-fleet assessment tuning. The period over which to tune the assessment is decided in such a way as to maximise the precision and minimise the bias in estimates of catchability in the final year, for those age classes where catchability is assumed constant. For a number of years the Working Group avoided progressive down-weighting of data from earlier years using a tricubic taper and had instead used a fixed tuning window of 10 years. As many of the assessments became more heavily dependent on survey data for tuning, the Working Group decided to abandon the 10-year fixed window approach and to use all years with data based on consistent survey methods. A further argument for this revised approach was to reduce variability introduced by the sudden exclusion of a year with influential catchability residuals. A 20-year tricubic taper is applied where progressive down-weighting of early year’s data is considered advisable. Time-series estimates from SURBA and from the catch-at-age analysis of relative spawning stock biomass, catch, and mean fishing mortality are compared.

a) The working group is aware of a lack of consistency in the value of F shrinkage standard error chosen for "weakly shrunk" single fleet XSAs. A range of values between 2.0 and 3.0 are used at this year's meeting for exploratory analyses. Whilst it is accepted that the value chosen is very often subjective, the working group does not feel that standardisation to a fixed value would be an appropriate measure. The weighting applied to the F shrinkage estimates is also determined by the strength of the signal in the tuning data. For example the use of an F shrinkage standard error of 2.0 coupled with a tuning fleet which gives consistent information about year-class strength might result in very little weight being applied to shrinkage estimates and a weakly shrunk assessment. On the other hand, the use of the same level of F shrinkage with a tuning fleet that gives less consistent year-class signals would result in a greater weighting being given to the F shrinkage estimates and a strongly shrunk assessment. Clearly, the value of the F shrinkage standard error on its own cannot be used to denote an assessment as either weakly or strongly shrunk.

b) Once the tuning fleets and the age range for XSA are chosen, ages for which recruit calibration (RCT3-type calibration) is appropriate are identified. These are typically the youngest ages tuned mainly by surveys and for which F-shrinkage gives unstable estimates of survivors. In these circumstances, the XSA fit for these age classes treats catchability as a power function of population size only if the relationship between Ln (adjusted survey indices) and Ln (XSA estimates) in singe-fleet runs is well defined, with an adequate number of observations. In view of concerns about the use of recruit calibration in XSA where the use of such a model may not be justified, all cases where this catchability model is used are reviewed closely by the Working Group using the criteria outlined above. For consistency of notation in the individual stock sections, ages which have been treated as recruits in this manner, and thus where catchability has been treated as a power function of population size are referred to as using the power model, whereas ages where this option has not been used are referred to as ages using the mean-*q* model.

c) The assessment outputs are examined for retrospective patterns in estimates of fishing mortality, SSB and recruitment. The possible sources of such patterns are investigated. If such patterns can not be resolved, additional tuning runs are carried out to investigate if increased shrinkage could reduce the bias in estimates of terminal F. Appropriate levels of shrinkage are also considered in the light of recent trends in F or the presence of individual high values of F over the period to which shrinkage is applied.

d) The detailed diagnostic output of the assessment is inspected. This helps to determine whether estimates for age groups in the final year should be replaced for input to prediction. Unless there is good reason for doing otherwise, the assessment estimates for recruiting age groups are used for the stock predictions. In some cases, these values are overwritten using the geometric mean level of recruitment. The long term geometric mean is chosen unless strong recent trends in the recruitment time series indicated that this is inappropriate. In some cases where there is evidence of recent depression of recruitment (for example due to a stock-recruit relationship), the geometric mean is computed over a shorter recent period. If tuned values are to be overwritten and additional recent survey data are available, the RCT3 programme is used to calibrate recruitment levels using its default options. As XSA cannot incorporate survey indices collected after the last year of the catch-at-age data, previous WG's have treated some spring surveys as if they were carried out at the end of the preceding year. The age ranges are then shifted down by one year. A consequence of this is the loss of tuning data for the oldest true age in the survey, which can cause problems for stocks with no other tuning data for these ages. However, the WG has previously been explicitly asked to use the most recent available data in the assessments. The WG therefore reverted to its previous practice of treating some spring surveys as if they were carried out at the end of the preceding year.

Minor exceptions to the implementation of the procedure outlined above are described in the relevant stock Sections.

The XSA algorithm contains a feature in the fitting procedure which is intended to reduce the risk of finding a local minimum, and is invoked for the first of each set of ten iterations chosen after the default of 30 have been completed. Results from XSA convergence on 31, 41, 51 etc.

iterations should be viewed with caution, as occasionally the feature can have the opposite effect. Carrying out more than 30 iterations is usually unlikely to be very fruitful.

B- ADAPT

The following text is adapted from Appendix 4 to the 2004 WGNSSK report (ICES CM 2005/ACFM:07), where further details on the background of the model and simulation testing can be found.

Absolute values of landings and landings at age, based on reported catches, for gadoid stocks in Divisions Via and VIIa are considered too biased to enable an analytical age based assessment using conventional assessment methods. Comparisons of analyses using reported catches and analyses using survey data alone indicate a clear mismatch between the levels of reported landings and actual removals. The mismatch may be due to a number of causes (misreporting, nonreporting, unaccounted discards, natural mortality, changes in catchability of fleet or surveys), and while these cannot be distinguished, an alternative model can be used to estimate a more realistic level of removals than indicated by the reported landings.

It is straightforward to show that if bias is present in the data on removals, the magnitude and sign of the log catchability residuals is proportional to the degree of bias. If $C_{a,y}$ represents catch at age a in year y, $N_{a,y}$ population numbers at age by year, $F_{a,y}$ fishing mortality at age by year, $Z_{a,y}$ total mortality (fishing + natural mortality M) and B_y the bias in year y; in the years without bias

$$N_{a,y} = C_{a,y}\, Z_{a,y}\, (1\text{-exp}(-Z_{a,y})) \,/\, F_{a,y}$$

and for the years with bias

$$N_{\,a,y} = B_y\, C_{a,y}\, Z_{a,y}\, (1\text{-exp}(-Z_{a,y})) \,/\, F_{a,y}$$

Survey catch per unit effort ($u_{a,y,f}$, where f denotes fleet or survey) is related to population abundance by a constant of proportionality or catchability $q_{a,f}$ which is assumed, in this study, to be constant in time and independent of population abundance

$$N_{a,y} = u_{a,y,f} \,/\, q_{y,f}$$

If the unbiased survey catchability can be calculated, an estimate of bias can be obtained from

$$B_y = N_{\,a,y} \,/\, (u_{a,y,f} / q_{y,f})$$

Gavaris and Van Eeckhaute (1998) examined the potential for using a relatively simple ADAPT model structure to estimate the removals bias of Georges Bank haddock. Their model fitted a year effect for the bias in each year of the assessment time series under the assumption that bias does not distort the age composition of landings, only the overall total numbers. The authors determined that the model was over-parameterised and that it was necessary to introduce a constraint, that one year-class abundance was known exactly, in order to estimate the remaining catchability, bias and population abundance parameters. They concluded that, for the data sets to which they applied the model, the indices of abundance from trawl surveys were so highly variable that this resulted in estimates of bias with wide confidence intervals and therefore the model could only be used as a diagnostic tool. A modification to the Gavaris and Van Eeckhaute ADAPT model (referred to here as BADAPT) can be made by assuming that the time series of landings can be divided into two periods; a historic time series in which landings were relatively unbiased and a recent period during which landings at age were biased by a common factor across all ages. The fit of the model to the early period of unbiased data provides estimates of appropriately scaled population abundance and survey catchability, thereby removing the indeterminacy noted by Gavaris and Van Eeckhaute.

Note that it is assumed that during both periods, landings numbers at age have relatively low random sampling variability (relative to survey variance) so that the population numbers at age can be determined using the virtual population analysis (VPA) equations. This assumption has been found to hold for the North Sea cod by the EMAS project (EMAS 2001) which examined the errors associated with current sampling programs. Within B-ADAPT, population numbers are estimated from the VPA equations

$$N_{a,y} = B_y C_{a,y} Z_{a,y} (1\text{-}\exp(\text{-}Z_{a,y})) / F_{a,y}$$

$$N_{a,y} = N_{a+1,y+1} \exp(Z_{a,y})$$

where B_y is estimated for years in which bias was considered to have occurred and defined as 1.0 for years without bias. Selection is assumed to be flat topped with fishing mortality at the oldest age defined as the scaled (*s*) arithmetic mean of the estimates from *n* younger ages, where *n* and *s* are user defined. That is for the oldest age *o*:

$$F_o = s\,[F_{o-1} + F_{o-2} + \; + F_{o\,n}] / n$$

The parameters estimated to fit the population model to the CPUE calibration data are the surviving population numbers $N_{a,fy}$ at the end of the final assessment year *fy* (estimated for all ages except the oldest) and the bias B_y in each year of the user selected year range. Under the assumption of log normally distributed errors, the least squares objective function for the estimated CPUE indices is

$$SSQ_{vpa} = {}_{a,y,f} \{ \ln u_{a,y,f} [\ln q_{a,f} + \ln N_{a,y}]\}^2$$

The year range of the summation extends across all years in the assessment for which catch at age data is available and also (if required) the year after the last catch at age data year. This allows for the inclusion of survey information collected in the year of the assessment WG meeting.

Testing with simulated data (ICES CM 2005/ACFM:07, Appendix 4) established that increasing the uncertainty in the survey indices results in estimates of bias and the derived fishing mortality that are more variable from year to year. One solution to this problem is to introduce smoothing to the model estimates.

A constraint used frequently in stock assessment models is that of restricting the amount that fishing mortality can vary from year to year. This reflects limitations on the ability of fleets to rapidly increase capacity and the lack of historic effort regulation reducing catching opportunities. However, given the current over-capacity in the fleets prosecuting the North Sea cod fishery this form of smoothing constraint was not considered appropriate. Anecdotal information supplied by the commercial industry has indicated that the recent severe changes in the TAC have not been adhered to. Therefore it was considered more approICES WGNSSK Report 2005 15 priate to apply smoothing to the total catches, across the years in which the bias was estimated. Smoothing of catches was introduced by an addition to the objective function sum of squares:

$$SSQ_{catches} = \{\ln (B_{y}\,{}_{a} [C_{a,y}\, CW_{a,y}])\ \ln (B_{y+1}\,{}_{a} [C_{a,y+1}\, CW_{a,y+1}])\}^2$$

Here $CW_{a,y}$ are the catch weights at age *a* in year *y* and natural logarithms were used to provide residuals of equivalent magnitude to those of log catchability within SSQ_{vpa}. is a user defined weight that allowed the effect of the smoothing constraint to be examined. The year range for the summation of the catch smoothing objective function was from the last year of the unbiased catches to the last year of the assessment. The total objective function used to estimate the model parameters was therefore

$$SSQ = SSQ_{vpa} + SSQ_{catches}$$

The least squares objective function was mimimised using the NAG Gauss Newton algorithm with uncertainty estimated using two methods, calculation of the variance covariance matrix and bootstrap re-sampling of the log catchability residuals to provide new CPUE indices.

2.7 Population Analysis and Recruit Estimation: Survey-Based Assessments

In accordance with the recommendation of the $WGNSDS_{2004}$ Review Group, when the quality of the estimated catch data were poorly validated, the WGNSDS undertook assessments based on standardised scientific surveys. Survey-based analysis were conducted using the SURBA software packages.

SURBA is a development of the RCRV1A model of Cook (1997). It assumes a separable model of fishing mortality, and generates relative estimates for population abundance (and absolute estimates for fishing mortality) by minimising the sum-of-squares differences between observed and fitted survey-derived abundance. The method is described in detail in Needle (2003) and the software is available on the ICES network. SURBA has been used to produce comparative stock analyses in several ICES assessment Working Groups ($WGNSSK_{2002}$, $WGNSDS_{2002-2005}$), and has been scrutinised by the ICES Working Group on Methods of Fish Stock Assessment ($WGMG_{2003\ \&\ 2004}$). The version of the software available to $WGNSDS_{2006}$ was Version 3.0. A length-based implementation of the survey-based analysis was provided to $WGNSDS_{2005}$ but has not been used in 2006.

The sequence of analysis for application of survey-based age assessments at $WGNSDS_{2006}$ is similar to that adopted for scrutinising tuning series independently of age-based assessment models:

a) The WG first considers if the survey series are potentially capable of providing an unbiased series of population indices for a given range of fish age classes. This is evaluated based on the distribution of fishing or survey stations relative to the known distribution of the stock; the type of fishing gear; the timing of a survey; whether or not changes in survey design or fishing gear over time have been examined and their effect quantified; quality of sampling for length or age. Where such evaluations were carried out in previous WG meetings, they are generally not repeated and any series previously excluded are not reconsidered unless there has been a significant change in the data.

b) The internal consistency of the data for each survey is evaluated by examining the coherence of year-class effects at each age. The SURBA model is run to examine how well the data conform to a simple model of separable year and age effects on mortality.

c) The consistency between the survey series is examined by inspecting catchability residuals from SURBA runs for each survey. The similarity of trends in the indices at each age is examined to check for consistency between fleets.

d) Exploratory runs were made to test for the sensitivity to catchability assumptions and degrees of smoothing. Age- and year- effects in log-catchability residuals over the entire time-series are examined. Based on the independent examination of survey series, a choice is then made on which surveys and age classes may be included in the final survey-based assessments.

e) Time-series estimates from SURBA and from the catch-at-age analysis of relative spawning stock biomass, recruitment, and mean total mortality are compared.

2.8 Short-term Predictions and Sensitivity Analyses

For stocks subject to a full analytical assessment, short-term predictions and sensitivity analyses are normally were carried out using either the Marine Labaroatory (Aberdeen) programmes (MLA), or the MFDP / MFYPR software (Multi-fleet Deterministic Projection / Multi-fleet Yield-Per-Recruit).

The proportions of F and M before spawning are both set to zero to reflect the SSB calculation date of January 1st.

Short-term predictions are made after deciding on the most appropriate value for recruitment in both the recent period and over the prediction period. Tuned estimates of recruiting year classes, if considered unreliable, are overwritten by a geometric mean value. In some cases, including where very recent survey data were available, recruitment estimates from the RCT3 recruit calibration program are used. Where tuned values are overwritten for prediction purposes, they are either directly replaced (e.g. with a RCT3 estimate), or in some cases the estimate at age 1 is adjusted to age 2 using the ratio of the population estimates of the relevant year class at those ages.

The WG estimates of landings for most stocks can differ substantially from the TAC due to partial uptake of national quotas, misreporting or discarding. Unless there is strong evidence that the catch in the interim year of the short-term forecast will be constrained by the TAC or other measures, the WG assumes *status quo* F in the interim year. In other cases, the value chosen as *status quo* F for each stock is considered in the light of recent variations or trends in the estimates of F. The estimate of *status quo* F used by default in short-term predictions is the unscaled mean F at age for the last three years. This procedure stems from the consideration that while the point estimate of terminal F represents the best available estimate of $F_{\text{Terminal Year}}$, it does not necessarily follow that it will also be appropriate as an estimate of F in the intermediate year and subsequent years. In the absence of any recent trends in F, an unscaled mean is considered a more appropriate estimate of *status quo* F than a scaled value.

The mean F vector is scaled to the mean F in the terminal year if there was clear evidence of a recent trend in F that is considered likely to continue or halt rather than increase again in the short term. A special case is a trend caused by retrospective bias. In this case, the true level of fishing mortality in the current year is essentially unknown, although it may still be possible to forecast the approximate *status quo* catch. To do this, the correlation between numbers and fishing mortality calculated from a given catch in the last year of the assessment must be retained otherwise the landings forecast may be substantially biased. In this case, a mean F over several years would be inappropriate. However, WGNSDS considers that all forecasts based on assessments with strong retrospective bias must remain suspect.

Over-optimistic forecasts have been noted in some stocks assessed by ICES in which trends in weight-at-age are apparent and future weights are specified as an arithmetic mean of historic values. The WG therefore checks for trends in weights at age. For some stocks, the mean weights in the last year are used in forecasts if a recent trend is evident. For some stocks year-class effects on growth are taken into account when calculating stock weights for forecasts.

A detailed short-term prediction is made for each stock using the *status quo* F option. The contribution of recent year classes to future SSB and yields was istabulated, and the contribution of different sources of uncertainty to the variance of predicted SSB and yield is estimated where possible by means of sensitivity analysis. The sensitivity analysis programme WGFRAN4 gives estimates of the proportion of the total variance of predicted SSB and catch contributed by different inputs. The description of the abbreviated variable names on the Figures and Tables which show the results of sensitivity analyses for each stock is as follows (*a* is the age at recruitment, numerals indicate years):

VARIABLE:	DESCRIPTION:
N*a*	Population number at age *a* in Intermediate Year
WS*a*	Stock weights at age *a* in prediction
WH*a*	Catch weights (landings) at age *a* in prediction
WD*a*	Catch weights (discards) at age *a* in prediction
M*a*	Natural mortality at age *a*
MT*a*	Proportion mature at age *a*
SH*a*	Selectivity (human consumption fleets) at age *a*
SD*a*	Selectivity (discards) at age *a*
sI*a*	Selectivity (bycatch) at age *a*
K*yy*	Year effect on natural mortality in prediction in Intermediate Year
HF*yy*	Year effect on (landings and discards) fishing mortality in Intermediate Year
R*yy*+1	Recruitment in Forecast Year (Intermediate Year +1)

2.9 Reference Points

The inability of the Working Group to generate assessments of absolute biomass for most stocks means that the calculation of biomass reference points was not possible. Furthermore the mortality estimates produced by survey-based assessments may not be directly comparable to mortality derived from other assessment methods. This is because of the influence of catchability assumptions in survey-based assessments. Re-evaluation of F-based reference points was therefore not possible at $WGNSDS_{2005}$.

2.10 Quality Control and Documentation of Procedures

The terms of reference for the WG request specific information on major deficiencies in assessments. The problems associated with individual assessments are discussed in the 'quality of assessment' sections within each individual stock section. In many cases, the problems are associated with data quality: e.g. due to misreporting; discard estimates of low precision; survey data with catchability problems, etc. For some stocks such as Irish Sea haddock and plaice, and Rockall haddock, there are clear deficiencies in the data due to the absence of time series of discard estimates particularly for young fish for which survey indices are available. For anglerfish there are major deficiencies in the understanding of the basic biology of the species that impede the development of appropriate stock assessments. In Rockall haddock and megrim there are major components of the catch for which there is no length or age sampling or a discontinuous time series of such data.

The Working Group has previously been asked to fully document the methods applied in assessments. The Working Groups intends to provide this documentation in the relevant Stock Annexes for stocks subject to SPALY update assessments. For observation list/benchmark and experimental assessments it is not possible to describe the procedure to the same extent. Elements of such assessments that remain relevant from year to year have been included in the Stock Annex for each stock. Other information is given in the WG report.

2.11 Software

The main software and versions used historically by WGNSDS include:

SOFTWARE	PURPOSE	PROGRAM/VERSION	FILE CREATION DATE
VPA suite (Separable VPA, XSA, Laurec-Shepherd *ad hoc* tuning)	Historical assessment	VPA95.exe Version 3.2	8/6/1998
Retrospective XSA	Retrospective analysis	Retvpa02.exe Version 3.1	18/4/2002
MFDP	Short-term forecast	Visual basic installation	Setup: 29/4/1996 Config: 28/6/2000
MFYPR	Yield per recruit	Visual basic installation	Setup: 29/4/1996 Config: 28/6/2000
PASoft (EXCEL add-in)	PA reference points estimation	PASoft with Fishlab.dll	June 1999
MAKEVCF	Header file generator for stock (sensitivity etc.)	Makevcf90.exe	20/5/2002
INSENS	Creates sensitivity & medium-term input files	Insens90.exe	20/5/2002
WGFRANSW	Sensitivity analysis	Wgfransw.exe	22/5/2001
RECAN	Stock-Recruitment modelling	Recan22.exe	7/10/2003
RECRUIT	S/R estimation	Recruit.exe	4/2/2002
RECRUIT2	S/R estimation – small stocks (but limited years)	Recruit2.exe	24/10/1996
WGMTERMC	Medium-term analysis	Wgmtermc.exe	3/11/1999
MTMPLOT	Medium-term & contour plotting program	Mtmplot.exe	2/12/1998
Various other plotting routines (PLOTCONV, WPAPLOT, PAPLOT, etc.)	SSB/F trajectory with reference points	e.g. Wpaplot.exe; plotconv.exe etc.	4/2/2002; 20/11/2000
SURBA	Survey-Based Analysis	Versions 2.20, Version 3.0	6 May 2004, 13 May 2005
Collie-Sissenwine Analysis	Stage-based, Catch-Survey Analysis	Version 2.0.14	June 2003
FSSSPS	Stochastic Projection Software	FSSmain.r	April 2005
TSA	Time Series Analysis	Versions compiled at WGNSDS	Program recompiles on execution
B-Adapt	Historical assessment	BADAPTv05.exe	October 2005
ICA	Historical assessment	ICA.exe	March 1999
FLR + packages	Management evaluation simulations	FLCore 1.2 + packages	May 2006

2.12 Information Provided as Working Documents

WD1: Biological parameters for Irish Demersal Stocks in 2004 and 2005

Full title: Biological parameters for Irish Demersal Stocks in 2004 and 2005 **Authors:** Hans Gerritsen **Summary:** The working document provides estimates for maturity and sex ratio at length and at age for demersal stocks around Ireland. Sampling took place on the IBTS 4th quarter Irish Groundfish Surveys and on 1st quarter Biological Surveys in 2004-5. ICES Divisions VIa, VIIa, VIIb, VIIg and VIIj were sampled. **WG Use**: No formal discussion by the working group but reference is made to this in individual stock sections.

WD2: Regional differences within one stock of haddock (Melanogrammus aeglefinus L.)

Full title: A simple method for comparing age-length keys reveals significant regional differences within one stock of haddock (Melanogrammus aeglefinus L.)**Authors:** Hans D.

Gerritsen, David McGrath and Colm Lordan**Summary:** Data from the 4th quarter IBTS Irish Groundfish Survey were used to describe a method for comparing age-length keys, using a simple multinomial model. The study revealed that the age at length distribution of haddock in VIa is spatially structured. Due to the large numbers of young fish in the shallow areas, the age-length-key in shallow areas, was significantly different from the deeper areas. Combining all aged data without weighting by the local abundance, resulted in an over-estimate of recruitment by a factor of nearly 200%. The findings also have implications for the 'dynamic pool' assumptions as this stock is spatially structured in its age-at-length distribution .**WG Use:** No formal discussion by the working group but reference is made to this in individual stock sections.

WD3: Regional differences in the length-weight relationships of haddock and whiting

Full title: WD3: Regional differences in the length-weight relationships of haddock (Melanogrammus aeglefinus, L.) and whiting (Merlangius merlangus, L.)**Authors:** Hans Gerritsen and Dave McGrath **Summary:** Data from the 4th quarter IBTS Irish Groundfish Survey were used to explore regional differences in the length-weight relationships and condition indices of haddock and whiting around Ireland. Limited variation in the length-weight relationships was found within stocks, but significant differences were revealed between stocks. When no length-weight relationship is available for a certain stock, the application of the length-weight relationship of a neighbouring stock, could result in a bias in the biomass estimate of up to 10%. **WG Use:** No formal discussion by the working group but reference is made to this in individual stock sections.

WD4: Skewed sex ratios of megrim in Groundfish survey

Full title: Skewed sex ratios of megrim (Lepidorhombus whiffiagonis) in Groundfish survey catches to the west of Ireland.**Authors:** Hans Gerritsen**Summary:** Data from the 4th quarter IBTS Irish Groundfish Survey and the 1st quarter Biological Surveys were used to investigate the sex ratio of megrim to the west of Ireland. The sex ratio in the catches of the shallow stations was nearly entirely dominated by females, while males made up around 2/3 of the numbers in the deep stations.**WG Use:** No formal discussion by the working group but reference is made to this in individual stock sections.

WD5: UK FSP surveys of Irish Sea roundfish: 2004 - 2006

Full title: Results of Fisheries Science Partnership surveys of Irish Sea roundfish: 2004 – 2006 **Authors:** Mike Armstrong and John Dann **Summary:** This Working Document report presents the results of FSP surveys of roundfish (cod, haddock and whiting) in the Irish Sea. The first FSP surveys of Irish Sea roundfish took place in spring 2004 using the semi-pelagic trawler *Benaiah IV* (Kilkeel) and the otter trawler *Kiroan* (Fleetwood) (Cotter *et al*. 2004a,b). The *Benaiah IV* fished in the western Irish Sea, and the *Kiroan* covered two relatively small cod hot-spots off Morecambe Bay. In spring 2005, the *Benaiah IV* covered the western Irish Sea, North Channel and the Clyde cod closure using the same gear as in 2004, whilst the FV *Isadale* (Fleetwood) fished a rockhopper otter trawl throughout the eastern Irish Sea (Armstrong *et al.* 2005). The survey in spring 2006 used the same vessels and gear as in 2005, and followed a generally similar survey design. **WG use:** No formal discussion by the working group but reference is made to this in individual stock sections.

WD6: Characteristics Of Rockall Haddock Reproductive Biology

Full title: Some Characteristics Of The Rockall Haddock (Mellanogrammus Aeglefinus) Reproductive Biology **Authors:** Filina E.A., Khlivnoy V.N. and V.I.Vinnichenko **Summary:** The information about peculiarities of the Rockall haddock, in particular, on length and age of sexual maturation has a great importance for estimation of its stock and the development of fishery regulation measures. At the same time, scientists have different opinions regarding the sexual maturation rates in haddock from this population. Allowing for practical importance of the problem the scientists from PINRO recently have been focused on study of haddock reproductive biology using also histological method. The main results of those investigations are given in this working document. **WG use**: No formal discussion by the working group but reference is made to this in individual stock sections.

WD7: Russian research on Rockall haddock and its fishery in 2005

Full title: Russian research on the Rockall haddock (*Melanogrammus aeglefinus*) and its fishery in 2005 **Authors:** V.N. Khlivnoy and V.I. Vinnichenko **Summary:** In 2005, Russian research on the haddock and its fishery in the Rockall area were continued. During the research new scientific and catch data was collected, which can contribute to the knowledge on biology, distribution and abundance dynamics of the haddock stock. The objective of the present paper is to summarize Russian data on biology and fishery obtained 2005, to prepare materials for the stock assessment and to evaluate haddock fishery prospects in the Rockall area. **WG use**: No formal discussion by the working group but reference is made to this in individual stock sections.

WD8: Proposals of the Russian Federation regarding the Rockall box

Full title: Proposals of the Russian Federation in response to the request of NEAFC to ICES regarding the effect of the Rockall box **Authors:** V.N.Khlivnoy and V.I. Vinnichenko: **Summary:** With the purpose to prepare a response to the specific request of NEAFC (detailed in section 1.2, term or reference m), Russian scientists have summarized and analysed information on the haddock biology, distribution, stock state and fishery. Proposals on optimal boundaries of the closed area aimed at protection of juvenile haddock were also elaborated. The main results of the above works are presented in this paper. **WG use**: Formally discussed by the working group. Reference is made to this in individual stock sections and in section 16 Rockall haddock closed area evaluation.

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3 Cod in sub-area VI

Cod in Division VIa are currently the subject of a recovery plan. The VIa cod stock is classified as an Observation list assessment.

Because of concerns over the quality of the catch data $WGNSDS_{2005}$ was requested to try to validate the catch data. The WG decided it was very difficult to determine up to which point commercial data can be considered to be reliable and decided on an assessment based only on survey data. No forecasts acceptable to ACFM can be made, however, if this approach is adopted. This year's WG therefore attempted to make a catch based final assessment and forecast, basing the choice of final assessment on that which gave the closest long term trend in SSB to an agreed survey based assessment.

3.1 Cod in Division VIa

3.1.1 Stock definition and the fishery

General information about the stock can be found in the stock annex.

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.

The demersal whitefish fisheries in Division VIa are predominantly conducted by otter-trawlers fishing for cod, haddock, anglerfish and whiting, with by-catches of saithe, megrim, lemon sole, ling and skates and rays. Recently there has been development of a directed fishery for anglerfish within the Scottish fleet, leading to a shift in fleet effort away from inshore areas to offshore and deeper waters. The general features of the fishery are summarised in the report of the 2001 ACFM meeting (ICES 2001).

3.1.1.1 ICES advice applicable to 2005 and 2006

In 2004 ICES recommended for 2005: *"Since no recovery has been observed in this stock ICES advises zero catch of cod in 2005"*

In 2005 ICES advice was in terms of single stock exploitation boundaries and mixed fishery implications:

Single-Stock stock exploitation boundaries:

In relation to agreed management plan

ICES is not in a position to give quantitative forecasts and can therefore not evaluate the management plan and provide upper bounds to a TAC.

In relation to precautionary limits

Since no recovery has been observed in this stock, ICES advises zero catch of cod in 2006.

In relation to target reference points

There will be no gain in the long-term yield by having fishing mortalities above Fmax (0.19).

Upper limit corresponding to single-stock exploitation boundary for agreed management plan or in relation to precautionary limits. Tonnes or effort in 2006

Since no recovery has been observed in this stock, ICES advises zero catch of cod in 2006.

Mixed fisheries advice:

“Demersal fisheries in Subarea VI should in 2006 be managed according to the following rules, which should be applied simultaneously. They should fish:

- without catch or discards of cod in Subarea VI;
- without catch or discards of spurdog;
- no directed fishery for haddock in Division VIb;
- concerning deep water stocks fished in Subarea VI, Volume 10;
- within the biological exploitation limits for all other stocks.

Furthermore, unless ways can be found to harvest species caught in mixed fisheries within precautionary limits for all those species individually then fishing should not be permitted.”

3.1.1.2 Management applicable to 2005 and 2006

The 2005 and 2006 TACs for cod in ICES areas Vb (EC waters), VI, XII and XIV were 721 t and 613 t respectively. The minimum landing size of cod in the human consumption fishery in this area is 35 cm.

Technical measures enforced for the West of Scotland including those associated with the Cod recovery Plan are described in Section 1.7.

The following table summarises ICES management advice and E.U. management applied for cod in Division VIa during 2001–2006:

YEAR	CATCHES CORRESPONDING TO ICES ADVICE (T)	BASIS	TAC FOR VB (EC), VI, XII, XIV (T)	% CHANGE IN F ASSOCIATED WITH TAC[1]
2001	-	Lowest possible *F*, recovery plan	3,700	-50%
2002	-	Recovery plan or lowest possible *F*	4,600	-10%
2003	-	Closure	1,808	-60%
2004	-	Closure	848	-80%
2005	-	Closure	721	(no assessment)
2006	-	Closure	613	(assessment of relative trends only)

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

3.1.1.3 The fishery in 2005

Tables and figures of total effort by the fleets operating in Division VIa can be found in section 17.

Reported effort in the Scottish light trawl fleet has declined rapidly from 35,698h in 2001 to 3063h in 2005. The Scottish seine fleet also reported declines in effort and the 2005 figure of 476h is the lowest in the series. The Scottish *Nephrops* fleets reported a more gradual decline in effort with 221,000h recorded in 2005 as opposed to 230,000h in 2004. Due to Scottish reporting problems, however, these effort data may be underestimates.

The probability that mis-reporting and under reporting takes place in this fishery is high, this can be attributed to restrictive TACs, seasonal/spatial closures of the fishery, and effort restrictions based on by-catch composition. The days at sea limitations associated with the cod recovery plan and the seasonal closure noted in 3.1.1.2 has, however, lead some of the Irish Demersal fleet to switch effort away from VIa.

Information on the number of vessels operating in the cod recovery zone to have been decommissioned in Division VIa was available at this working group for the Scottish fleet between 2001 and 2004, as follows:

	TOTAL VIA 2001	DECOMM. TO 2004	PERCENTAGE
Number of vessels > 10m	298	96	30.2%

The WG did not have information on the size and power of the boats decommissioned. This will have a bearing on the effective effort removed from the fishery.

The following area closures have continued in 2005:

1) The Greencastle codling fishery from mid November to mid February. This closure applied to both January-February and November-December 2005. 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 by Council Regulation No. EC 2287\2003, known as the ‘windsock’, see Figure 3-2.

3.1.2 Catch data

3.1.2.1 Official Catch Statistics

Official catch data for each country participating in the fishery are presented in Table 3-1. Revisions to catch data are made in Table 3-1 to the 2004 figures.

Landings, discards and catch estimates 1978–2005, as used by the WG, are presented in Table 3-3. The reported landings and human consumption estimates for 2005 are both the lowest in the available time series.

3.1.2.2 Quality of the catch data

There have been concerns that the quality of landings data is deteriorating, giving a possible reason for the different stock dynamics implied by the commercial fleet and the annual survey (ScoGFSQ1) used in recent years. In 2004 ACFM highlighted concerns over the fitting of a persistent trend in survey catchability in previous TSA assessments of gadoid stocks in VIa (Figure 3-1). Their concern was that allowing a trend in survey catchability made *a priori* assumptions on the quality of survey data as compared to landings data. Differing signals from catch data and survey data may be due to several confounding factors. Mis-reporting (specifically under reporting) could cause this effect. Spatial and temporal differences in the effort distribution could also contribute. Commercial fleet effort is concentrated on areas of high abundance and is distributed throughout the year, whereas survey effort is concentrated on a given quarter only, and samples VIa entirely following a stratified design, see Figure 3-2.

3.1.3 Commercial catch-effort series and research vessels surveys

3.1.3.1 Commercial catch-effort series

A number of 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. An updated series was presented to the 2002 and 2003 WG meetings.

The commercial CPUE data available for this meeting consisted 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.

Commercial effort and landings-per-unit effort are summarised in Table 3-5. For all tuning series, the oldest age given represents a true age, rather than a plus group.

No commercial Scottish CPUE series have been used in the final assessment presented by the WG during any of its last seven meetings, although they were previously used in exploratory and comparative analyses. Given the current concerns about mis-reporting of catch and effort, the IreOTR series has also not been considered as a tuning fleet.

3.1.3.2 Research vessels surveys

Four research vessel survey series for cod in Division VIa are available:

- Scottish first-quarter west coast groundfish survey (ScoGFSQ1): ages 1–7, years 1985–2006.
- Irish fourth-quarter west coast groundfish survey (IreGFS): ages 0–3, years 1993–2002.
- Scottish fourth-quarter west coast groundfish survey (ScoGFSQ4): ages 0–8, years 1996–2005.
- Irish fourth-quarter west coast groundfish survey (IRGFS); ages 0-4, years 2003-2005.

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). The Irish quarter four survey was a comparatively short series, was discontinued in 2003 and has been replaced. The replacement survey (IRGFS) has only been running for three years and is not yet suitable for tuning. The Scottish quarter four survey was presented to the WG for the first time in 2005.

Fleet and survey descriptions are given in Appendices 1 and 2 of the report of the 1999 meeting of this WG (ICES CM 2000/ACFM:1). All available survey data are given in Table 3-5. For all tuning series, the oldest age given represents a true age, rather than a plus group.

3.1.4 Age compositions and mean weights at age

3.1.4.1 Landings age composition and mean weights-at-age

Quarterly catch-at-age data were available from Scotland and Ireland. The countries that provide data are listed in Table 2.2, and sampling levels are shown in Table 2.3. Landings age distributions were estimated from market samples. For Irish data, ALKs are occasionally augmented by samples collected during research vessel surveys. The procedures used to aggregate national data sets into total international landings are given in Section 2.2.1.

Total WG estimates of international landings-at-age are given in Table 3-8. Annual mean weights-at-age in landings are given in Table 3-10. Figure 3-4 shows the mean weights-at-age in the 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. There is no evidence of a trend in weight at ages 1, 2 and 7+ for VIa cod landings, but some evidence of a gradual long term decline at age 3 and a more recent decline at ages 4 to 6.

3.1.4.2 Discards age composition and mean weights-at-age

A summary of the available discard information from the Scottish and Irish sampling programme is given in Table 3-12. Discards of cod only occur regularly at ages one and two. From Figure 3-4 there is no evidence of a trend in weight at age for VIa cod 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). Historically discard age compositions from Scottish sampling have been applied to unsampled fleets. This is still true for data up to 2002. New raising procedures were initiated for the Irish data (using the methods of Borges et al. 2005) and data from 2003 onwards has been raised by the new method. The revision of the Irish discard data has not yet been applied to earlier years.

Work is underway to revise the Scottish discard estimates with an aim to reduce bias and increase precision. A working document provided to $WGNSDS_{2004}$ set out the methodology of this work (Fryer, R. & Millar, 2004).

3.1.4.3 Catch age composition and mean weights-at-age

Total catch numbers and mean weights-at-age are given in Table 3-14 and Table 3-16 respectively. Stock weights are assumed to equal catch weights.

3.1.5 Natural mortality and maturity at age

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. The proportion of F and M acting before spawning is set to zero. The maturity ogive used by the WG for this stock is as follows:

AGE	0	1	2	3	4–15+
Mat	0.00	0.00	0.52	0.86	1.00

Survey-derived maturity ogives for gadoid stocks in Division VIa were presented as a Working Document to the 2002 WG (Burns and Reid, WGNSDS 2002 WD 1). These indicated proportion mature at age 2 of between 48% and 100%, and greater than 90% at age 3 (data coverage - 1995–2001). Estimates were not disaggregated by sex. Sex-disaggregated estimates are now available, but have not yet been fully analysed. The validity and management implications of the use of such data have not yet been fully evaluated, and therefore their use needs to be investigated.

3.1.6 Data screening and exploratory runs

3.1.6.1 Commercial catch data

Given concerns about mis-reporting of catch and effort, the commercial catch data are not currently considered for tuning purposes. Because of concerns over mis-reporting leading to bias landings and discards numbers later than 1994 have not been used in a final assessment, see section 3.1.6.3. Weights at age for the stock are still required to obtain biomass estimates and so the full series of stock weights was always used.

3.1.6.2 Survey data

Log mean-standardised survey time-series by age and year-class are shown in figure 3-6. The ScoGFSQ1 series appears to track well the development of relative year-class strength down cohorts, although this signal is degraded in older ages for some cohorts. The IreGFS series tracks year classes well for ages 1 and 2, but not ages 0 and 3. The ScoGFSQ4 tracks ages 1 and 2 well, but not older ages.

Log catch curves are shown in Figure 3-8. The figure for the ScoGFSQ1 shows a strong "hook" at the younger ages, with abundance at age two often higher than at age one. The figure for ScoGFSQ4 shows a lack of coherence in this index series.

Comparative scatterplots at age are given in Figure 3-10, Figure 3-12 and Figure 3-14.

The WG could not use the IreGFS survey or ScoGFSQ4 survey in survey based analyses using the available software, due to insufficient number of ages consistently tracked by these surveys, (both surveys track ages 1 and 2 well but not other ages). Furthermore, the Irish survey has been discontinued.

Therefore, all subsequent analyses were carried out using only the ScoGFSQ1 series.

In response to concerns over possible trends in catchability of the Scottish groundfish survey, $WGNSDS_{2005}$ examined mean length and weight at age in the survey. No trends were apparent in the data.

3.1.6.3 Exploratory assessment runs

Two methods were considered.

- TSA: giving absolute assessments using commercial landings and discards data, and incorporating the ScoGFSQ1 index for tuning.
- SURBA: using survey data only and giving an assessment of relative trends in biomass.

SURBA analysis

On the basis that the choice of natural mortality estimates is arbitrary for gadoid stocks, mortality results from the latest version of SURBA are in terms of mean Z, or Z at age. It should be noted that this measure is not an absolute measure of mortality but a measure of the decline down cohorts as measured by a survey, and as such is dependent on the catchability of that survey. However, if the catchability of the survey remains constant over time then the trends in Z should reflect the trends in the absolute Z for the stock.

To reduce the influence of the single large haul of cod in the ScoGFSQ1 in 2001 the model settings were altered, compared to the final assessment run from WGNSDS$_{2005}$ to down-weight the index values at ages 3, 4 and 5 in this year. Figure 3-16 shows how this reduces noise in the mean Z time series and improves retrospectives of both mean Z and SSB. The model settings for this run are given below followed by explanations for these settings:

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						

Age range

At WGNSDS$_{2005}$ runs were conducted to test the sensitivity of the results to use of different age ranges. It was found there was some sensitivity to the age range. The abundance of fish at age 7 in the ScoGFSQ1 is very low. Given the sensitivity to age range included the WG considered age 7 should be left out of the analysis. Abundance numbers are also low for age 6 but it was felt useful information could be lost if this age was also excluded.

Smoothing parameter λ

Survey data estimates of mean Z tend to be noisy. SURBA has an additive penalty function, λ, placed on the variation in year effect of mortality which effectively acts as a smoother. It was found that if no smoothing were used results for mean Z (2-5) could become negative. Smoothing was therefore applied to runs. A lambda value of 2 appeared reasonable, reducing noise in Z without over-smoothing the trends.

Catchabilities (q)

Equal catchabilities were initially set for all ages. This was unlikely to be satisfactory for cod given the “hooked” nature of the log catch curves, (Figure 3-8). Evidence that the catchabilities of younger ages should be reduced can be found from the age effects estimated from SURBA. An ad-hoc method of obtaining positive age effects is to reduce the catchability at age one until the condition is met. It was uncertain to the WG whether the ad-hoc method of reducing catchability at age 1 until all age effects are positive is defensible. An alternative method was to compare raw survey indices with numbers at age estimates from a TSA run. These ratios were then standardised relative to a given reference age. No catch-at-age analysis has been accepted as a final assessment for some years. However, the WGNSDS$_{2005}$ decided that even if there are concerns over mis-reporting of commercial data, so long as the relative catch numbers between ages remains constant the catchabilities generated using a catch-at-age analysis will be valid and it was important to include this additional information on the stock if possible. The TSA run not allowing a trend in survey catchability and using all years of available catch data was chosen to provide the catchabilities for this stock. Figure 3-18 shows the age effects resulting from this last approach compared to that when catchability is considered constant across ages.

TSA

Figure 3-20 shows a mean standardised plot of SSB comparing three TSA runs and the agreed SURBA run using the ScoGFSQ1 data. Two TSA runs use the full series of commercial catch data, the difference being whether a persistent trend in survey catchability was allowed to be estimated. It is now known that fixing the variance measuring persistent changes in survey catchability to zero will have little impact, because the divergence between the catch data and the survey data will then be picked up by the variance measuring transient changes in survey catchability. Fixing both variances to zero might have some impact, depending on the relative precision of survey and catch data. If the catch data are precise but with trends in bias, then the catch data will dominate the survey data and give biased stock trends. As expected the SSB trends are extremely similar and only diverge at the point of forecast estimate for 2006 (the estimate at this point from the model not allowing survey catchability trend has not been influenced by commercial data observations).

In light of disparities between assessed trends in SSB between analyses based on catch data and those based on survey data, the $WGNSDS_{2004}$ performed runs with catch data being progressively removed and 1994 was concluded the optimal year after which to remove landings data. The third TSA run presented in Figure 3-20 used catch data up to 1994 only. Only a run not allowing a 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.

All results show a downward trend in SSB but there is a clear divergence between TSA results using the full set of commercial data and SURBA from the mid 1990s. The trends are, however, more similar between SURBA and TSA using a reduced set of data, highlighting the different signals being produced by survey and commercial data.

Attempts by the WG to produce short term forecasts using relative assessment results output from a survey based assessment (SURBA) were rejected by ACFM.

> "…the RGNSDS did not accept the SURBA-based forecasts which were undertaken in some cases. The problem is that these use (Z-M) as a proxy for F, when the survey Z is really only a measure of loss and not necessarily a measure of total mortality. These are regarded as a useful exploration of the possibility of providing catch advice using SURBA, but again there is a need for these approaches to be further studied and simulation tested. "

The WG concluded that it would adopt the approach of using TSA run on a reduced set of data. This would allow conventional forecasts based on absolute assessment results while also producing assessment results that matched (to the greatest extent possible) the SSB trends found from an agreed best SURBA run. The WG was also tasked wirh evaluating the current cod recovery plan, (see section 15).

3.1.7 Final assessment run

A TSA run using commercial catch data to 1994 and allowing no persistent trend in survey catchability was chosen as the final assessment model. Model settings and input parameter settings for the final run are given in Table 3-19. Final parameter estimates from the TSA run are given in Table 3-21, alongside final run estimates for VIa cod from previous WGs.

A summary plot for this run is shown in Figure 3-22. The disparity between the estimated total catch and landings compared to the supplied commercial data is clear. There is a noticeable long term downward trend in recruitment.

Standardised prediction errors at age from the final assessment run (which can be interpreted as residuals) are shown in Figure 3-24 (landings), Figure 3-26 (discards) and Figure 3-28 (ScoGFSQ1). Errors within ±2 are considered reasonable. Some prediction errors fall just outside of this range but the majority of values are within the range. There is some evidence of a trend in prediction errors at age 1 from the ScoGFSQ1 data.

Table 3-23 gives the TSA population numbers-at-age and Table 3-25 gives their associated standard errors. Estimated F at age is given Table 3-27 and standard errors on log fishing mortality are given in Table 3-29. Full summary output for run one is given in Table 3-31.

Retrospectives for the final assessment run are shown in Figure 3-30. Very little retrospective bias is seen with respect to SSB and recruitment. The value of mean F using data to 2005 is that much higher in recent years compared to the retrospective runs. Figure 3-30 also shows lines at ± 2 se (approximate 95% confidence limits) around the run using all years of data. All retrospectives fall well within these proxy confidence limits but the confidence interval is wide, reflecting uncertainty in estimation of mean F when that estimation is based on the age structure present in survey data. This does little to change the perception of the stock, however, as all mean trends show mean F above F_{lim} in this period and the lower confidence limit is always above F_{pa}.

3.1.8 Comparison with last year’s assessment

The assessment carried out by the WGNSDS in 2005 was based on SURBA analysis of survey data. Adjustments were made to improve the retrospectives compared to the final assessment run of 2005 but this left the trend in SSB over the period of available survey data very little changed (see Section 3.1.6.3 and Figure 3-16). The final run using TSA was chosen in part because of the consistency between its SSB time series and that of the SURBA analysis. Perceptions of the stock have therefore not changed but absolute estimates of stock numbers at age are available.

3.1.8.1 Estimating recruiting year-class abundance

Recruitment was estimated as a geometric mean of the last ten years. Recruitment in 2008 was taken to be equal to that in 2007.

3.1.8.2 Long term trends in biomass, mortality and recruitment

The overall trend in SSB for this stock is decreasing throughout the period for which data is available, (Figure 3-20, Figure 3-22). From Figure 3-22 there is a noticeable long term downward trend in recruitment with the estimate for 2005 the lowest in the series. Mean F shows an upward trend over the majority of the last two decades, but with signs of a decline in recent years.

3.1.8.3 Short-term stock projections

A short term projection was made using WGFRANS. Mean weights at age have been relatively stable over the recent past so a mean over the last three years was taken to represent the mean weights at age appropriate for a short term projection. Numbers at age in 2006 were taken from the TSA output. CVs were calculated from the standard errors on numbers at age. F at age was partitioned into landings and discard F by proportion weight in catch and three year means taken. The larger of the CVs from the estimation of these two means was used as the CV in the forecast. Input data to the short term projection is shown in Table 3-33. Management options from the forecast are shown in Table 3-35 and detailed tables of catch numbers at age for status quo F are shown in Table 3-37.

A plot of the short term forecast is shown in Figure 3-33. Results from sensitivity analysis from this forecast is shown in Figure 3-35 and probability profiles in Figure 3-37. Figure 3-39 shows the probability of SSB being below B_{pa} over the next ten years, given a range of fishing mortalities.

3.1.9 Medium-term stock projections

Medium term predictions are not being made at this WG. It was felt that recruitment can not be assumed to conform to historical patterns as the stock is at a historic low.

3.1.10 Yield and biomass per recruit

In the absence of new catch at age assessments, yield and biomass per recruit analyses were not conducted at the 2005 meeting. $WGNSDS_{2004}$ provided 4 final run options for cod in VIa, and the yield and biomass per recruit output for final run 3 (a TSA tuned to catch data (landings and discards) from 1978 to 1994 and survey data from 1985-2004, with no survey catchability trend permitted) is presented here. This run provided the most similar trend in SSB to the SURBA run presented in this report and is based on the same assumptions regarding catch data validity as the final TSA assessment considered this year. Yield and biomass per recruit values are shown in Figure 3-41.

3.1.11 Biological reference points

ICES has 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 1980's.

3.1.12 Quality of the assessment

Landings

In the recent past, 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. Furthermore, both TSA and XSA (used at previous WGs) are strongly influenced by catch data.

Effort

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

Discards

Available discard estimates are calculated mainly from the Scottish sampling program. The method used is to sample on a stratified basis and then raise by some auxiliary variable to, initially, total strata discards, and ultimately international discards. These estimates are prone to bias. At $WGNSDS_{2004}$ a new method of raising discard data was introduced (WD 2), using the same raw data, and which will reduce estimation bias. The method is being applied and tested on data from both the Northern Shelf and North Sea regions before the resulting revised data is released to assessment working groups. Data using the new method was therefore not available for 2006 and so the data as calculated by the existing method was used.

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.

Biological factors

Biological responses of cod in VIa as a localised species to high exploitation and low population numbers are so far unknown to the working group. Morphological changes, changes in maturity and fecundity, and changes in distribution may all be causing systematic bias due to long-standing assumptions on mean weight at length and mean maturity at age.

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, in the case of VIa cod only one survey series is considered sufficiently long and self-consistent for use in assessment. As stated earlier, concerns over bias in catch data mean the WG also feels unable to make forecasts based on commercial catch-at-age data.

3.1.12.1 Management considerations

Assessments based wholly on survey indices or catch at age analysis with recent catch data removed give uncertain estimates of mortality, whether mean overall mortality Z or mean fishing mortality F. These estimates are based on the age structure indicated by the survey series, which are known to be noisy. In contrast spawning biomass and recruitment appear to be robust measures of stock dynamics. All exploratory runs showed SSB for cod in VIa to have declined for 2005.

Cod are taken in a mixed demersal fishery with haddock and whiting, and management advice needs to be considered in that context. Interactions between fisheries are discussed in Section 1.5.

Under Council Regulation No. 51/2006 the use of gillnets has been banned outside 200m depth. $WGFTFB_{2006}$ report that this has greatly reduced effort at depths greater than 200m in VIa. The measure was aimed to protect monkfish and deepwater shark and it is unclear what effect it will have on cod. $WGFTFB_{2006}$ also report that the latest days allocations under Regulation No. 51/2006 still provides no incentive for *Nephrops* fishermen to use a mesh size larger than 80mm and there has been a steady shift into smaller mesh fisheries. The days at sea restrictions imposed in division VIa do not apply west of a line running close to the shelf edge, see Figure 3-2. This figure shows that historically, significant CPUE of mature cod were obtained from the ScoGFSQ1 in waters outside of effort restrictions. What also seems apparent from the same figure is the contraction of cod into isolated and relatively inshore areas in recent years.

The EU Cod Recovery Plan regulation, (Council Regulation No. 423/2004) impacts on management measures for 2007, which will be formulated with reference to the estimates and forecasts of SSB in relation to limit and precautionary reference points. 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:

4. 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,
5. 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.

The TSA assessment indicates SSB to be below $\mathbf{B_{lim}}$. The declining trend indicated by this assessment points to SSB for 2005 and 2006 at the lowest observed biomass in the survey series. All indications from this and previous WGs are that the stock is at a historic low level.

3.2 Cod in Division VIb

Officially reported catches are shown in Table 3.20There were revisions to 2004 data, (inclusion of reported landings from Ireland). No analytical assessment of this stock has been carried out.

Table 3.1: Cod in Division VIa. Official catch statistics in 1985–2005, 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*[2]	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

*** Preliminary.**

Country	2003	2004	2005*			
Belgium						
Denmark						
Faroe Islands		2	0			
France	172	91	79			
Germany	+					
Ireland	120	34	17			
Netherlands	-					
Norway	46	10				
Spain	3					
UK (E., W., N.I.)	79	46				
UK (Scotland)	879	413				
UK			403			
Total landings	1,299	596	499			

*** Preliminary.**

Table 3.2: Cod in Division VIa. Landings, discards and catch estimates 1978–2005, as used by the WG.

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

Table 3.3: 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					
33617	743.00	224.48	64.14	41.83	13.01	3.72
38465	120.91	128.90	197.32	25.17	19.13	5.03
38640	403.38	223.25	75.45	37.21	13.44	4.13
37208	26.53	473.12	129.81	42.39	7.95	0.88
36689	405.78	139.18	137.35	31.99	14.11	3.76
38080	1205.65	509.03	65.34	58.51	14.63	4.88
29561	275.95	56.40	78.78	25.58	17.39	10.23
26365	982.36	199.94	27.31	23.41	4.88	4.88
19960	348.05	84.78	30.70	6.35	4.23	1.06
26332	4461.36	552.51	48.68	67.56	18.88	4.97
21383	63.84	451.06	41.87	4.98	3.99	1.00
39350	560.31	138.71	152.45	31.07	6.74	4.16
23235	99.96	566.35	31.11	60.19	11.87	2.06
25787	364.64	132.65	164.98	16.25	28.93	8.39
20273	1390.05	228.60	35.92	46.85	4.09	5.01
24315	86.98	389.31	87.56	10.26	16.08	2.90
21305	175.94	138.49	145.48	23.03	5.90	4.96
21950	134.47	372.92	68.30	60.81	9.78	2.11
15205	82.21	318.54	106.62	17.28	15.61	1.30
11449	317.44	102.89	77.06	23.31	12.33	13.52
11166	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 3.3: (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.

SCOLTR	SCOTTISH LIGHT TRAWLERS					
1978	2005					
1	1	0	1			
1	6					
127387	2242.51	685.36	185.50	133.92	32.74	7.94
99803	161.44	212.39	485.00	57.12	31.06	6.01
121211	694.04	699.09	328.14	129.35	34.24	10.46
165002	123.59	1588.52	524.05	183.42	31.06	3.88
135280	1623.74	367.84	616.01	163.81	46.10	5.89
112332	1634.45	1408.23	196.00	163.65	51.38	18.08
132217	974.48	593.35	419.46	85.37	93.80	30.56
142815	6421.55	1734.74	218.21	131.35	21.19	22.25
126533	1403.22	376.19	384.35	67.13	30.32	3.25
131720	23524.40	1058.11	143.60	116.68	27.92	12.96
158191	319.66	2464.85	309.82	49.97	37.98	8.00
217443	1795.80	291.27	989.06	200.39	46.89	19.53
142502	195.62	1334.61	87.08	202.71	37.25	6.93
209901	2081.88	815.93	534.85	38.68	97.23	30.51
189288	2197.22	655.91	193.06	240.73	17.16	24.27
189925	246.98	1274.46	301.98	46.14	80.17	10.51
174879	348.87	458.79	463.67	88.90	16.55	22.76
175631	488.40	839.26	188.99	168.65	21.32	4.31
214159	133.75	790.18	355.22	79.78	83.08	9.88
179605	819.38	371.40	394.35	109.46	18.88	18.82
142457	181.66	1343.76	100.25	64.43	21.22	5.63
98993	129.77	226.02	433.87	20.55	19.74	11.62
76157	988.51	233.22	79.43	119.99	6.99	6.12
35698	95.85	461.23	51.31	26.92	24.54	1.39
15174	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 3.3: (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						
56335	77	453	115	33	6	1	1
60709	72	200	95	30	15	4	1
62698	215	120	57	24	6	5	2
57403	28	138	16	16	7	3	0
53192	10	65	16	3	2	0	0
46913	131	42	17	6	1	0	0
48358	19	90	14	5	3	0	0
37231	39	32	22	2	1	0	0
39803	7	37	6	5	1	0	0
35140	3	7	3	1	1	0	0
30941	4	8	2	1	0	0	0

Table 3.4: Cod in Division VIa. Survey data made available to the WG. Data used in preliminary and final runs are highlighted in bold. For ScoGFSQ1, numbers are standardised to catch-rate per 10 hours.

ScoGFSQ1	**Scottish west coast groundfish survey**						
1985	2006						
1	1	0	0.25				
1	7						
10	1.5	23.7	8.6	13.6	3.9	2.5	1.2
10	1.5	6.9	26.8	5.6	7.3	2.5	1.9
10	57.4	16.2	15.3	22.8	3.0	2.8	0.0
10	0.0	64.9	14.2	3.4	2.1	0.7	0.2
10	4.5	7.2	45.1	8.6	1.9	0.5	0.8
10	2.0	24.6	4.1	14.7	4.2	1.6	0.8
10	4.8	5.4	17.4	5.2	13.4	2.8	0.5
10	7.3	11.5	5.4	7.6	3.4	2.3	0.5
10	1.7	38.2	12.7	1.7	1.4	1.1	0.0
10	13.6	14.7	25.1	5.8	1.0	0.0	0.0
10	6.4	23.8	14.0	16.5	1.2	1.9	0.7
10	2.8	20.9	24.1	4.1	2.8	1.3	0.0
10	11.1	7.7	11.6	7.9	4.2	4.7	1.0
10	2.8	30.9	5.3	8.7	3.7	0.6	2.0
10	1.5	8.2	8.2	1.4	3.2	0.5	0.5
10	13.3	5.4	6.9	1.3	0.0	0.4	0.0
10	2.7	18.4	5.7	13.2	19.5	1.1	1.6
10	5.3	4.3	10.6	2.6	0.5	3.0	0.0
10	2.7	16.7	2.0	4.7	1.8	0.7	0.4
10	5.7	3.0	5.6	2.3	1.7	0.0	0.0
10	1.3	1.5	1.2	0	0	0.4	0
10	2.2	1.9	1.1	0.3	0	0	0.3

Table 3.4: (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 3.4: (cont) Cod in Division VIa. Survey data made available to the WG. For ScoGFSQ4, numbers are standardised to catch-rate per 10 hours. "+" indicates value less than 0.5 after standardising.

SCOGFSQ4	QUARTER 4 SCOTTISH GROUND FISH SURVEY								
1996	2005								
1	1	0.75	1.00						
0	8								
10	0	1	14	5	3	1	0	0	0
10	1	11	2	1	1	1	0	0	0
10	+	15	9	1	0	0	0	0	0
10	2	4	6	9	1	0	0	0	0
10	0	16	3	0	0	0	0	0	0
10	1	2	9	1	1	0	0	0	0
10	1	10	3	7	1	0	0	0	0
10	1	2	11	3	1	0	0	0	0
10	0	5	4	0	+	0	0	0	0
10	+	2	3	0	1	+	0	0	0

Table 3.4: (cont) Cod in Division VIa. Survey data made available to the WG. For IRGFS, numbers are standardised to catch rate per hour.

IRGFS	IRISH WEST COAST GROUNDFISH				
2003	2005				
1	1	0.79	0.92		
0	4				
1127	0	10	11	0	0
1200	0	24	10	1	0
960	63	13	7	0	2

Table 3.5: 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

Table 3.6: 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

Table 3.7: Cod in Division VIa. Discard dataset from Scottish & Irish sampling programmes, ages 1–3, years 1978–2005. Data from 1978-2001 raised from Scottish sampling only; later data raised from both Irish and Scottish sampling.

DISCARDS AT AGE (THOUSANDS).					B) MEAN WEIGHT-AT-AGE IN DISCARDS (KG).			
	Age					**Age**		
Year	**1**	**2**	**3**		**Year**	**1**	**2**	**3**
1978	8904	1203	0		**1978**	0.37	0.321	0
1979	11	119	0		**1979**	0.276	0.43	0
1980	2758	0	0		**1980**	0.361	0	0
1981	289	1475	0		**1981**	0.135	0.326	0
1982	5264	2	0		**1982**	0.314	0.392	0
1983	7371	1005	0		**1983**	0.223	0.374	0
1984	2117	10	0		**1984**	0.298	0.435	0
1985	43508	3122	0		**1985**	0.178	0.346	0
1986	4483	10	0		**1986**	0.267	0.305	0
1987	52582	159	0		**1987**	0.166	0.37	0
1988	714	3256	0		**1988**	0.296	0.283	0
1989	8443	25	0		**1989**	0.332	0.59	0
1990	1835	158	0		**1990**	0.132	0.454	0
1991	3255	319	0		**1991**	0.245	0.351	0
1992	12498	143	2		**1992**	0.22	1.03	2.382
1993	595	51	0		**1993**	0.239	0.812	3.723
1994	773	2	0		**1994**	0.24	0.365	0
1995	1111	126	0		**1995**	0.203	0.256	0
1996	233	86	0		**1996**	0.226	0.389	0
1997	1074	27	0		**1997**	0.321	0.328	0
1998	472	837	3		**1998**	0.23	0.367	0.59
1999	283	16	0		**1999**	0.294	0.299	0
2000	2081	53	0		**2000**	0.28	0.421	0
2001	216	373	0		**2001**	0.248	0.417	0
2002	508	32	0		**2002**	0.263	1.021	0
2003	77	38	8		**2003**	0.272	0.57	0.39
2004	232	21	0		**2004**	0.258	0.581	0
2005	108	20	0		**2005**	0.285	0.501	0

Table 3.8: 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

Table 3.9: 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

Table 3.10: Cod in Division VIa. TSA parameter settings for the final assessment run.

PARAMETER	SETTING	JUSTIFICATION
Age of full selection.	$a_m = 4$	Based on inspection of previous XSA runs.
Multipliers on variance matrices of measurements.	$B_{landings}(a) = 2$ for ages 6, 7+ $B_{survey}(a) = 2$ for age 1, 5, 6	Allows extra measurement variability for poorly-sampled ages.
Multipliers on variances for fishing mortality estimates.	H(1) = 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 1994, age 6 in 1995 and 2002, ages 4, 5, 6 in 2001 (the latter are from a single large haul, 24 fish > 75 cm in 30 mins.)	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.	

Table 3.11: Cod in Division VIa. TSA parameter estimates for 2002, 2003 & 2004 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 final assessment.

Parameter	*Notation*	Description	2002 WG	2003 WG	2004 WG	2004 WG	2004 WG	2006 WG
					Run1	Run2	Run3	
Initial fishing mortality	F (1, 1978)	Fishing mortality at age *a* in year *y*	0.03	0.64	0.61	0.76	0.64	0.6378
	F (2, 1978)		0.25	0.62	0.57	0.79	0.57	0.5333
	F (4, 1978)		0.67	0.82	0.64	1.32	0.66	0.5743
Survey selectivities	$\Phi(1)$	Survey selectivity at age *a*	0.83	0.33	0.42	0.81	0.47	0.6275
	$\Phi(2)$		4.41	1.98	1.99	3.97	3.19	3.5857
	$\Phi(4)$		18.28	10.65	11.06	20.3	14.92	15.9096
Fishing mortality standard deviations	σ_F	Transitory changes in overall fishing mortality	0.10	0.04	0.07	0.11	0.07	0.0947
	σ_U	Persistent changes in selection (age effect in F)	0.10	0.06	0.05	0.06	0.03	0.0242
	σ_V	Transitory changes in the year effect in fishing mortality	0.00	0.07	0.08	0.00	0.10	0.0844
	σ_Y	Persistent changes in the year effect in fishing mortality	0.16	0.07	0.04	0.20	0.00	0.0425
Survey catchability standard deviations	σ_Ω	Transitory changes in survey catchability	0.24	0.00	0.0	0.24	0.00	0.1224
	σ_β	Persistent changes in survey catchability	0.00	0.45	0.48	0.00 (f)	0.00 (f)	0.00 (f)
Measurement standard deviations	$\sigma_{landings}$	Standard error of landings-at-age data	0.12	0.13	0.11	0.12	0.10	0.0935
	$\sigma_{discards}$	Standard error of discards-at-age data	n/a	0.94	0.96	0.99	1.42	1.2669
	σ_{survey}	Standard error of survey data	0.36	0.56	0.43	0.46	0.35	0.3887
Discards	$\sigma_{logit\ p}$	Transitory trends in discarding	n/a	0.30	0.28	0.15	0.00	0.00
	$\sigma_{persistent}$	Persistent trends in discarding	n/a	0.16	0.27	0.23	0.68	0.5735
Recruitment	η_1	Ricker parameter (slope at the origin)	0.82	0.62	0.54	0.60	0.80	0.6584
	η_2	Ricker parameter (curve dome occurs at $1/\eta_2$)	0.03	0.003	0.00	0.004	0.01	0.0049
	cv_{rec}	Coefficient of variation of recruitment data	0.36	0.56	0.52	0.50	0.49	0.4184

Table 3.12: Cod in Division VIa. TSA population numbers-at-age (millions).

	AGE						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1978	17.249	9.070	2.539	1.407	0.522	0.160	0.130
1979	25.764	9.492	4.199	1.116	0.519	0.180	0.097
1980	29.933	13.461	4.332	1.364	0.283	0.123	0.062
1981	9.642	16.373	6.167	1.813	0.500	0.100	0.066
1982	24.017	4.972	6.824	2.369	0.679	0.194	0.060
1983	15.009	11.632	2.140	2.576	0.847	0.238	0.090
1984	23.049	5.884	4.471	0.756	0.830	0.273	0.101
1985	11.323	11.895	2.182	1.426	0.225	0.215	0.105
1986	18.276	4.231	3.923	0.703	0.325	0.064	0.075
1987	54.412	9.743	1.774	1.382	0.229	0.103	0.046
1988	5.640	16.945	3.662	0.558	0.358	0.067	0.043
1989	18.736	2.498	5.754	1.152	0.186	0.108	0.034
1990	5.841	8.822	0.947	1.537	0.337	0.055	0.040
1991	10.562	3.017	3.440	0.353	0.491	0.118	0.034
1992	15.535	4.533	0.983	1.131	0.123	0.153	0.047
1993	6.477	7.802	1.821	0.300	0.339	0.042	0.069
1994	13.099	3.194	3.095	0.575	0.108	0.113	0.038
1995	11.307	6.947	1.423	1.146	0.215	0.040	0.056
1996	5.337	5.721	2.848	0.488	0.416	0.077	0.034
1997	15.359	2.432	2.210	0.898	0.167	0.144	0.038
1998	8.092	7.563	0.869	0.681	0.293	0.055	0.060
1999	5.371	3.817	2.773	0.244	0.218	0.093	0.037
2000	10.590	2.442	1.389	0.807	0.076	0.068	0.041
2001	4.025	5.074	0.901	0.424	0.266	0.025	0.035
2002	7.536	1.707	1.771	0.251	0.129	0.084	0.018
2003	2.850	3.486	0.545	0.468	0.074	0.038	0.030
2004	3.727	1.046	1.043	0.130	0.125	0.019	0.017
2005	2.292	1.374	0.271	0.208	0.031	0.030	0.009
2006*	2.352	0.924	0.397	0.058	0.052	0.008	0.010
2007*	1.281	1.006	0.290	0.098	0.016	0.014	0.005
GM(78-05)	10.430	5.212	2.079	0.731	0.248	0.086	0.046

***2006 and 2007 values are TSA-derived projections of population numbers.**

Table 3.13: Cod in Division VIa. Standard errors on TSA population numbers-at-age (millions).

	AGE						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1978	2.996	0.608	0.132	0.093	0.056	0.033	0.024
1979	2.462	0.592	0.197	0.068	0.050	0.035	0.022
1980	2.805	0.825	0.242	0.105	0.034	0.030	0.023
1981	1.285	1.303	0.350	0.105	0.040	0.015	0.014
1982	2.357	0.394	0.410	0.142	0.041	0.016	0.005
1983	1.898	0.912	0.132	0.177	0.070	0.027	0.010
1984	1.909	0.550	0.302	0.055	0.078	0.039	0.016
1985	1.598	0.832	0.159	0.119	0.025	0.041	0.021
1986	1.553	0.353	0.251	0.051	0.040	0.012	0.018
1987	8.691	0.680	0.099	0.094	0.019	0.017	0.008
1988	1.127	1.597	0.190	0.036	0.033	0.010	0.007
1989	2.029	0.190	0.476	0.069	0.012	0.013	0.005
1990	1.207	0.470	0.053	0.128	0.024	0.006	0.006
1991	1.455	0.222	0.185	0.017	0.037	0.011	0.003
1992	1.344	0.301	0.069	0.071	0.008	0.018	0.006
1993	0.824	0.407	0.112	0.023	0.029	0.004	0.008
1994	1.956	0.287	0.239	0.057	0.010	0.016	0.005
1995	2.086	1.070	0.189	0.158	0.035	0.007	0.010
1996	1.654	1.004	0.464	0.083	0.070	0.016	0.007
1997	2.711	0.729	0.420	0.184	0.034	0.031	0.009
1998	1.883	1.323	0.284	0.158	0.075	0.015	0.017
1999	1.404	0.875	0.547	0.095	0.061	0.031	0.013
2000	1.818	0.596	0.333	0.187	0.032	0.024	0.016
2001	1.071	0.811	0.208	0.108	0.062	0.011	0.012
2002	1.499	0.466	0.336	0.069	0.040	0.025	0.008
2003	0.999	0.712	0.167	0.123	0.025	0.016	0.013
2004	1.182	0.412	0.281	0.050	0.046	0.010	0.010
2005	1.002	0.538	0.136	0.093	0.017	0.018	0.007
2006*	0.945	0.437	0.180	0.035	0.029	0.005	0.008
2007*	0.653	0.442	0.144	0.048	0.010	0.009	0.004
GM(78-05)	1.715	0.598	0.215	0.084	0.034	0.017	0.010

***2006 and 2007 values are standard errors on TSA-derived projections of population numbers.**

Table 3.14: Cod in Division VIa. TSA estimates for fishing mortality-at-age.

	AGE						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1978	0.459	0.577	0.623	0.762	0.792	0.791	0.786
1979	0.435	0.610	0.833	0.983	0.956	0.935	0.916
1980	0.389	0.601	0.672	0.784	0.805	0.785	0.775
1981	0.420	0.666	0.757	0.757	0.680	0.729	0.738
1982	0.517	0.637	0.761	0.823	0.845	0.837	0.842
1983	0.614	0.725	0.827	0.906	0.911	0.950	0.960
1984	0.488	0.719	0.880	0.959	1.033	0.989	0.963
1985	0.684	0.886	0.914	1.155	1.020	1.114	1.095
1986	0.400	0.669	0.836	0.920	0.929	0.922	0.894
1987	0.793	0.780	0.947	1.113	1.028	1.035	1.037
1988	0.603	0.812	0.957	0.888	0.999	0.965	0.947
1989	0.534	0.769	1.054	1.029	1.016	1.066	1.038
1990	0.512	0.742	0.763	0.944	0.822	0.800	0.790
1991	0.642	0.896	0.913	0.845	0.964	0.965	0.987
1992	0.444	0.709	0.968	1.004	0.876	0.860	0.885
1993	0.502	0.721	0.952	0.817	0.899	0.871	0.860
1994	0.428	0.602	0.790	0.782	0.792	0.776	0.790
1995	0.479	0.693	0.869	0.815	0.829	0.830	0.831
1996	0.547	0.751	0.948	0.873	0.863	0.879	0.880
1997	0.515	0.782	0.968	0.909	0.901	0.897	0.902
1998	0.554	0.797	1.011	0.926	0.929	0.927	0.926
1999	0.579	0.822	1.035	0.957	0.955	0.953	0.951
2000	0.524	0.798	0.986	0.896	0.913	0.916	0.915
2001	0.615	0.853	1.069	0.973	0.949	0.971	0.972
2002	0.583	0.889	1.102	1.001	0.999	0.996	1.002
2003	0.669	0.955	1.175	1.065	1.071	1.065	1.066
2004	0.704	0.991	1.262	1.127	1.112	1.118	1.116
2005	0.684	1.003	1.254	1.141	1.136	1.125	1.126
2006*	0.649	0.958	1.202	1.095	1.093	1.093	1.091
2007*	0.649	0.949	1.188	1.082	1.082	1.082	1.082
GM(78-05)	0.538	0.758	0.920	0.927	0.924	0.925	0.922

***Estimates for 2006 and 2007 are TSA projections.**

Table 3.15: Cod in Division VIa. Standard errors of TSA estimates for log fishing mortality-at-age.

	AGE						
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7+**
1978	0.200	0.121	0.070	0.069	0.084	0.101	0.103
1979	0.207	0.122	0.063	0.061	0.074	0.096	0.100
1980	0.213	0.114	0.068	0.068	0.073	0.096	0.100
1981	0.216	0.102	0.065	0.067	0.080	0.099	0.104
1982	0.204	0.101	0.068	0.070	0.087	0.101	0.110
1983	0.191	0.093	0.066	0.067	0.081	0.098	0.103
1984	0.200	0.100	0.066	0.067	0.075	0.096	0.103
1985	0.195	0.079	0.069	0.063	0.080	0.092	0.100
1986	0.212	0.101	0.068	0.069	0.078	0.102	0.100
1987	0.173	0.096	0.061	0.062	0.084	0.097	0.105
1988	0.203	0.080	0.059	0.067	0.076	0.105	0.107
1989	0.185	0.086	0.066	0.062	0.078	0.092	0.107
1990	0.205	0.071	0.067	0.068	0.080	0.099	0.103
1991	0.189	0.070	0.064	0.067	0.077	0.097	0.107
1992	0.187	0.078	0.067	0.067	0.086	0.096	0.107
1993	0.205	0.083	0.076	0.083	0.095	0.112	0.108
1994	0.223	0.121	0.114	0.121	0.131	0.132	0.133
1995	0.242	0.142	0.138	0.139	0.141	0.142	0.142
1996	0.244	0.145	0.140	0.142	0.142	0.144	0.144
1997	0.242	0.150	0.143	0.144	0.145	0.146	0.146
1998	0.247	0.149	0.148	0.146	0.147	0.148	0.148
1999	0.248	0.155	0.148	0.150	0.149	0.151	0.151
2000	0.250	0.159	0.155	0.153	0.154	0.154	0.154
2001	0.247	0.155	0.152	0.150	0.151	0.153	0.153
2002	0.249	0.160	0.151	0.152	0.153	0.154	0.155
2003	0.252	0.159	0.157	0.154	0.156	0.157	0.157
2004	0.251	0.166	0.156	0.157	0.159	0.161	0.161
2005	0.261	0.174	0.170	0.167	0.167	0.169	0.169
2006*	0.273	0.186	0.182	0.179	0.179	0.179	0.180
2007*	0.278	0.194	0.190	0.187	0.187	0.187	0.187
GM(78-05)	0.218	0.114	0.093	0.094	0.105	0.118	0.122

***Estimates for 2006 and 2007 are standard errors of TSA projections of log *F*.**

Table 3.16: Cod in Division VIa. TSA stock summary table. "Obs." denotes sum-of-products of numbers and mean weights-at-age, not reported caught, landed and discarded weight. * Estimates 2006, 2007 are TSA projections.

Year	Landings (000 tonnes)			Discards (000 tonnes)			Total catch (000 tonnes)			Mean F (2–5)		SSB (000 tonnes)		TSB (000 tonnes)		Recruitment at age	
	Obs.	Pred.	SE	Obs.	Pred.	SE	Obs.	Pred.	SE	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
1978	13.521	13.248	0.589	3.681	2.510	0.724	17.201	16.170	1.122	0.688	0.032	25.633	0.803	37.675	1.615	17.249	2.996
1979	16.089	15.541	0.673	0.054	2.981	0.651	16.143	23.382	1.808	0.846	0.035	27.758	0.837	53.112	2.186	25.764	2.462
1980	17.879	17.274	0.808	0.996	2.769	0.759	18.875	22.805	1.656	0.715	0.032	31.692	1.116	55.582	2.118	29.933	2.805
1981	23.865	22.206	1.355	0.520	0.877	0.285	24.384	23.965	1.503	0.715	0.032	38.037	1.284	52.267	1.924	9.642	1.285
1982	21.511	22.443	1.061	1.654	2.125	0.663	23.165	24.935	1.486	0.766	0.036	37.250	1.239	53.245	1.813	24.017	2.357
1983	21.305	20.688	0.934	2.020	1.392	0.428	23.325	22.063	1.284	0.842	0.036	31.655	1.121	43.357	1.616	15.009	1.898
1984	21.272	19.694	0.999	0.636	2.061	0.581	21.907	23.203	1.525	0.897	0.038	29.388	1.175	47.254	1.880	23.049	1.909
1985	18.607	17.119	0.837	8.825	1.119	0.335	27.432	16.727	1.008	0.994	0.040	21.563	0.909	29.459	1.208	11.323	1.598
1986	11.820	11.847	0.662	1.200	1.329	0.352	13.020	13.433	0.868	0.838	0.037	18.616	0.765	28.688	1.106	18.276	1.553
1987	18.971	18.296	0.944	8.788	3.382	1.194	27.758	20.350	1.894	0.967	0.041	19.755	0.713	38.060	2.209	54.412	8.691
1988	20.413	19.164	1.262	1.133	0.761	0.271	21.546	18.985	1.366	0.914	0.036	23.620	0.977	36.013	1.819	5.640	1.127
1989	17.169	15.928	1.029	2.818	1.755	0.567	19.987	17.508	1.277	0.967	0.039	21.571	1.079	32.625	1.544	18.736	2.029
1990	12.176	12.147	0.607	0.314	0.339	0.124	12.490	12.521	0.708	0.818	0.033	17.962	0.675	24.988	0.915	5.841	1.207
1991	10.927	11.010	0.495	0.910	0.774	0.282	11.836	11.626	0.685	0.904	0.035	15.298	0.521	21.890	0.836	10.562	1.455
1992	9.086	8.981	0.404	2.902	0.994	0.279	11.989	9.643	0.535	0.889	0.039	12.494	0.453	19.776	0.702	15.535	1.344
1993	10.314	10.364	0.421	0.185	0.588	0.178	10.499	11.192	0.550	0.847	0.046	14.329	0.509	22.763	0.830	6.477	0.824
1994	8.928	9.009	0.418	0.186	0.815	0.263	9.114	10.456	0.665	0.742	0.065	14.527	0.833	23.812	1.374	13.099	1.956
1995	9.439	10.255	1.234	0.258	0.672	0.229	9.697	11.251	1.348	0.801	0.083	15.512	1.415	23.913	2.046	11.307	2.086
1996	9.427	11.276	1.496	0.086	0.421	0.190	9.513	12.076	1.611	0.859	0.089	16.573	1.689	23.540	2.369	5.337	1.654
1997	7.034	9.155	1.456	0.354	1.455	0.557	7.387	11.191	1.658	0.890	0.095	13.350	1.628	22.854	2.463	15.359	2.711
1998	5.714	8.663	1.413	0.418	0.641	0.273	6.131	9.114	1.390	0.916	0.098	11.172	1.400	17.855	2.047	8.092	1.883
1999	4.201	7.948	1.332	0.088	0.531	0.251	4.289	8.618	1.384	0.942	0.103	10.935	1.468	15.924	1.983	5.371	1.404
2000	2.977	6.597	1.243	0.605	0.899	0.386	3.582	7.549	1.192	0.898	0.102	9.156	1.256	15.152	1.767	10.590	1.818
2001	2.347	6.495	1.011	0.209	0.386	0.195	2.556	6.669	0.979	0.961	0.104	8.352	0.975	12.274	1.364	4.025	1.071
2002	2.243	5.599	1.057	0.166	0.678	0.316	2.409	6.505	1.027	0.998	0.109	7.343	0.972	12.045	1.440	7.536	1.499
2003	1.241	4.603	0.846	0.046	0.329	0.196	1.287	4.978	0.864	1.066	0.118	5.623	0.808	8.719	1.216	2.850	0.999
2004	0.540	3.350	0.765	0.072	0.370	0.208	0.612	3.654	0.742	1.123	0.128	4.127	0.769	6.092	1.044	3.727	1.182
2005	0.511	2.346	0.676	0.041	0.255	0.162	0.552	2.559	0.657	1.133	0.141	2.681	0.674	4.396	1.022	2.292	1.002
2006*	NA	1.714	0.545	NA	0.236	0.140	NA	1.942	0.529	1.087	0.150	1.964	0.579	3.447	0.916	2.352	0.945
2007*	NA	1.498	0.470	NA	0.136	0.090	NA	1.615	0.475	1.076	0.158	1.754	0.542	2.827	0.864	1.281	0.653
Min	0.511	2.346	0.404	0.041	0.255	0.124	0.552	2.559	0.535	0.688	0.032	2.681	0.453	4.396	0.702	2.292	0.824
GM	7.862	10.648	0.867	0.484	0.919	0.333	8.677	11.864	1.099	0.884	0.056	15.210	0.948	23.576	1.502	10.430	1.715
AM	11.412	12.187	0.930	1.399	1.186	0.389	12.810	13.683	1.171	0.891	0.065	18.070	1.002	27.976	1.588	13.609	1.957
Max	23.865	22.443	1.496	8.825	3.382	1.194	27.758	24.935	1.894	1.133	0.141	38.037	1.689	55.582	2.463	54.412	8.691

Table 3.17: Cod in Division VIa. Inputs to short-term predictions from final TSA run. Mean weights assumed from final 3 years.

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

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	2351900	0.40	WS1	0.39	0.18
N2	924100	0.47	WS2	1.00	0.07
N3	396500	0.45	WS3	2.32	0.11
N4	58300	0.60	WS4	4.12	0.07
N5	52100	0.56	WS5	5.71	0.12
N6	7500	0.72	WS6	7.70	0.11
N7	9800	0.81	WS7	9.59	0.07
H.cons selectivity			Weight in the HC catch		
sH1	0.19	0.55	WH1	0.69	0.12
sH2	0.85	0.07	WH2	1.07	0.08
sH3	1.20	0.05	WH3	2.38	0.09
sH4	1.11	0.04	WH4	4.12	0.07
sH5	1.11	0.03	WH5	5.71	0.12
sH6	1.10	0.03	WH6	7.70	0.11
sH7	1.10	0.03	WH7	9.59	0.07
Discard selectivity			Weight in the discards		
sD1	0.50	0.55	WD1	0.27	0.05
sD2	0.13	0.07	WD2	0.55	0.08
sD3	0.04	0.05	WD3	0.13	1.73
sD4	0.00	0.04	WD4	0.00	0.00
sD5	0.00	0.03	WD5	0.00	0.00
sD6	0.00	0.03	WD6	0.00	0.00
sD7	0.00	0.03	WD7	0.00	0.00
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		
HF06	1.00	0.05	K06	1.00	0.10
HF07	1.00	0.05	K07	1.00	0.10
HF08	1.00	0.05	K08	1.00	0.10
Recruitment in 2007 and 2008					
R06	6513472	0.54			
R07	6513472	0.54			

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

Stock numbers in 2006 are TSA survivors.

Table 3.18: Cod in Division VIa. Results of short-term forecasts from final TSA run. Management options.

Table_____.Cod,VIa

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

	Year 2006	2007						
Mean F Ages								
H.cons 2 to 5	1.11	0.00	0.22	0.44	0.66	0.89	1.11	1.33
Effort relative to 2005								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Biomass								
Total 1 January	3445	4780	4780	4780	4780	4780	4780	4780
SSB at spawning time	1964	1706	1706	1706	1706	1706	1706	1706
Catch weight (,000t)								
H.cons	1723	0	534	976	1342	1647	1900	2112
Discards	250	0	161	301	424	531	625	706
Total Catch	1973	0	695	1277	1766	2178	2525	2818
Biomass in year.... 2008								
Total 1 January		11355	9995	8854	7896	7089	6408	5834
SSB at spawning time		6015	5030	4214	3536	2973	2503	2112

	Year 2006	2007						
Effort relative to 2005								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.22	0.33	0.33	0.33	0.33	0.33	0.33	0.33
SSB at spawning time	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26
Catch weight								
H.cons	0.24	0.00	0.36	0.30	0.29	0.29	0.29	0.29
Discards	0.51	0.00	0.72	0.68	0.66	0.65	0.64	0.63
Biomass in year.... 2008								
Total 1 January		0.30	0.31	0.32	0.33	0.35	0.36	0.37
SSB at spawning time		0.31	0.32	0.34	0.36	0.38	0.41	0.44

Table 3.19: Cod in Division VIa. Results of short-term forecasts from final TSA run. Detailed tables.

Table_____.Cod,VIa
Detailed forecast tables.

Forecast for year 2006
F multiplier H.cons=1.00

Populations		Catch number		
Age	Stock No.	H.Cons	Discards	Total
1	2351900	294976	774117	1069093
2	924100	462188	70439	532627
3	396500	252048	7382	259430
4	58300	36089	0	36089
5	52100	32169	0	32169
6	7500	4624	0	4624
7	9800	6042	0	6042
Wt	3445	1723	250	1973

Forecast for year 2007
F multiplier H.cons=1.00

Populations		Catch number		
Age	Stock No.	H.Cons	Discards	Total
1	6513472	816922	2143880	2960802
2	970662	485476	73988	559464
3	283106	179965	5271	185236
4	94886	58736	0	58736
5	15715	9703	0	9703
6	14114	8701	0	8701
7	4701	2898	0	2898
Wt	4780	1900	625	2525

Table 3.20: Cod in Division VIb (Rockall). Official catch statistics.

COUNTRY	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Faroe Islands	18	-	1	-	31	5	-	-	-	1	-
France	9	17	5	7	2	-	-	-	-	-	-
Germany	-	3	-	-	3	-	-	126	2	-	-
Ireland	-	-	-	-	-	-	400	236	235	472	280
Norway	373	202	95	130	195	148	119	312	199	199	120
Portugal	-	-	-	-	-	-	-	-	-	-	-
Russia	-	-	-	-	-	-	-	-	-	-	-
Spain	241	1200	1219	808	1345	-	64	70	-	-	-
UK (E. & W. & N.I.)	161	114	93	69	56	131	8	23	26	103	25
UK (Scotland)	221	437	187	284	254	265	758	829	714	322	236
Total	1,023	1,973	1,600	1,298	1,886	549	1,349	1,596	1,176	1,097	661

COUNTRY	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005*
Faroe Islands	-	-	-	-	-	n/a	n/a	n/a			
France	-	-	-	-	-	+	+*	1			0.08
Germany	-	10	22	3	11	1	-	-			
Ireland	477	436	153	227	148	119	40	18	11	7	
Norway	92	91	55*	51*	85*	152*	89	28	25	23	7
Portugal	-	-	5	-	-	-	-	-			
Russia	-	-	-	-	-	7	26	-			
Spain	2	5	1	6	4	3	1		6		
UK (E. & W. & N.I.)	90	23	20	32	22	4	2	2	3		
UK (Scotland)	370	210	706	341	389	286	176	67	57		
UK										45	44
Total	1,031	775	962	660	659	572	334	115	102	75	51

*** Preliminary**

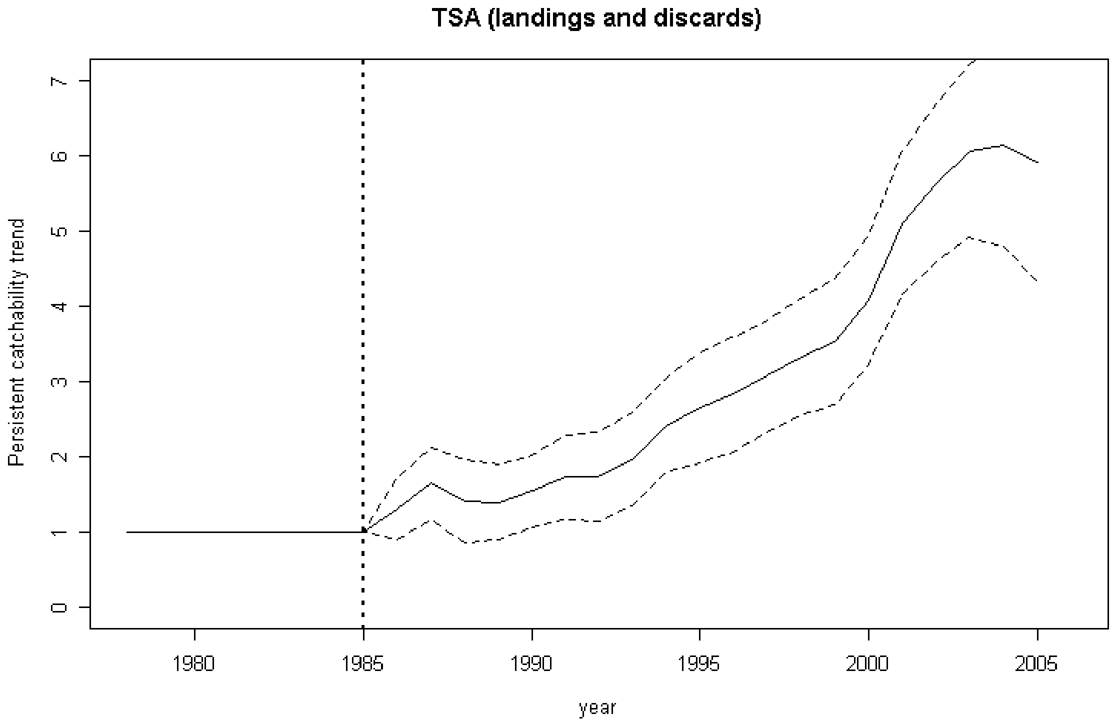


Figure 3.1: Cod in Division VIa. Trends in comparing the Scottish quarter one ground fish survey (ScoGFSQ1) to commercial catch data. Residuals using TSA run. Vertical line is the first year of survey data.

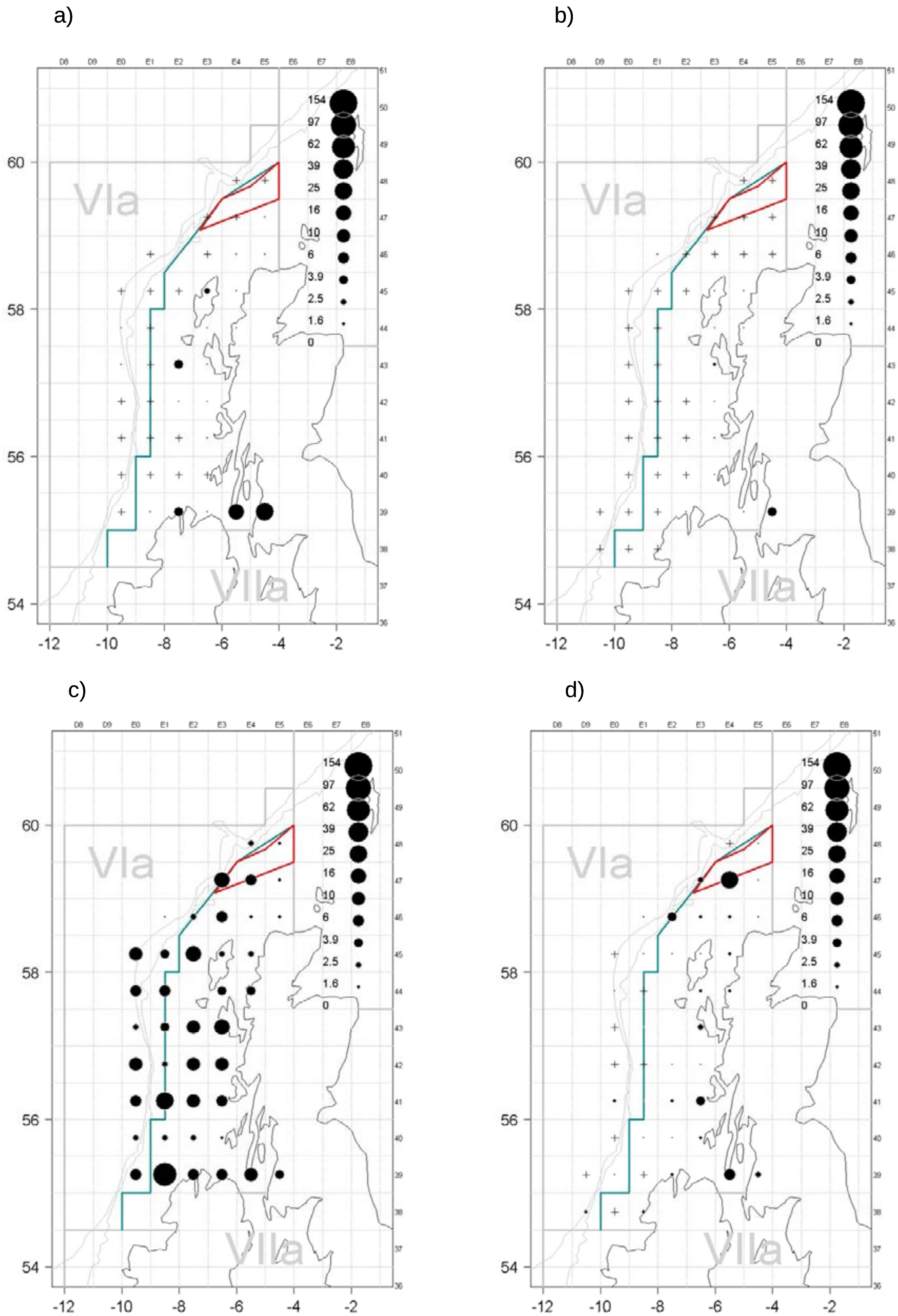


Figure 3.2: Cod in Division VIa. CPUE numbers at age by ICES statistical rectangle resulting from Scottish quarter one ground fish survey (ScoGFSQ1). Maps show the distribution of age 1 fish and fish of age 2+. For each age group five year means are presented. a) age 1 1983-1987; b) age1 2001-2005; c) age 2+ 1983-1987; d) age2+ 2001-2005. A plus indicates a stat square that was sampled but where no fish were found. Enclosed area is closed area known as the 'windsock' introduced by Council Regulation No 2287\2003. Dark line running close to shelf edge is boundary to current cod recovery plan and effort restrictions in VIa (Council Regulation No 51\2006).

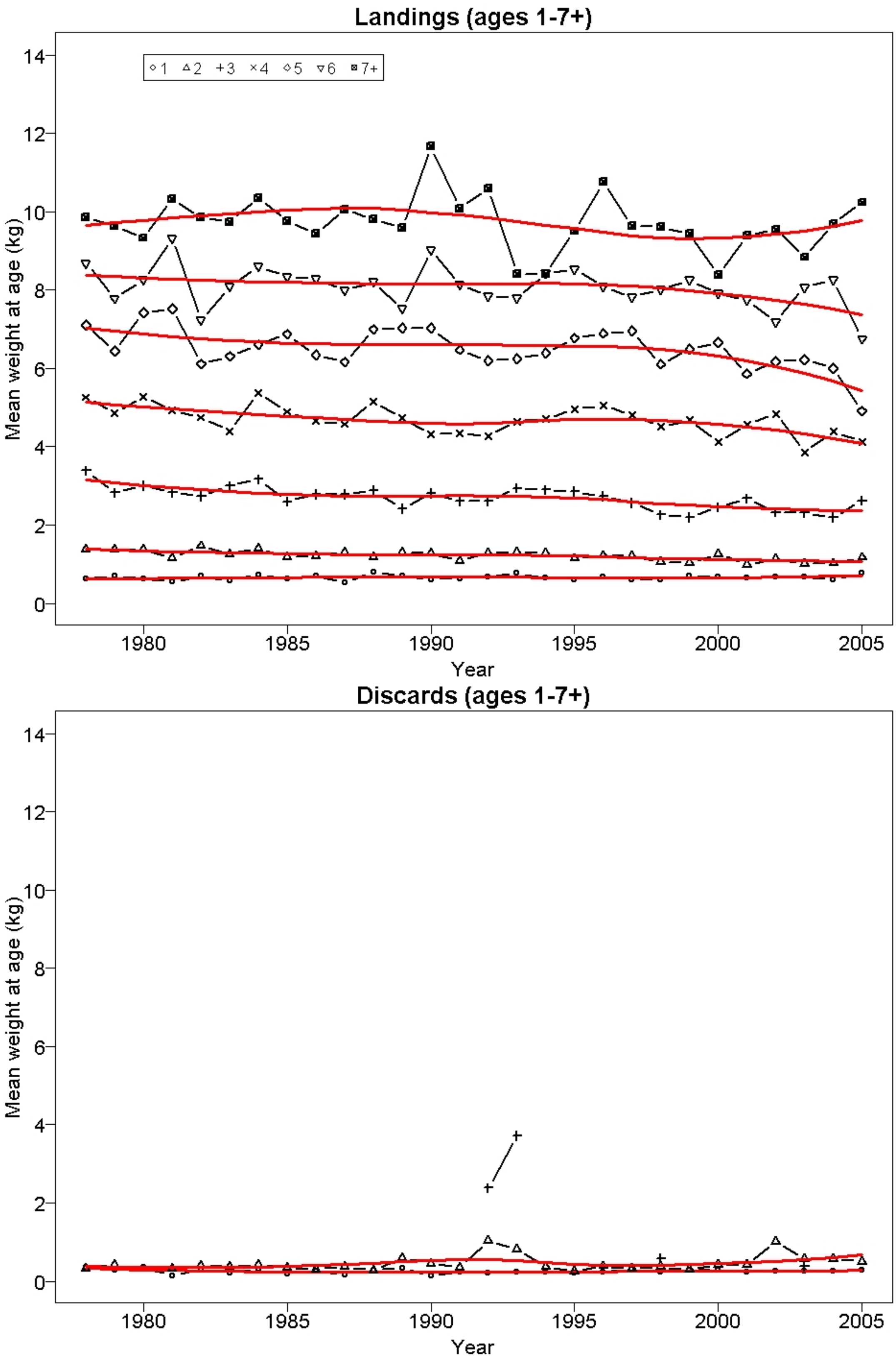
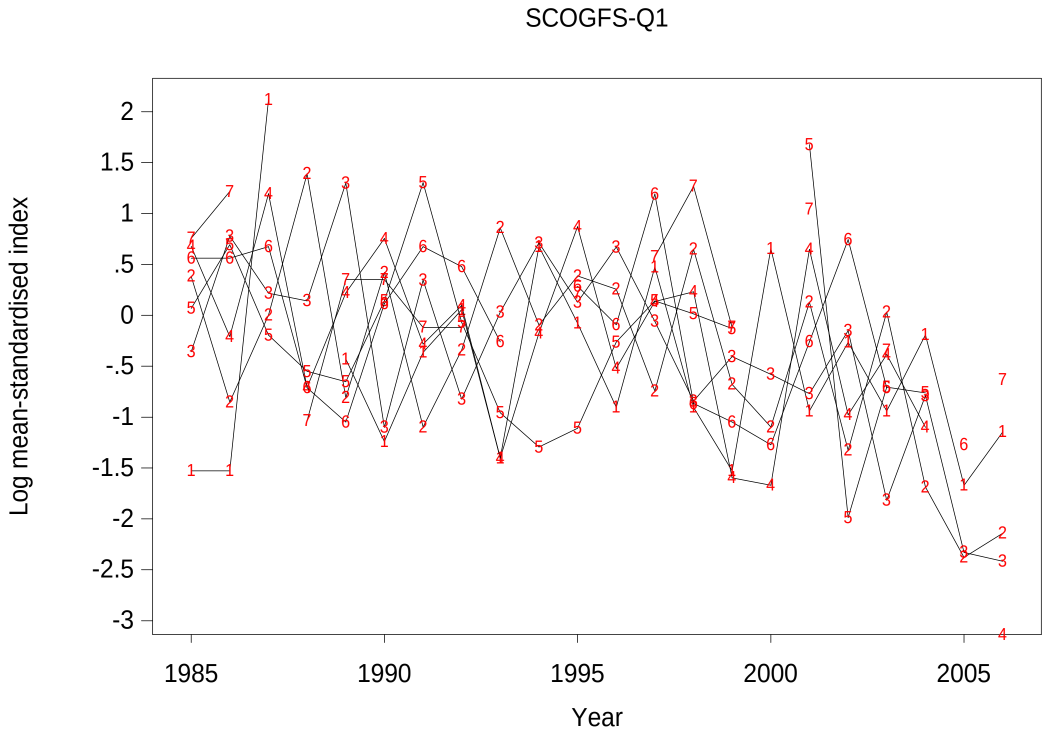


Figure 3.3: Cod in Division VIa. Mean weights-at-age in landings and discards.



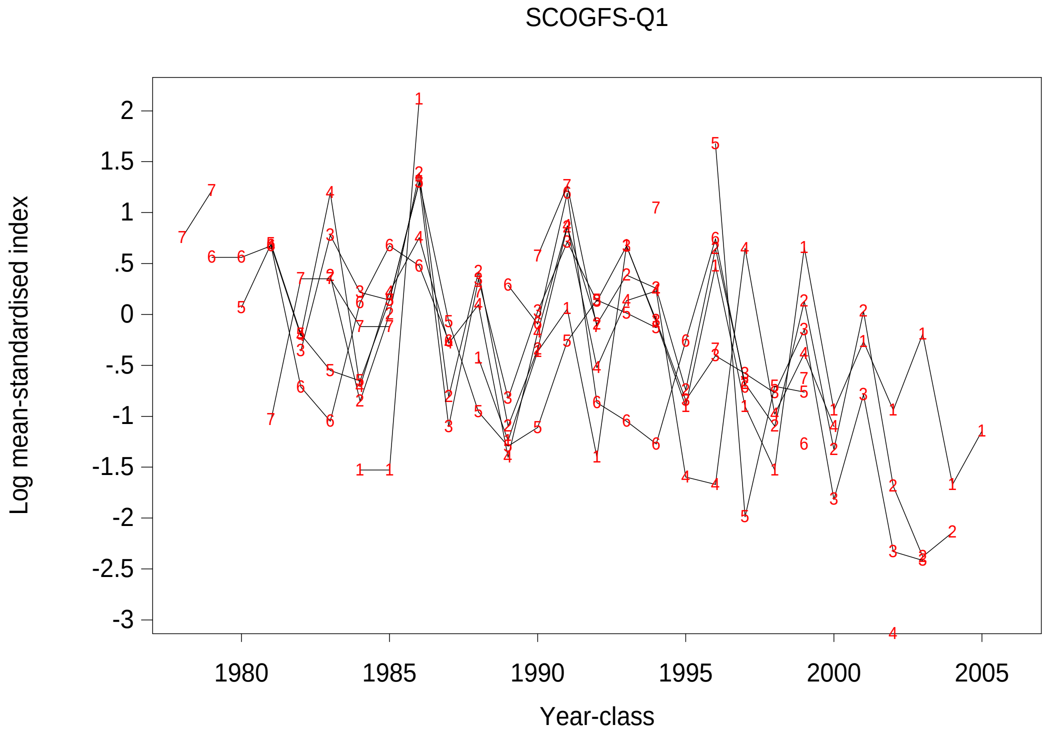


Figure 3.4: Cod in Division VIa. Log mean standardised survey index across all available ages. Scottish quarter one ground fish survey (ScoGFSQ1) by year (upper) and year-class (lower).

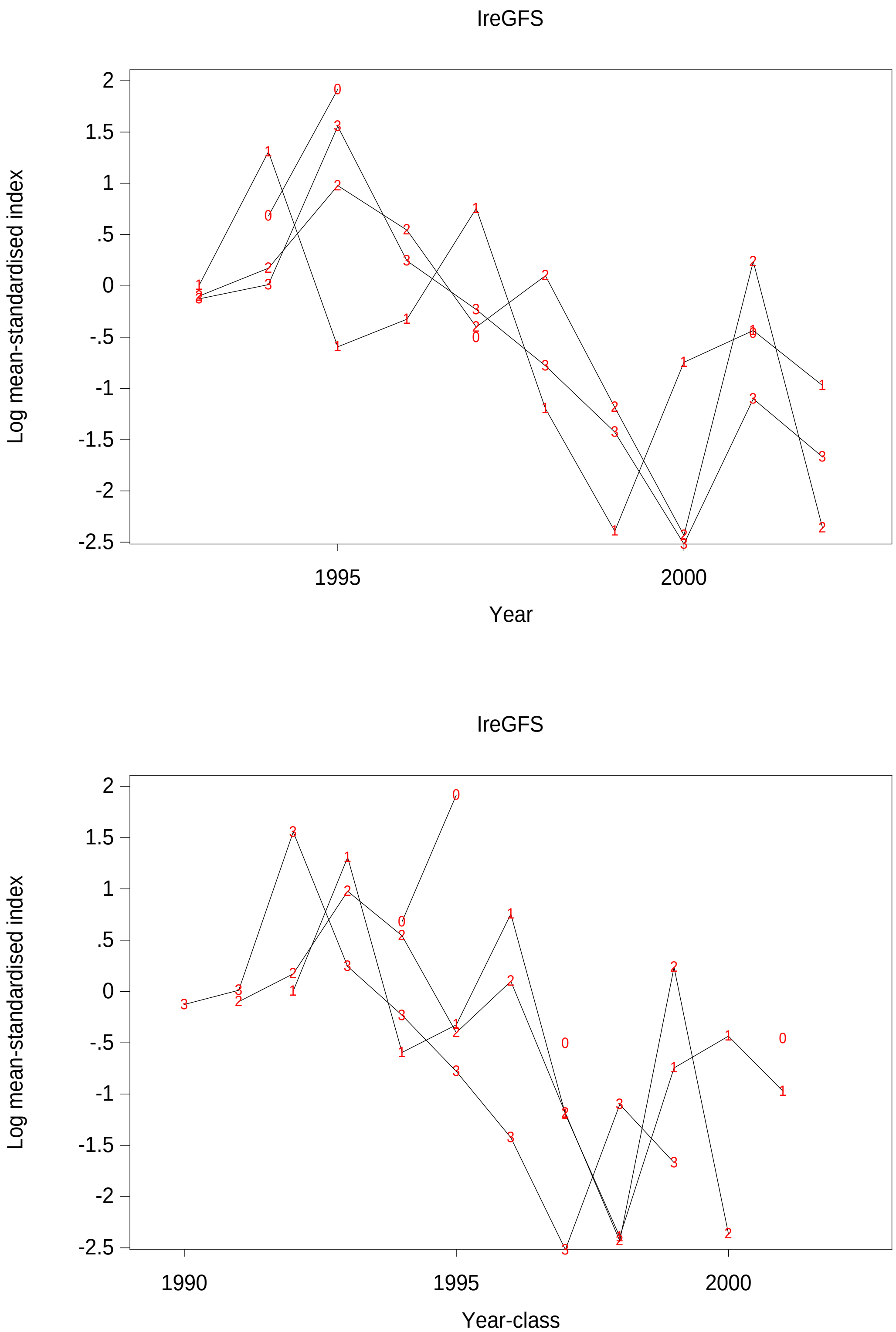


Figure 3.4: (cont). Cod in Division VIa. Log mean standardised survey index across all available ages. Irish ground fish survey (IreGFS) by year (upper) and year-class (lower).

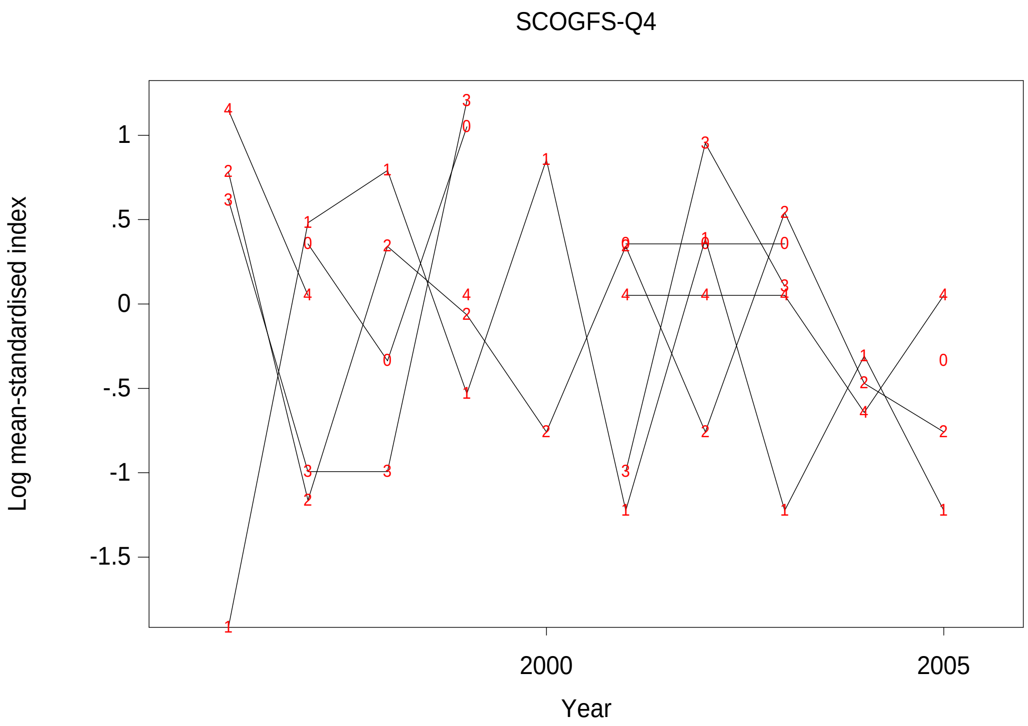
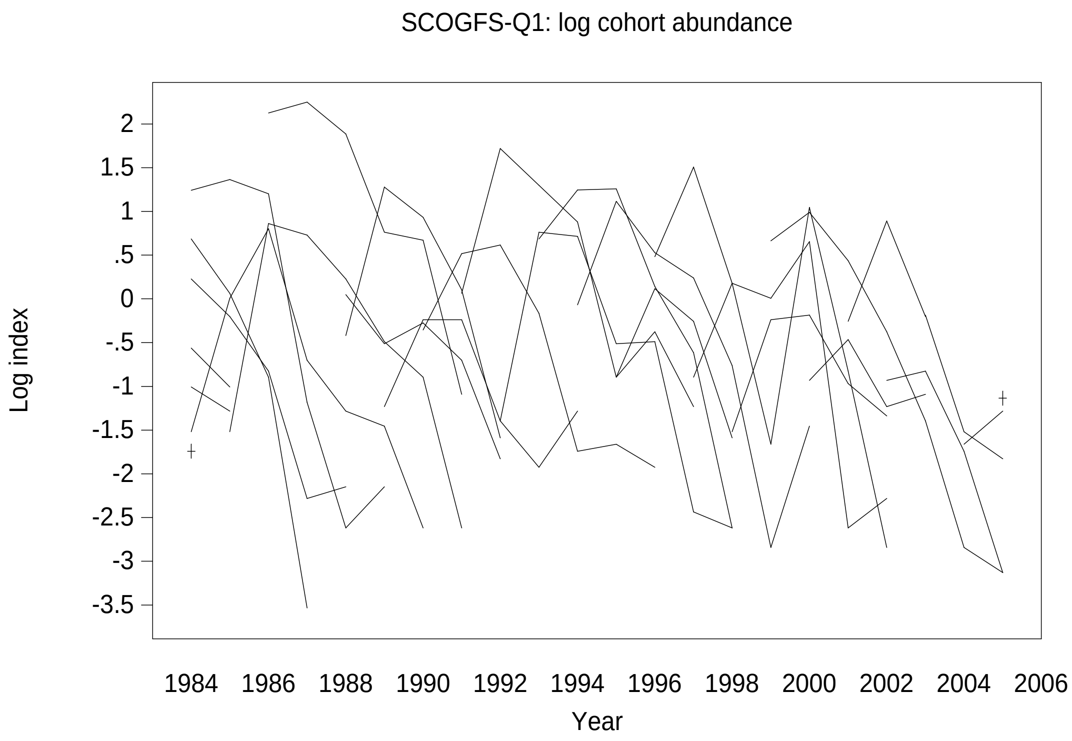


Figure 3.4: (cont). Cod in Division VIa. Log mean standardised survey index across all available ages. Scottish quarter four ground fish survey (ScoGFSQ4) by year (upper) and year-class (lower).



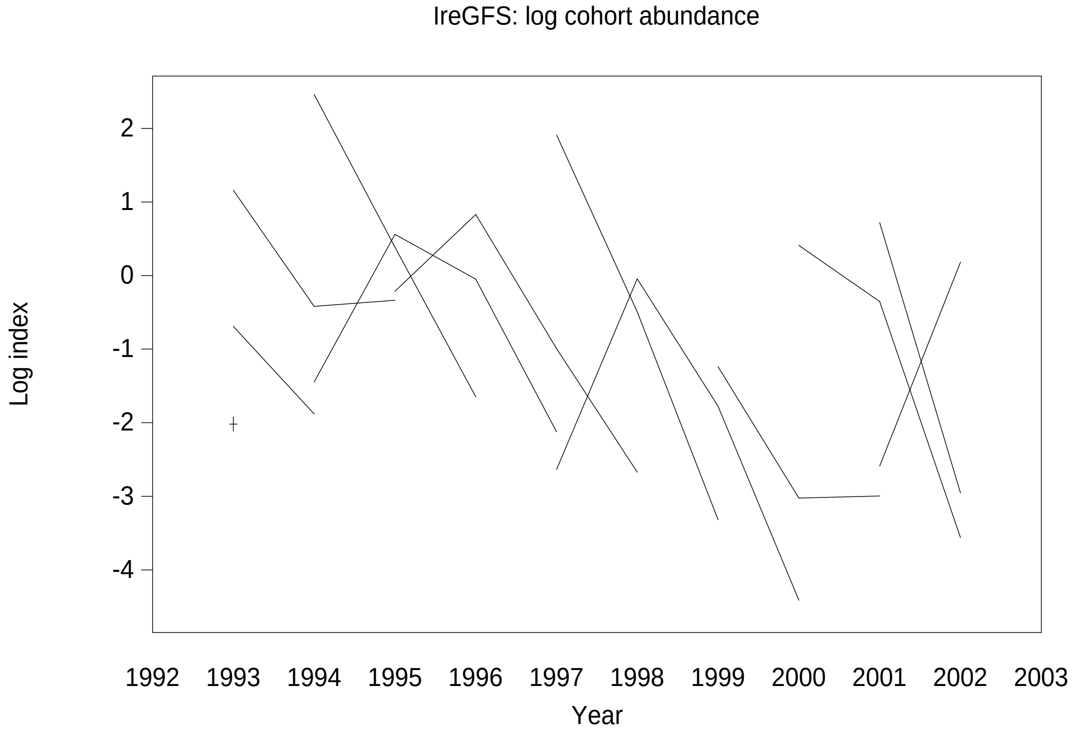


Figure 3.5: Cod in Division VIa. Log catch curves from Scottish quarter one ground fish survey (ScoGFSQ1), Irish ground fish survey (IreGFS) and scottish quarter four ground fish survey (ScoGFSQ4).

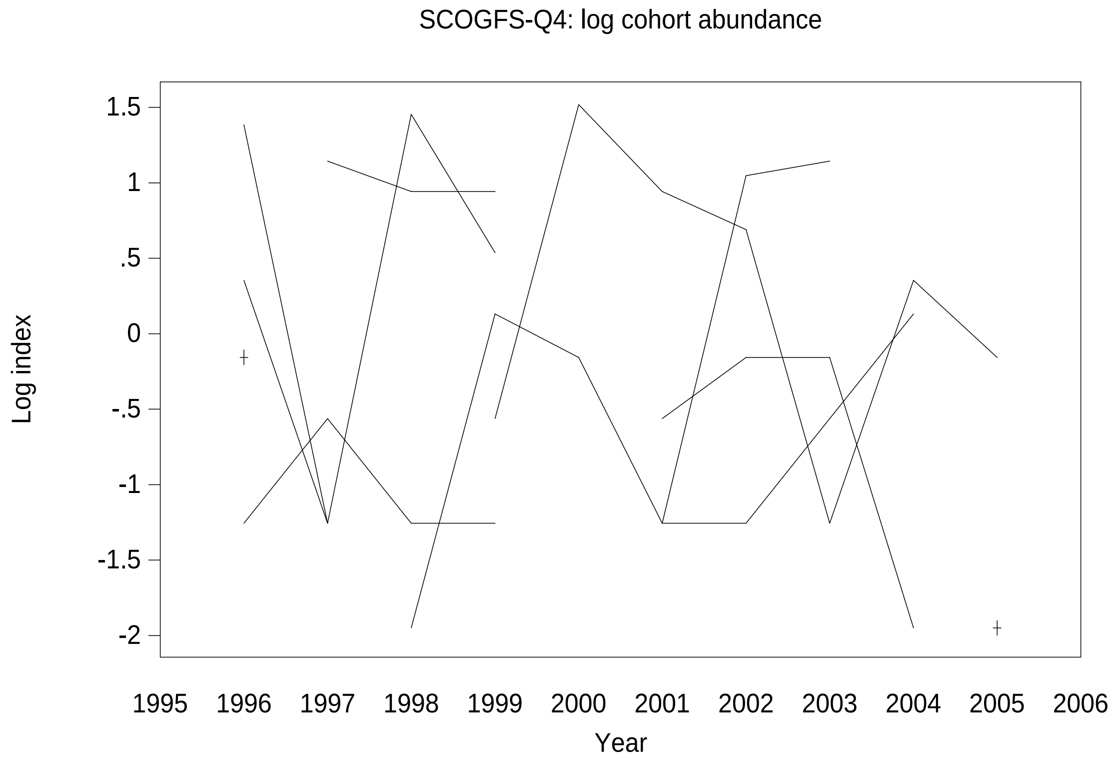


Figure 3.5: (cont): Cod in Division VIa. Log catch curves from Scottish quarter one ground fish survey (ScoGFSQ1), Irish ground fish survey (IreGFS) and scottish quarter four ground fish survey (ScoGFSQ4).

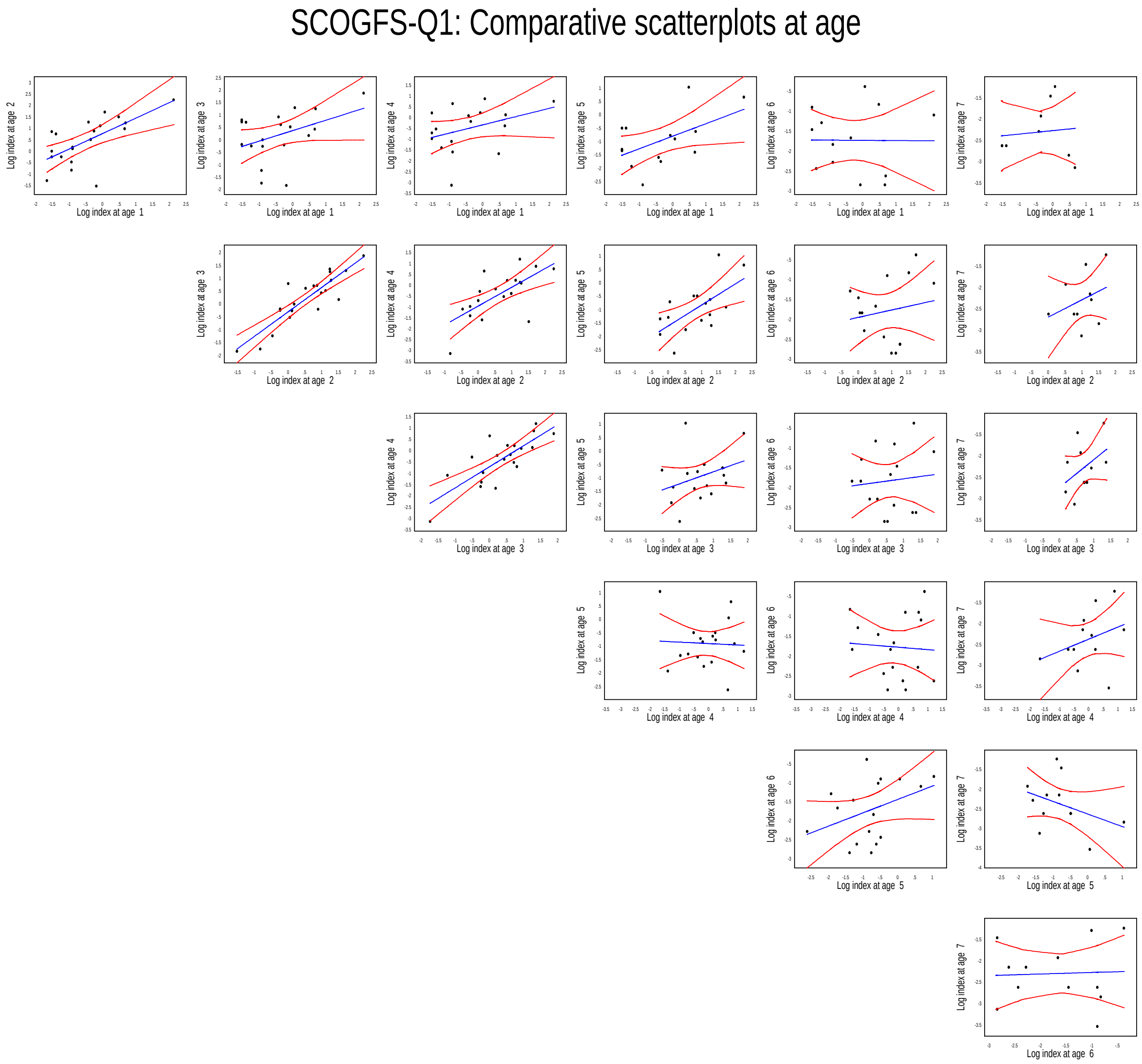


Figure 3.6: Cod in Division VIa. Comparative scatterplots at age for Scottish quarter one ground fish survey (ScoGFSQ1).

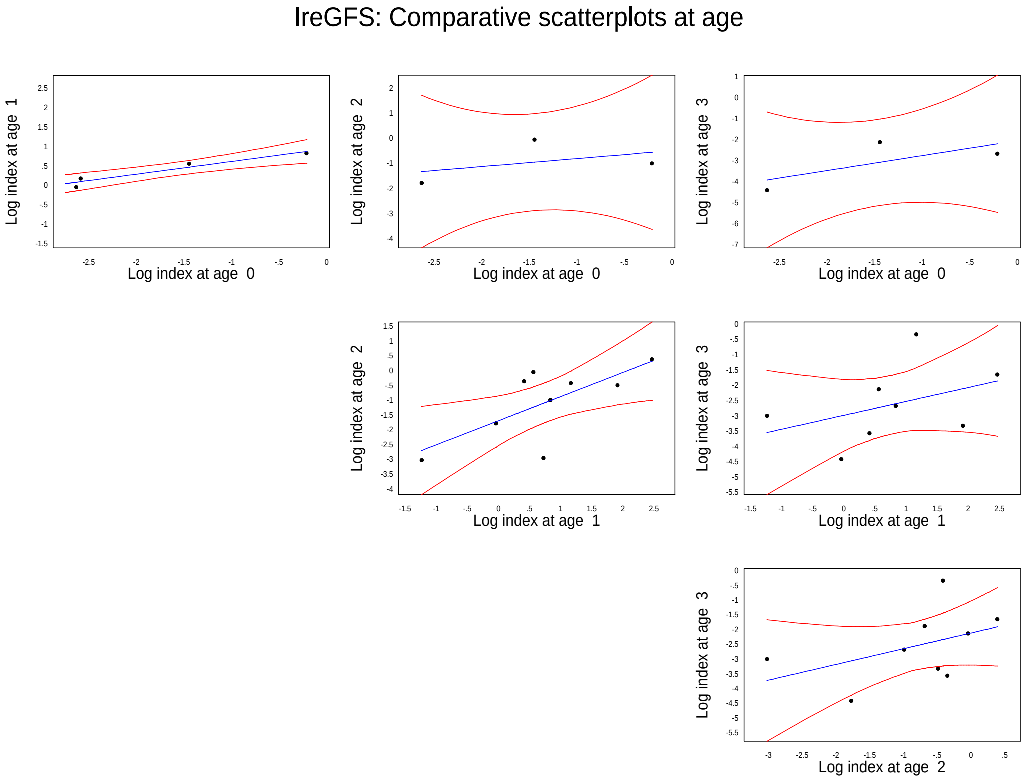


Figure 3.7: Cod in Division VIa. Comparative scatterplots at age for Irish ground fish survey (IreGFS).

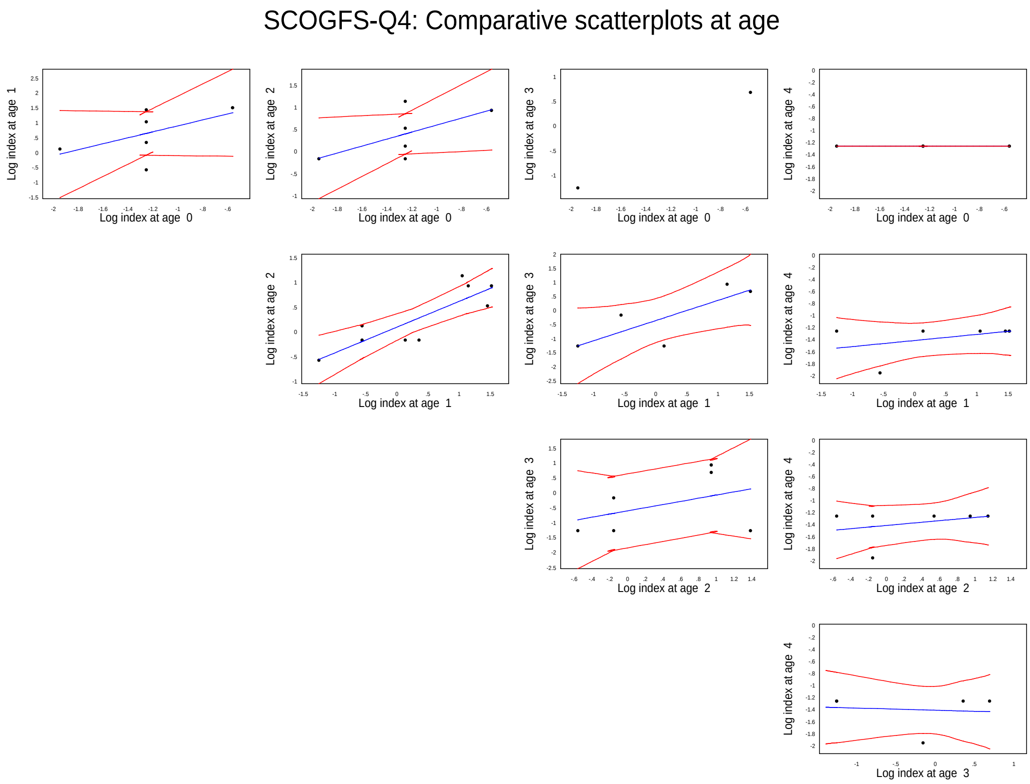


Figure 3.8: Cod in Division VIa. Comparative scatterplots at age for Scottish quarter four ground fish survey (ScoGFSQ4).

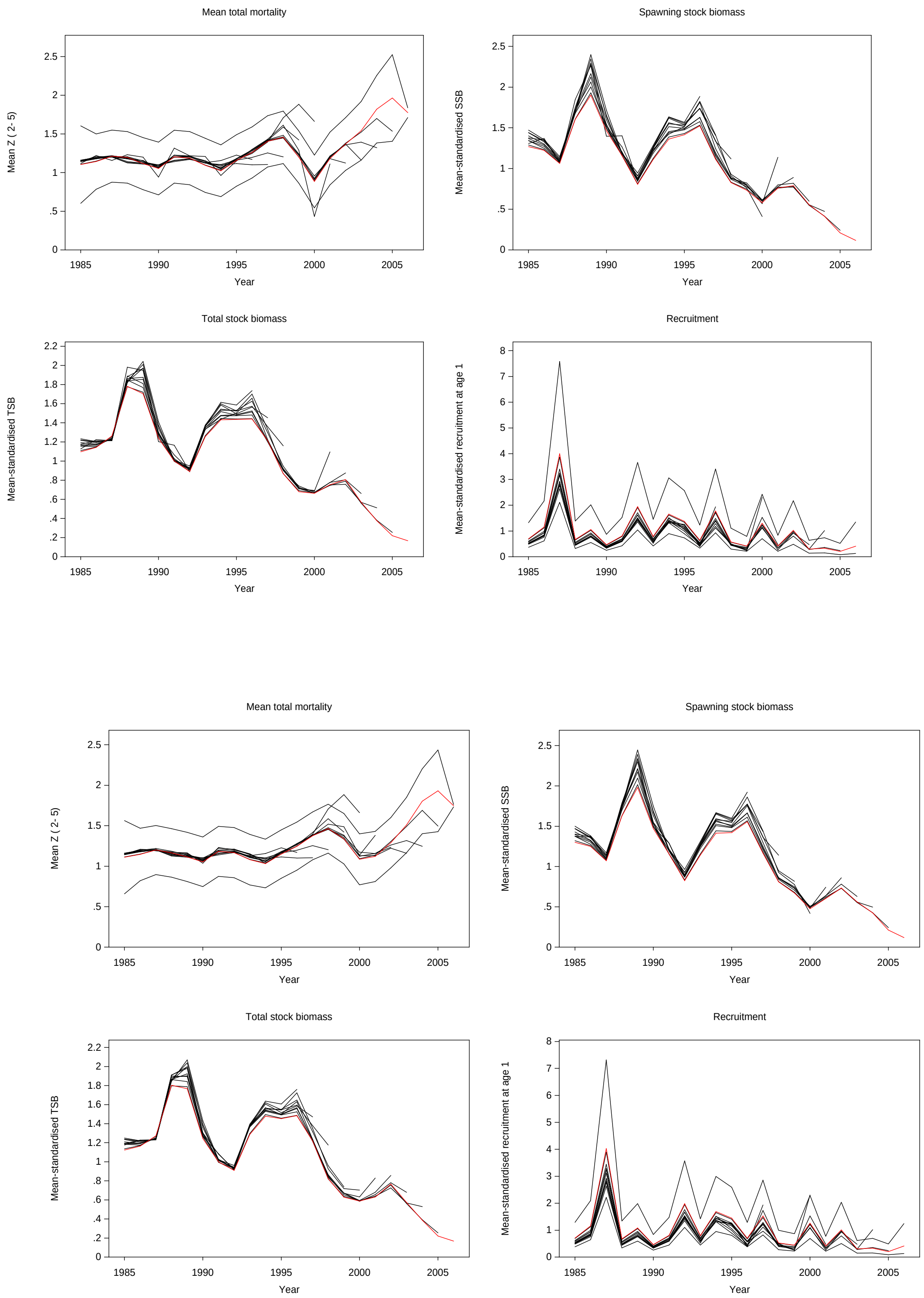


Figure 3.9: Cod in Division VIa. Retrospective summary plots of SURBA runs using settings as used in last year's final assessment (upper) and after survey index values at ages 3, 4 and 5 are given zero weighting in 2001 (lower).

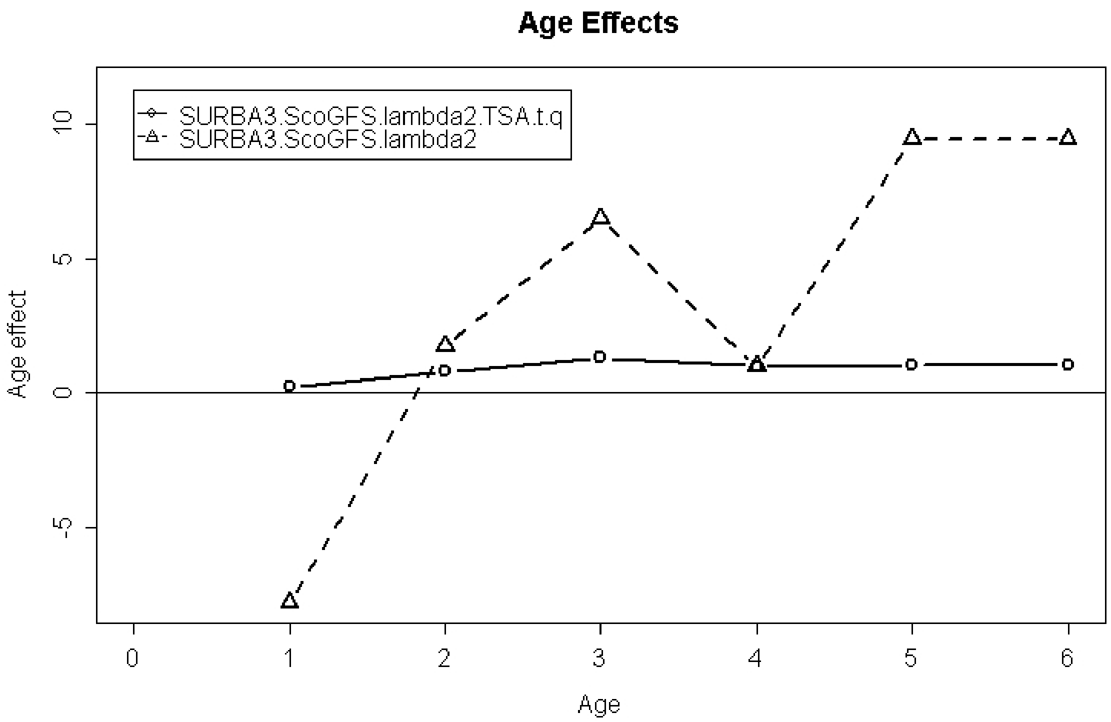


Figure 3.10: Cod in Division VIa. Age effects estimated from SURBA using ScoGFSQ1 data. solid line shows result after using catchabilities derived from comparison of TSA estimates to survey index values, dashed line shows result after assuming equal catchability at age.

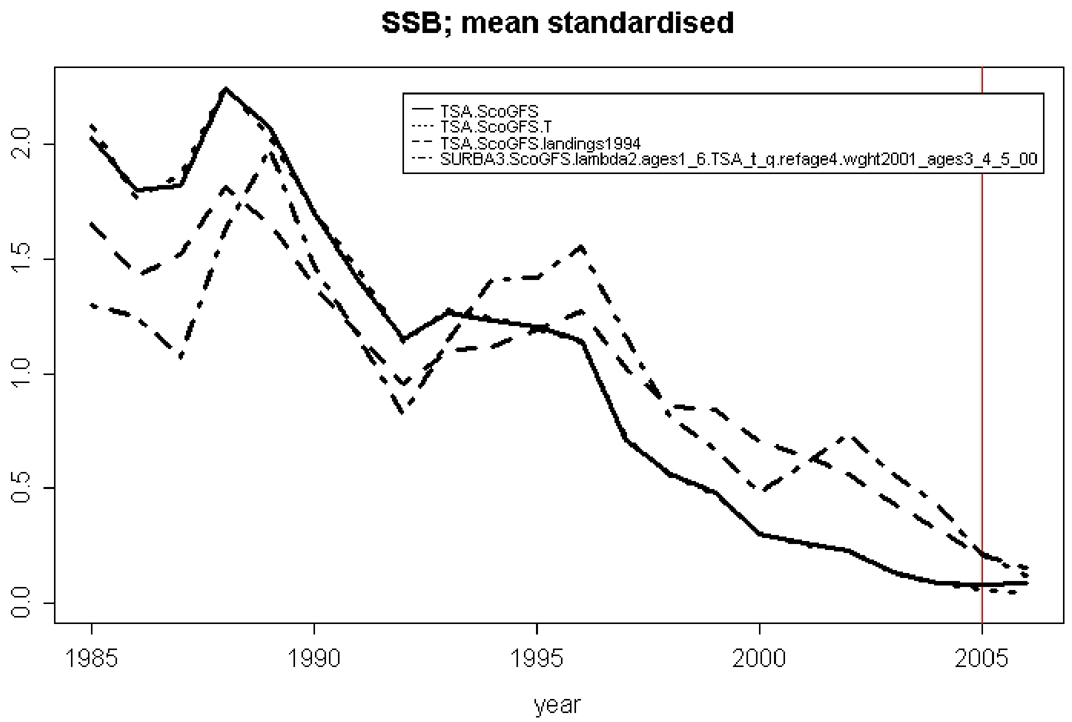


Figure 3.11: Cod in Division VIa. Mean standardised SSB. Comparison of TSA run using all commercial catch data and allowing trend in survey catchability (TSA.Sco.GFS.T); TSA run using all commercial catch data and allowing no trend in survey catchability (TSA.ScoGFS); TSA run using commercial catch data to 1994 only and no trend in survey catchability (TSA.ScoGFS.landings1994); SURBA run using Scottish quarter one ground fish survey data and settings as used for final run at WGNSDS$_{2004}$, (SURBA3.ScoGFS.lambda2.ages1_6.TSA_t_q.refage4_wght2001_ages3-4-5-00).

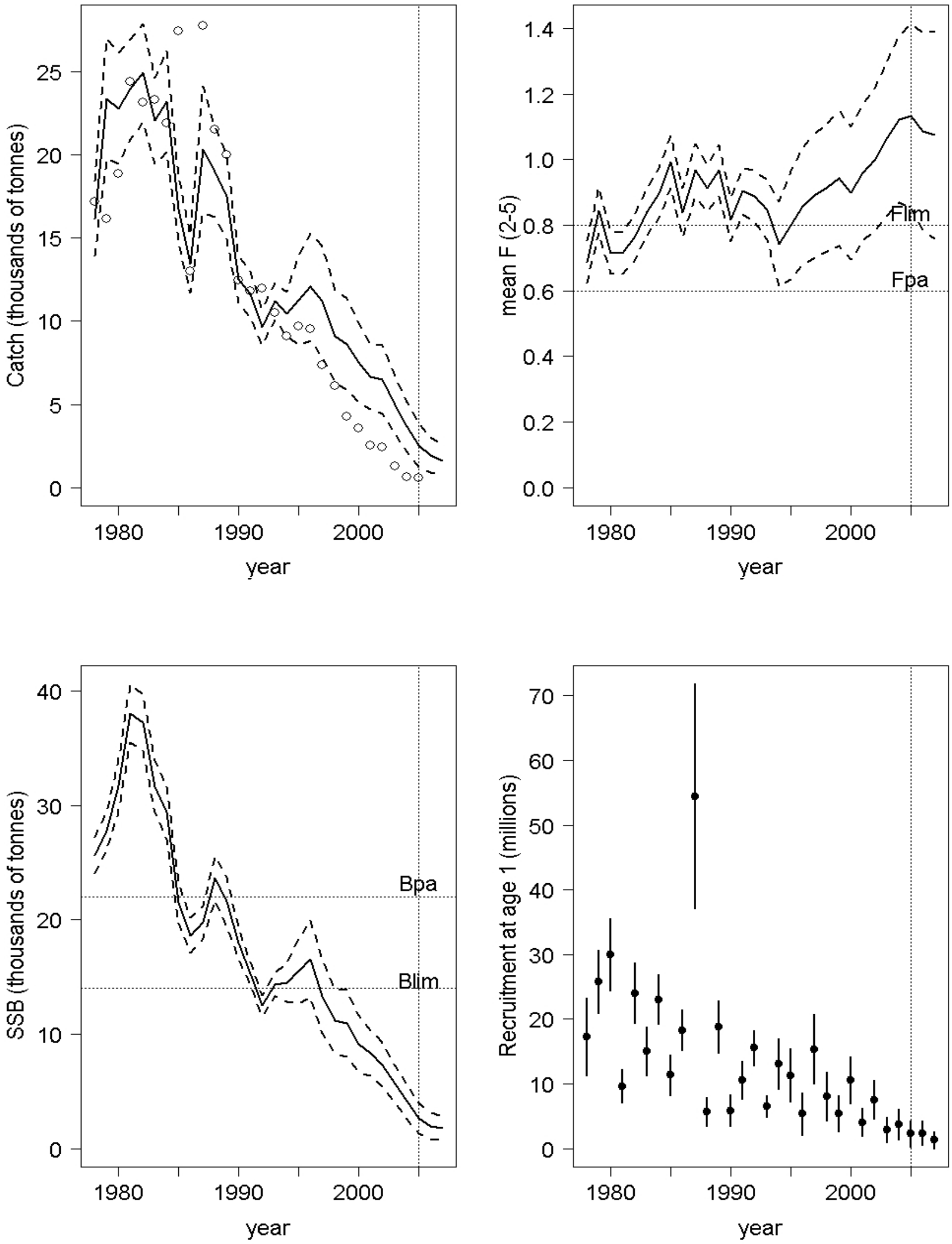


Figure 3.12: Cod in Division VIa. Summary plot of final TSA assessment run.

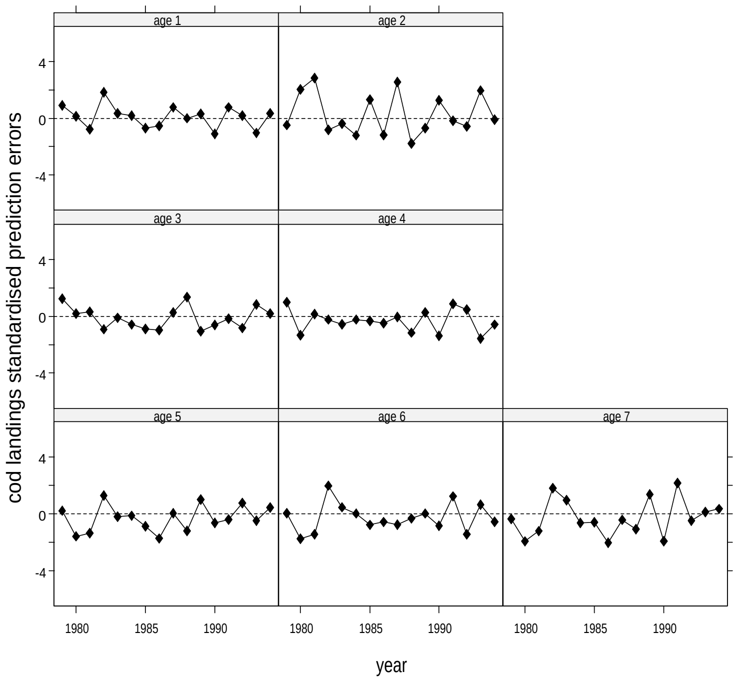


Figure 3.13: Cod in Division VIa. TSA final run. Standardised prediction errors at age plots for landings.

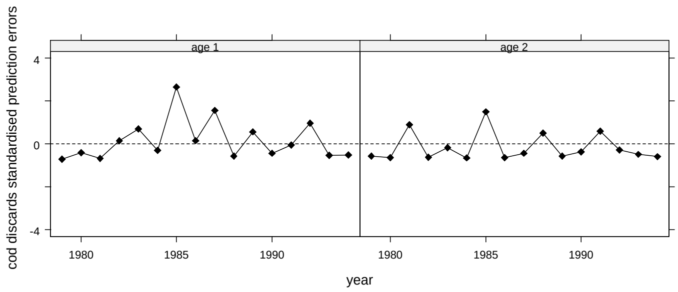


Figure 3.14: Cod in Division VIa. TSA final run. Standardised prediction errors at age plots for discards.

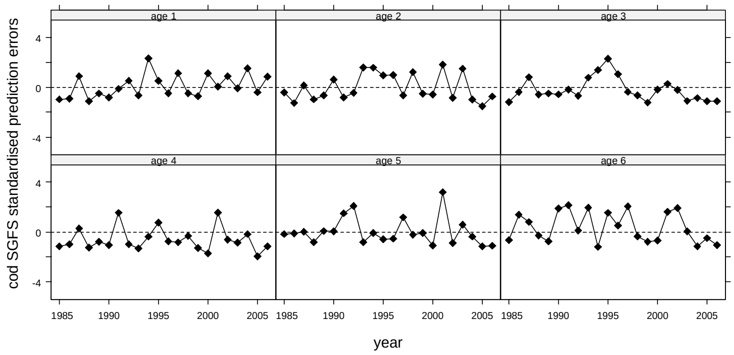


Figure 3.15: Cod in Division VIa. TSA final run. Standardised prediction errors at age plots for ScoGFSQ1.

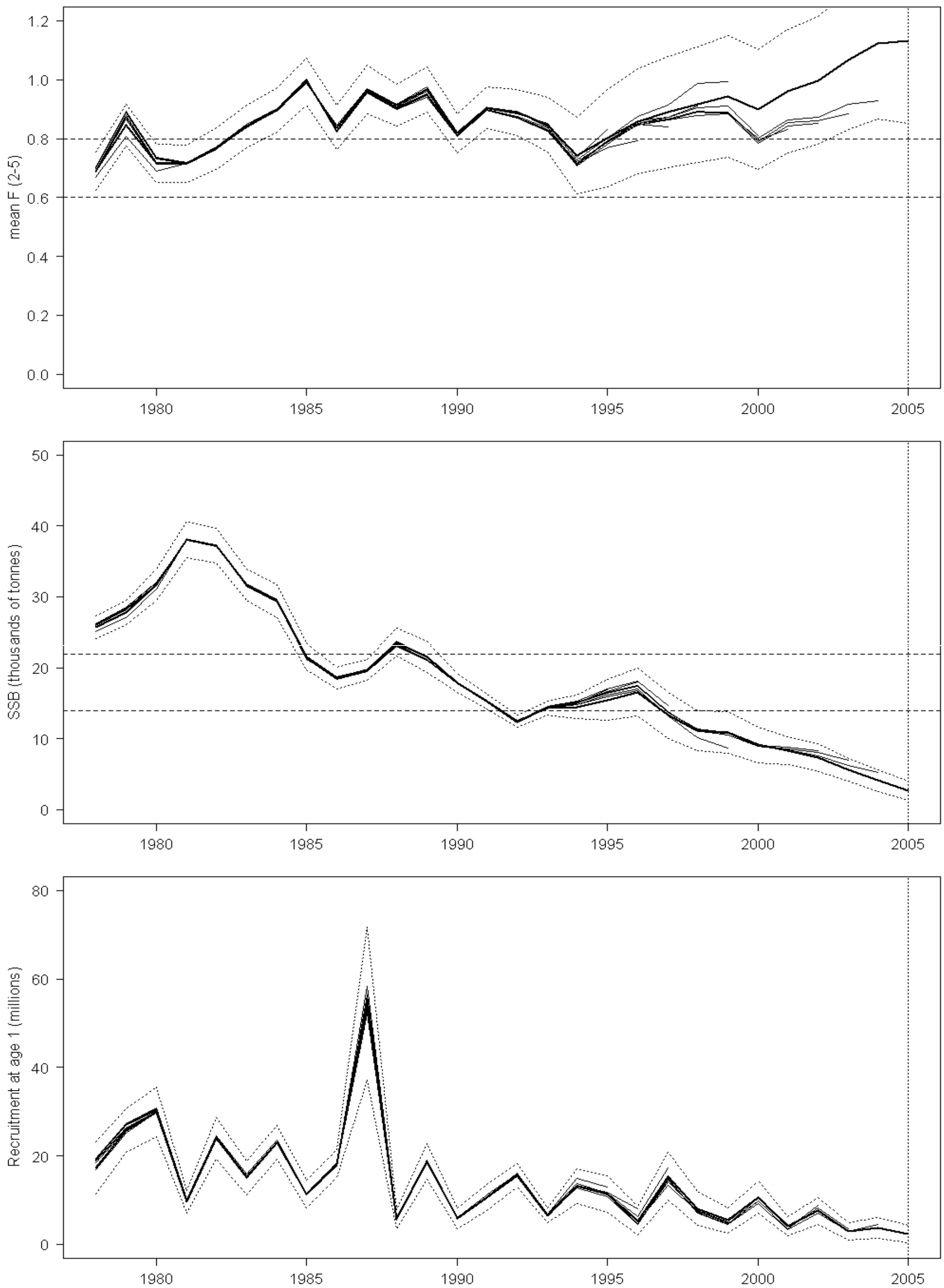


Figure 3.16: Cod in Division VIa. TSA final run. Retrospective plots of TSA final run. Biological reference points are given by dashed lines. Confidence intervals for the run using all years of data are shown by dotted lines.

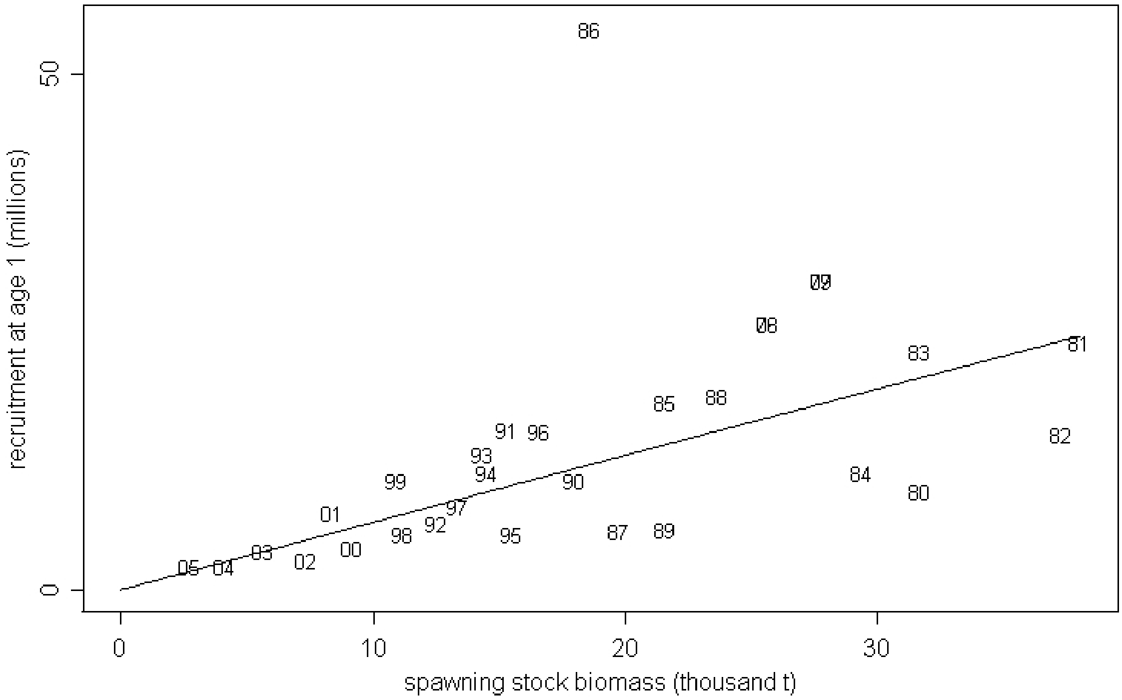


Figure 3.17: Cod in Division VIa. TSA final run. Stock-recruit relationship.

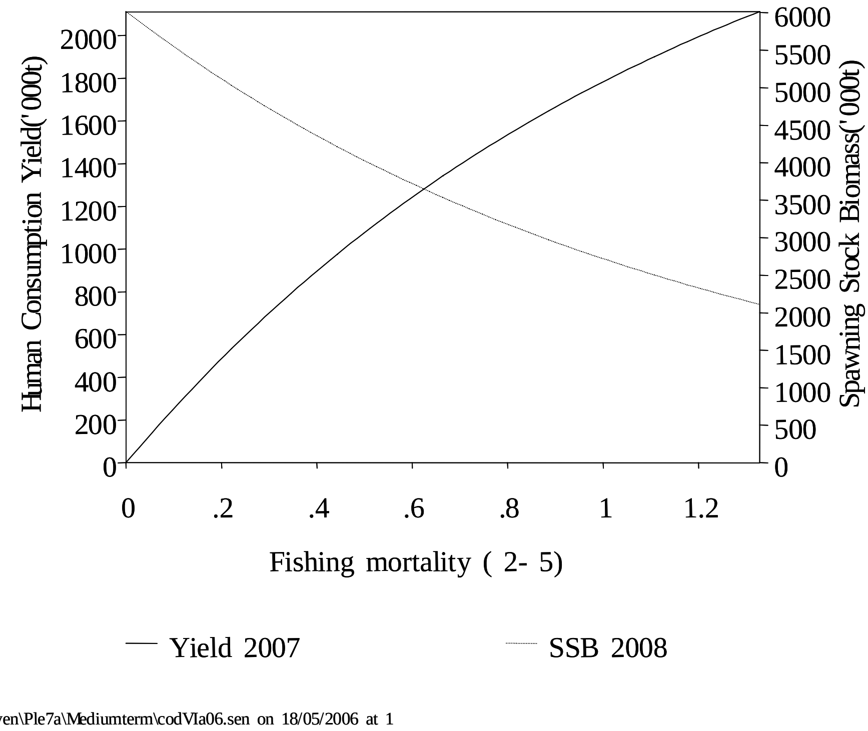
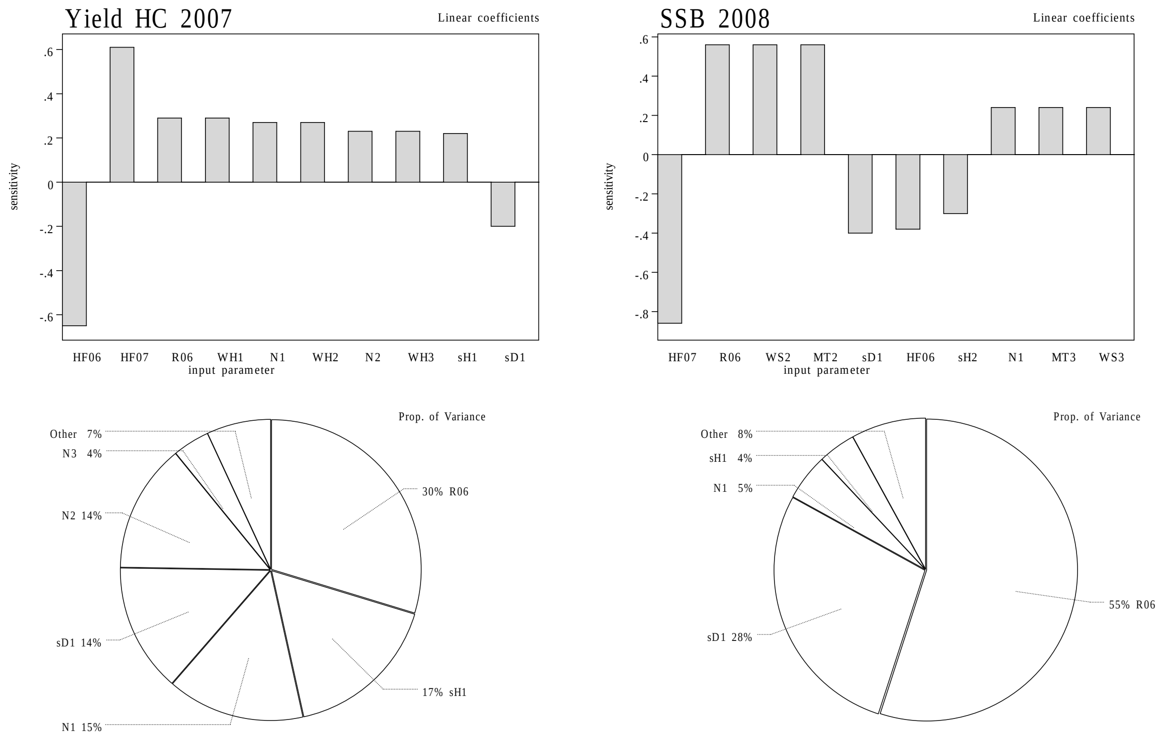


Figure 3.18: Cod in Division VIa. Short term forecast.

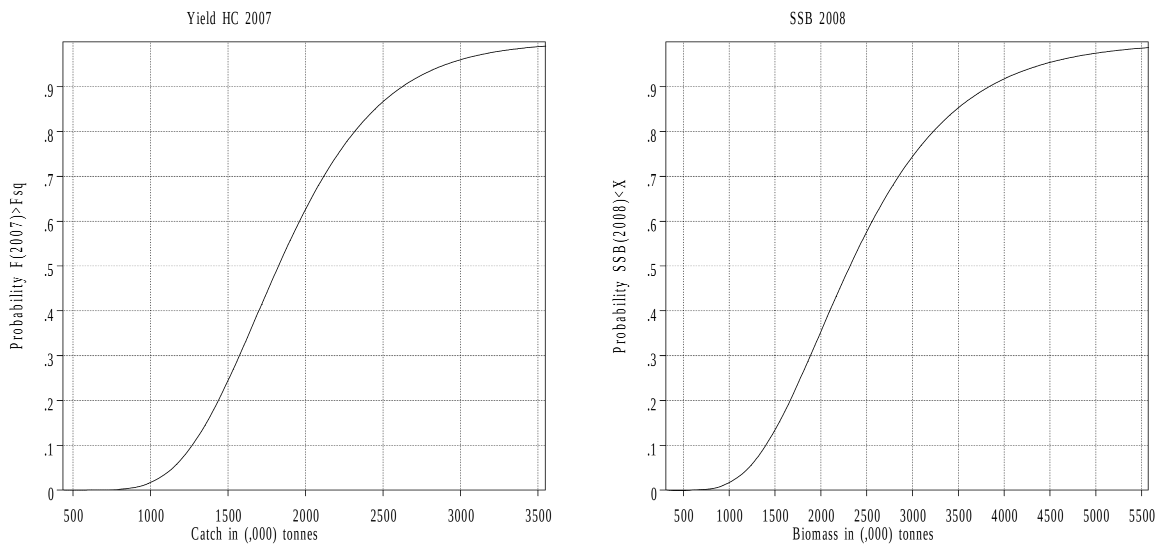
Figure Cod,VIa. Sensitivity analysis of short term forecast.



Data from file:D:\NOSH2006\Sven\Ple7a\Mediumterm\codVIa06.sen on 18/05/2006 at 1

Figure 3.19: Cod in Division VIa. Sensitivity analysis of short term forecast.

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



Data from file:D:\NOSH2006\Sven\Ple7a\Mediumterm\codVIa06.sen on 18/05/2006 at 1

Figure 3.20: Probability profiles for short term forecast.

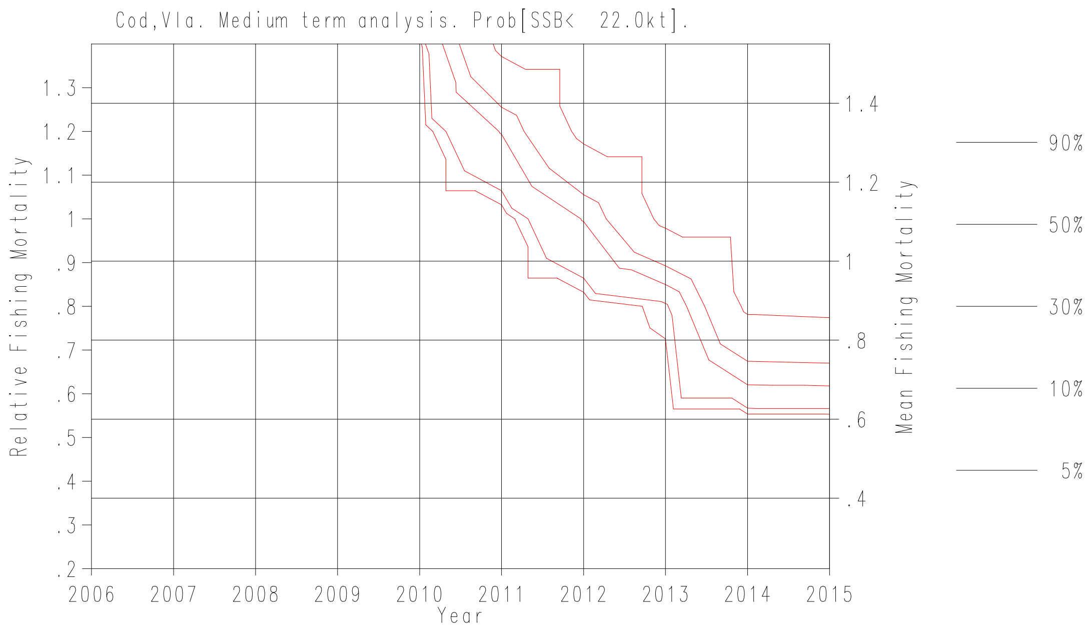


Figure 3.21: Cod in Division VIa. Probability of SSB being below Bpa over the next ten years.

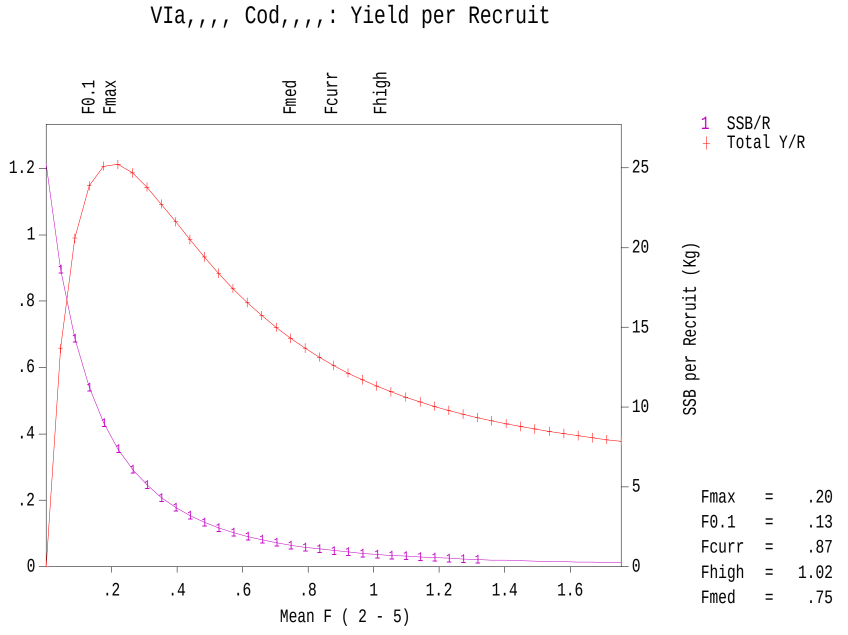


Figure 3.22: Cod in Division VIa. Yield and biomass per recruit.

4 HADDOCK IN SUB-AREA VI

4.1 Haddock in Division VIa

In 2004, continued concerns were raised by the WGNSDS Review Group in its October 2004 meeting about the appropriateness of the assessment models in the light of uncertainty in catch data and also concerns about assumptions and parameter settings in the assessment methods for this stock. The WG concluded that there were good reasons to examine more carefully an assessment method that utilised survey data. In 2005, as a result of these concerns, the WG explored the use of survey based assessments and concluded on a final assessment using SURBA. It was not clear to the Review Group why a TSA run, which showed similar results, had been rejected: consequently the Review Group was provided with an updated TSA as the definitive assessment for 2005, and a forecast was run based on this.

In 2006, a TSA run is presented as the final assessment which is based on: two surveys - the Scottish (Quarter 1) Groundfish Survey and the Scottish (Quarter 4) western division bottom trawl survey; and the omission of the catch (and discard) data from 1995-2005. A SURBA run using both surveys showed similar trends.

A Stock Annex is available for this stock (A.2).

4.1.1 The fishery

General information on the fishery can be found in the Stock Annex (A.2). This was last updated in 2004.

4.1.1.1 ICES advice applicable to 2005 and 2006

Following the ACFM meeting in October 2002, ICES recommended the closure of all fisheries for cod as a target or bycatch species. This advice was based on very low estimated stock size, poor recent recruitments, and continued high fishing mortality. Haddock are a key component of the mixed whitefish demersal fishery in Division VIa which also targets cod, and advice for the two species has generally been linked in the past (although the nature and strength of the linkage is uncertain). For this reason, ICES advised that fishing for haddock in Division VIa should not be permitted unless ways to harvest haddock without incidental catch or discards of cod could be demonstrated.

The form of ICES' advice changed in 2003 to take more account of the mixed nature of the fisheries prosecuting haddock. Management of haddock is, therefore, now also considered as part of other concerns in the Celtic Sea and West of Scotland ecosystem.

The advice relating to the single-species exploitation boundary in 2005 was:

> *"Exploitation boundaries in relation to high long term yield, low risk of depletion of production potential and considering ecosystem effects:*
>
> *The current estimated fishing mortality is 0.56. There will be no gain in the long term yield to have fishing mortalities above $\boldsymbol{F}_{max}$ (0.21). Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits.*
>
> *Exploitation boundaries in relation to precautionary limits:*
>
> *In order to maintain SSB above $\boldsymbol{B}_{pa}$ in 2006, ICES recommends a reduction in fishing mortality to less than 0.39. This corresponds to landings less than 7,600 t in 2005."*

The advice relating to the single-species exploitation boundary in 2006 was:

> *"Exploitation boundaries in relation to high long term yield, low risk of depletion of production potential and considering ecosystem effects:*
>
> *The current estimated fishing mortality is 0.49. There will be no gain to the long-term yield by having fishing mortalities above $\boldsymbol{F}_{max}$ (0.21). Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits.*
>
> *Exploitation boundaries in relation to precautionary limits:*
>
> *In order to maintain SSB above $\boldsymbol{B}_{pa}$ in 2007, ICES recommends a reduction in fishing mortality to less than 0.35. This corresponds to landings less than 8,000 t in 2006. Due to recent poor recruitments and in order to maintain SSB above $\boldsymbol{B}_{pa}$ also after 2007, a TAC for 2006 well below 8,000 t should be considered."*

The advice relating to the Celtic Sea and West of Scotland in 2006 was:

ICES have identified the stocks that are below $\mathbf{B}_{\mathrm{lim}}$, i.e. cod in Division VIa and haddock in Division VIb. These stocks are the overriding concerns in the management advice of all demersal fisheries:

- for cod in Division VIa ICES recommends a zero catch;
- for haddock in Division VIb the catches should be reduced to the lowest possible level;
- for spurdog the catches should be zero.

Demersal fisheries in Subarea VI should, in 2006, be managed according to the following rules, which should be applied simultaneously:

They should fish:

- without catch or discards of cod in Subarea VI;
- without catch or discards of spurdog;
- no directed fishery for haddock in Division VIb;
- concerning deep water stocks fished in Subarea VI;
- within the biological exploitation limits for all other stocks (see table above).

Furthermore, unless ways can be found to harvest species caught in mixed fisheries within precautionary limits for <u>all</u> those species individually then fishing should not be permitted.

4.1.1.2 Management applicable in 2005 and 2006

The 2005 TAC for haddock in ICES areas Vb (EC waters) and VIa was 7600 tonnes. In 2006, the TAC was 7810 tonnes.

Minimum landing size for this stock is 30 cm.

Regulations implemented for the west of Scotland, including technical measures associated with the cod recovery plan, are described in Section 1.7.

The following table summarises ICES management advice and the EC management applied for haddock in Division VIa during 2004–2006:

YEAR	SINGLE-SPECIES EXPLOITATION BOUNDARY	BASIS	TAC FOR VB (EC), VI, XII, XIV	% CHANGE IN F ASSOCIATED WITH TAC[1]	2006 WG ESTIMATE OF LANDINGS
2004	12.2	No cod catches	6.50[2]	-50%	3.20
2005	7.6	0.75*$\mathbf{F}_{pa}$	7.60[2]	-30%	3.15
2006	7.8	0.7*$\mathbf{F}_{sq}$	7.81[2]	3%	-

Values are thousand tonnes. [1]Based on *F*-multipliers from forecast tables. [2]TAC for Vb (EC) and VIa only.

4.1.1.3 The fishery in 2005

The fishery for haddock on the west coast of Scotland in area VIa takes place as part of a mixed fishery with varying proportions of other species present in the catches depending on location and time of year. Most of the haddock are taken by medium sized trawlers operating outside the inshore areas of the Minches and Firth of Clyde. Cod is present in some locations and management arrangements directed at conserving this species had a major effect on haddock fishing in 2005. In particular, the completion of a major round of Scottish decommissioning, the implementation of restrictive days at sea regulations and the presence of a closed area for cod to the north west of Scotland (where haddock catches are also made) have had the effect of reducing activity for haddock.

Reported effort declined to very low levels in both Scottish fleets for which effort data are available to the WG (pair trawlers and light trawlers; see Figure 4.1.1 and Table 4.1.1). The historic 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 WGNSSK (ICES 2001). The LPUE for the Scottish light trawlers does, however, bear some resemblance to the trends in the assessment (*cf.* Figures 4.1.1 and Figure 4.1.26).

The latest ICES WG FTFB report outlines a number of technical issues relating to fishing technology that may impact on fishing mortality and more general ecological impacts. Specific points in relation to VIa haddock are:

- There is evidence of whitefish boats moving between Areas IVa and VIa to retain haddock and monkfish quotas and create track record in both areas. There is evidence of mis-reporting of haddock and other species caught in VIa & b landed as IVa (implication: inaccurate landings data).
- There is increasing concern in the industry in the rising cost of fuel, with many vessel owners seriously considering leaving the industry. Several twin-rig vessels targeting monkfish have reverted to single-rigging. Fuel costs across nearly all sectors are now running at 35-50% of their gross earnings. Certain beam trawl fleets, the larger twin-riggers and the 30m+ whitefish trawlers have been hardest hit. Owners have become increasingly fuel conscious, steaming to and from fishing grounds at reduced speed and shutting down all engines while at port. There is also evidence of fishermen begin to experiment with gear designs to improve fuel efficiency (implication: Change in CPUE).

4.1.2 Catch Data

4.1.2.1 Official Catch Statistics

Official (reported) catch data for each country participating in the fishery are given in Table 4.1.2. The data for 2005 seem incomplete with figures unavailable for some countries.

4.1.2.2 Revisions to catch data

There were small revisions to WG estimates of catch data made by Ireland. Official statistics were updated.

4.1.2.3 Quality of the Catch data

The quality of catch statistics for this stock is questionable. The TAC for haddock in Division VIa in 2005 was intentionally restrictive, which increases the likelihood that underreporting may be high, but uncertainty about both recorded effort and recorded landings means that the WG has no quantitative basis on which to draw conclusions about the presence or extent of any misreporting. The predicted *status quo* landings in 2005 were 12800 t, which is considerably higher than the corresponding WG estimate used at the WG (3148 t).

Since it was not possible to investigate the reliability of the catch data fully, the WG instead took the decision once again to pay particular attention to a survey based approach in an effort to avoid relying on poor catch statistics.

4.1.3 Commercial catch-effort data and research vessel surveys

The available commercial and research-vessel CPUE data are described in the Stock Annex (Sections B.3 and B.4), and are tabulated in Table 4.1.1 and Table 4.1.3 respectively. The commercial effort and landings per unit effort are plotted in Figure 4.1.1.

In view of the decision to utilise a survey dominated approach, closer attention was paid to the full range of surveys available for this stock. In recent years the only tuning series used in the assessment has been the Scottish Q1 groundfish survey (SCOGFS). A second survey conducted by Scotland in the fourth quarter (the Scottish western division bottom trawl survey - SCOQ4) now has ten years of data from 1996. It was considered worthwhile to utilise this survey. Some questions were raised about the independence of the two survey datasets, given that the survey design criteria applied are those taken from the IBTS survey which is a fixed station design. In actual fact, a fixed set of stations exist from which each sample can be chosen, but the selection of these is such that the positions are rarely identical for the two (*cf.* Figure 4.1.2a and Figure 4.1.2b). More significantly, the two surveys take place three months apart and this should provide sufficient temporal variation to ensure that the two are independent.

The Irish groundfish survey (IREGFS) has been examined in earlier WG meetings. This survey has previously not been considered to be a good abundance index of haddock in Division VIa - it has also been discontinued. At the 2005 WG it was felt worthwhile to re-examine the characteristics of this survey alongside the two Scottish ones using the multisurvey SURBA: this was repeated this year to confirm the utility of this survey using the latest version of SURBA (v3.0). A new survey (IRGFS) replacing the IREGFS has only been running for two years and is not yet suitable for tuning. Further discussion of the available commercial tuning data are described in the Stock Annex (Section B.4).

4.1.4 Age compositions and mean weights at age

4.1.4.1 Landings age compositions and mean weights-at-age

The WG estimate for total international catch in 2005 is 6,903 t, consisting of 3,148 t landed and 3,755 t discarded fish. These estimates for total catch and landings are the lowest in the available 41 year time-series, and the estimate for discards is the fifth-lowest (Table 4.1.4).

Quarterly catch-at-age data were available from Scotland and Ireland. The countries that provide data are listed in Table 2.2, and sampling levels are shown in Table 2.3.

The sampling, raising and collation procedures for age-compositions and mean weights-at-age are described in the Stock Annex (Sections B.1 and B.2). Data are presented in Tables 4.1.5 and 4.1.6 (estimated numbers-at-age in total catch and landings,), and Tables 4.1.7–4.1.8 (mean weights-at-age in these catch components). Figures 4.1.3–4.1.4 show that mean weights-at-age in total catches and landings have generally declined in recent years over all ages, with the exception of the older year classes (ages 7 and 8) which have increased in mean weight in recent years.

4.1.4.2 Discards age compositions

Discard age compositions from Scottish and Irish sampling are given in Table 4.1.9. Since these samples are raised to landings figures the quality of the estimated magnitude is questionable although the age compositions are thought to be reliable. Discard mean weights-at-age are quite variable, and do not show obvious trend (Table 4.1.10 and Figure 4.1.5).

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). Historically discard age compositions from Scottish sampling have been applied to the unsampled fleets. The revision of the Irish discard data to accommodate a new raising procedure and the provision of a time series will require that the overall time series of discard estimates is recalculated. Work is also underway to revise the Scottish discard estimates with an aim to reduce bias and increase precision. A working document set out the methodology of this work at the 2004 WG and it is expected that changes will be made once parallel work for the North Sea is completed.

4.1.5 Natural mortality, maturity and stock weights at age

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

AGE	1	2	3+
Proportion mature	0.00	0.57	1.0

The derivation of these values is discussed in the Stock Annex (Section B.2). Proportion *F* and *M* before spawning were both set to 0.0, in order to generate abundance (and hence SSB) estimates dated to January 1st.

4.1.6 Catch at age analysis

Section 2.7 outlines the general approach adopted at this year’s WG meeting. A catch at age TSA analysis was carried out as part of this year’s assessments, but the catch at age and discards at age data from 1995-2005 inclusive were excluded from the model fit.

4.1.6.1 Data screening

Commercial catch data

Given concerns about misreporting of catch and effort in the last 12 years, these data are not considered for assessment or tuning purposes. Previous examinations of the commercial catch data were based on a separable VPA (Lowestoft assessment suite; Darby and Flatman 1994) run on the available catch-at-age dataset (years 1978–2004, ages 1–8+). The data prior to and including 1994 are considered to be more reliable. TSA, which can use a restricted time series provided that an up to date set of survey data are also available, was therefore, considered the most appropriate model to use when incorporating catch data.

Survey data

SURBA 3.0 was used to explore the survey characteristics for the three surveys available. Figure 4.1.6 shows mean-standardised log survey indices for SCOGFS, SCOQ4 and IREGFS, both by year-class and by year. The SCOGFS and SCOQ4 surveys track cohort strengths well, except for a period in the mid-to-late 1990s when cohorts are less clearly defined. Tracking is less obvious in some cohorts in the IREGFS.

Catch curves for the two Scottish surveys (Figure 4.1.7) are relatively linear and not very noisy, and indicate a fairly consistent drop in abundance from ages 2 to 3. The exception, as pointed out in the October 2003 ACFM Technical Minutes, is the 1999 year-class which shows a reduced decline in abundance between ages 2 and 3. The IREGFS shows a noisier pattern, reduced linearity and several large hooks where the abundance at age 2 is greater than that at age 1 for the same year class.

Log index values at different ages are compared for each survey in bi-variate plots in Figure 4.1.8. The Scottish survey results support the conclusion that the index value at age *a* of a cohort is a good indicator of the index value at age *a* + 1. The bi-variate plot for the IREGFS has wider confidence bounds, has occasional inverse relationships (high index values at age *a* of a cohort associated with low index values at age *a* + 1), and involves rather few data. The relationships for the older ages are particularly poor.

4.1.6.2 Exploratory assessments

SURBA

At the 2005 WG, SURBA 3.0 was used to analyse the three available surveys: SCGFS, SCOQ4 and IREGFS. Settings for SURBA were established from several exploratory runs, and the SPALY settings for last year's final run were used in this year's analyses:

SETTING	SCOGFS	SCOQ4	IREGFS
Year range	1985-2006	1996-2005	1993-2002
Age range	1-7	1-5	1-7
Reference age	4	4	4
Catchability at age	1	1	1
Lambda	1	1	1
Age weighting	1*	1	1

* Weightings were modified as described below for SCOGFS in the final run.

Some difficulties were experienced with last year's SURBA runs, so some of the exploratory runs were carried out again to confirm which options were best used in the final run with the latest version of SURBA (v3.0). A run using all three surveys gave the unsatisfactory residual patterns from the IREGFS (Figure 4.1.9). Using all three surveys, also gave significant retrospective patterns in Z, SSB and TSB. When combined with examination of the raw data, which show the IREGFS to have poor bi-variate plots (Figure 4.1.8) and large catch curve hooks (Figure 4.1.7), it was decided to remove the IREGFS from subsequent analyses.

Subsequent analyses concentrated on the SCOGFS and SCOQ4 surveys. A SPALY run (using just the SCOGFS) was found to produce similar results to a run which included both surveys. As the surveys were deemed sufficiently independent for both to be considered, and as both showed consistent signals, it was decided that the final SURBA run would use both surveys. Examination of the residual patterns form the dual survey run (Figure 4.1.10) indicated that three data points fitted more poorly to the model (1995 age 7; 2004 age 7; and 2000 age 5), so these were down weighted (weighting of 0.5). Down weighting is achieved using a weighting file (*.DAT) with the same structure as the input data files, only replacing the index values with the weights: this weighting file is specified as input to SURBA on line 15 of the *.idx file. The effect of using two surveys on the precision and bias of the assessment could not be evaluated fully at the working group and it is recommended that this be done intersessionally.

The latest version of SURBA has a scan settings mode which allows several runs to be performed allowing for various permutations of the settings. Settings were varied as follows: reference age 2, 3, 4, 5 and 6; lambda 0, 0.5, 1.0, 2.0 and 3.0; catchability at age 1 (Q1) 1, 0.5 and 0.1. The summary plots (mean Z, recruitment, TSB and SSB) from these three sets of options are given in Figures 4.1.11, 4.1.12 and 4.1.13 respectively. Adjusting the reference age had little effect (Figure 4.1.11), particularly on TSB, SSB, and recruitment where the difference is almost negligible. The main effect of reducing lambda (Figure 4.1.12) was to produce much variable fishing mortalities. The smoothing effects were much more superficial for SSB and recruitment. It appears that using a value of 1 reduces the amplitude of noise (characteristic of survey data with higher variance) without removing important trends. The effect of catchability at age 1 influences TSB as might be expected, but has little effect on SSB and recruitment (Figure 4.1.13).

Figure 4.1.14 gives the output from SURBA for the final dual survey run. The model inputs, settings and output results are given in Table 4.1.11. The assessment shows an increase in biomass in the latter part of the series arising from the 1999 year class; the biomass peaked in 2002 and has since declined, while Z has dropped from high values in the late 1990's to about 0.8 in the last 3 years. Temporal-trend estimates (i.e., the year-effect in fishing mortality) are sensitive to variability in survey data and are hence noisy, while the age-effect is relatively smooth with a dip at the reference age. Figure 4.1.15 shows the retrospective runs from the final dual survey SURBA run: with the exception of fishing mortality, these are relatively well behaved.

TSA

An update of one of the TSA assessments performed at the 2004 and 2005 WGs was carried again this year. Given the continuing uncertainty about the reliability of the catch data over a period of years, it was decided to update the Option C assessment which involved excluding catch data from 1995 to 2005 and including the SCOGFS survey series without a catchability trend. All settings were set the same as in 2005 (SPALY). The stock summary (mean $F_{2\text{–}6}$, SSB and recruitment) from the SPALY TSA run (Figure 4.1.16) shows that following high values in the mid to late 1990's, fishing mortality has now declined to one of the lowest in the series. The assessment suggests that following a peak in spawning biomass in 2002, there has been a recent decline. Predicted landings are stable and higher than observed, while predicted discard numbers (and catch) have declined as a result of the lower recruitments since 1999. The results from the equivalent TSA run from 2005 are given in Figure 4.1.17.

An exploratory TSA run was then performed using both of the Scottish trawl surveys (SCOGFS and SCOQ4). Once the coding was completed for the model to accept two surveys, some model adjustments had to be made in terms of starting value parameterisation. Two data points were also down-weighted based on an examination of the prediction errors from the SCOQ4 survey data (see Figure 4.1.18).

4.1.6.3 Final assessment

The final assessment was carried out using TSA and both of the Scottish trawl surveys (SCOGFS and SCOQ4). The catch and discard data from 1995 to 2005 were not included as part of the model fit. Table 4.1.12 lists TSA parameter estimates from the final run along with the SPALY run described above, and some of the final-run estimates from previous WG reports. Standardised SCOQ4 prediction errors for the final TSA runs are given in Figure 4.1.19 for comparison with those from the exploratory run. Standardised landings prediction errors for the TSA runs are given in Figures 4.1.20. Most of these residuals lie within the expected range (-2, 2), with only occasional year age values greater than 3. The equivalent plots for discards (Figures 4.1.21) show a few more, larger residual values. Those for the SCOGFS survey (Figures 4.1.22) are generally well behaved. Estimated discard ogives generally fit the observed data well for the final TSA runs (Figure 4.1.23). The exception is towards the end of the time series, where the projected discard proportions are lower than the observed proportions for most of these years. However, the data from 1995-2005 are fitted with the same ogive parameters due to the catch and discard data not being used and so the reliability of these fits is poor. A stock-recruit scatterplot from the final runs is presented in Figure 4.1.24; the Ricker curve used in the TSA estimation process is included. Population estimates from the final TSA model run are given in Table 4.1.13. Fishing mortalities-at-age are given in Table 4.1.14. Table 4.1.15 contains the stock summaries, which are plotted in Figure 4.1.25.

Retrospective plots (terminal years 2001–2005) for the final TSA run are given in Figures 4.1.27 to Figures 4.1.29 for mean fishing mortality, SSB and recruitment respectively. There seems to be some retrospective pattern in SSB that is for example not present in the SURBA retrospectives (Figure 4.1.15). Reasons for this should be investigated.

The final TSA run is compared to the final SURBA run in Figure 4.1.26. The trends are remarkably consistent between the two analysis methods, which although not surprising considering that they are both dominated by the same two surveys and both have separability assumptions, gives some credence to both estimates. The SSB trends in particular are very similar.

4.1.6.3.1 Comparison with last year’s assessment

The final assessments carried out by WGNSDS in 2005 were based on SURBA, although a TSA run similar to the one carried out here (albeit using only one survey) was also carried out. Outputs from that TSA run were eventually used by the review group as inputs for short term predictions which formulated the advice. The findings of the recent assessment are broadly similar to the 2005 TSA assessment (*cf.* Figure 4.1.25 from 2006 with Figure 4.1.17 from 2005) with the exception that in this year’s TSA, biomass has continued to decline.

4.1.7 Estimating recruiting year class abundance

TSA’s estimate of recruitment at age 1 of the 2005 year-class (recruiting in 2006) is derived principally from the survey, and can thus be used directly in forecasts. The stock-recruitment plot presented in Figure 4.1.24 shows that the data are variable and dominated by occasional large recruitments characteristic of haddock; the resulting Ricker model does not fit these data very well. The use of the TSA-estimated value of recruitment for the 2006 year-class (recruiting in 2007), which is specified by the TSA-fitted Ricker curve, is therefore unlikely to be appropriate. A long-term (1978–2005) geometric mean was used instead for the 2006 and 2007 year-classes, recruiting at age 1 in 2007 and 2008: 108.514 millions.

Working Group estimates of the relative year-class strength at age 1 are summarised below. Estimates used in the forecasts are shown in **bold** type. Current recruitment is below the mean.

	NUMBER (THOUSANDS) AT AGE 1	
Yr	**TSA**	**GM (78-05)**
2006	**52,626**	108,514
2007	121,480*	**108,514**
2008	-	**108,514**

* Estimate from Ricker stock recruit.

A plot of the recruitment predicted from the assessment against the recruit indices at age 1 from the two surveys is given in Figure 4.1.30. The SCOQ4 survey fits the recruitment at age 1 prediction form TSA rather well, whilst the relationship with the SCOGFS is not so good.

4.1.8 Long-term trends in biomass, fishing mortality and recruitment

Historical trends in landings, discards, total catch, mean $F_{2–6}$, SSB, and recruitment are summarised in Tables 4.1.15 and Figures 4.1.25. Mean F_{2-6} in 2005 is estimated to be at 0.53, slightly higher than in recent years, although the level of Mean F_{2-6} has been quite stable for the past four years, and fallen markedly from a sustained period of high values in the late 1990's. SSB in recent years peaked in 2002 (68,521 t) and has declined with the transition of the 1999 year class through the fishery, to a level of 46,873 t in 2005. The number of recruits at age 1 are very variable and currently at a low level, 60,499,000 in 2005, which is below the long-term geometric mean (1978-2005 GM = 108,514,000).

4.1.9 Short-term stock predictions

ACFM (October 2003 Technical Minutes) expressed concerns about the previous use in assessments of the TSA projections of fishing mortality in forecasts. Fishing mortalities in 2006 are estimated using the 2006 survey data in a manner similar to previous years, with the obvious exception that only one of the two surveys was available. Esimates of fishing mortality and their variance, in 2007, are obtained from the state equations: in practice this means that the estimate of fishing mortality in 2007 is identical to those in 2006 but have greater variance. The WG decided to use a three-year (2003-2005) mean fishing mortality in the short-term forecasts based on the final TSA run. Partial Fs for landings and discards components were calculated by applying 3-year mean landings and discard proportions to the 3-year total mean F. The larger of the CVs from the estimation of these two means was used as the CV in the forecast. The CVs estimated by TSA were used for the TSA-based forecasts.

The values of discard proportions from TSA were compared to empirical values calculated from Tables 4.1.5 and 4.1.6: these were found to be very similar, so the latter values were used.

Mean weights-at-age have been an issue of some concern due to the slow growth of the large 1999 year class. Two options were considered for the forecasts to calculate weights at age in 2006:

1) weights at age in 2006 were based on a three year mean (2003-2005) – the SPALY option;

2) weights at age in 2006 were predicted from a linear model fitting the weight as a function of time (in years). These models are shown as the solid lines in Figure 4.1.31 and Figure 4.1.32 for the total catch and landings respectively: the estimates of weights at age are plotted

as the single points in 2006. Values for the 2004 and 2005 year class (age 2 and 1 in 2006) were based on mean weights, as linear models could not be fitted to these (single points).

The weights at age calculated from the two options were:

		AGE							
	Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**
Stock weights									
1) 3-year mean	2006	0.113	0.209	0.289	0.382	0.485	0.571	0.929	1.030
2) Linear model	2006	0.113	0.209	0.284	0.374	0.537	0.491	0.572	1.069
Landings weights									
1) 3-year mean	2006	0.254	0.333	0.399	0.454	0.566	0.595	0.934	1.034
2) Linear model	2006	0.254	0.333	0.463	0.503	0.612	0.621	0.612	1.027

The short-term projection was produced for option (2) described above, because of the effect that the large slow growing 1999 year class may have on estimates of the mean weights at age. Input data for the projection is given in Table 4.1.16. The results of the forecast assuming status quo F during 2004 are shown in Table 4.1.17 (management options) and Table 4.1.18 (detailed). Results of a sensitivity analysis of the status quo catch prediction are given in Figure 4.1.33. Cumulative probability distributions are presented in Figure 4.1.34. Short-term forecasts for landings and spawning stock biomass are presented in Figure 4.1.35.

The following table summarises the results of the short-term forecast assuming status quo F:

YEAR	LANDINGS (000 T)	DISCARDS (000 T)	SSB (000 T)
2006	9.35	6.00	34.0
2007	7.79	6.46	29.3
2008			28.7

It is important to note that the forecast presented here is based on survey estimates of mortality with corresponding population abundance. Whilst the assumed natural mortality and discarding have been accounted for, any additional and unallocated removals from the fishery have not and are, therefore, also included in the estimates of fishing mortality used in the forecast. Care should be taken when using the forecast estimates of landings (from the human consumption component of the fishery) to determine a future TAC since these values will include estimates of unallocated removals such as mis-reporting. Estimates of SSB corresponding to the different levels of fishing mortality should, however, remain appropriate.

4.1.10 Medium-term projections

Stochastic medium-term projections were not produced for this stock. The lack of a clear relationship between spawning-stock biomass and recruitment, and the reliance of the fishery on intermittent large year-classes, make the usefulness of medium-term projections questionable in any case.

4.1.11 Yield and biomass per recruit

The yield-per-recruit plot is given in Figure 4.1.36. Figure 4.1.37 presents the stock-recruitment scatterplot with estimated replacement lines analogous to fishing mortality reference points. F_{max} was estimated as 0.295 and $F_{0.1}$ as 0.156.

4.1.12 Reference points

$\boldsymbol{B}_{pa}$ is set at 30,000 tonnes and is defined as $\boldsymbol{B}_{lim}$*1.4. $\boldsymbol{B}_{lim}$ is defined as the lowest observed SSB, considered to be 22,000 tonnes when the current reference points were established in

1998. $\boldsymbol{F}_{pa}$ is 0.5 on the technical basis of a high probability of avoiding SSB falling below $\boldsymbol{B}_{pa}$ in the long term. $\boldsymbol{F}_{lim}$ is not defined.

4.1.13 Quality of assessment

4.1.13.1 Landings

The extent of misreporting in the fisheries prosecuting this stock is unknown. No correction has been made to landings data to account for any misreporting. Absolute abundance estimates are likely to be incorrect as a result, particularly in the later parts of the time series generated by catch dependent analysis such as XSA. Hence, the approach used in 2006 was to exclude landings data from 1995 to 2005 in a TSA model which included two bottom trawl survey indices. The effect of the inclusion of estimates of misreporting may not be straightforward, however, and it would be wrong to conclude that abundance estimates would necessarily increase should account be taken of misreporting. The behaviour of the fleet in recent years and in years to come with enforcement changes is likely to be difficult to predict.

4.1.13.2 Effort

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 improved time series of effort data in the future but still leaves uncertainties surrounding the historic parts of the of the time series.

4.1.13.3 Discards

Discard estimates are used in the assessment of this stock, derived from Scottish and Irish sampling programmes. As discussed in the Stock Annex, there are currently problems with the Scottish sampling design which is significantly over-stratified. Work on the development of a new Scottish estimate-collation scheme is ongoing Area VI and Area IV. Once completed a full revision of the Scottish discard data will be carried out and consideration given to redesign of the sampling scheme.

4.1.13.4 Surveys

There still remains some concern about the utility of the Scottish groundfish survey indices as a good indicator of haddock abundance although the data exploration included here suggests that it has reasonable internal consistency. The catchability mismatch trends described in previous Working Groups could be explained equally well by a change in survey catchability or by misreporting. The survey changed vessel in 1999, although this post-dates the apparent switch in catchability mismatch by several years, and there have also been modifications in on-board sampling procedures. At present there are no strong reasons for thinking that the index is fundamentally flawed but a full evaluation of survey design and implementation would be beneficial, as would greater transparency in the underlying sample distributions and catches making up the index. The 2005 WG found that there did not appear to be a major problem with declining weights at age in the survey data that could contribute significantly to catchability trends.

4.1.13.5 Model Formulation

The WG has previously wrestled with the question of the most appropriate assessment model to use for this stock and concluded the model run used here was probably the most appropriate given the uncertainties in the landings figures. Faced with a choice between methods employing recognised but unquantified uncertainty and bias in catch statistics and a method employing data from a controlled approach to sampling – albeit with higher variability, the

WG has chosen the latter as its basis for an assessment on this stock. There does, however, need to be a greater examination of TSA model diagnostics and its assumptions. It would also be useful to consider the use of the discard to landings proportion and the use of the age structure in the excluded catch data.

4.1.14 Management considerations

The predictions conducted here provide guidance on the likely trajectories of stock biomass under various mortality scenarios. The shape of these trajectories also depends on the input weights at age. In the predictions carried out here the weights at age in 2006 were predicted from a simple linear model applied to each year class' weight at age (see Section 4.1.9 above). Although other more complex options (e.g. von Bertalanffy model) might also be contemplated, the simple linear models seem to fit the data reasonably well for the age ranges considered (Figures 4.1.31 and 4.1.32).

There have been several technical conservation measures introduced in the demersal fishery in Division VIa in recent years. These will have affected selectivity for haddock. There have also been a number of decommissioning rounds in the Scottish fleet, which will have reduced effective effort. The effect of recent effort regulations is also still to be ascertained. Management for haddock will be strongly linked to that for cod for which there is an ongoing recovery plan.

In 2005, Ireland introduced a decommissioning scheme aimed at removing around 6,000 GT/18,000 kW from the Irish fleet. This follows from the two Whitefish Renewal Schemes, which introduced around 32 new vessels into the Irish fleet. The decommissioning scheme is targeted at demersal and scallop vessels over 18m. The scheme is split into three rounds, with around 8 vessels already scrapped as part of the first phase and a total of 44 vessels in all due to be scrapped by the end of 2006. These changes in fleet structure are likely to have an impact on CPUE in this component of the data.

Special attention needs to be given to considering the sporadic nature of haddock recruitment and how to manage periods of low recruitment interspersed with large, occasional pulses.

Table 4.1.1 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.

Scottish Pair trawl					
	Effort	Age			
	(hrs/ year)	2	3	4	5
1987	67500	5664.559	3462.921	8254.314	386.953
1988	73448	19333.629	2791.134	1561.027	3555.323
1989	69051	622.245	6453.549	833.344	617.050
1990	24365	1209.336	432.811	2413.249	161.210
1991	33826	3815.610	267.760	165.980	1059.521
1992	24141	1587.775	1068.706	80.518	28.226
1993	23975	8049.086	3189.459	582.533	48.833
1994	21003	2354.895	2614.523	861.390	226.916
1995	22848	1573.402	3915.253	1501.480	365.819
1996	22237	7475.948	1085.826	2281.053	1002.653
1997	8552	1136.375	3876.218	340.837	523.864
1998	8425	2137.106	1315.696	2734.416	232.941
1999	2483	1936.938	1521.928	399.642	641.984
2000	2335	394.239	620.963	319.038	45.263
2001	1342	230.091	97.936	241.187	46.188
2002	14	115.105	120.723	2.223	2.909
2003	5	107.443	150.615	288.114	29.322
2004	88	141.598	40.075	98.517	221.673
2005	0	22.448	31.323	22.161	32.800

Scottish Light Trawl					
			Age		
	Effort (hrs/ year)	2	3	4	5
1978	127387	205.970	157.024	1412.263	205.040
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	1345.070	10272.253	662.105
1984	132217	2210.088	3687.112	809.840	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	6465.250	249.058
1988	158191	17326.463	2369.239	1008.226	2273.141
1989	217443	1459.316	10332.354	934.040	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	49.730
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 4.1.1b 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.

	Irish IR-OTB							
	Effort	**Age**						
	(hrs/ year)	**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 4.1.2 Haddock in Division VIa. Nominal catch (tonnes) of haddock, 1986–2005, as officially reported to ICES.

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005[1]
Belgium	-	29	8	9	-	9	1	7	1	+	1	3	2	2	1	2	+	+		+
Denmark	+	+	+	+	+	+	1	1	-	1	1	-	+	-	-	-	-	+	-	
Faroe Islands	1	-	-	13	-	1	-	-	-	-	-	-	-	-	n/a	n/a			4	
France	4,956	5,456	3,001	1,335[1,2]	863[1,2]	761[1,2]	761	1,132	753	671	445	270	394[1]	788	282	160	151	183	173	233
Germany	25	21	4	4	15	1	2	9	19	14	2	1	1	2	1	1	+	-		+
Ireland	2,026	2,628	2,731	2,171	773	710	700	911	746	1,406	1,399	1447	1,352	1054	677	744	672	497	194	n/a
Norway	45	13	54	74	46	12	72	40	7	13	16[1]	21[1]	28	18	70	32	30	23	4	21
Spain	-	-	-	-	-	-	-	-	-	-	-	-	2	4	9	4	4	5		
UK (E & W)[3]	222	425	114	235	164	137	132	155	254	322	448	493	458	315	199	201	237			
UK (N. Ireland)	1	1	35								...	...	…	...	…	…	…			
UK (Scotland)	12,955	18,503	15,151		10,964	8,434	5,263	10,423	7,421	10,367	10,790	10,352	12,125	8,630	5,933	5,886				
UK (total)				19,940													6,225	4,688	3,002	2,972
Netherlands																			1	
Total	203,851	27,076	21,098	23,781	12,825	10,065	6,932	12,678	9,201	12,794	13,102	12,587	14,360	10,813	7,163	7,030	7,113	4,884	3,007	3,227

[1]Preliminary. [2]Includes Divisions Vb(EC) and VIb. [3]1989–2002 N. Ireland included with England and Wales. n/a = Not available. Landings available to the WG are available in Table 4.1.4.

Table 4.1.3. Haddock in Division VIa. Research vessel survey tuning series made available to the WG. Numbers at age per 10 hours fishing. Data from both the Scottish surveys were used in the final assessment.

ScoGFS	Scottish Groundfish Survey (Quarter 1)						
	Age						
	1	2	3	4	5	6	7
1985	1104	4085	68	80	141	388	27
1986	753	1669	1877	17	14	47	90
1987	5518	446	460	690	25	34	25
1988	571	3610	303	112	246	10	4
1989	178	488	1701	98	49	69	5
1990	2577	87	54	296	26	6	36
1991	1591	1763	92	25	184	9	4
1992	3618	1193	321	12	13	28	6
1993	5371	5922	675	167	0	2	18
1994	1151	2300	787	126	39	3	1
1995	7112	1074	1697	485	65	30	10
1996	4401	3742	315	456	125	20	11
1997	4262	2018	1915	147	151	53	2
1998	5034	2720	616	562	40	64	19
1999	961	3038	701	171	131	15	12
2000	8036	563	447	97	13	20	0
2001	3421	5762	143	146	34	16	6
2002	2339	3246	5293	56	70	24	9
2003	2650	1696	1449	1874	23	34	18
2004	1397	2765	869	1199	609	11	3
2005	573	633	1402	351	512	402	5
2006	633	892	539	397	156	170	51

SCOQ4	Scottish western division bottom trawl survey (Q4)				
	Age				
	1	2	3	4	5
1996	761	656	70	137	57
1997	1359	282	151	25	26
1998	1640	486	148	137	17
1999	366	574	267	92	68
2000	4231	147	191	59	25
2001	2219	3563	48	138	22
2002	1709	1770	2841	34	50
2003	2023	965	1470	639	28
2004	574	1068	410	649	524
2005	419	409	410	223	309

Table 4.1.3 contd. Haddock in Division VIa research vessel survey data. Numbers at age per 10 hours fishing.

	IREGFS Age	Irish west coast groundfish survey							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1993	143	2493	5691	1606	693	29	112	56	35
1994	76	1237	3538	3303	367	187	13	18	66
1995	967	3104	1149	4152	1663	187	149	29	14
1996	192	2536	3688	2155	627	254	126	45	24
1997	2900	8289	636	532	375	294	45	8	3
1998	96	1098	1538	1353	192	84	75	15	49
1999	7985	1028	1967	1530	679	237	118	25	34
2000	1454	8865	569	691	484	183	32	30	0
2001	1951	2728	3548	136	187	151	36	4	0
2002	6618	2541	2768	1788	67	90	32	5	2

IRGFS	Irish groundfish survey Age										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
2003	207	7588	2382	839	355	22	30	7	0	3	2
2004	86	2163	3322	1281	941	957	60	10	21	0	0
2005	233	1160	767	778	315	87	3	0	0	1	0

Table 4.1.4. Haddock in Division VIa. Total catch weight, landings weight and discards weight as provided to the Working Group (all figures tonnes)

Year	Catch	Discards	Landings
1965	35893	3430	32463
1966	30585	710	29875
1967	27687	7387	20300
1968	45801	25334	20467
1969	51494	25222	26272
1970	40331	6156	34175
1971	58475	12180	46295
1972	57456	16412	41044
1973	40198	11369	28829
1974	33344	15373	17971
1975	46634	32951	13683
1976	34072	15314	18758
1977	23657	4356	19301
1978	19512	2333	17179
1979	28847	14016	14831
1980	17478	4715	12763
1981	33306	15088	18218
1982	39681	10068	29613
1983	36287	6890	29397
1984	46364	16345	30019
1985	41836	17451	24385
1986	26926	7352	19575
1987	43222	16218	27003
1988	31301	10164	21137
1989	19871	3178	16693
1990	15542	5406	10136
1991	19752	9192	10560
1992	20752	9398	11353
1993	35971	16905	19066
1994	25435	11192	14243
1995	21167	8794	12372
1996	25290	11838	13453
1997	19489	6623	12866
1998	20114	5712	14402
1999	15559	5132	10426
2000	15156	8207	6949
2001	13979	7247	6731
2002	16025	8932	7093
2003	9575	4244	5330
2004	7664	4464	3201
2005	6903	3755	3148

Table 4.1.5. Haddock in Division VIa. Total catch at age (numbers in thousands).

	Age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**
1978	15942	2095	971	24357	2938	351	247	575
1979	70070	17282	1865	470	9863	833	114	221
1980	22729	21927	5636	922	143	3082	229	54
1981	251	83911	20697	1768	194	39	822	60
1982	15492	5019	73676	8167	898	108	272	332
1983	14524	20233	6040	36122	3398	597	41	444
1984	98976	8626	12910	6242	22790	2449	371	162
1985	22820	78922	4667	4184	1789	11189	964	157
1986	8127	11235	45367	1823	916	449	2611	409
1987	89021	16824	10150	23857	1452	1116	642	2203
1988	10007	58414	7598	4185	9255	428	235	1167
1989	5010	3420	25724	2755	1556	3634	255	666
1990	37247	5856	1884	12158	871	279	519	85
1991	36924	21991	1259	834	5132	412	283	457
1992	51840	18971	11331	565	236	1577	157	169
1993	43659	60785	20763	4669	306	219	915	250
1994	19484	32638	21527	5671	1579	76	175	279
1995	17580	15759	23599	6865	1472	387	34	203
1996	33344	39812	6641	10225	3663	1007	324	80
1997	23843	10507	21550	2178	2668	870	259	67
1998	11421	18001	8032	15116	1352	1036	377	175
1999	6179	18055	11569	3004	4919	579	452	115
2000	50142	6642	8596	4213	1055	1104	205	156
2001	11023	33496	2432	3666	1521	533	314	104
2002	16427	12394	32248	833	714	549	238	172
2003	6972	5592	6848	12830	222	209	70	56
2004	15160	6506	2384	3839	6706	286	101	37
2005	7190	6202	3700	2116	2669	2704	57	48

Table 4.1.6. Haddock in Division VIa. Landings at age (thousands).

Year	Age 1	2	3	4	5	6	7	8+
1978	1030	1006	813	23620	2912	344	247	575
1979	2068	10448	1761	468	9810	833	114	221
1980	2505	12871	5341	915	143	3082	229	54
1981	200	20553	15695	1768	194	39	822	60
1982	250	1342	46283	8004	898	108	272	332
1983	568	4917	4585	34659	3387	597	41	444
1984	3341	4386	10754	5959	20352	2449	371	162
1985	939	19434	4437	4112	1782	11031	964	157
1986	603	4812	26770	1823	916	449	2611	409
1987	4254	7388	9206	23551	1452	1116	642	2203
1988	847	20687	6873	4091	9205	428	235	1167
1989	927	1414	18417	2744	1556	3633	255	666
1990	787	3198	1342	9450	848	279	519	85
1991	2145	10578	1217	834	5131	412	283	457
1992	691	10194	10010	553	236	1575	157	169
1993	745	15008	15975	4594	290	219	910	250
1994	1017	6326	15037	5240	1484	76	175	279
1995	540	3669	12774	6483	1472	387	34	203
1996	437	9457	4968	8626	3622	1007	324	80
1997	883	2831	16921	2125	2638	870	259	67
1998	1345	7129	5675	13387	1352	1036	377	175
1999	346	5501	7159	2960	4864	493	452	115
2000	759	2507	5864	3841	1054	1090	205	156
2001	245	8535	1822	3523	1393	533	314	104
2002	177	1227	13557	691	707	549	199	172
2003	21	1029	2150	8809	221	206	69	55
2004	14	245	804	1819	4071	286	100	37
2005	7	287	792	1252	1212	2018	57	48

Table 4.1.7 Haddock in Division VIa. Mean weight-at-age in total catch (kg).

	Age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**
1978	0.134	0.278	0.388	0.516	0.827	1.045	1.152	1.338
1979	0.182	0.325	0.457	0.730	0.777	1.040	1.491	1.754
1980	0.134	0.319	0.572	0.719	0.998	0.985	1.143	1.747
1981	0.252	0.245	0.467	0.887	0.975	1.376	1.294	1.379
1982	0.157	0.273	0.376	0.746	1.126	1.539	1.549	1.555
1983	0.178	0.282	0.461	0.557	1.002	1.370	1.716	1.572
1984	0.149	0.319	0.456	0.688	0.667	1.087	1.392	1.724
1985	0.138	0.268	0.486	0.636	0.802	0.868	1.272	1.694
1986	0.182	0.270	0.362	0.637	0.903	1.115	1.043	1.462
1987	0.168	0.270	0.418	0.566	0.880	1.105	1.250	1.183
1988	0.170	0.254	0.444	0.562	0.704	1.027	1.280	0.984
1989	0.226	0.301	0.402	0.625	0.749	0.894	1.115	1.109
1990	0.112	0.355	0.445	0.534	0.891	1.108	1.280	1.860
1991	0.184	0.297	0.547	0.618	0.678	0.931	1.053	1.200
1992	0.133	0.321	0.437	0.766	0.892	0.932	1.407	1.639
1993	0.108	0.277	0.458	0.650	0.861	0.898	1.022	1.483
1994	0.169	0.253	0.405	0.611	0.698	0.929	0.959	0.992
1995	0.149	0.274	0.354	0.553	0.833	0.978	1.322	1.020
1996	0.128	0.243	0.404	0.462	0.645	0.750	0.754	1.137
1997	0.153	0.263	0.394	0.614	0.730	0.925	1.057	1.020
1998	0.164	0.283	0.382	0.502	0.689	0.802	0.951	1.077
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	1.016
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	1.017

Table 4.1.8 Haddock in Division VIa. Mean weight-at-age in landings (kg).

	Age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**
1978	0.257	0.353	0.419	0.524	0.832	1.060	1.152	1.338
1979	0.269	0.386	0.467	0.732	0.779	1.040	1.491	1.754
1980	0.251	0.373	0.587	0.722	0.998	0.985	1.143	1.747
1981	0.289	0.357	0.502	0.887	0.975	1.376	1.294	1.379
1982	0.285	0.369	0.452	0.754	1.126	1.539	1.549	1.555
1983	0.479	0.424	0.518	0.568	1.004	1.370	1.716	1.572
1984	0.273	0.388	0.486	0.705	0.713	1.087	1.392	1.724
1985	0.283	0.346	0.494	0.641	0.803	0.875	1.272	1.694
1986	0.294	0.373	0.440	0.637	0.903	1.115	1.043	1.462
1987	0.276	0.337	0.435	0.570	0.880	1.105	1.250	1.183
1988	0.310	0.338	0.462	0.567	0.706	1.027	1.280	0.984
1989	0.372	0.406	0.468	0.625	0.749	0.894	1.115	1.108
1990	0.335	0.443	0.532	0.618	0.908	1.108	1.280	1.860
1991	0.287	0.382	0.556	0.618	0.678	0.931	1.053	1.200
1992	0.310	0.384	0.461	0.777	0.892	0.932	1.407	1.639
1993	0.313	0.395	0.509	0.655	0.889	0.898	1.026	1.483
1994	0.280	0.352	0.454	0.633	0.723	0.929	0.959	0.992
1995	0.293	0.375	0.415	0.567	0.833	0.978	1.322	1.020
1996	0.285	0.363	0.445	0.492	0.649	0.750	0.754	1.137
1997	0.275	0.365	0.425	0.621	0.735	0.925	1.057	1.020
1998	0.265	0.331	0.416	0.524	0.689	0.802	0.951	1.077
1999	0.313	0.353	0.420	0.496	0.614	0.820	0.840	1.172
2000	0.265	0.347	0.410	0.465	0.572	0.724	0.840	0.813
2001	0.243	0.332	0.457	0.439	0.538	0.657	0.808	1.016
2002	0.254	0.321	0.383	0.566	0.608	0.632	0.691	0.939
2003	0.240	0.311	0.389	0.428	0.654	0.651	0.917	1.091
2004	0.253	0.329	0.394	0.391	0.448	0.541	0.718	0.988
2005	0.270	0.358	0.415	0.542	0.596	0.594	1.167	1.023

Table 4.1.9 Haddock in Division VIa. Discards at age (thousands).

	Age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**
1978	14911	1090	157	738	27	7	0	0
1979	68002	6833	104	2	53	0	0	0
1980	20224	9057	295	7	0	0	0	0
1981	51	63359	5002	0	0	0	0	0
1982	15241	3678	27393	163	0	0	0	0
1983	13957	15316	1456	1464	12	0	0	0
1984	95634	4240	2156	284	2438	0	0	0
1985	21882	59488	231	71	6	159	0	0
1986	7524	6423	18597	0	0	0	0	0
1987	84767	9436	944	306	0	0	0	0
1988	9160	37727	725	95	49	0	0	0
1989	4083	2007	7308	11	0	1	0	0
1990	36460	2658	542	2708	23	0	0	0
1991	34779	11413	42	0	1	0	0	0
1992	51148	8776	1322	12	0	2	0	0
1993	42914	45777	4787	74	16	0	5	0
1994	18467	26312	6490	432	94	0	0	0
1995	17040	12090	10825	382	0	0	0	0
1996	32907	30354	1674	1599	41	0	0	0
1997	22961	7676	4629	53	30	0	0	0
1998	10075	10872	2357	1728	0	0	0	0
1999	5834	12554	4410	44	54	86	0	0
2000	49383	4136	2731	372	1	14	0	0
2001	10778	24961	611	143	128	0	0	0
2002	16250	11168	18692	142	8	0	39	0
2003	6951	4564	4697	4021	2	2	1	0
2004	15146	6261	1580	2021	2635	0	1	0
2005	7184	5915	2908	864	1457	686	0	1

Table 4.1.10. Haddock in Division VIa. Mean weight-at-age in discards (kg).

	Age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**
1978	0.125	0.208	0.231	0.259	0.265	0.308	0.000	0.000
1979	0.180	0.230	0.272	0.266	0.303	0.000	0.000	0.000
1980	0.120	0.243	0.287	0.334	0.000	0.000	0.000	0.000
1981	0.106	0.209	0.360	0.000	0.000	0.000	0.000	0.000
1982	0.155	0.238	0.247	0.363	0.000	0.000	0.000	0.000
1983	0.165	0.237	0.283	0.298	0.536	0.000	0.000	0.000
1984	0.145	0.248	0.303	0.331	0.278	0.000	0.000	0.000
1985	0.132	0.242	0.326	0.362	0.423	0.353	0.000	0.000
1986	0.173	0.193	0.248	0.000	0.000	0.000	0.000	0.000
1987	0.163	0.218	0.247	0.281	0.000	0.000	0.000	0.000
1988	0.157	0.208	0.279	0.331	0.341	0.000	0.000	0.000
1989	0.193	0.226	0.237	0.491	0.961	1.423	0.000	2.810
1990	0.108	0.250	0.228	0.242	0.268	0.000	0.000	0.000
1991	0.178	0.218	0.278	0.000	0.263	0.000	0.000	0.000
1992	0.130	0.247	0.258	0.242	0.000	0.947	0.000	0.000
1993	0.105	0.238	0.287	0.382	0.348	0.000	0.430	0.000
1994	0.163	0.229	0.291	0.337	0.304	0.000	0.000	0.000
1995	0.144	0.243	0.281	0.310	0.000	0.000	0.000	0.000
1996	0.126	0.206	0.282	0.300	0.317	0.000	0.000	0.000
1997	0.148	0.226	0.283	0.340	0.317	0.000	0.000	0.000
1998	0.151	0.251	0.298	0.337	0.000	0.000	0.000	0.000
1999	0.163	0.213	0.276	0.318	0.311	0.206	0.000	0.000
2000	0.125	0.223	0.257	0.259	0.625	0.337	0.000	0.000
2001	0.109	0.211	0.243	0.254	0.245	0.000	0.000	0.000
2002	0.117	0.196	0.253	0.305	0.456	0.000	0.358	0.000
2003	0.123	0.223	0.233	0.282	0.462	0.439	0.496	0.493
2004	0.112	0.183	0.237	0.242	0.256	0	0.411	0
2005	0.103	0.190	0.262	0.320	0.290	0.322	0.416	0.493

Table 4.1.11 Haddock in Division VIa . SURBA 3 model inputs, run settings and output.

SURBA 3.0

Run performed at 11:21:38 on 13/05/2006
Working directory: C:\DATA\ICES\WGNSDS\2006\Haddock\SURBA

Landings file exists: HAD6ALA.DAT
Catch numbers file exists: HAD6ACN.DAT
Catch weights file exists: HAD6ACW.DAT
Stock weights file exists: HAD6ASW.DAT
Natural mortality file exists: HAD6ANM.DAT
Proportion mature file exists: HAD6AMO.DAT
Prop. F bef. spawn. file exists: HAD6APF.DAT
Prop. M bef. spawn. file exists: HAD6APM.DAT

Age-structured tuning file exists: HAD6AEF_all.DAT
No age-structured catchability file selected.
Age-structured weighting file exists: HAD6A_weighting_0.5.DAT
No biomass tuning file selected.
No biomass index weighting file selected.

Available catch data

	Ages		Years	
Landings	1	8	1965	2005
Catch numbers	1	8	1965	2005
Catch weights	1	8	1965	2005
Stock weights	1	8	1965	2005
Nat. mort.	1	8	1965	2005
Maturity	1	8	1965	2005
F prop.	1	8	1965	2005
M prop.	1	8	1965	2005

Available age-structured indices

	Ages		Years	
SCOLTR	2	5	1965	2005
SCOPTR	2	5	1988	2005
SCOGFS	1	7	1985	2006
IREGFS	1	7	1993	2002
SCOQ4	1	5	1996	2005

All age-structured catchabilities assumed to be 1.0.

Available age-structured weightings

	Ages		Years	
SCOLTR	2	5	1965	2005
SCOPTR	2	5	1988	2005
SCOGFS	1	7	1985	2006
IREGFS	1	7	1993	2002
SCOQ4	1	5	1996	2005

No biomass indices available.

Table 4.1.11 contd. Haddock in Division VIa . SURBA 3 model inputs, run settings and output.

Selected catch data

	Ages		Years	
Landings	-	-	1985	2005
Catch numbers	1	7	1985	2005
Catch weights	1	7	1985	2005
Stock weights	1	7	1985	2005
Nat. mort.	1	7	1985	2005
Maturity	1	7	1985	2005
F prop.	1	7	1985	2005
M prop.	1	7	1985	2005

Selected age-structured index data

	Ages		Years		Alpha	Beta
SCOGFS	1	7	1985	2006	0.000	0.250
SCOQ4	1	5	1996	2005	0.000	0.900

No biomass index data.

No errors in reading file: HAD6ALA.DAT
No errors in reading file: HAD6ACN.DAT
No errors in reading file: HAD6ACW.DAT
No errors in reading file: HAD6ASW.DAT
No errors in reading file: HAD6ANM.DAT
No errors in reading file: HAD6AMO.DAT
No errors in reading file: HAD6APF.DAT
No errors in reading file: HAD6APM.DAT

Missing catch weights filled with 3-year mean.
Missing stock weights filled with 3-year mean.
Missing natural mortalities filled with 3-year mean.
Missing maturities filled with 3-year mean.
Missing proportions F before spawning filled with 3-year mean.
Missing proportions M before spawning filled with 3-year mean.
Missing proportions Z before spawning filled with 3-year mean.

No errors in reading file: HAD6AEF_all.DAT
No errors in reading file: HAD6A_weighting_0.5.DAT
…….
Lambda smoothing parameter = 1.0000
Reference age = 4
Retrospective analyses to be run.

Linear regressions between log mean-std indices at age
…….
RSS 2.7168E+01
IFAIL 5 (Good solution)

Table 4.1.11 contd. Haddock in Division VIa . SURBA 3 model inputs, run settings and output.

Stock summary

Year	Rec		SSB		TSB		Mean Z 2-6	
	est	se log	est	se	est	se	est	se
1985	1.168	0.174	1.268	NA	1.946	NA	0.944	0.187
1986	0.899	0.166	1.011	NA	1.279	NA	0.721	0.152
1987	6.459	0.171	0.781	NA	1.952	NA	0.919	0.148
1988	0.520	0.170	1.235	NA	1.870	NA	0.880	0.147
1989	0.286	0.198	1.138	NA	1.255	NA	1.647	0.146
1990	2.065	0.166	0.312	NA	0.571	NA	0.853	0.147
1991	1.870	0.169	0.469	NA	1.021	NA	1.020	0.148
1992	4.980	0.171	0.591	NA	1.448	NA	1.108	0.146
1993	4.490	0.171	0.915	NA	1.836	NA	1.094	0.149
1994	1.792	0.155	1.089	NA	1.752	NA	0.606	0.147
1995	6.890	0.160	1.296	NA	2.501	NA	1.239	0.142
1996	2.732	0.149	1.234	NA	2.094	NA	1.308	0.140
1997	3.337	0.143	1.029	NA	1.754	NA	1.056	0.133
1998	4.334	0.139	0.925	NA	1.938	NA	0.985	0.135
1999	0.790	0.164	1.054	NA	1.551	NA	1.667	0.135
2000	9.404	0.152	0.409	NA	1.661	NA	1.337	0.132
2001	4.961	0.129	1.042	NA	2.271	NA	0.660	0.132
2002	2.354	0.134	1.593	NA	2.240	NA	0.698	0.132
2003	3.177	0.140	1.447	NA	2.040	NA	0.727	0.134
2004	1.171	0.158	1.179	NA	1.521	NA	0.865	0.137
2005	0.773	0.189	0.965	NA	1.123	NA	0.872	0.157
2006	0.684	0.315	0.654	NA	0.785	NA	0.821	0.032

Running retrospective analysis: last year = 2005
IFAIL 5 (Good solution)
Running retrospective analysis: last year = 2004
IFAIL 5 (Good solution)
Running retrospective analysis: last year = 2003
IFAIL 5 (Good solution)
Running retrospective analysis: last year = 2002
IFAIL 5 (Good solution)
Running retrospective analysis: last year = 2001
IFAIL 5 (Good solution)
Running retrospective analysis: last year = 2000
IFAIL 5 (Good solution)
Running retrospective analysis: last year = 1999
IFAIL 5 (Good solution)
Running retrospective analysis: last year = 1998
IFAIL 5 (Good solution)
Running retrospective analysis: last year = 1997
IFAIL 5 (Good solution)
Running retrospective analysis: last year = 1996
IFAIL 5 (Good solution)
Running retrospective analysis: last year = 1995
IFAIL 5 (Good solution)

4.1.12 Haddock in Division VIa. TSA parameter estimates. Corresponding estimates from previous years' assessments are given for comparison. The estimate for the 2004, 2005 and 2006 SPALY assessments were run C = catch 1978–1994 & survey with no trend. * = fixed parameter.

Parameter	Notation	Description	2003 estimate	2004 estimate	2005 estimate	2006 SPALY	2006 final run
Initial fishing mortality	F (1, 1978)	Fishing mortality at age a in year y	0.42	0.28	0.26	0.25	0.23
	F (2, 1978)		0.67	0.50	0.51	0.50	0.50
	F (4, 1978)		0.53	0.51	0.51	0.54	0.51
Survey selectivities SCOGFS	Φ(1)	SCOGFS survey selectivity at age a	3.99	2.25	2.35	2.45	2.49
	Φ(2)		4.84	2.71	2.45	2.64	2.55
	Φ(4)		2.10	1.51	2.11	2.17	2.19
Survey selectivities SCOQ4	Φ(1)	SCOQ4 survey selectivity at age a	-	-	-	-	1.99
	Φ(2)		-	-	-	-	1.99
	Φ(4)		-	-	-	-	2.25
Fishing mortality standard deviations	σF	Transitory changes in overall F	0.00	0.11	0.10	0.09	0.10
	σU	Persistent changes in selection (age effect in F)	0.05	0.04	0.01	0.00	0.00
	σV	Transitory changes in the year effect in F	0.27	0.23	0.22	0.23	0.23
	σY	Persistent changes in the year effect in F	0.00	0.14	0.09	0.09	0.09
Survey catchability standard deviations	$\sigma\Omega_{SCOGFS}$	Transitory changes in survey catchability	0.00	0.08	0.18	0.28	0.30
	$\sigma\beta_{SCOGFS}$	Persistent changes in survey catchability	0.14	0.00*	0.00*	0.00*	0.00*
	$\sigma\Omega_{SCOQ4}$	Transitory changes in survey catchability	-	-	-	-	0.30
	$\sigma\beta_{SCOQ4}$	Persistent changes in survey catchability	-	-	-	-	0.00*
Measurement standard deviations	σlandings	Standard error of landings-at-age data	0.22	0.25	0.23	0.22	0.20
	σdiscards	Standard error of discards-at-age data	0.51	0.43	0.45	0.44	0.42
	σsurvey	Standard error of SCOGFS survey data	0.40	0.34	0.53	0.53	0.57
	σsurvey	Standard error of SCOQ4 survey data	-	-	-	-	0.57
Discard curve parameters	σP	Transitory changes in overall discard proportion	0.50	0.19	0.20	0.18	0.19
	σα1	Transitory changes in discard-ogive intercept	0.00	0.15	0.02	0.01	0.00
	σν1	Persistent changes in discard-ogive intercept	0.26	0.21	0.22	0.21	0.21
	σα2	Transitory changes in discard-ogive slope	0.34	0.01	0.03	0.37	0.21
	σν2	Persistent changes in discard-ogive slope	0.02	0.61	0.43	0.19	0.23
Trend parameters	θν1	Trend parameter for discard-ogive intercept	0.00*	0.00*	0.00*	0.00*	0.00*
	θν2	Trend parameter for discard-ogive slope	0.00*	0.00*	0.00*	0.00*	0.00*
Recruitment	η1	Ricker parameter (slope at the origin)	9.10	9.63	9.71	9.69	9.73
	η2	Ricker parameter (curve dome occurs at 1/η2)	0.33	0.29	0.31	0.32	0.29
	cvrec	Standard error of recruitment data	0.52	0.89	0.89	0.55	0.90

Table 4.1.13 Haddock in Division VIa. TSA population numbers-at-age (thousands) from final run (dual survey, missing catch data 1995–2005 & no persistent survey trend).

	Age							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8+**
1978	79.68	8.03	2.38	66.27	4.44	0.62	0.53	1.11
1979	189.52	47.82	4.02	1.02	26.25	1.44	0.22	0.62
1980	488.05	98.35	18.26	1.56	0.37	9.33	0.38	0.26
1981	58.75	326.42	46.99	6.93	0.60	0.15	3.86	0.20
1982	74.73	40.15	193.58	22.32	3.14	0.29	0.08	1.90
1983	53.20	50.57	23.85	103.79	11.22	1.61	0.15	1.00
1984	331.17	31.92	27.24	11.87	50.39	5.49	0.77	0.56
1985	71.88	194.66	12.86	9.83	4.29	19.74	2.08	0.51
1986	61.67	41.37	94.48	5.42	3.99	1.84	8.08	1.09
1987	240.98	40.81	22.49	48.18	2.68	2.01	0.93	4.55
1988	20.89	133.29	15.47	7.90	16.46	0.89	0.65	1.86
1989	17.64	10.19	58.08	5.75	2.83	5.95	0.33	0.93
1990	93.28	8.62	4.34	23.07	2.03	0.98	2.01	0.43
1991	132.19	55.54	3.28	1.92	9.70	0.85	0.42	1.03
1992	191.31	74.17	23.63	1.22	0.75	3.59	0.32	0.54
1993	164.27	119.86	36.41	10.29	0.52	0.33	1.54	0.37
1994	65.77	93.87	45.98	11.77	3.31	0.16	0.10	0.59
1995	237.60	37.23	43.59	18.61	4.40	1.27	0.06	0.27
1996	117.89	136.87	16.16	17.49	6.92	1.60	0.47	0.12
1997	139.79	65.89	58.41	6.07	6.31	2.47	0.57	0.21
1998	158.01	77.32	27.21	21.28	2.08	2.18	0.85	0.27
1999	37.69	86.05	30.93	9.62	7.04	0.69	0.73	0.37
2000	578.50	19.78	32.88	10.20	3.03	2.20	0.22	0.35
2001	233.08	315.15	8.06	11.53	3.35	1.01	0.73	0.19
2002	111.49	138.81	149.46	3.45	4.65	1.33	0.40	0.36
2003	139.30	71.67	73.95	73.59	1.62	2.18	0.62	0.36
2004	58.32	90.89	39.79	37.83	35.79	0.80	1.06	0.48
2005	60.50	37.81	50.20	20.34	18.92	17.70	0.39	0.76
2006*	52.63	38.36	19.92	24.27	9.45	8.88	8.23	0.54
2007*	121.48	33.14	19.89	9.50	11.08	4.31	4.05	4.00

*Estimates for 2006 and 2007 are TSA forecasts.

Table 4.1.14. Haddock in Division VIa. TSA estimates of fishing mortality-at-age from final run (dual survey, missing catch data 1995–2003 & no persistent survey trend).

Year	Age 1	2	3	4	5	6	7	8+
1978	0.315	0.490	0.642	0.745	0.738	0.721	0.706	0.713
1979	0.430	0.651	0.736	0.767	0.798	0.777	0.789	0.784
1980	0.222	0.466	0.556	0.633	0.581	0.596	0.598	0.588
1981	0.194	0.352	0.458	0.467	0.473	0.461	0.479	0.473
1982	0.190	0.322	0.422	0.468	0.455	0.465	0.470	0.460
1983	0.297	0.422	0.413	0.493	0.502	0.510	0.506	0.522
1984	0.332	0.601	0.750	0.808	0.735	0.756	0.772	0.751
1985	0.334	0.507	0.604	0.661	0.641	0.686	0.658	0.650
1986	0.211	0.399	0.472	0.503	0.487	0.474	0.498	0.501
1987	0.375	0.732	0.800	0.855	0.881	0.901	0.895	0.867
1988	0.367	0.600	0.730	0.776	0.785	0.759	0.765	0.780
1989	0.365	0.583	0.691	0.762	0.780	0.800	0.790	0.792
1990	0.311	0.582	0.614	0.667	0.668	0.644	0.669	0.665
1991	0.380	0.637	0.715	0.741	0.787	0.768	0.793	0.775
1992	0.254	0.508	0.631	0.655	0.587	0.642	0.639	0.629
1993	0.358	0.758	0.926	0.932	0.972	1.011	0.969	0.976
1994	0.368	0.559	0.704	0.785	0.756	0.752	0.768	0.757
1995	0.352	0.621	0.714	0.785	0.800	0.786	0.786	0.787
1996	0.380	0.652	0.777	0.820	0.829	0.838	0.831	0.831
1997	0.393	0.686	0.810	0.873	0.861	0.868	0.869	0.868
1998	0.407	0.712	0.838	0.904	0.898	0.896	0.898	0.899
1999	0.427	0.751	0.891	0.947	0.951	0.950	0.947	0.947
2000	0.403	0.713	0.850	0.915	0.899	0.907	0.904	0.903
2001	0.296	0.548	0.662	0.712	0.707	0.702	0.705	0.704
2002	0.248	0.417	0.513	0.556	0.561	0.550	0.553	0.553
2003	0.224	0.399	0.454	0.511	0.505	0.512	0.507	0.508
2004	0.229	0.395	0.472	0.487	0.501	0.507	0.506	0.505
2005	0.255	0.440	0.527	0.566	0.557	0.566	0.565	0.565
2006*	0.263	0.457	0.541	0.584	0.584	0.584	0.584	0.584
2007*	0.263	0.458	0.543	0.585	0.585	0.585	0.585	0.585

*Estimates for 2006 and 2007 are TSA forecasts.

Table 4.1.15. Haddock in Division VIa. TSA stock summary from final run. “Obs.” denotes the SOP of numbers and mean weights-at-age, rather than the reported caught, landed and discarded yield; “Pred.” are fitted values; and “SE” denotes standard errors. *Estimates for 2006 and 2007 are TSA projections and are not used to derive the summary statistics in the final 4 rows.

Year	Landings (tonnes)			Discards (tonnes)			Total catches (tonnes)			Mean $F_{(2–6)}$		SSB (tonnes)		TSB (tonnes)		Recruitment (thousands at age 1)	
	Obs.	**Pred.**	**SE**	**Obs.**	**Pred.**	**SE**	**Obs.**	**Pred.**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**
1978	17178	20475	1387	2327	2884	517	19505	23327	1572	0.667	0.051	42803	978	54401	1367	79683	7148
1979	14820	16705	1393	13857	13484	2165	28678	30828	2875	0.746	0.055	34714	1841	75994	3675	189519	14667
1980	12759	13430	1400	4715	15862	2611	17474	31407	3683	0.566	0.047	39902	2596	119017	6274	488046	35964
1981	18233	19347	2252	15048	15390	2604	33281	35583	4101	0.442	0.040	79821	4662	129032	7012	58754	4079
1982	29635	29871	3694	10063	7244	1250	39698	35485	3817	0.426	0.036	102690	6536	119143	6676	74726	6823
1983	29405	30415	3122	6787	5798	890	36192	36196	3424	0.468	0.037	92226	5353	107798	5601	53197	5710
1984	30012	32728	2535	16343	15073	3280	46355	47050	4649	0.730	0.053	67976	3372	121807	6497	331166	35051
1985	24393	23087	2134	17444	14882	2588	41837	37701	3983	0.620	0.048	66265	4042	98600	6128	71881	7514
1986	19561	19958	2268	7153	4941	871	26714	23848	2642	0.467	0.040	59626	4160	75653	4588	61665	5841
1987	27012	28144	2583	16193	13639	2751	43205	41966	4258	0.834	0.059	54091	3445	99415	6147	240984	26959
1988	21136	19579	1926	9536	8434	1602	30672	27991	3045	0.730	0.055	45778	2904	63888	4259	20887	3296
1989	16688	17117	2017	2981	2627	547	19669	19236	2206	0.723	0.055	37537	2839	42842	3075	17640	3249
1990	10135	10844	1283	5387	2972	594	15522	12897	1464	0.635	0.052	22278	1790	34117	2309	93284	10637
1991	10557	9771	924	8691	9775	1681	19248	20061	2267	0.730	0.057	21425	1495	52881	3508	132189	13544
1992	11350	10206	1040	9163	9935	1468	20513	20965	2158	0.605	0.051	30186	2144	65742	4096	191313	18425
1993	19060	19004	1766	16811	16654	2238	35871	35716	3089	0.920	0.085	45147	3120	77243	5282	164271	21585
1994	14243	13587	1559	11098	12251	2055	25342	26157	2712	0.711	0.103	42470	4494	63798	7087	65774	16860
1995	12368	15123	4147	8552	14047	4245	20920	28854	7450	0.741	0.161	36760	6156	76444	11294	237603	45626
1996	13453	14664	4338	11364	14818	4368	24817	29545	7833	0.783	0.166	39741	6687	69160	11177	117892	29324
1997	12874	17133	5178	6470	14149	4389	19344	32062	8317	0.819	0.170	44370	7568	73180	11600	139786	32605
1998	14401	14941	4379	5535	15826	4717	19936	31714	8077	0.850	0.175	37804	6274	73182	11328	158005	34288
1999	10430	13803	4374	4891	10545	3427	15321	24815	6507	0.898	0.183	34433	5957	50353	8850	37694	13422
2000	6952	11538	3953	7899	24330	9185	14851	35585	11503	0.857	0.176	23260	4871	99093	21317	578504	148531
2001	6731	13793	6207	6657	26315	8588	13389	40705	12223	0.666	0.140	54831	11498	113702	20744	233082	38230
2002	7097	19487	7802	8880	13847	5085	15977	30859	7909	0.519	0.110	68521	10812	94168	12836	111494	27091
2003	5334	20045	6218	4104	9208	3401	9438	26766	6460	0.476	0.103	62167	7802	86722	9975	139304	28032
2004	3199	16817	4729	4380	6362	2286	7579	19845	4682	0.472	0.107	48124	5506	62031	6966	58322	16486
2005	3148	19363	5298	3546	4884	2160	6694	20205	4759	0.531	0.133	46873	5911	56329	6878	60499	18777
2006*	NA	14844	3945	NA	4012	2085	NA	17110	4396	0.550	0.162	37441	6139	46820	10026	52626	58942
2007*	NA	11469	3453	NA	5212	3553	NA	15253	5233	0.552	0.171	29036	8313	45720	16298	121480	109023
Min	3148	9771	924	2327	2627	517	6694	12897	1464	0.426	0.036	21425	978	34117	1367	17640	3249
GM	12930	17359	2726	7670	9993	2267	21336	28446	4212	0.649	0.078	45801	4130	76437	6509	108514	16162
AM	15077	18249	3211	8781	11649	2913	23859	29549	4917	0.665	0.091	49351	4815	80562	7734	150256	23920
Max	30012	32728	7802	17444	26315	9185	46355	47050	12223	0.920	0.183	102690	11498	129032	21317	578504	148531

Table 4.1.16. Haddock in Division VIa. Inputs to short-term predictions for final TSA run (catch & discard data from 1995–2005 not fitted to model, no trend in survey q) assuming predicted weights in 2006 from linear models shown in Figure 4.1.31 and Figure 4.1.32.

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

Label	Value	CV	Label	Value	CV
Number at age			Weight in the stock		
N1	52626	1.12	WS1	0.11	0.09
N2	38359	0.31	WS2	0.21	0.13
N3	19922	0.27	WS3	0.28	0.02
N4	24271	0.22	WS4	0.37	0.18
N5	9452	0.23	WS5	0.54	0.31
N6	8876	0.21	WS6	0.49	0.12
N7	8232	0.24	WS7	0.57	0.24
N8	535	0.24	WS8	1.07	0.05
H.cons selectivity			Weight in the HC catch		
sH1	0.00	0.76	WH1	0.25	0.06
sH2	0.04	0.92	WH2	0.33	0.07
sH3	0.14	0.23	WH3	0.46	0.04
sH4	0.30	0.18	WH4	0.50	0.17
sH5	0.36	0.41	WH5	0.61	0.19
sH6	0.48	0.16	WH6	0.62	0.09
sH7	0.52	0.06	WH7	0.61	0.24
sH8	0.52	0.06	WH8	1.03	0.05
Discard selectivity			Weight in the discards		
sD1	0.24	0.76	WD1	0.11	0.09
sD2	0.37	0.92	WD2	0.20	0.11
sD3	0.35	0.23	WD3	0.24	0.06
sD4	0.22	0.18	WD4	0.28	0.14
sD5	0.16	0.41	WD5	0.34	0.33
sD6	0.05	0.16	WD6	0.25	0.90
sD7	0.01	0.06	WD7	0.44	0.11
sD8	0.00	0.06	WD8	0.33	0.87
Natural mortality			Proportion mature		
M1	0.20	0.10	MT1	0.00	0.10
M2	0.20	0.10	MT2	0.57	0.10
M3	0.20	0.10	MT3	1.00	0.10
M4	0.20	0.10	MT4	1.00	0.00
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
M8	0.20	0.10	MT8	1.00	0.00
Relative effort in HC fishery			Year effect for natural mortality		
HF06	1.00	0.08	K06	1.00	0.10
HF07	1.00	0.08	K07	1.00	0.10
HF08	1.00	0.08	K08	1.00	0.10
Recruitment in 2007 and 2008					
R07	108514	0.84			
R08	108514	0.84			

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

Stock numbers in 2006 are TSA survivors.

Table 4.1.17. Haddock in Division VIa. Results of short-term forecasts from final TSA run (catch & discard data from 1995–2005 not fitted to model, no trend in survey q) assuming predicted weights in 2006 from linear models shown in Figure 4.1.31 and Figure 4.1.32. Management options giving weights in thousands of tonnes.

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

	Year 2006	Year 2007						
Mean F Ages								
H.cons 2 to 6	0.49	0.00	0.10	0.20	0.30	0.39	0.49	0.59
Effort relative to 2005								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Biomass								
Total 1 January	43.4	44.6	44.6	44.6	44.6	44.6	44.6	44.6
SSB at spawning time	34.0	29.3	29.3	29.3	29.3	29.3	29.3	29.3
Catch weight (,000t)								
H.cons	9.35	0.00	1.88	3.58	5.12	6.52	7.79	8.93
Discards	6.00	0.00	1.49	2.87	4.15	5.35	6.46	7.49
Total Catch	15.36	0.00	3.37	6.45	9.28	11.87	14.25	16.43
Biomass in year.... 2008								
Total 1 January		63.9	60.0	56.3	53.0	50.0	47.2	44.7
SSB at spawning time		43.6	40.1	36.8	33.8	31.1	28.7	26.4

	Year 2006	Year 2007						
Effort relative to 2005								
H.cons	1.00	0.00	0.20	0.40	0.60	0.80	1.00	1.20
Est. Coeff. of Variation								
Biomass								
Total 1 January	0.19	0.31	0.31	0.31	0.31	0.31	0.31	0.31
SSB at spawning time	0.13	0.22	0.22	0.22	0.22	0.22	0.22	0.22
Catch weight								
H.cons	0.17	0.00	0.41	0.24	0.20	0.18	0.17	0.17
Discards	0.40	0.00	0.66	0.56	0.54	0.53	0.53	0.52
Biomass in year.... 2008								
Total 1 January		0.33	0.34	0.35	0.36	0.37	0.38	0.39
SSB at spawning time		0.31	0.32	0.33	0.34	0.35	0.36	0.38

Table 4.1.18. Haddock in Division VIa. Results of short-term forecasts from final TSA run (catch & discard data from 1995–2005 not fitted to model, no trend in survey q) assuming predicted weights in 2006 from linear models shown in Figure 4.1.31 and Figure 4.1.32. Detailed tables.

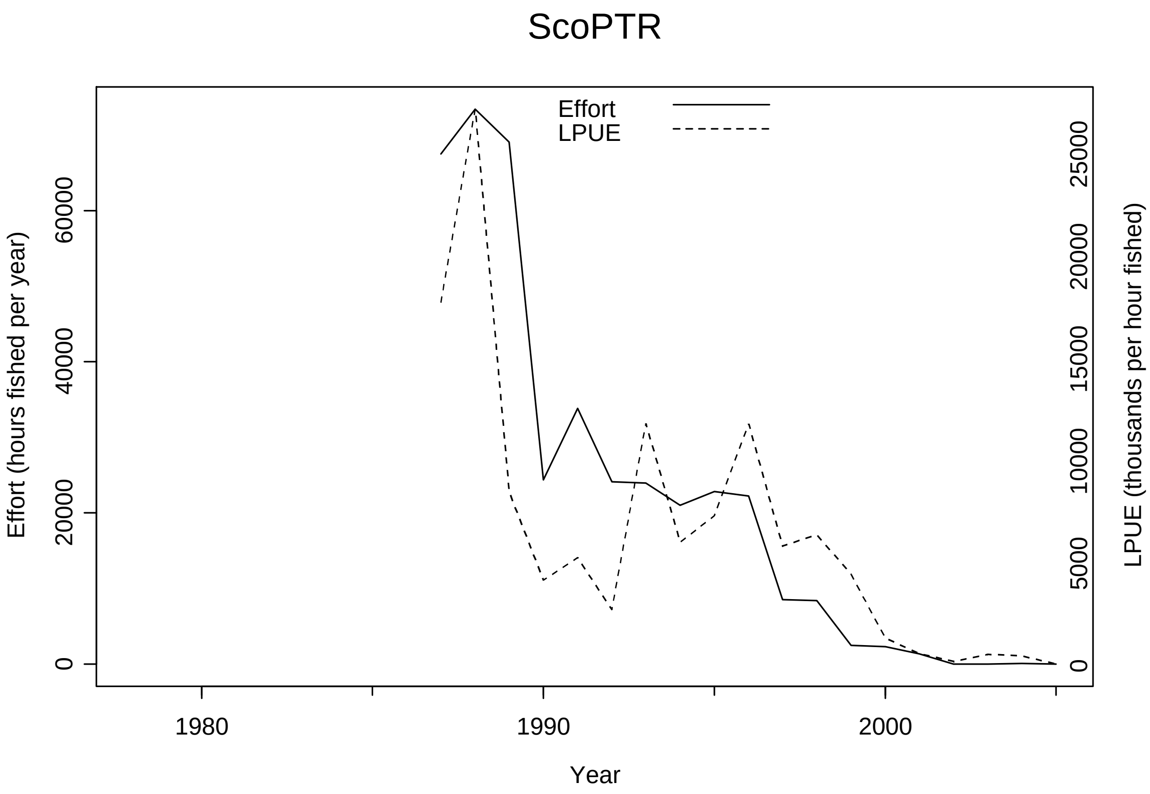
Table_____.Haddock,VIa
Detailed forecast tables.

Forecast for year 2006
F multiplier H.cons=1.00

Age	Stock No. (Populations)	H.Cons (Catch number)	Discards (Catch number)	Total (Catch number)
1	52626	0	10066	10066
2	38359	1062	10735	11797
3	19922	2019	4976	6995
4	24271	5257	3753	9010
5	9452	2404	1105	3509
6	8876	3033	296	3329
7	8232	3043	35	3078
8	535	199	1	200
Wt	43	9	6	15

Forecast for year 2007
F multiplier H.cons=1.00

Age	Stock No. (Populations)	H.Cons (Catch number)	Discards (Catch number)	Total (Catch number)
1	108514	0	20757	20757
2	34029	942	9523	10465
3	20822	2110	5200	7311
4	10042	2175	1553	3728
5	11802	3002	1379	4381
6	4596	1570	153	1724
7	4286	1585	18	1603
8	4242	1577	9	1586
Wt	45	8	6	14



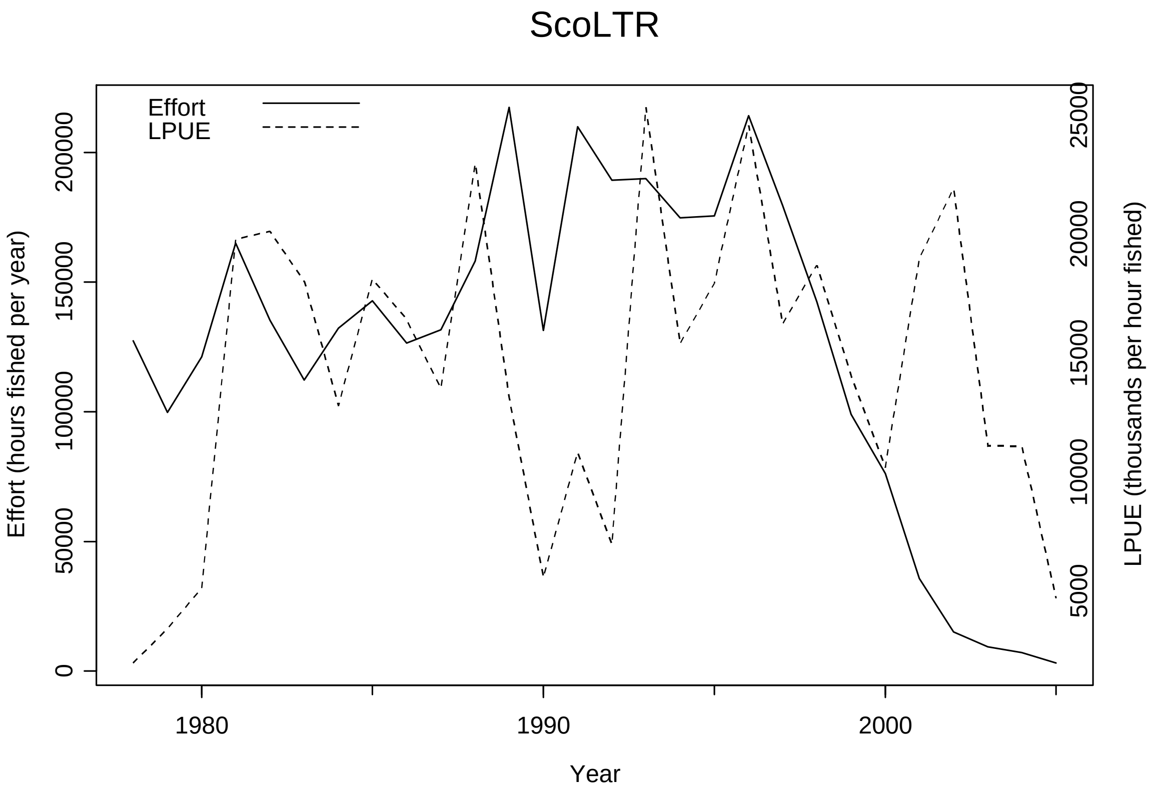
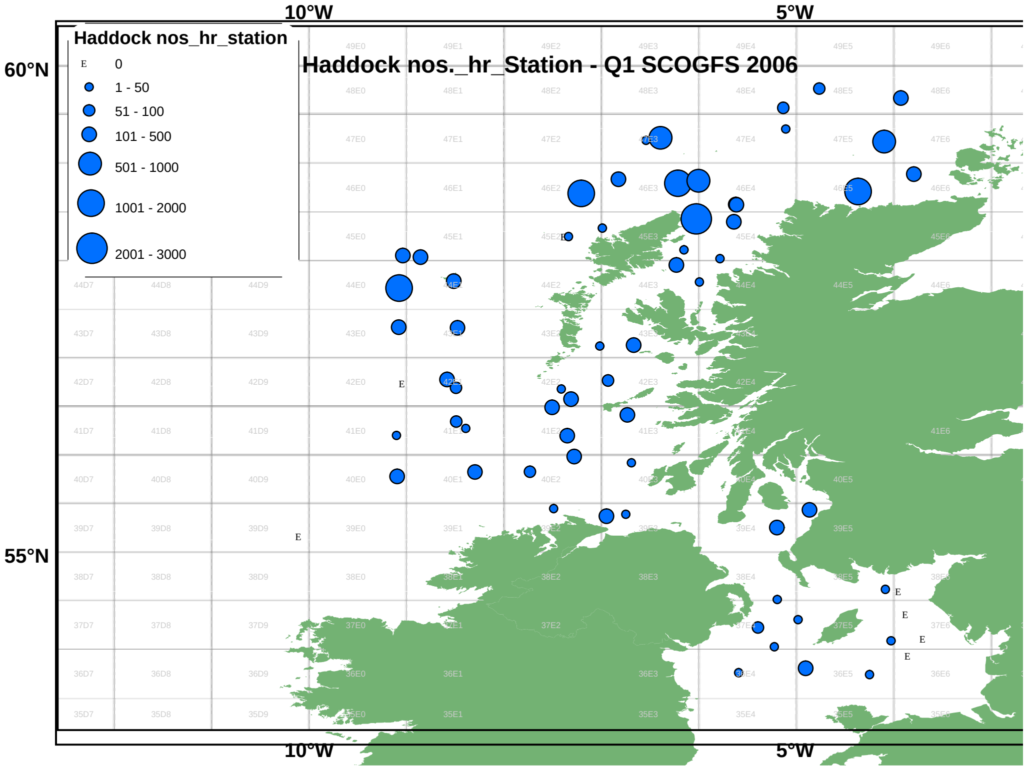


Figure 4.1.1 Haddock in Division VIa. Time-series of reported commercial effort and landings-per-unit-effort (LPUE) for the Scottish pair trawl (ScoPTR) and light trawler (ScoLTR) fleets.



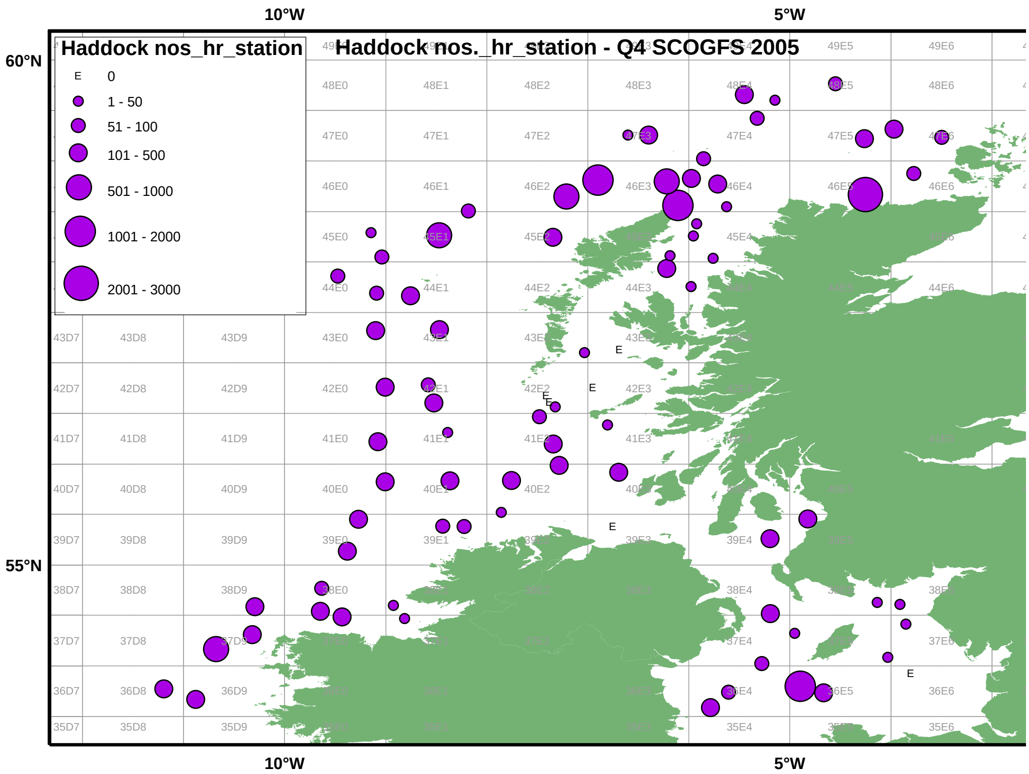


Figure 4.1.2. Haddock Via. Maps of the west of Scotland indicating the position of trawl stations samples taken during the two Scottish western division bottom trawl surveys: (a) ScoGFS (Q1 2006); and (b) ScoQ4 (2005). The area of the circles is proportional to survey catch per 10 hours fishing according to the scale on the legend.

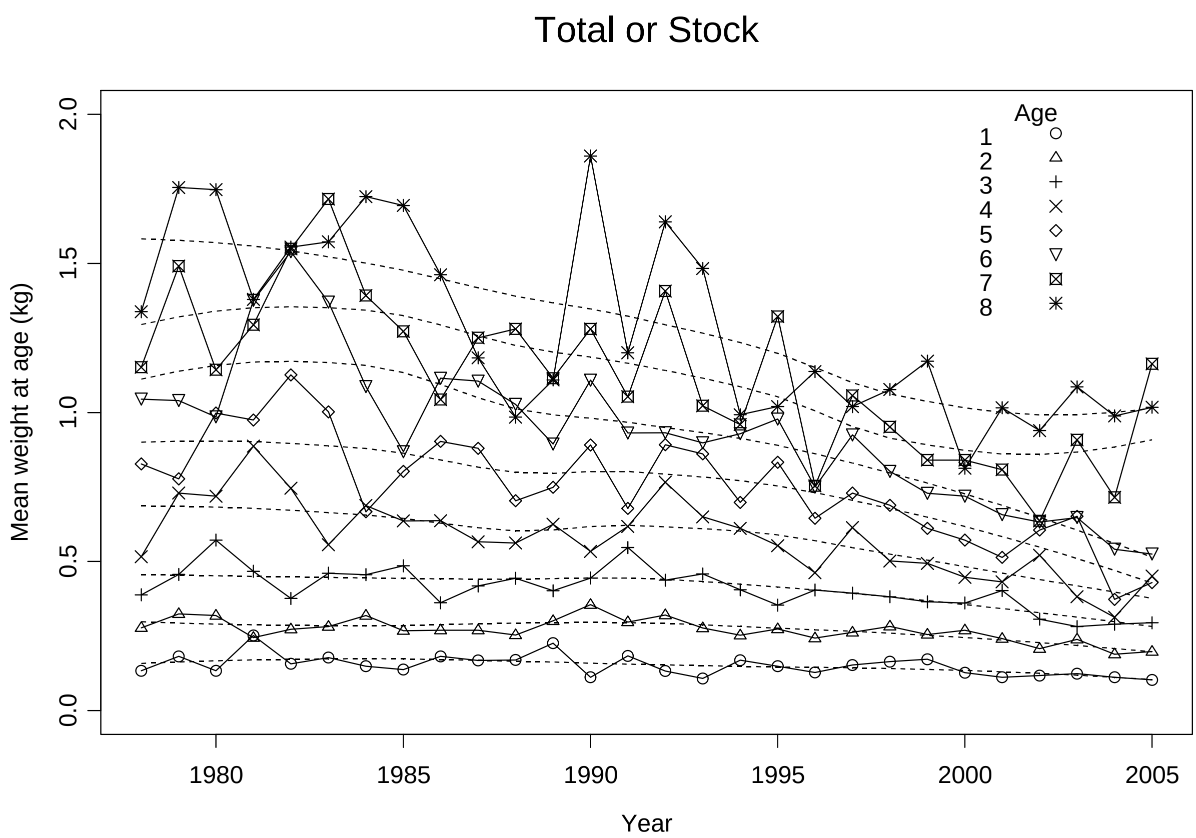


Figure 4.1.3 Haddock in Division VIa. Mean weights-at-age (kg) in total catch (also used for stock weights). Dotted lines show loess smoother fitted through each time-series at age.

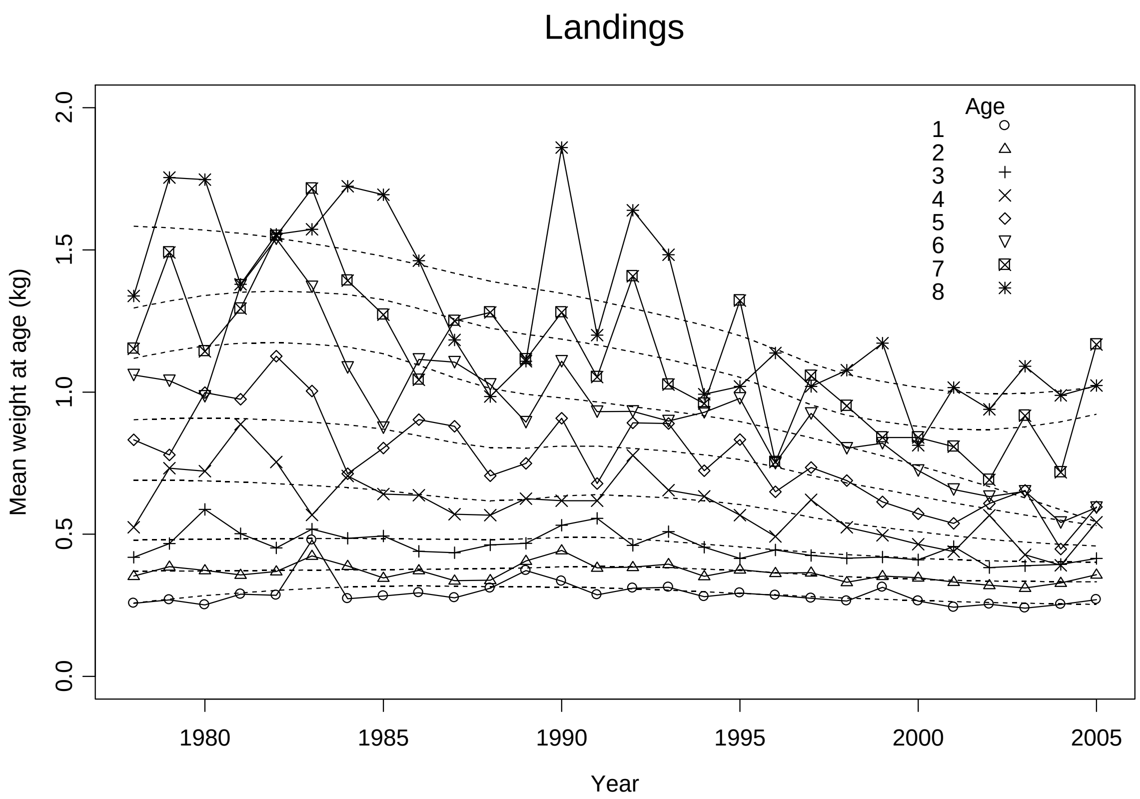


Figure 4.1.4 Haddock in Division VIa. Mean weights-at-age (kg) in landings for human consumption. Dotted lines show loess smoother fitted through each time-series at age.

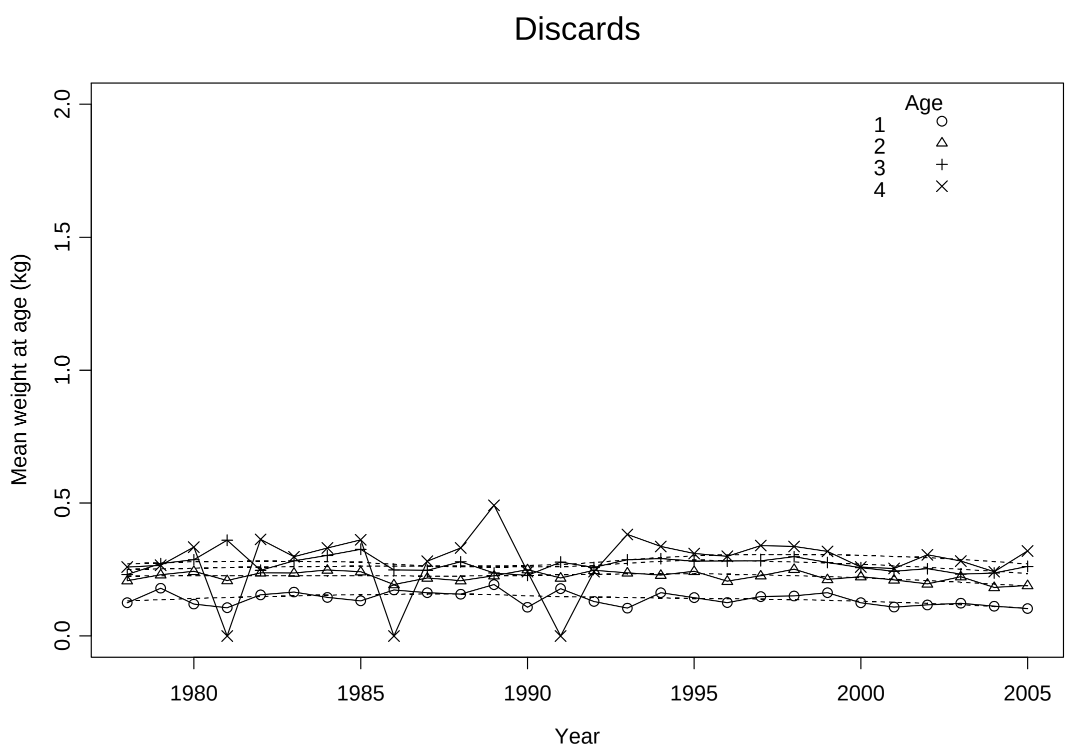


Figure 4.1.5 Haddock in Division VIa. Mean weights-at-age (kg) in discards (ages 1–4 only). Dotted lines show loess smoother fitted through each time-series at age.

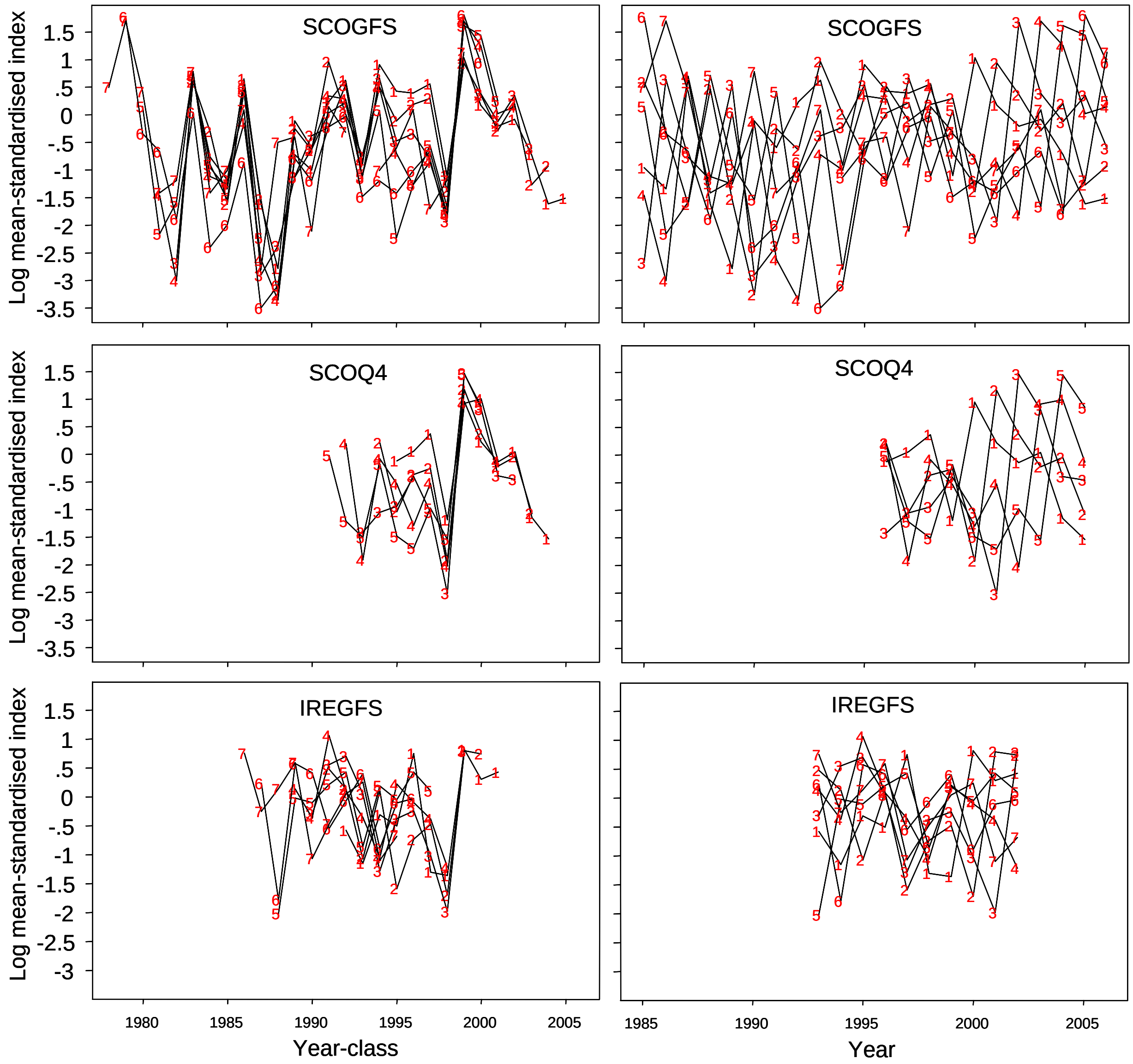


Figure 4.1.6. Haddock in Division VIa. Mean-standardised log survey indices, plotted by age and year-class (left plot), and age and year (right plot). Scottish groundfish survey (SCOGFS), Scottish quarter 4 survey (SCOQ4) and Irish West Coast groundfish survey (IREGFS).

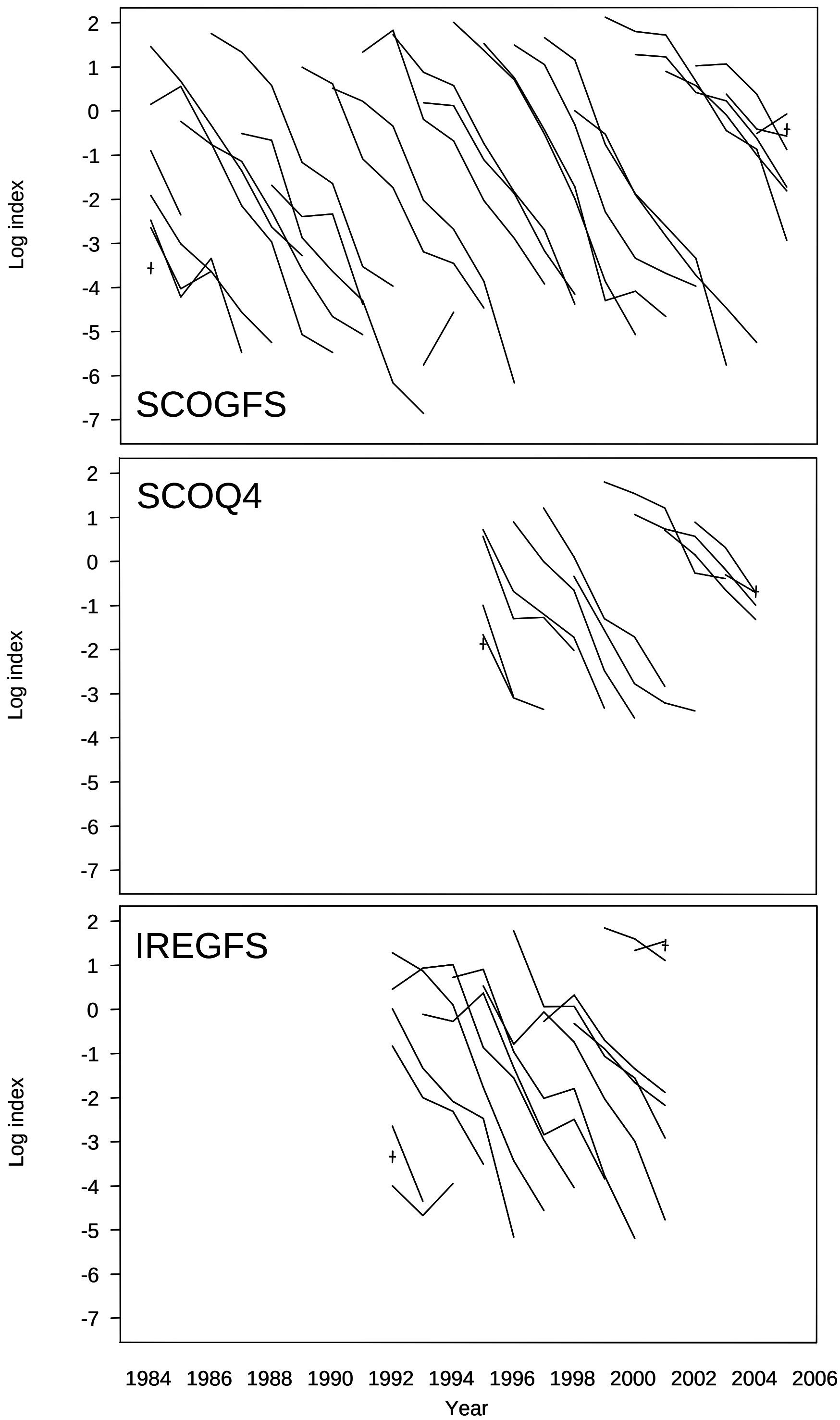


Figure 4.1.7. Haddock in Division VIa. Catch curves (log abundance indices for each cohort) for ScoGFS, ScoQ4 and IREGFS.

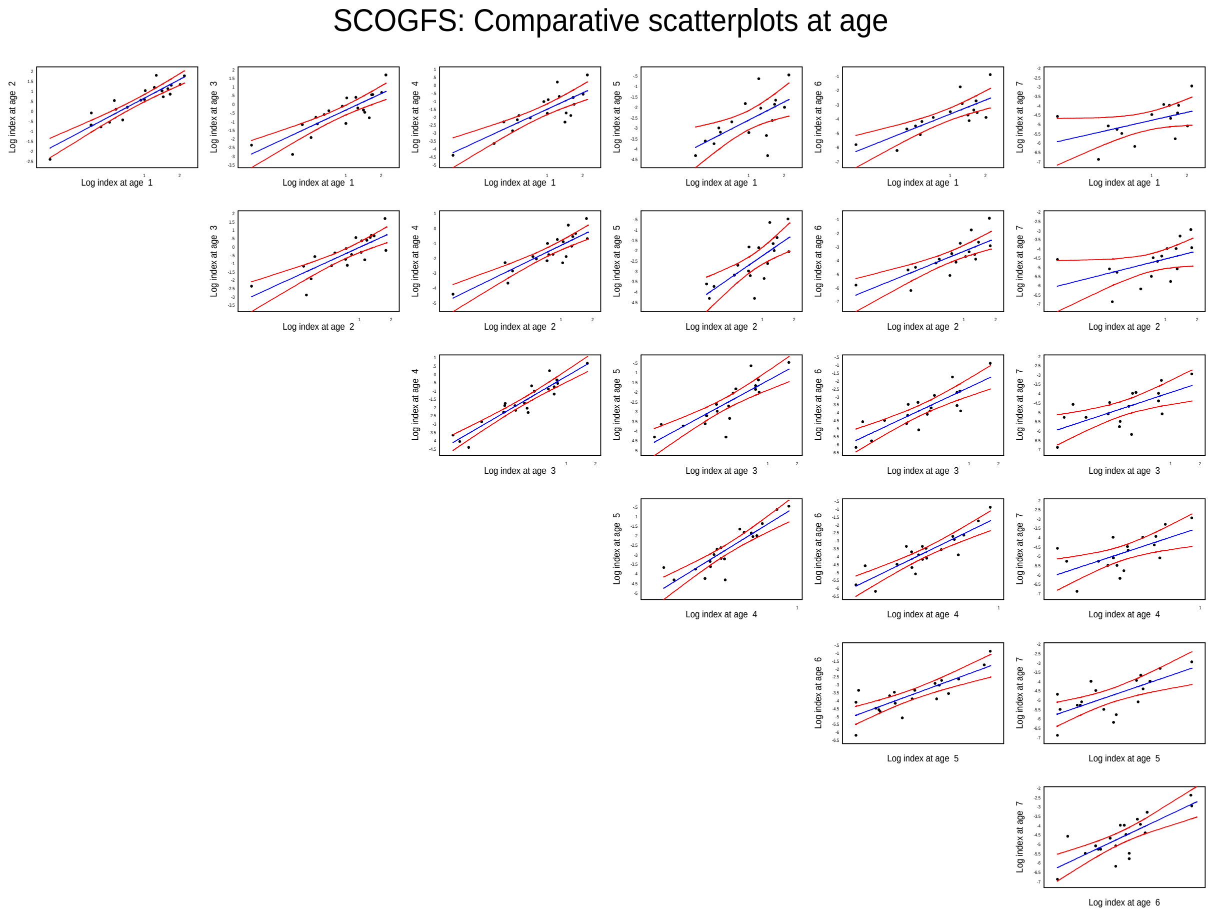


Figure 4.1.8. Haddock in Division VIa. Pairwise scatterplots of log ScoGFS (top) and ScoQ4 (bottom) survey indices at age, for ages 1–7 and 1-5 respectively. Lines give least-squares linear regression fits with approx. pointwise 95% confidence intervals.

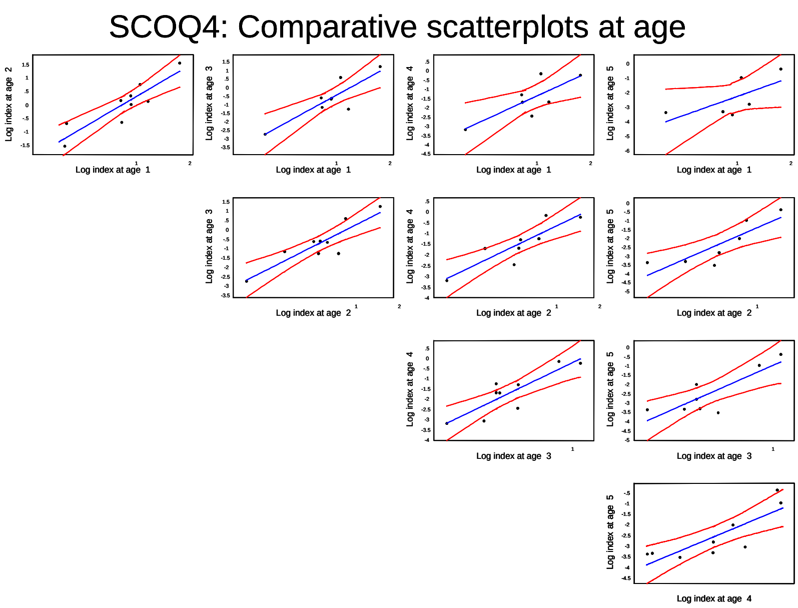


Figure 4.1.8. Haddock in Division VIa. Pairwise scatterplots of log ScoGFS (top) and ScoQ4 (bottom) survey indices at age, for ages 1–7 and 1-5 respectively. Lines give least-squares linear regression fits with approx. pointwise 95% confidence intervals.

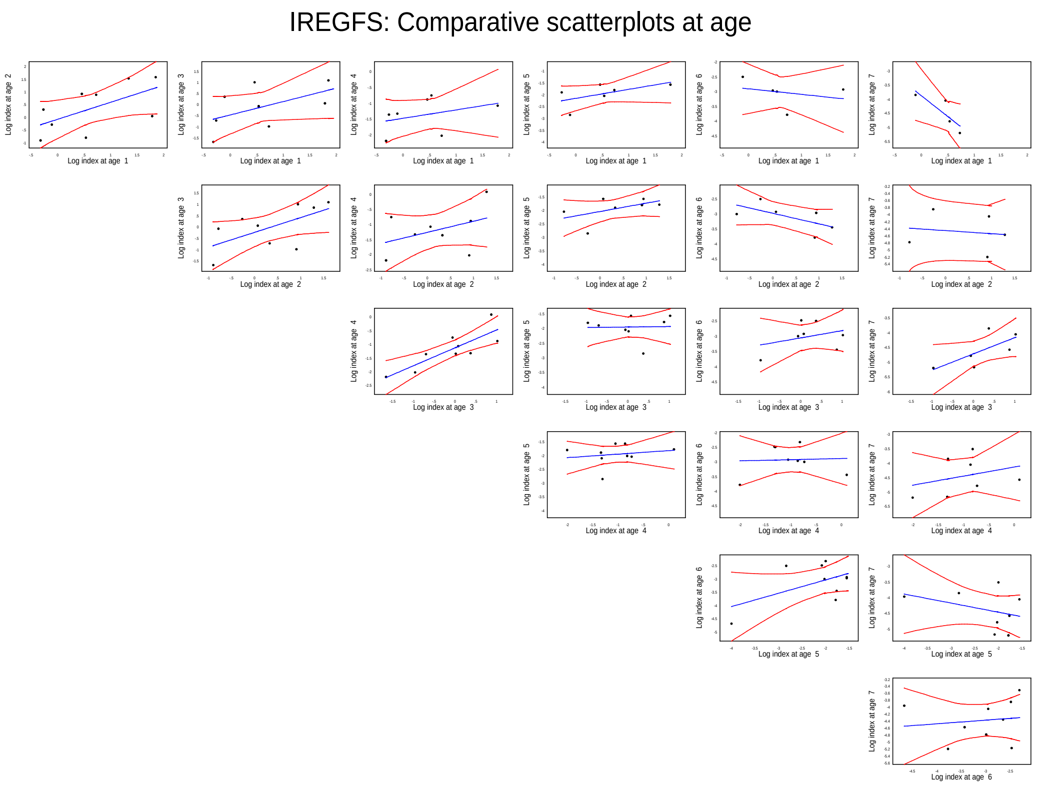


Figure 4.1.8 contd. Haddock in Division VIa. Pairwise scatterplots of log IREGFS survey indices at age, for ages 1–7. Lines give least-squares linear regression fits with approx. pointwise 95% confidence intervals.

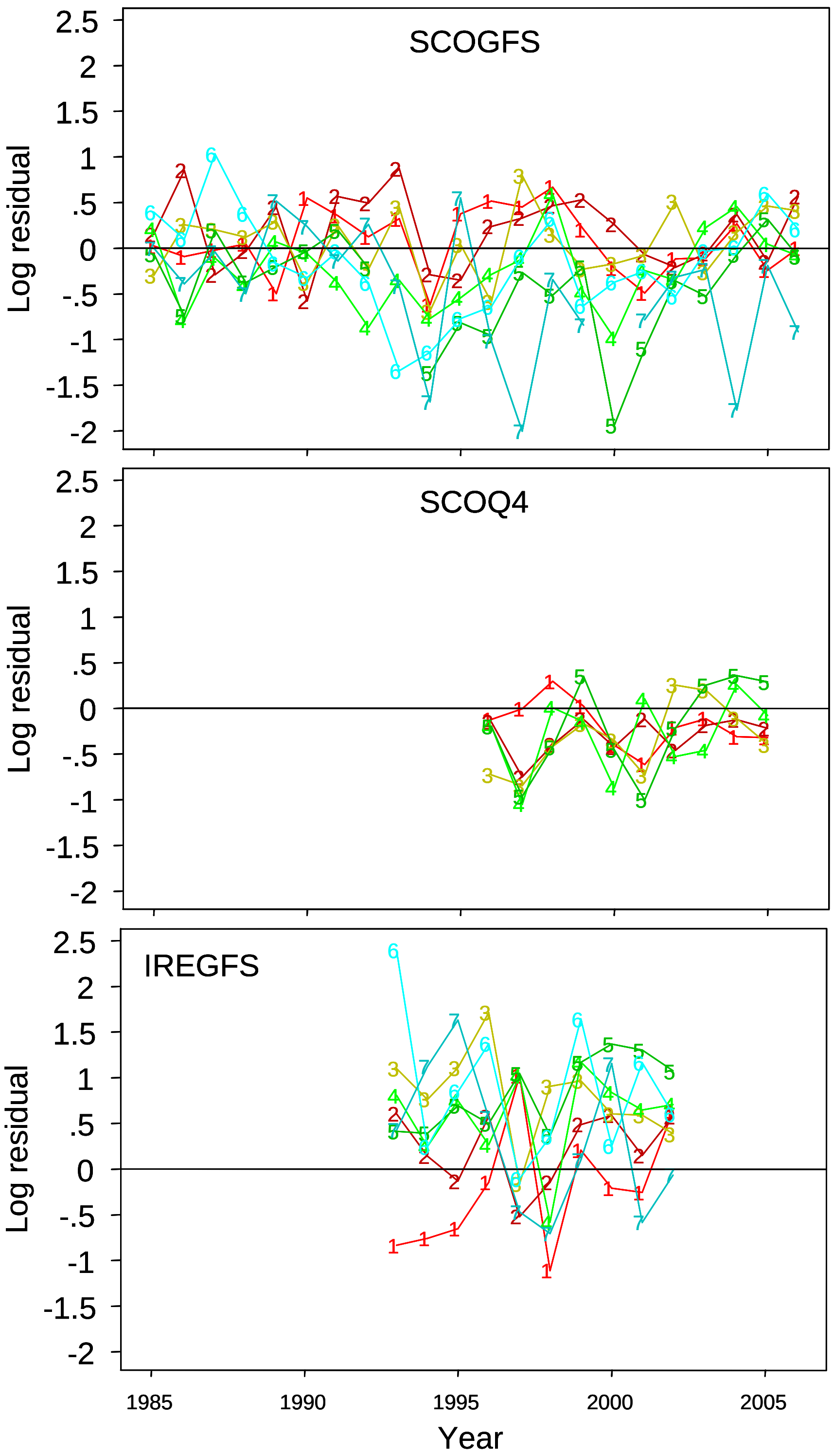


Figure 4.1.9. Haddock in Division VIa. Plots of Residuals from SURBA analysis using all three surveys combined: SCOGFS, SCOQ4 and IREGFS.

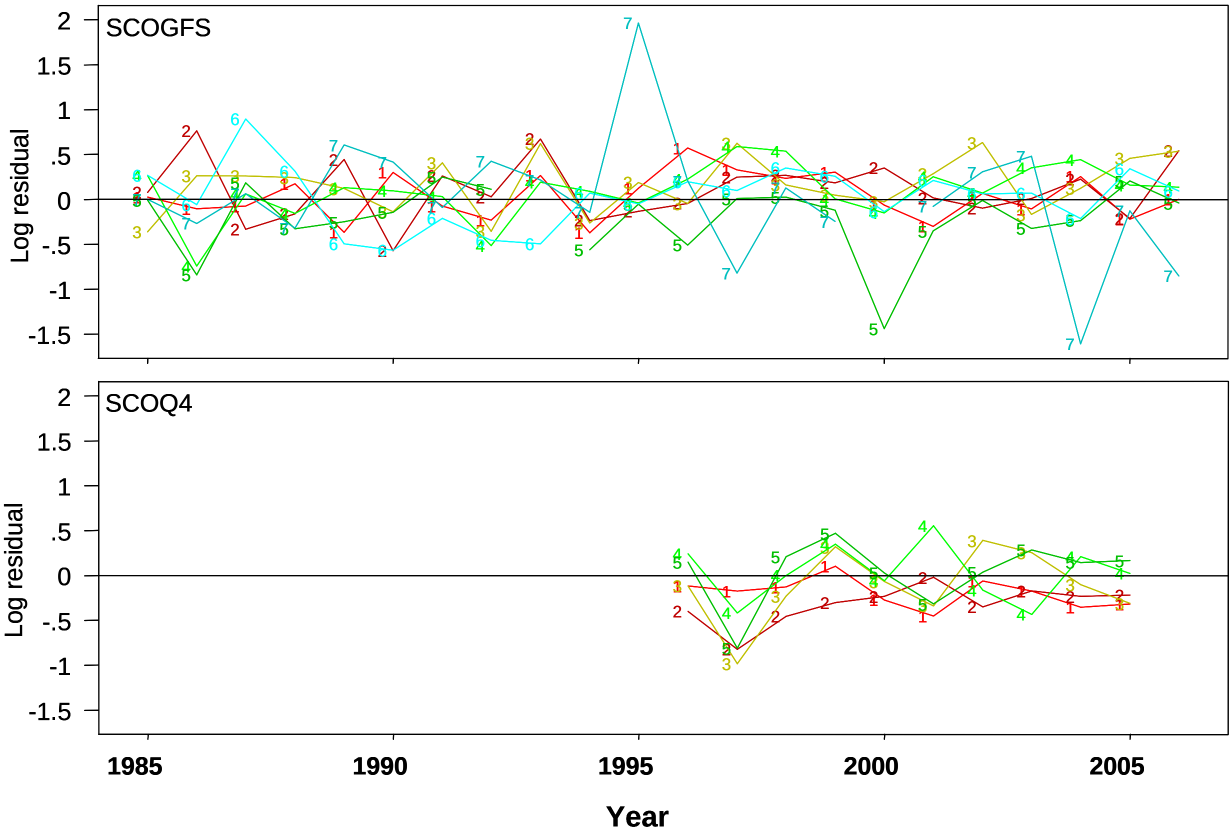


Figure 4.1.10. Haddock in Division VIa. Plots of Residuals from SURBA analysis using the two Scottish surveys combined: SCOGFS and SCOQ4.

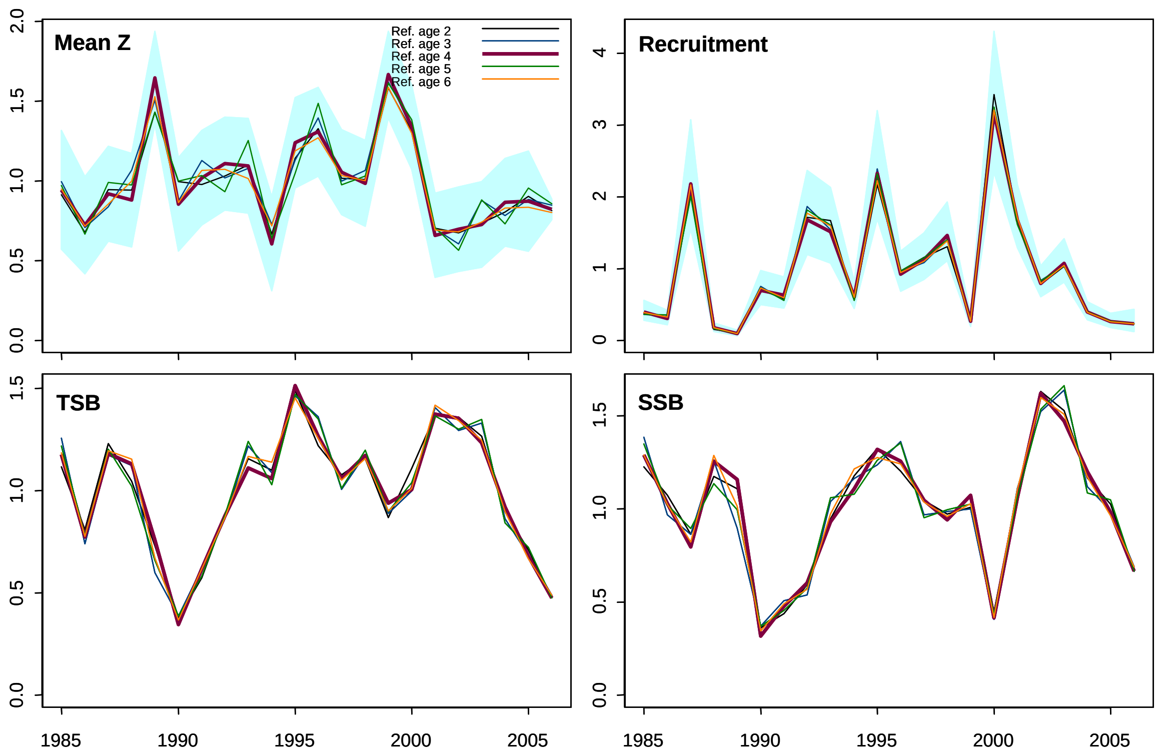
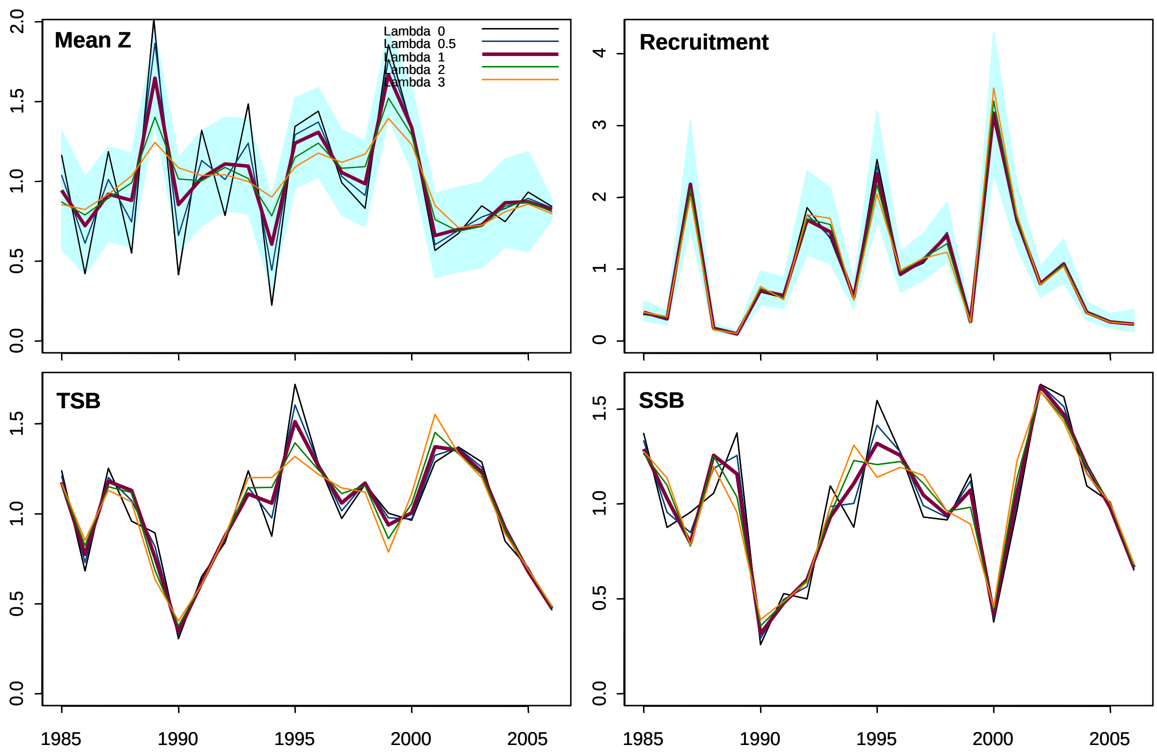


Figure 4.1.11. Haddock in Division VIa. Summary plots for dual survey run of SURBA scanning through options of reference age = 2, 3, 4, 5 and 6. Shaded area indicates estimates of precision from single run at default reference age = 4.



Fig

Figure 4.1.12. Haddock in Division VIa. Summary plots for dual survey run of SURBA scanning through options of lambda = 0, 0.5, 1, 2 and 3. Shaded area indicates estimates of precision from single run at default lambda = 1.

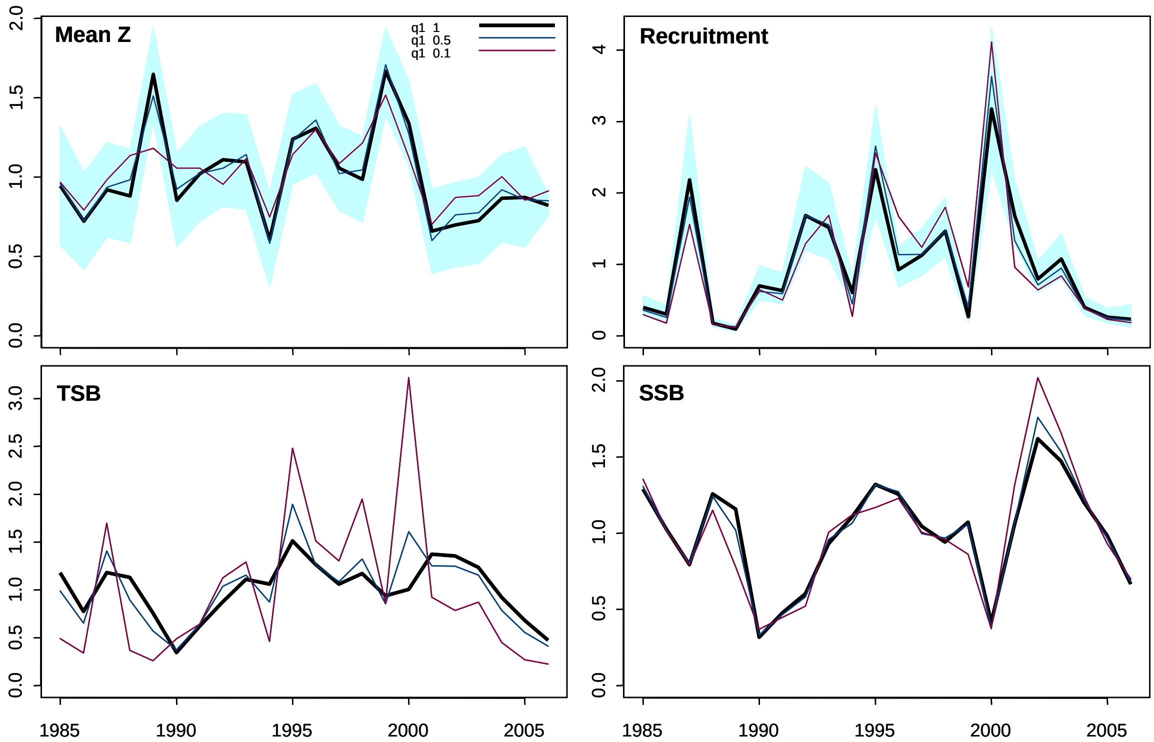


Figure 4.1.13. Haddock in Division VIa. Summary plots for dual survey run of SURBA scanning through options of catchability at age 1 = 1, 0.5 and 0.1. Shaded area indicates estimates of precision from single run at default reference age = 4.

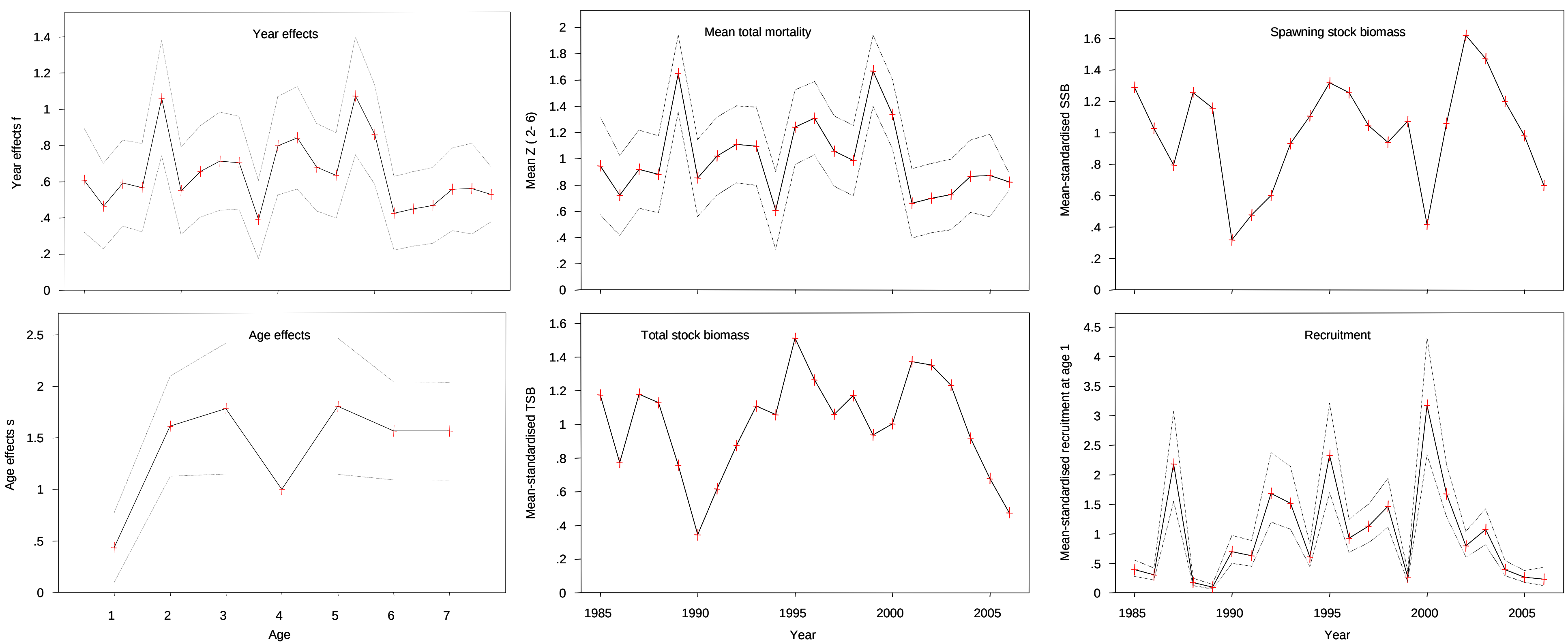


Figure 4.1.14. Haddock in Division VIa. Summary of SURBA run using both the SCOGFS and SCOQ4 surveys. Stcok summaries. Top row: fitted temporal trends, estimated mean Z $_{2\text{-}6}$ and relative SSB. Bottom row: age effects, relative total stock biomass and relative recruitment.

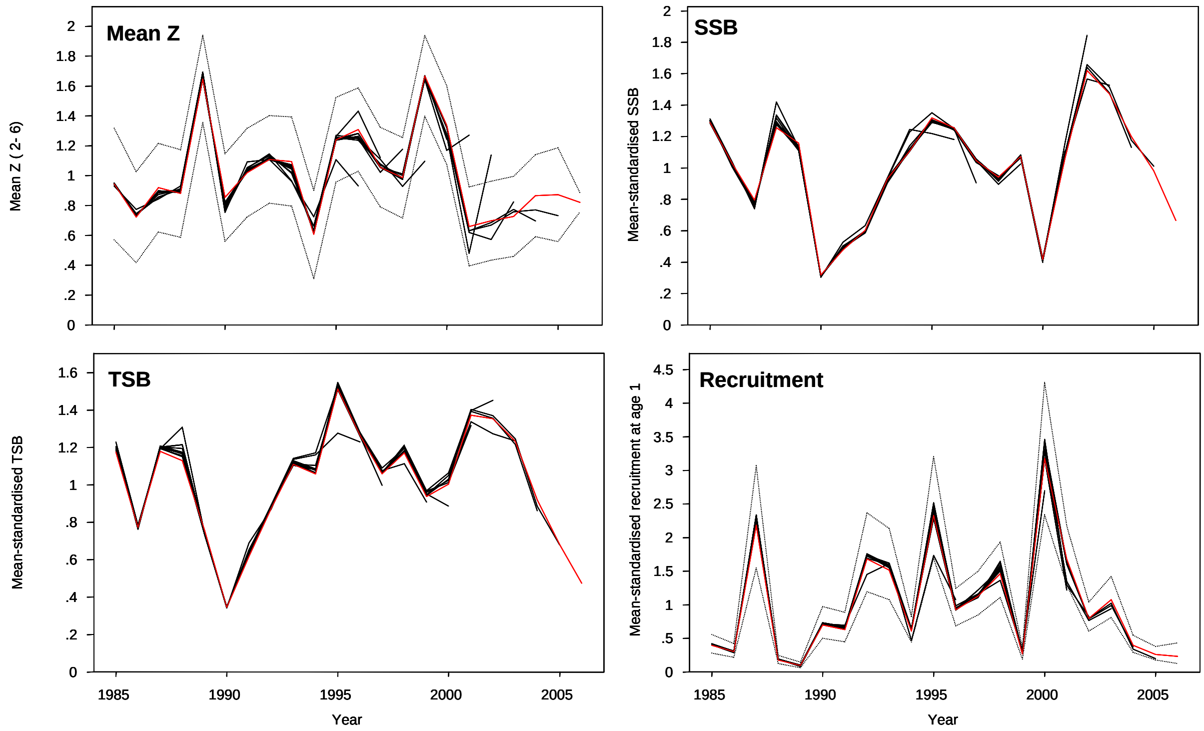


Figure 4.1.15. Haddock in Division VIa. SURBA final run (using both the SCOGFS and SCOQ$ surveys) retrospective plots.

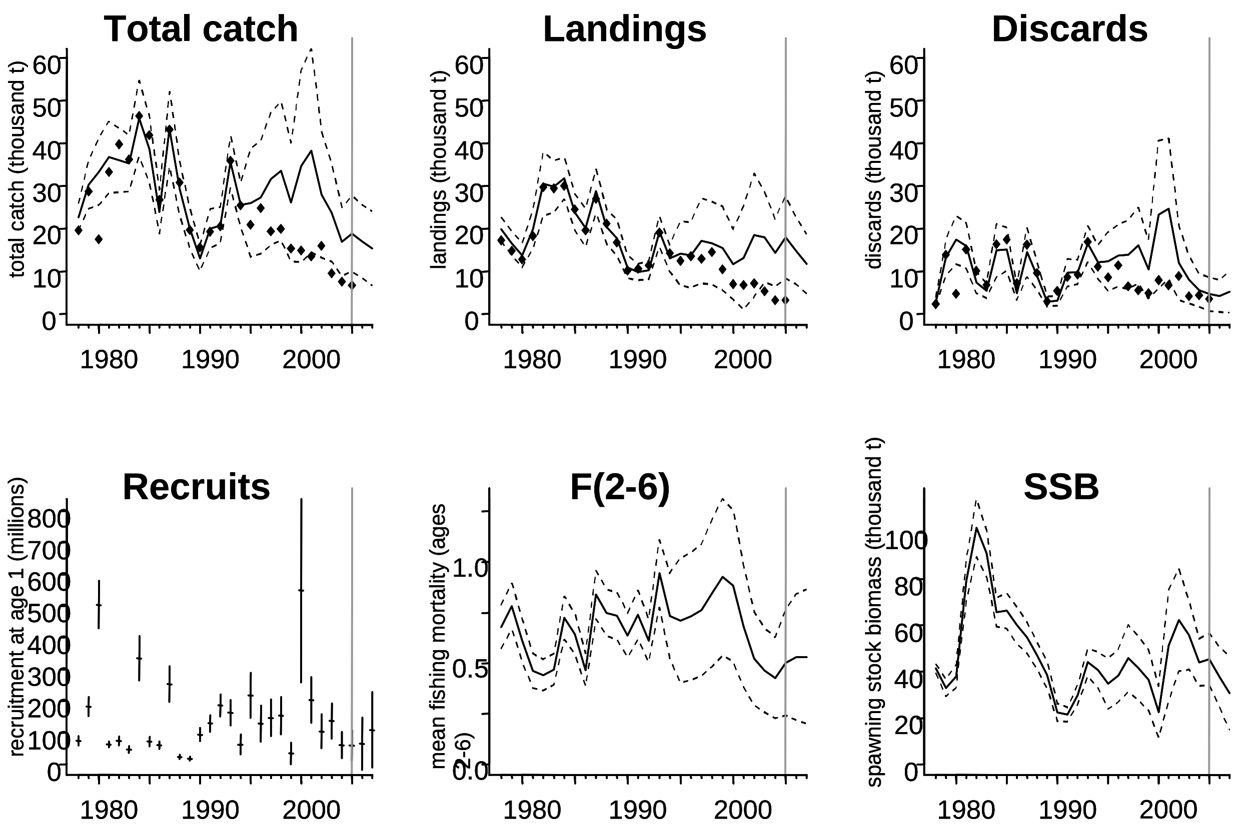


Figure 4.1.16 Haddock in Division VIa. TSA stock summary from run with 2006 SPALY run (catch & discard from 1995-2005 not fitted, SCOGFS only and no survey trend). Estimates are plotted with approximate pointwise 95% confidence bounds. The dotted vertical line on each graph show the last year of available catch data.

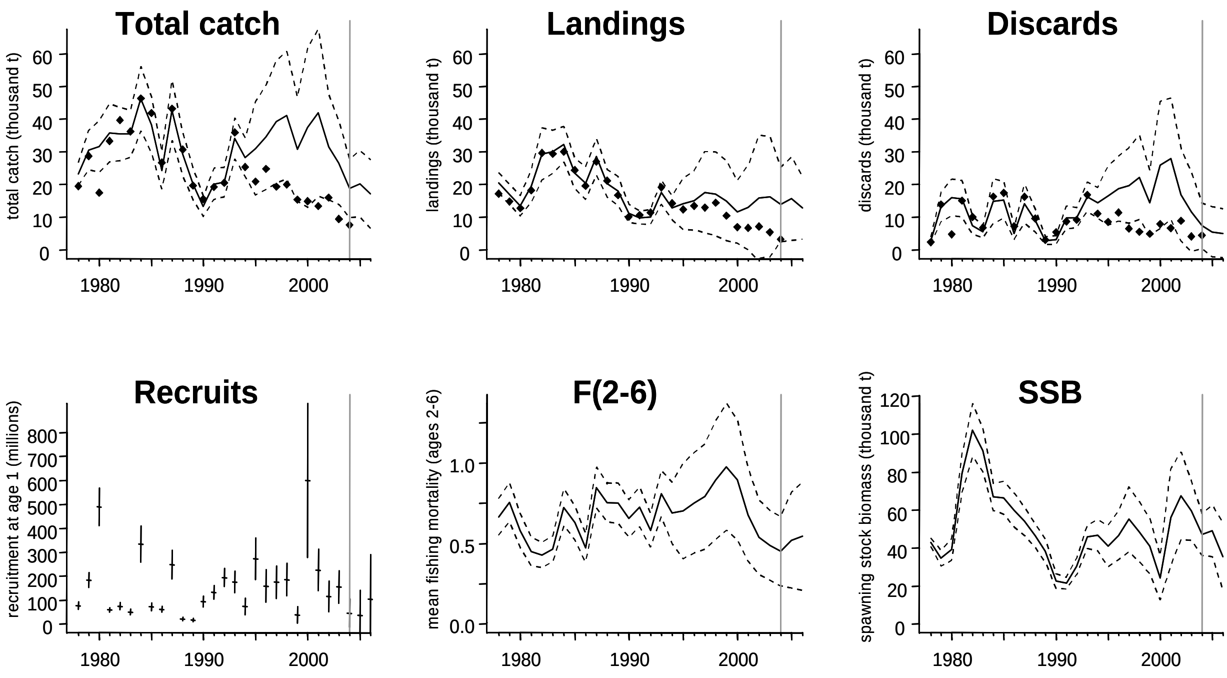


Figure 4.1.17 Haddock in Division VIa. TSA stock summary from the 2005 assessment (catch & discard from 1995-2005 not fitted, SCOGFS only and no survey trend). Estimates are plotted with approximate pointwise 95% confidence bounds. The dotted vertical line on each graph show the last year of available catch data.

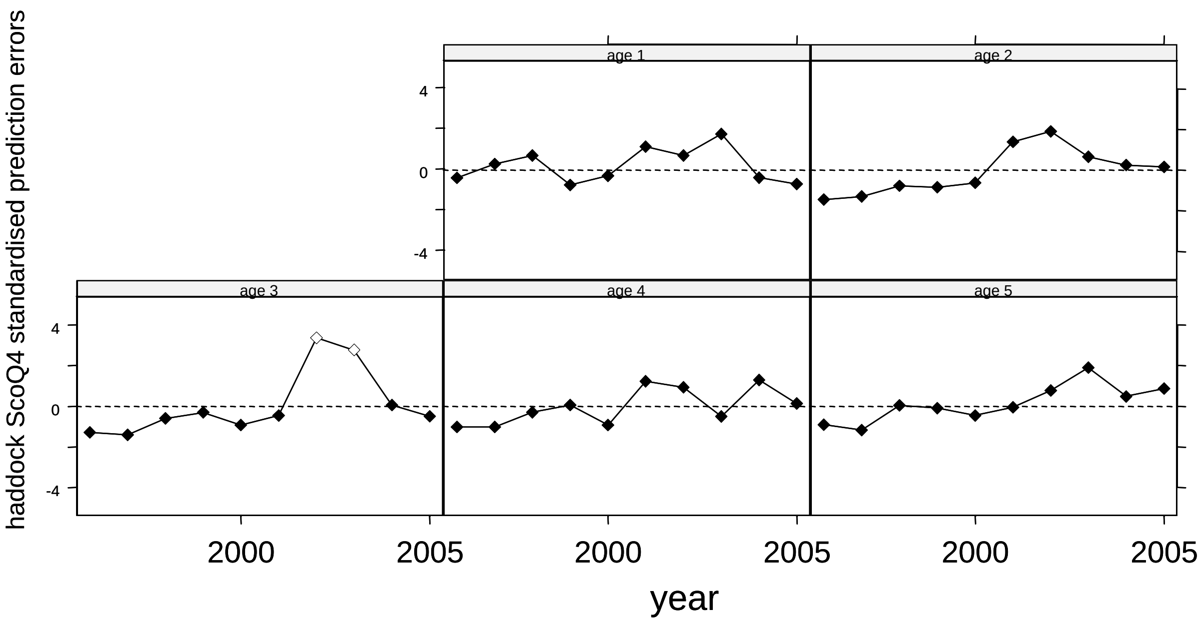


Figure 4.1.18. Haddock Via. Standardised prediction errors by age for the SCOQ4 survey, from the first TSA run with two Scottish trawl surveys. The two points at Age 3 (2003 and 2002; open symbols), were subsequently downweighted in the final TSA run (see Figure 4.1.19 below).

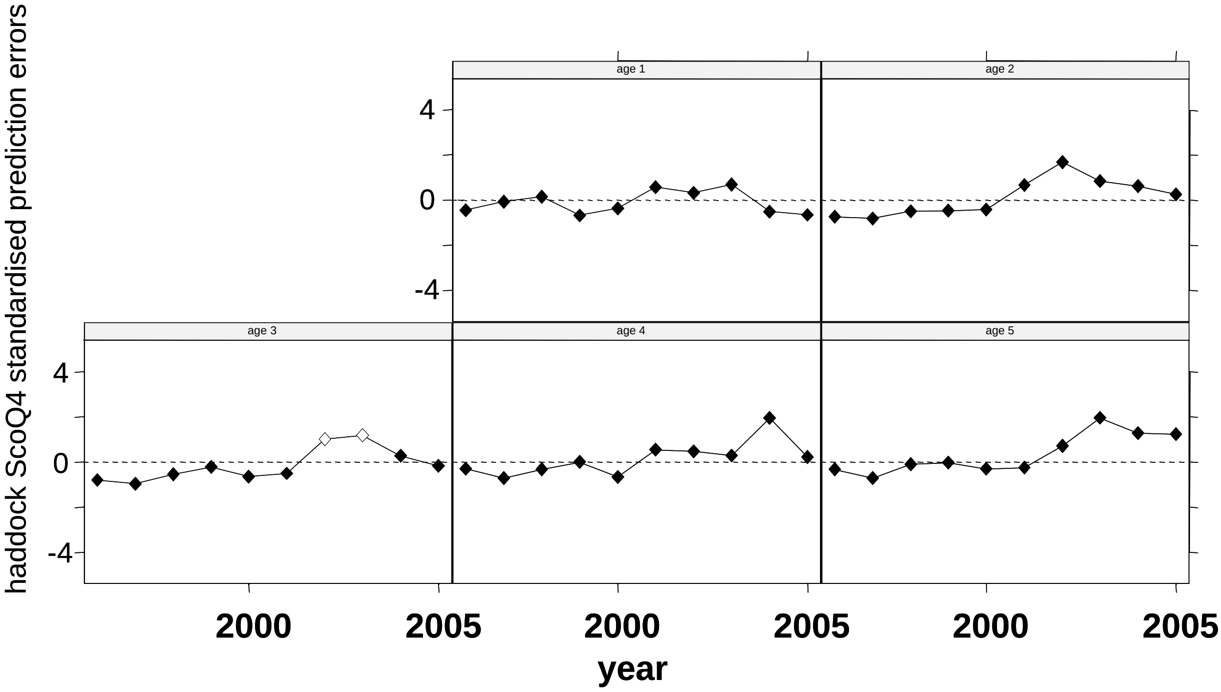


Figure 4.1.19. Haddock in Division VIa. Standardised SCOQ4 survey prediction errors by age from final TSA run (missing catch 1995–2005, two surveys & no survey trend). The two points at Age 3 (2003 and 2002; open symbols), were downweighted.

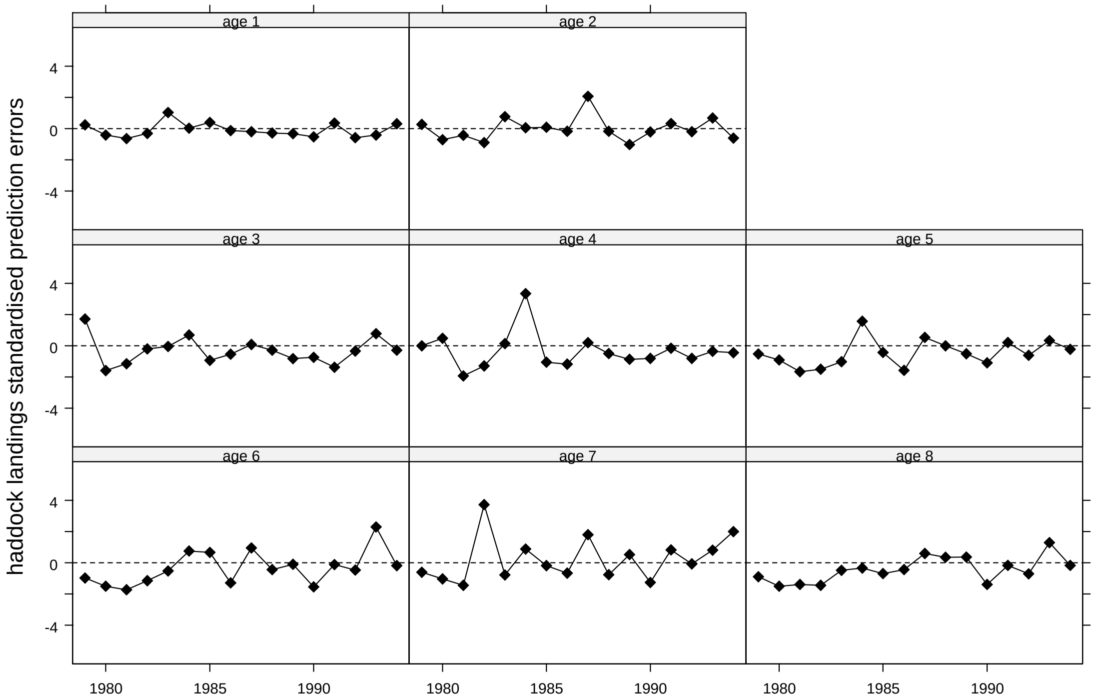


Figure 4.1.20. Haddock in Division VIa. Standardised landings prediction errors by age from final TSA run (missing catch 1995–2005, two surveys & no survey trend).

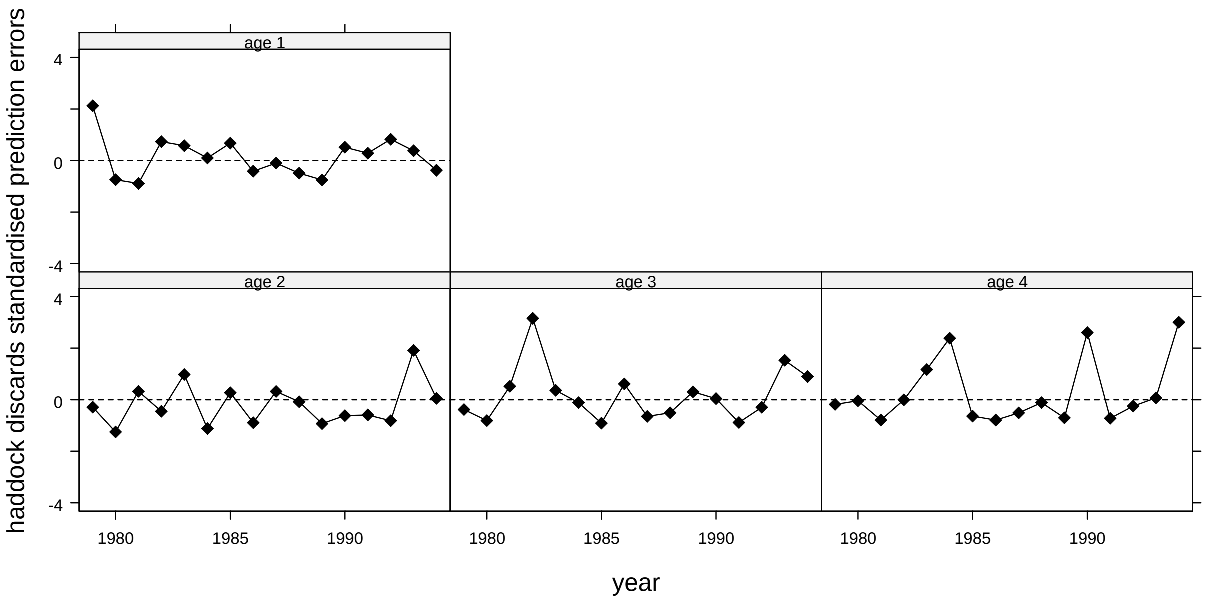


Figure 4.1.21. Haddock in Division VIa. Standardised discard prediction errors by age from final TSA run (missing catch 1995–2005, two surveys & no survey trend).

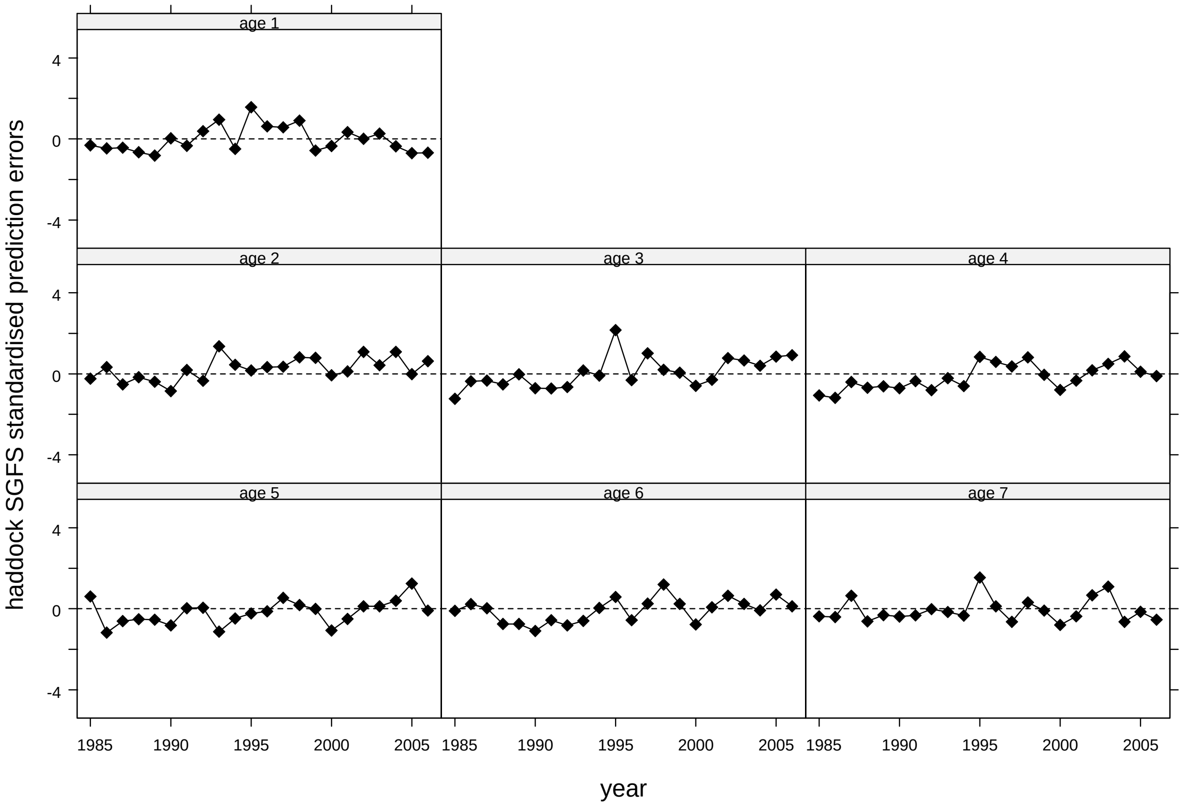


Figure 4.1.22. Haddock in Division VIa. Standardised SCOGFS survey prediction errors by age from final TSA run (missing catch 1995–2005, two surveys & no survey trend).

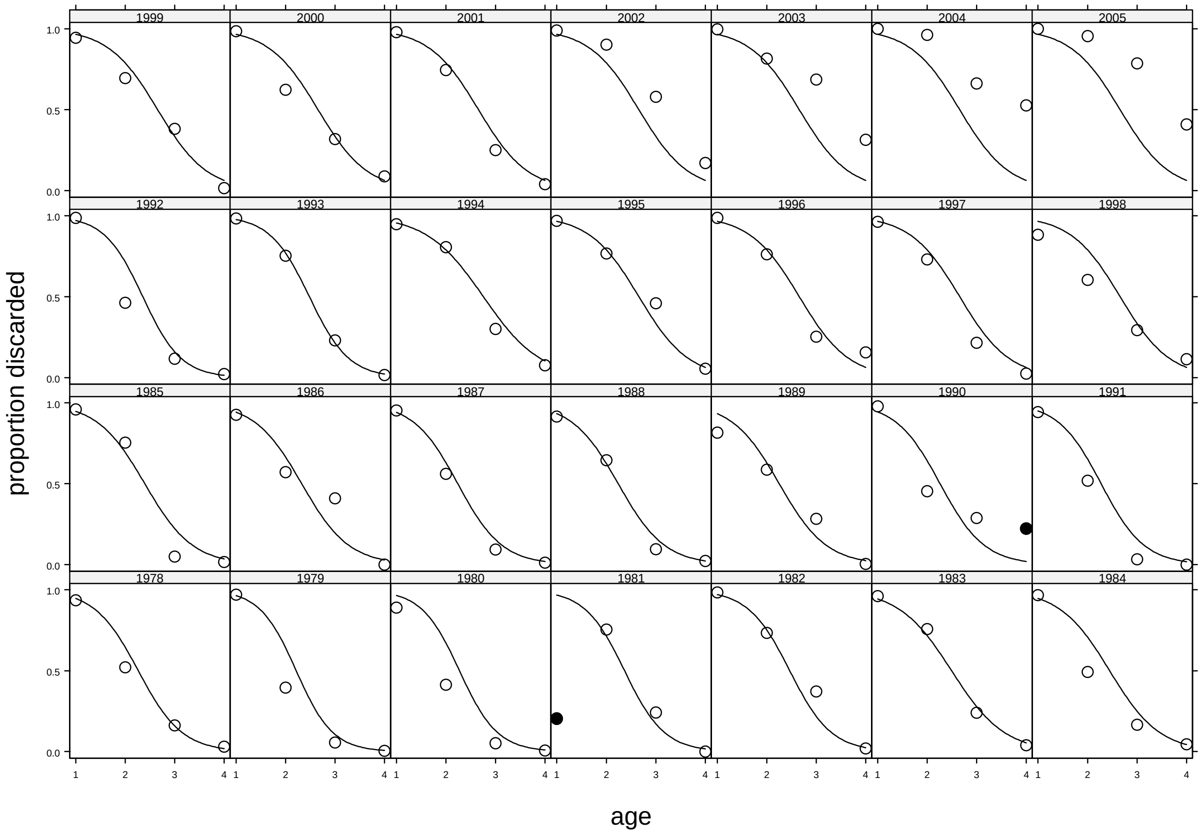


Figure 4.1.23. Haddock in Division VIa. Fitted discard ogives from final TSA run (missing catch 1995–2005 two surveys & no survey trend). Points show observed discard proportions at age.

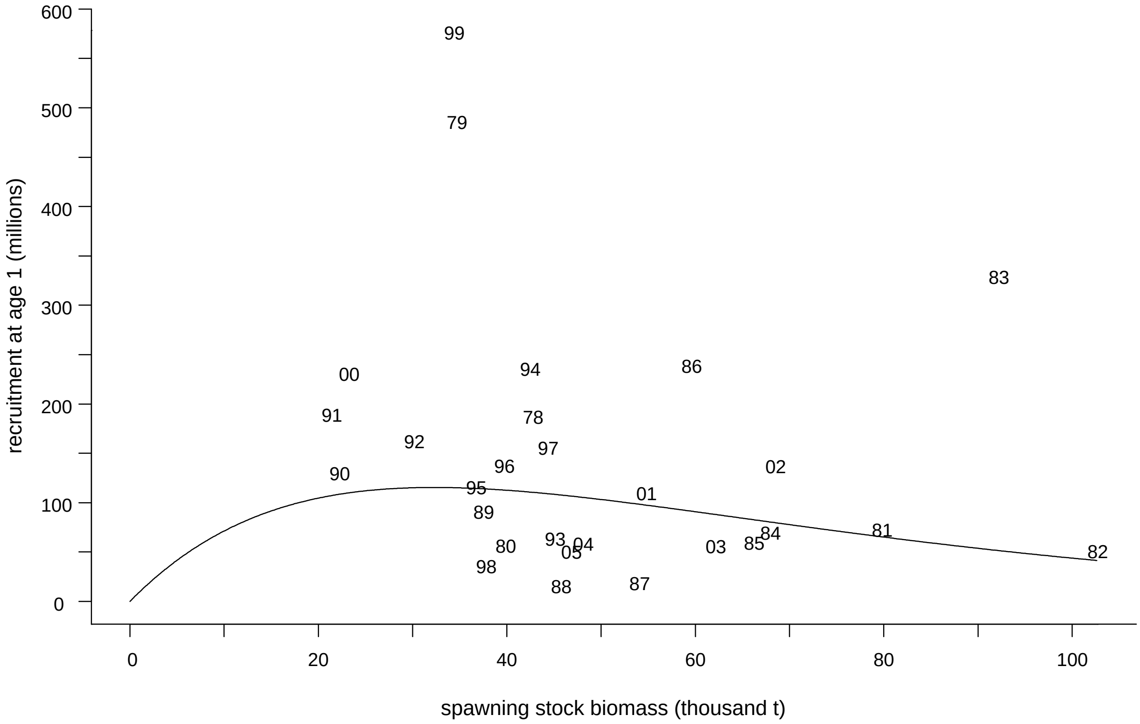


Figure 4.1.24. Haddock in Division VIa. TSA stock-recruitment scatterplot from final run (missing catch 1995–2005, two surveys & no survey trend). Line gives TSA-estimated Ricker curve. Labels denote year-classes.

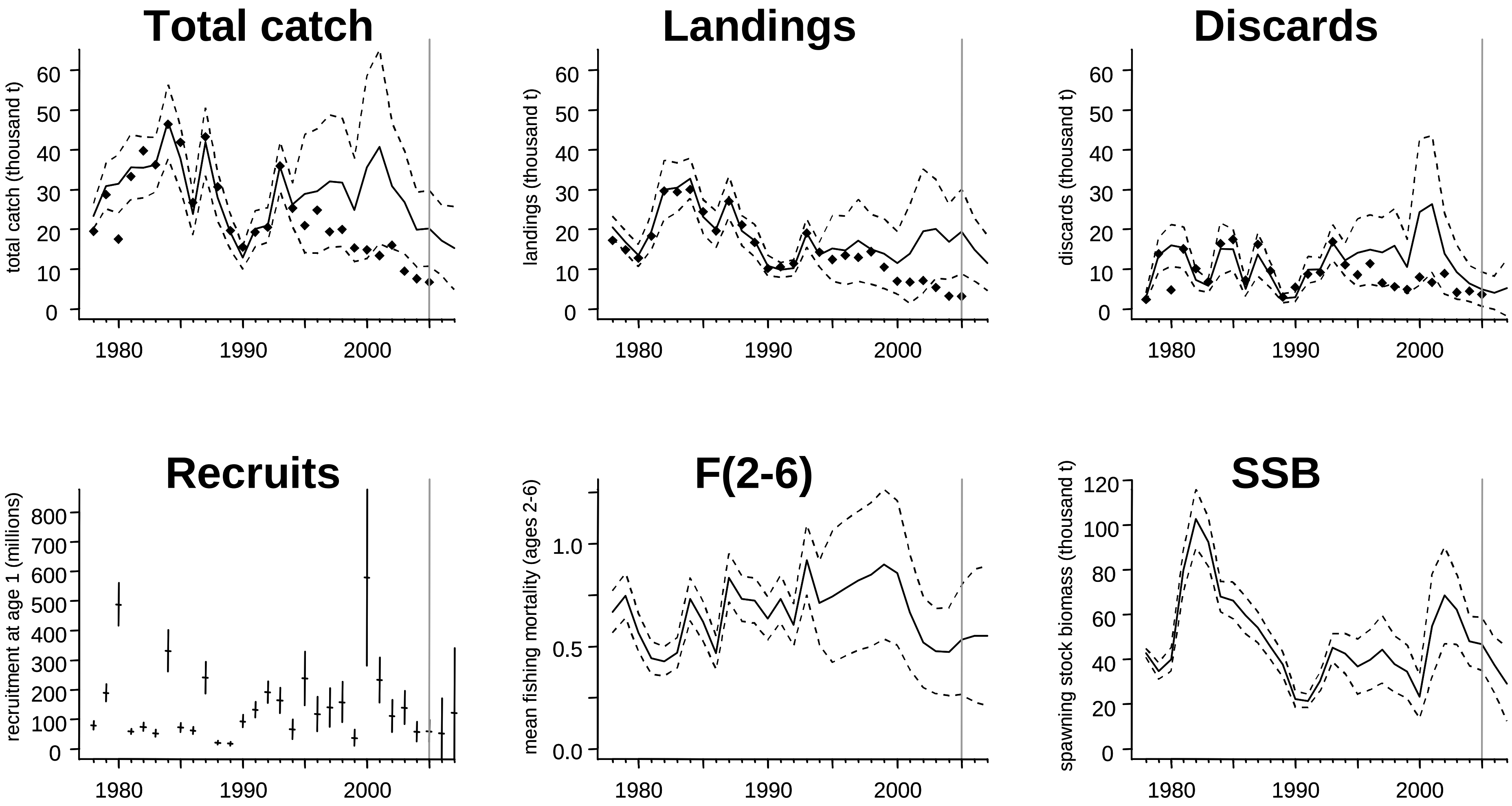


Figure 4.1.25. Haddock in Division VIa. TSA stock summary from final run (missing 1995–2005 catch, two surveys & no survey trend). Estimates are plotted with approximate pointwise 95% confidence bounds. The dotted vertical line on each graph shows the last year of available catch data.

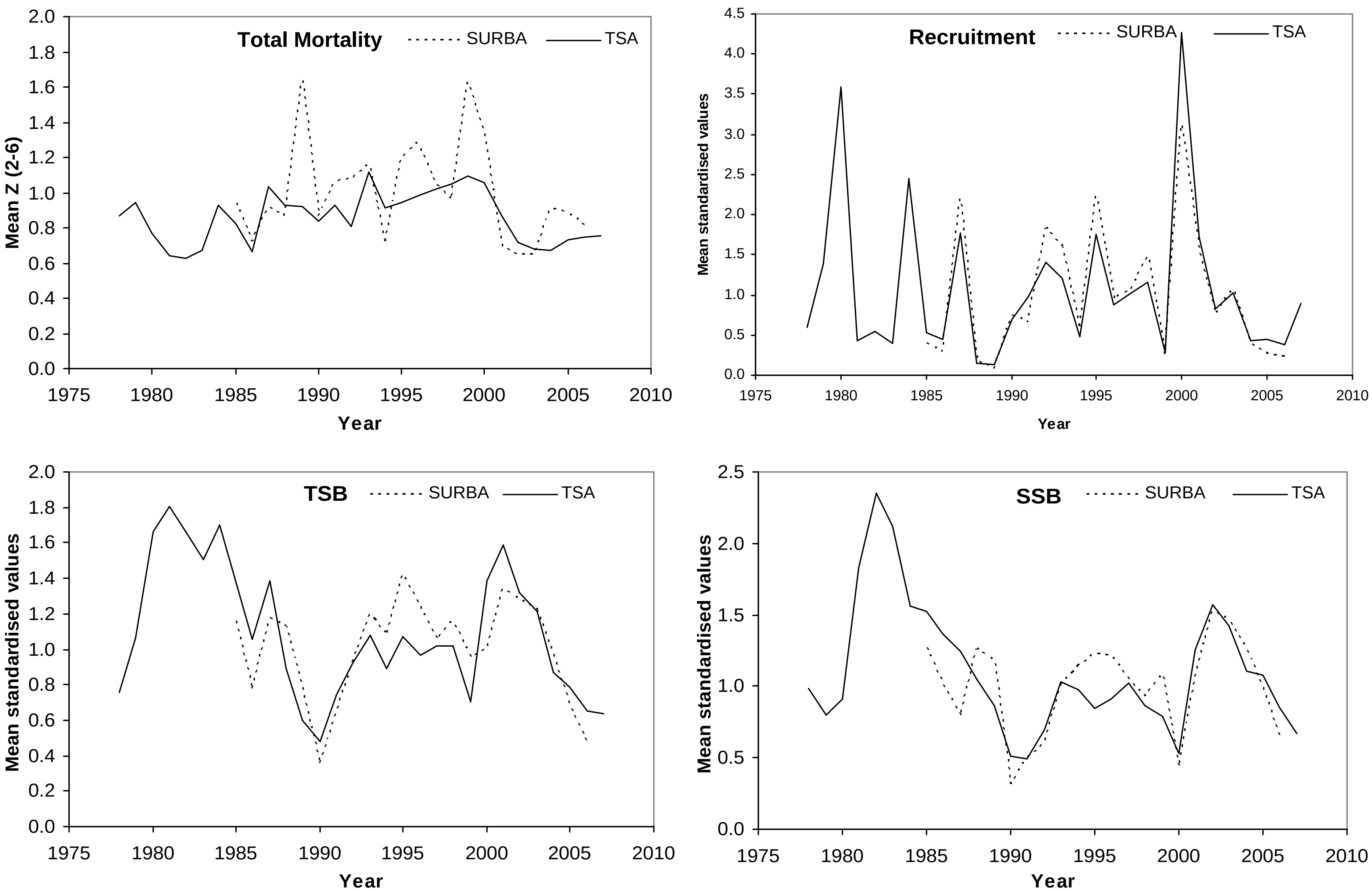


Figure 4.1.26. Haddock in Division VIa. Stock summary plots from final TSA run and final SURBA run.

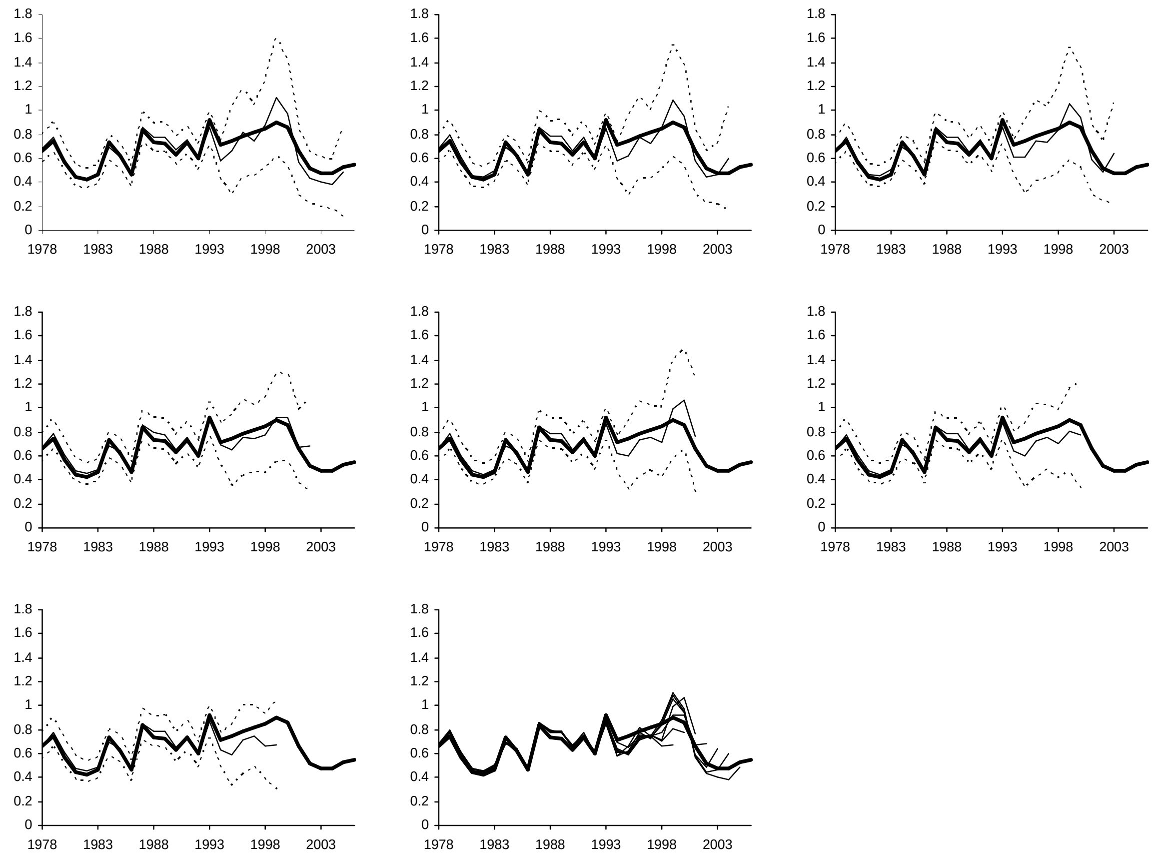


Figure 4.1.27. Haddock in Division VIa. Retrospective estimates of mean $F_{2–6}$ from final TSA run (catch & discards from 1995–2003 not fitted to model & no survey trend). The thick line is the current assessment, the thin lines are the retrospective estimates, and the dotted lines are upper and lower approximate pointwise 95% confidence intervals for the retrospective estimates. All estimates are compared in the final plot.

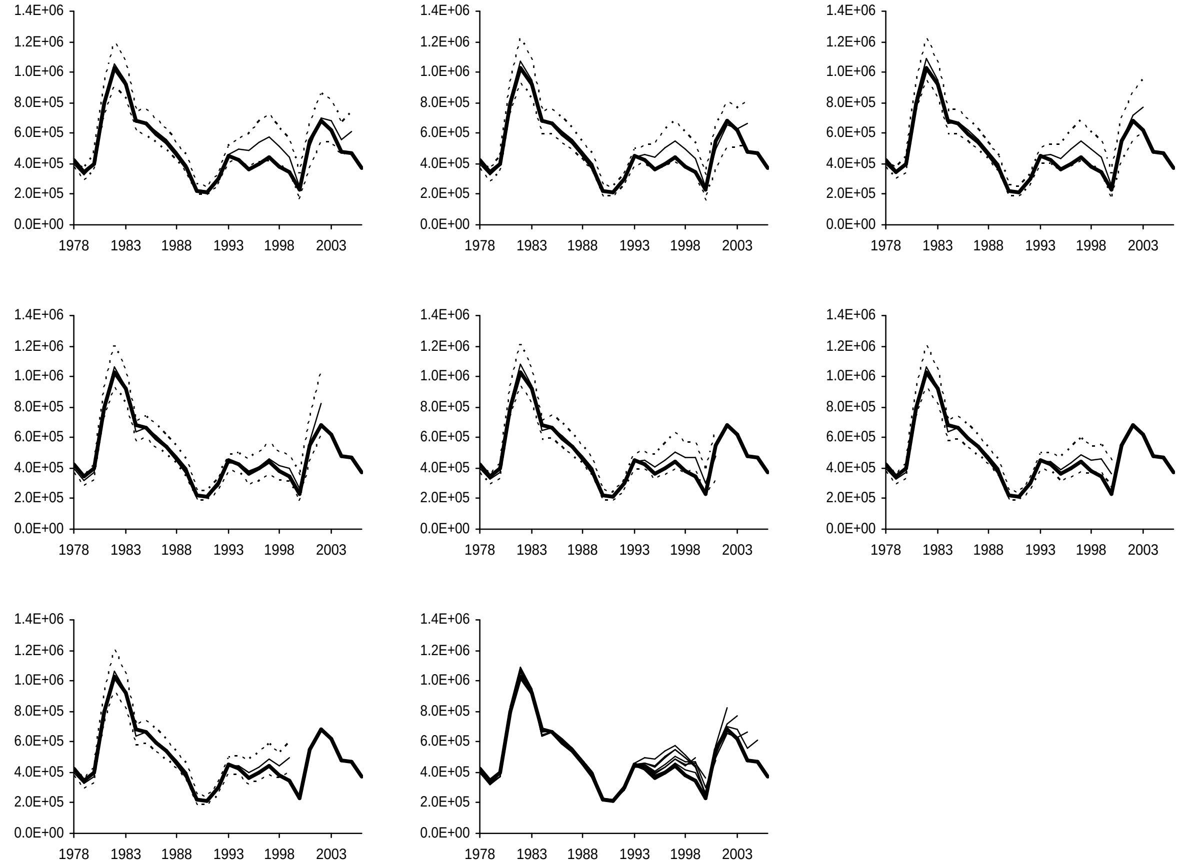


Figure 4.1.28. Haddock in Division VIa. Retrospective estimates of SSB from final TSA run (catch & discards from 1995–2003 not fitted to model & no survey trend). The thick line is the current assessment, the thin lines are the retrospective estimates, and the dotted lines are upper and lower approximate pointwise 95% confidence intervals for the retrospective estimates. All estimates are compared in the final plot.

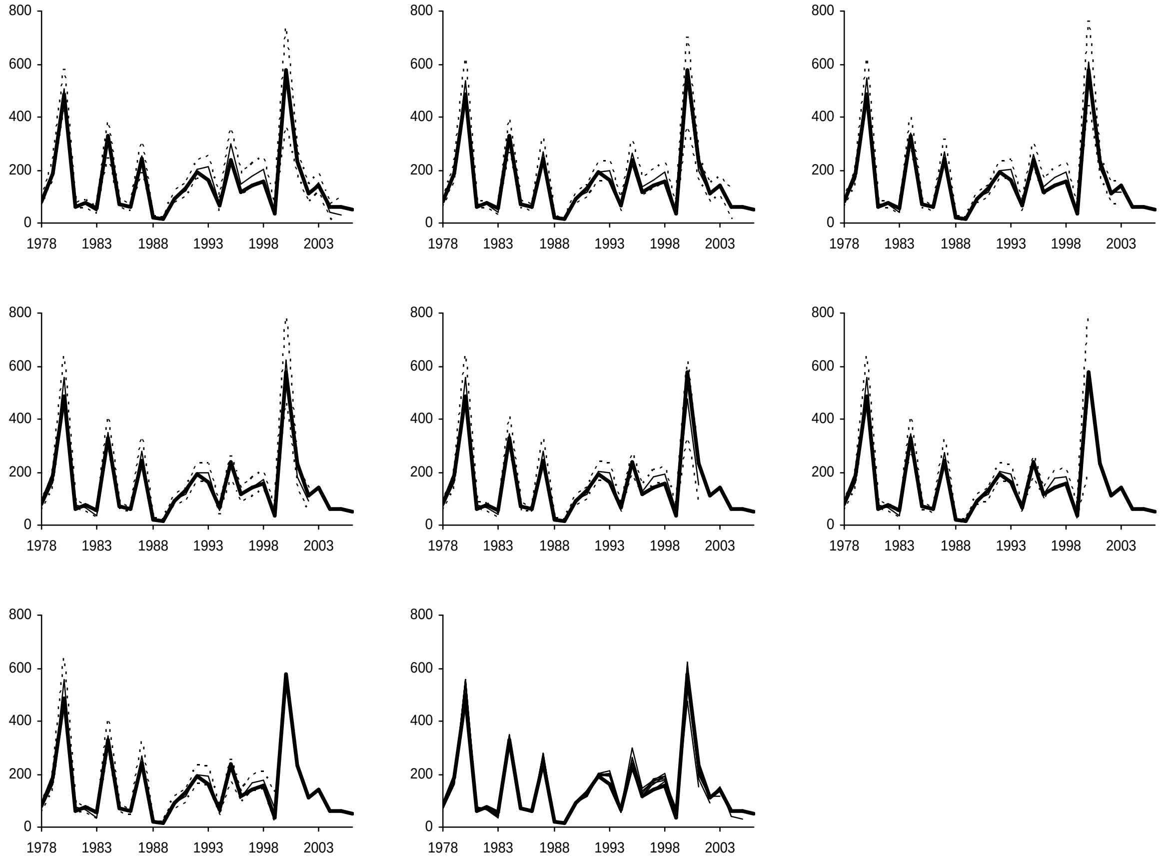


Figure 4.1.29. Haddock in Division VIa. Retrospective estimates of recruitment at age 1 from final TSA run (catch & discards from 1995–2003 not fitted to model & no survey trend). The thick line is the current assessment, the thin lines are the retrospective estimates, and the dotted lines are upper and lower approximate pointwise 95% confidence intervals for the retrospective estimates. All estimates are compared in the final plot.

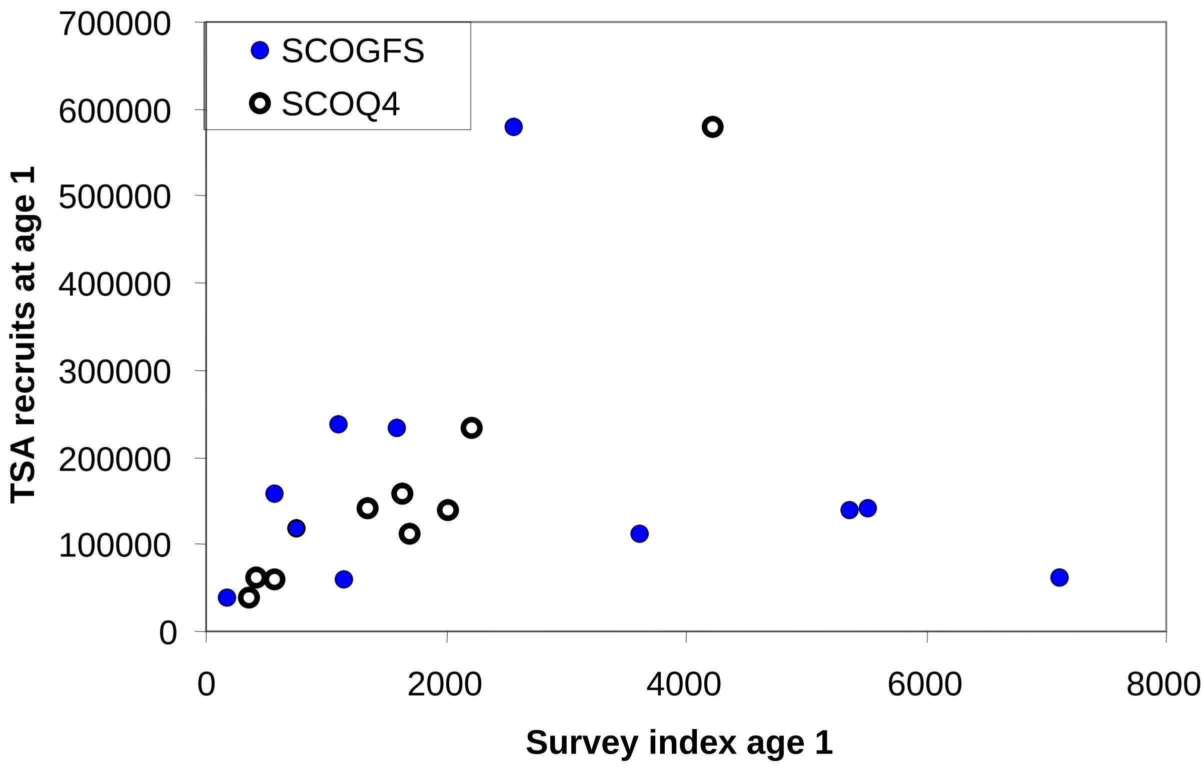


Figure 4.1.30. Haddock in Division VIa. Comparison of the numbers at age 1 from the survey indices with the predicted recruitment at age 1 from TSA.

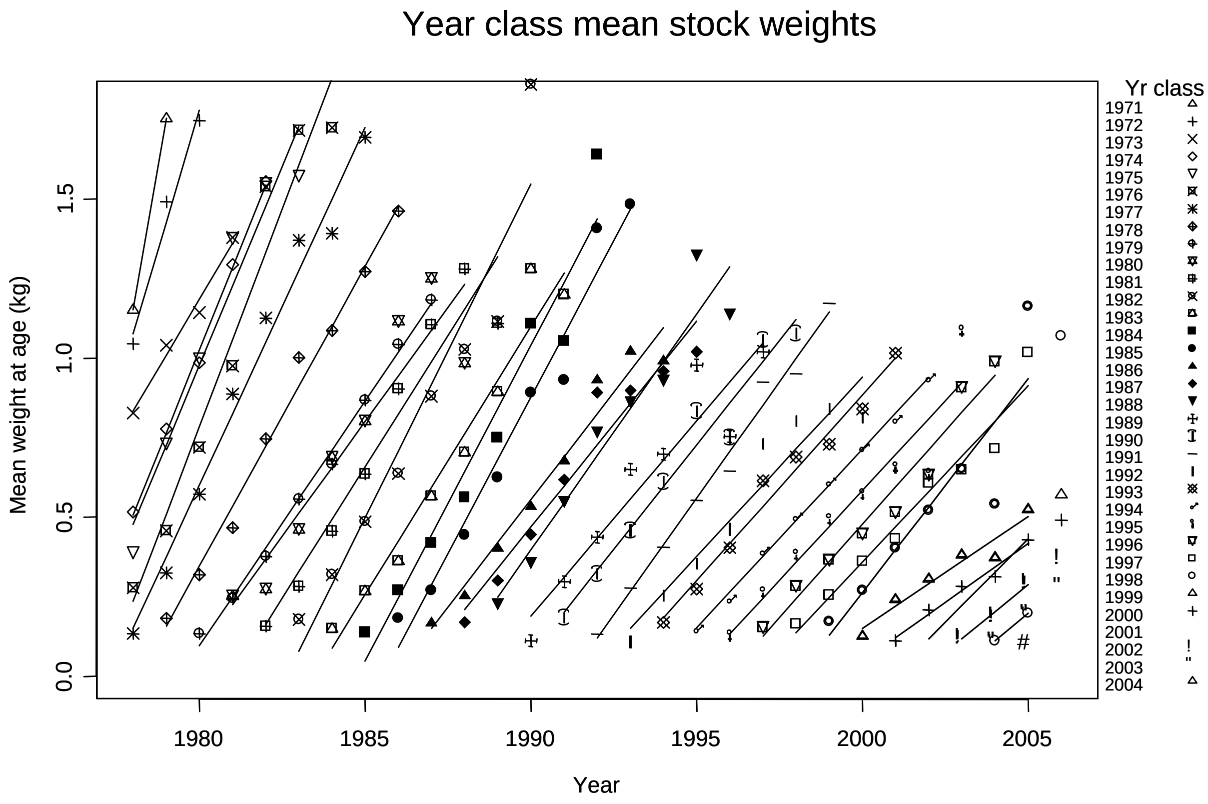


Figure 4.1.31. Haddock in Division VIa. Mean weights-at-age (kg) in total catch tracked by year class with a GLM fit (solid lines); the single symbols in 2006 represent predicted values from the GLM.

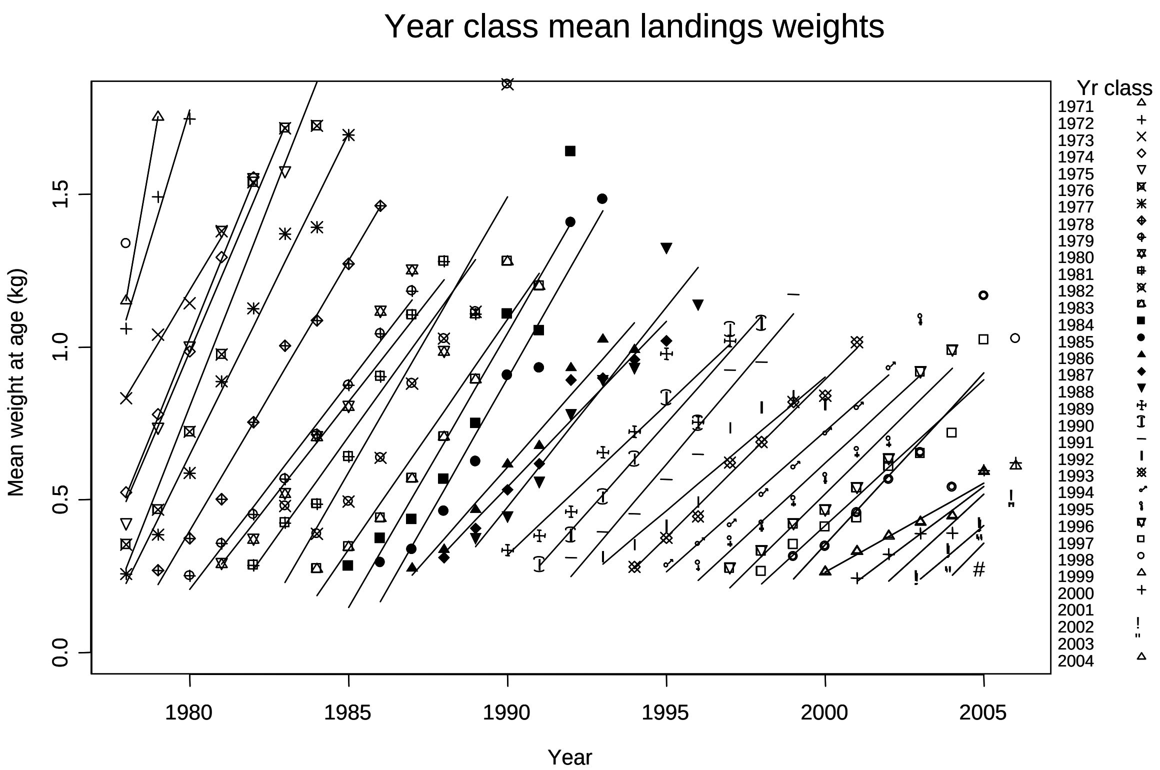


Figure 4.1.32. Haddock in Division VIa. Mean weights-at-age (kg) in landings tracked by year class with a GLM fit (solid lines); the single symbols in 2006 represent predicted values from the GLM.

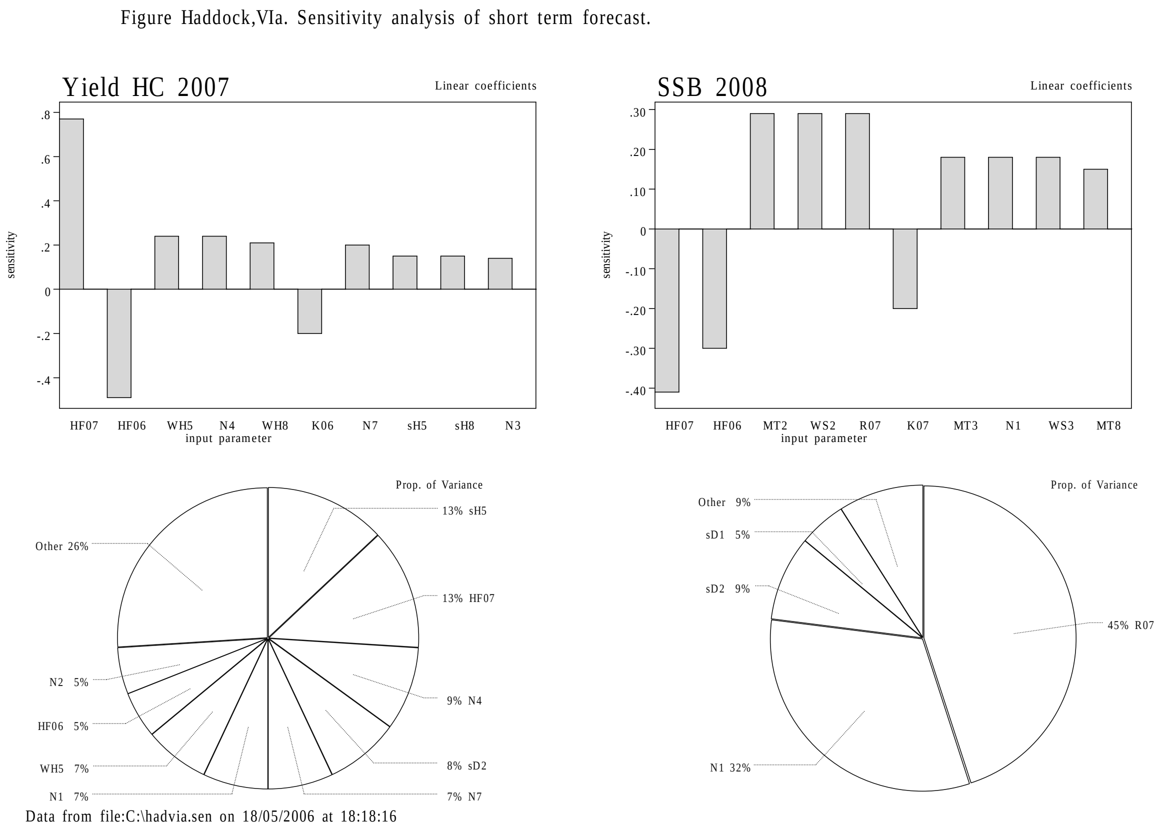


Figure 4.1.33. Sensitivity analysis of short-term forecast for final TSA run (catch & discards 1995–2005 not fitted to model, no trend in survey q) assuming predicted weights in 2006 from linear model.

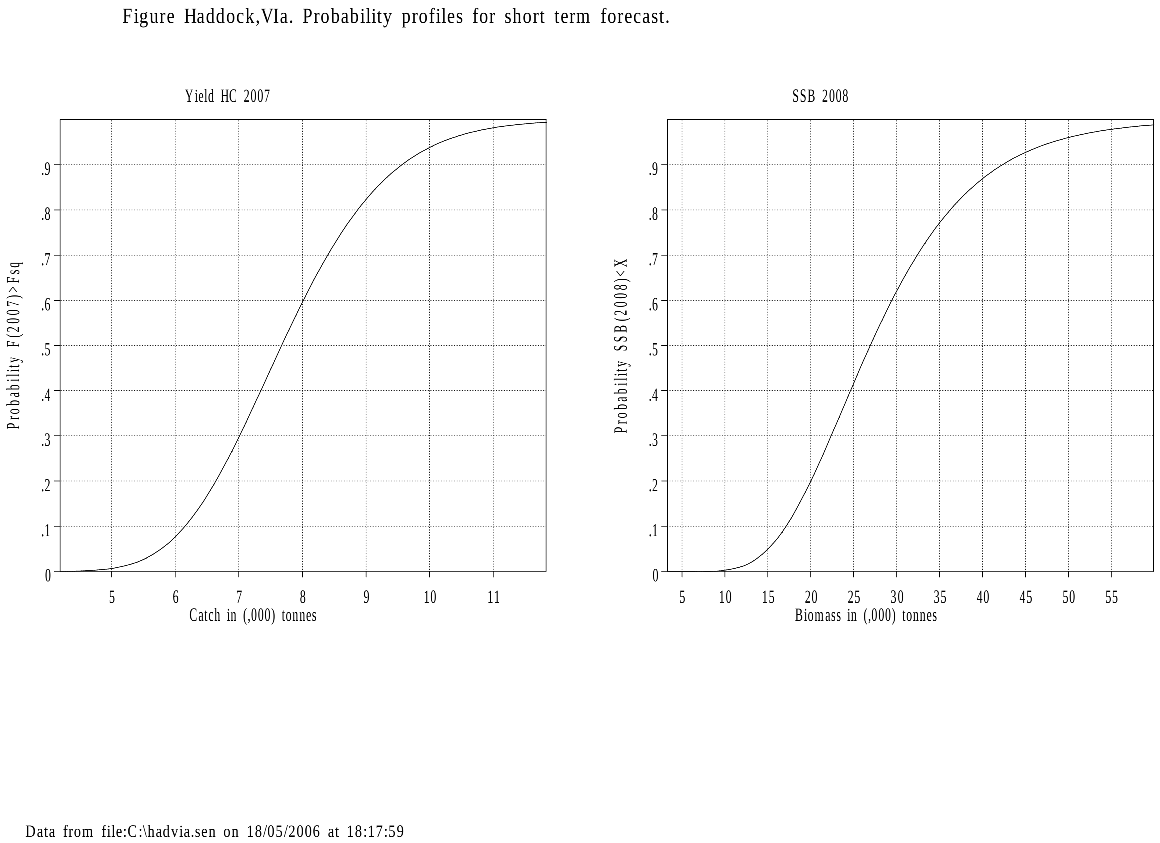


Figure 4.1.34. Probability profiles for short-term forecast for final TSA run (catch & discards 1995–2005 not fitted to model, no trend in survey q) assuming predicted weights in 2006 from linear model.

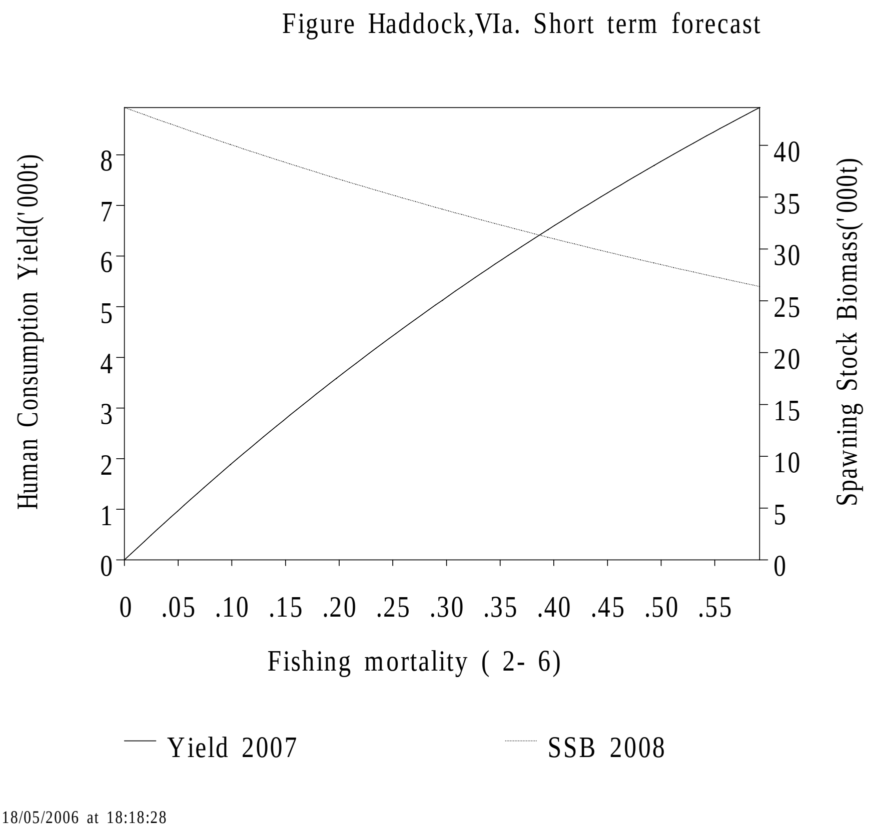


Figure 4.1.35. Short-term forecast for final TSA run (catch & discards 1995–2005 not fitted to model, no trend in survey q) assuming predicted weights in 2006 from linear model.

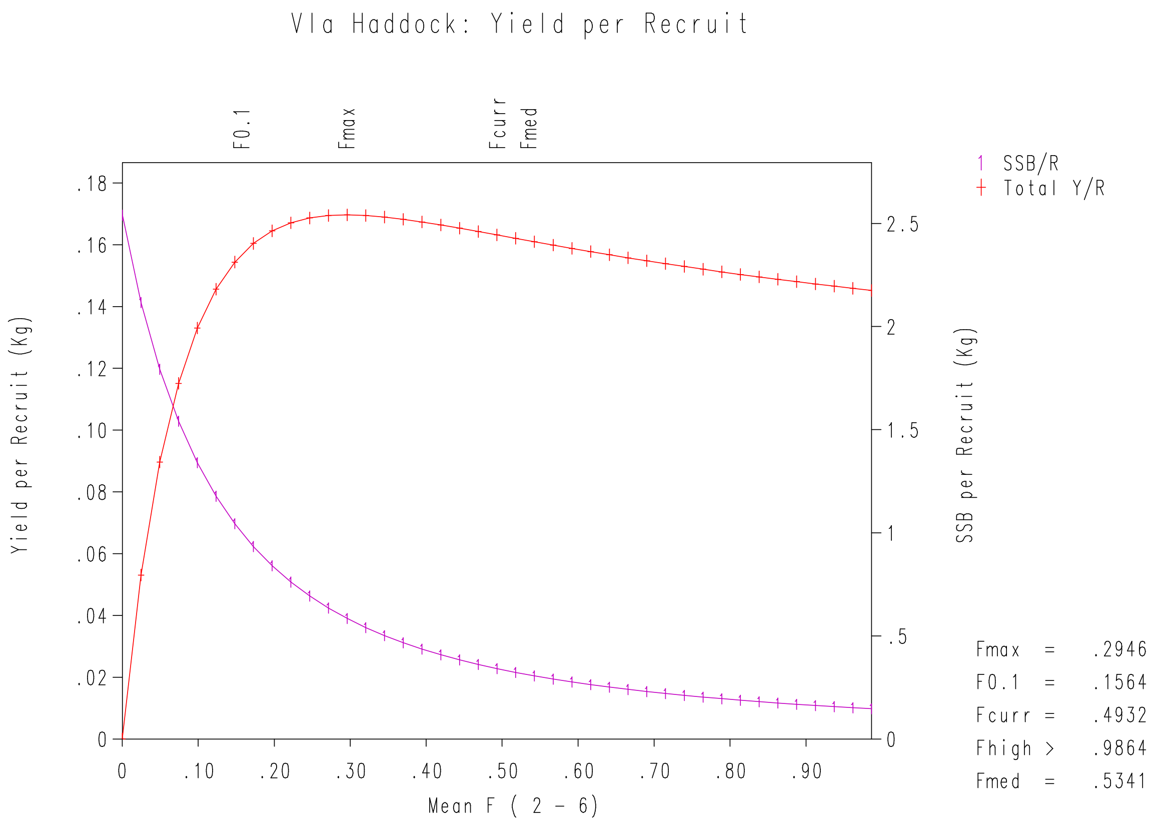


Figure 4.1.36. Yield-per-recruit for final TSA run (catch & discards 1995–2005 not fitted to model, no trend in survey q) assuming predicted weights in 2006 from linear models shown in Figure 4.1.31 and Figure 4.1.32.

Figure 4.1.37. Yield-per-recruit for final TSA run (catch & discards 1995–2005 not fitted to model, no trend in survey q) assuming predicted weights in 2006 from linear models shown in Figure 4.1.31 and Figure 4.1.32.

4.2 Haddock in Division VIb

The lack of discarding information from the European fleets has required that recent assessments approximate the Russian Catch as EU landings equivalents above the EU minimum landing size. This approach was necessary to avoid the possible mis-interpretation of the sudden appearance of the Russian catch of smaller haddock as evidence of strong recruitment. However, the approach underestimates the total catch from the fishery.

$WGNSDS_{2004}$ was presented with an experimental assessment (Khlivnoy, 2004) which allows the modelling of the total catch (including discards) of the Irish, Scottish and Russian fleets. To facilitate the potential use of different models for the experimental assessment of Rockall haddock the WG collated separate Russian and EU catch-at-age matrices. In the Technical Minutes of its October 2004 meeting, the review group (RGNSDS) recommended that the WG evaluate this approach at 2005 meeting. August 2004 meeting, RGNSDS recommended that the WGNSDS should explore alternative (experimental) approaches to assessment and advice using the data from existing and future planned surveys.

The response from the Working Group to the NEAFC request for advice on closed areas for haddock in VIb is provided in Section 16.

4.2.1 The fishery

The development of the Rockall haddock fishery is documented in the 2001 Working Group report, and in the report of the ICES Group meeting on Rockall haddock convened in January 2001 (ICES, 2001). That meeting was set up to respond to a NEAFC request for information on the Rockall haddock fishery. NEAFC had agreed to consider regulation of the international fishery in 2001 and the report of the Expert Group was considered by ACFM working by correspondence prior to the NEAFC meeting.

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 led to opportunities for other nations, notably Russia, to exploit the fishery in this area. The table of Official Statistics (Table 4.2.1) now includes Russian catches from the Rockall area. The Russian fleet started fishing operations in international waters at Rockall in May-October 1999. Russian catches increased from 460t in 1999 to 2150t in 2000. In 2001 Russian haddock catches were markedly reduced to 630 t due to the introduction of a closed area and low density of fish concentrations. Catches increased again in 2002-2004 when Russian catches were 1,630 and 5,844 t correspondingly. In 2005, Russian catches are estimated to be 4708 t. The Russian haddock fishery uses bottom trawls with cod-end mesh size of 40-100mm (mainly 40-70mm) and retains haddock of all length classes in the catch.

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 200m and 400m. 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 2004-2005, a considerable proportion of EU landings were taken in the international waters. Historical fishing patterns of the Scottish fleet on Rockall is presented by Newton *et al*. (2003).

This pattern of fishing at Rockall, with vessels fishing on concentrations of haddock during spring, and increased activity by Russian vessels, is reported to have occurred in 2000, indicating a marked expansion of the fishery in 1999 and 2000. The Russian fishery targets concentrations of haddock mainly during the spring, and the beginning of summer.

Information on the Russian fishery and biological investigations from commercial vessels fishing in Rockall during 2005 are presented in WD 7.

An analysis of the spatial and depth distributions of Rockall haddock in association with oceanographic variables is presented by V. Vinnichenko and E. Sentyabov (2004), a WD to the 2004 WGNSDS meeting. Changes in distribution have occurred over a period coincidental with changes in oceanographic variables. Information on oceanographic conditions on Rockall bank in spring 2005 is presented by E. Sentyabov (2005).

4.2.1.1 ICES advice applicable to 2004 and 2005

ICES advice for 2004*:

ICES recommends that fishing mortality in 2004 should be reduced to the lowest possible level.

ICES advice for 2005*:

“Catches in 2005 should be reduced to the lowest possible level.”

ICES advice for 2006*:

* - single-stock boundary and the exploitation of this stock should be conducted in the context of mixed fisheries protecting stocks outside safe biological limits.

4.2.1.2 Management applicable in 2005 and 2006

The TAC for Haddock VIb has previously been set for Sub area Vb, VI, XII and XIV combined and was 8,675 t in 2003, 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 XII and XIV. The TAC was set at 702 t for VIb, XII and XIV in 2004 and 2005. The TAC was set at 597 t for VIb, XII and XIV in 2006.

The ICES advice, agreed TAC for EC waters and a comparison with WG estimates of landings is summarised below. All values are in tonnes

YEAR	ICES ADVICE (VIB)	BASIS	AGREED TAC	WG LANDINGS
2002	< 1300	Reduce F below 0.2	1300[a]	3123
2003	-	Lowest possible F	702[a]	6055
2004	-	Lowest possible F	702[b]	6426
2005	-	Lowest possible F	702[b]	5106
2006	-	Lowest possible F	597[b]	

[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.

It is not possible to calculate the percentage change in F associated with the TAC for this stock due to the lack of a previously accepted assessment.

In May 2001, the International Waters element of statistical rectangle 42D5, which is mainly at depths less than 200 m, was closed by NEAFC to all fishing activities, except with longlines.. In Spring 2002, the EU component of this rectangle, again mostly shallow water, was also closed to trawling activities (EC No 2287/2003). The total 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

These management measures for the International Waters were in force up to 2005 inclusive.

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

4.2.1.3 The fishery in 2005

Russian fishery in 2005

In 2005 the Russian fishery for haddock started in the second ten-day period of March. Until the end of May, catches were dominated by haddock (on average 82 % of the catch weight). Maximum yield and catch rates were registered in March-May (Tables 4.2.2 and 4.2.3). The number of trawlers operated in this area varied from 2 to 10. In May – June catch rates of the haddock fishery declined while the proportion of blue whiting (*Micromesistius poutassou*) in catches increased (Table 4.2.3). In May, the number of vessels in the haddock fishery reduced to 4-2 trawlers, in June it decreased to 1 vessel. In June – August, haddock in small amount (9 tonnes) were caught in the long-line fishery for ling (*Molva molva*). In August – September haddock occurred in bycatch (2 to 15 %) during the trawl fishery for grey gurnard (*Eutrigla gurnardus*). In the second half of September Russian fishery in the Rockall area was terminated

The total Russian catch in 2005 in the Rockall area taken by bottom trawls was 9.5 thousand tonnes of fish including 4.7 thousand tonnes of haddock (Tables 4.2.2 and 4.2.3). The second important fish species in this fishery was grey gurnard. Among other fish species it is worth mentioning blue whiting. Besides, saithe (*Pollachius virens*), angler fish and flat fishes also occurred in catches but in small amount.

Irish fishery in 2005

The landings of haddock from VIb by Irish fleet in 2005 totalled 105 ton and was catch by the otter trawl fleet. The vessels were operating primarily in ICES rectangles 43D5 and 43D6. In 2005 only twin-rig vessels reported haddock landings from Rockall.

Scottish fishery in 2005.

The number of Scottish vessels fishing at Rockall and the number of trips made to Rockall have declined substantially since 2000 (WD 6 to WGNSDS 2004). Scottish landings in 2005 are estimated to be 375 t (Table 4.2.1). In contrast, officially reported effort at Rockall has increased in 2003 & 2005, but it is not known to what extent this reflects an increase in targeting haddock (See below for discussion of effort).

The landings data also indicate a number of English vessels landing from VIb (possibly deep-water vessels) which may increase the reported hours fished in VIb, but not necessarily with a corresponding increase in the landings of haddock.

4.2.2 Catch data

4.2.2.1 Official catch statistics

Nominal landings as reported to ICES are given in Table 4.2.1, along with Working Group estimates of total estimated landings. Reported international landings of Rockall haddock in 1991-2005 were about 4.0-6.0 thousand tonnes, except for 2001-2002, when they decreased down to 2.3 –2.9 thousand tonnes

Revisions to official catch statistics for previous years are also shown in Table 4.2.1.

4.2.2.2 Quality of the catch data

Misreporting of haddock from Rockall is known to have occurred historically, but an estimation of overall magnitude is not possible.

4.2.3 Commercial catch-effort data

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. Russian and Scottish data shows a peak in effort for 2000 and 2004. The Peak in Russian effort for 2000 is mainly due to the 10^{th} class tonnage vessels targeting the large scale grey gurnard fishery. There has been a substantial decrease in reported Scottish light trawl effort since 1996 and an increase in effort by larger Scottish heavy trawl vessels during 1999 and 2000 reflecting the change in fishing pattern noted in Section 4.2.1 of last year's report. In 2003 and 2004, effort estimates for these heavy trawl Scottish vessels has increased substantially. However, 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 the 2000 WGNSSK (CM 2001/ACFM:07) for further details). 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 a reduction in effort in recent years and effort in 2004 is the lowest in the time series. The majority of this effort is concentrated in Quarter 2.

In 2005, during the target fishery for haddock (March-May) the catch rate of vessels of tonnage class 9 was one of the highest in recent years and inferior only to the catch rate in 2003. In March-May the catch rate of vessels of tonnage class 10 was slightly lower than in 2004 but higher compared to 2000 (Figure 4.2.2). In March-April the catch rate of vessels of this tonnage class was much higher than in 2001 and in May it was considerably higher than in 1999. The highest catch rate of vessels of tonnage class 10 was reached in 2003 (WD7).

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.

4.2.4 Research vessel surveys

There is only one research survey index available for VPA assessment this stock (Table 4.2.4, Figure 4.2.3a). However, from 1997 onwards this Scottish survey is only conducted in September of alternate years. Due to recent concerns about the haddock stock at Rockall some extra time was allocated to conduct a partial survey in September 2002. The survey was conducted on 49 standard trawl stations however, the survey area and number of stations varied in different years. The majority of stations are within the 200m 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 GOVtrawl and from 60 min tows to 30 min tows (mesh size of 20 mm). The indices have been adjusted for tow duration, but no calibration has been made for gear changes.. A 20mm mesh size is used on the survey.

In spring 2005 the Russian trawl-acoustic survey (TAS) for haddock on the Rockall Bank was conducted first time (Oganin et al., 2005). Hauls were made evenly in the surveyed area from the top of the bank to the limits of the stock distribution except for the northern slope of the bank, where trawling is impossible because of a great number of corals (Figure 4.2.3b). The investigations covered depths of 140 to 580 m. The haul were carried out using a "Campelen-1800" demersal trawl with a small-meshed cod-end liner with a mesh size of 20 mm. Haddock abundance and biomass according to the results from the trawl survey were calculated by the stratified method dividing all the area surveyed into geographical strata with the size of 15′ by latitude and 15′ by longitude. To assess the haddock stock and its pelagic component, a hydroacoustic survey was conducted simultaneously with the trawl one, according to methods of MS TAS (multi-species trawl-acoustic survey) for the Barents Sea demersal fish species (Anon., 1989) with adaptations for the surveyed area. To estimate the pelagic component, the check tows by midwater trawl with 50 x 50 m opening with a mesh size of 30 mm were made. Frequency of trawlings depended on the existence and character of echo recordings. Biomass of haddock was calculated with FAO isoline base method (Johannesson & Mitson, 1983).

The stock calculation by the trawl survey method showed that in the surveyed area of 5,553.7 sq.miles the total abundance of haddock amounted to 190.63 x 10^6individuals. The biomass was 43.36 x 10^3 t. The distribution of biomass by strata is presented by Oganin et al., 2005.

Data from the hydroacoustic survey in the international waters of the bank (an area of 3,374 sq.miles) gave a biomass estimation of haddock of 41.1 x 10^3 tonnes with the abundance of 144.2 x 10^6 individuals. The spawning stock was estimated at 38.5 x 10^3 t with the abundance of 133 x 10^6 individuals. In the EU zone, 2180 sq.miles were surveyed using acoustic tracks, and the total stock was 18.9 x 10^3 t with an abundance of 81.7 x 10^6 individuals. The spawning stock was estimated to be 16.3 x 10^3 t with an abundance of 52.4 x 10^6 individuals. As a whole, the stock biomass was estimated to be 60.0 x 10^3 t with the total abundance of 225.9 x 10^6 individuals. Mature individuals were predominate and their proportion was 91.5% by biomass and 82.1% by abundance. The pelagic component of the stock made up 13.7% and was estimated to be 31.1 x 10^6 individuals, corresponding to a biomass of 8.2 x 10^3 t.

The estimates of biomass from the two methods are quite similar.

4.2.5 Age compositions and mean weights at age

The total annual catch was estimated by summing up data on catch landings and haddock discards.

4.2.5.1 Landings age composition

Age composition and mean weight by age of Scottish and Irish landings was 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 (WGNSDS). From the beginning of the Russian fishery in 1999, the whole volume of the haddock caught by the Russian vessels was considered instead of reducing the Russian catch down to indices equivalent to the landings above EU minimum size. During the entire period trawlers operated in the international waters at a depth range of 200 to 400 m.

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 decribed as:

$$P_L = S_L p_L \quad (1.)$$

where P_L- portion of fish with length L in catches, p_L- portion of fish with length L in the stock (survey), S_L- proportion of fish of length L taken aboard. S_L is determined using a theoretical selectivity curve (Figure 4.2.4) which may be described by the formula (2) :

$$S_L = \frac{1}{1+\exp(S_1 - S_2 L)}. \quad (2.)$$

where S_L- portion of taken aboard fish with this or that size in the stock size composition, L – size group, S_1 and S_2 are coefficients.

The selectivity curve (Figure 4.2.4), fitted to the data on catch measurements in different periods of the Russian fishery in 2003 is described well by equation (2) with coefficients S_1 = 12,539465, S_2 = 0,495085. The estimated length frequency distributions for 2003 are compared to the measured length frequency distributions for this year in Figure 4.2.5. 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.

4.2.5.2 Discards age composition

The haddock catch is underestimated as a result of unaccounted for discarding of small individuals in the Scottish and Irish fisheries in most years. On Russian vessels, the whole catch of haddock is kept onboard and therefore, total catch is equivalent to landings.

Haddock discards onboard 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 higher proportion of discards of small haddock: from 12 to 75 % by weight (Table 4.2.5) (and up to 80-90% of catch abundance. Discard trips in 1995, 1997, 1998, 2000 and 2001 showed that discarding by Irish fishing vessels also reaches considerable values (Table 4.2.6).

Total numbers and weight landed and discarded by age on the Scottish observer trips in 1999 and 2001 are presented in Tables 4.2.7 and 4.2.8.

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 4.2.6). 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:

$$ND_L = PD_L * NP_L \quad (3.)$$

where ND_L- number of discarded fish with length *L*, NP_L- number of fish caught with length *L*, PD_L- portion of discarded fish with length *L*.

The length composition of fish taken onboard by Scottish and Irish trawlers was calculated by applying the logistic selectivity curve (Figure 4.2.7) 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 = 12,6075, S_2 = 0,435985 for the Scottish fleet and S_1 = 26,24777, S_2 = 0,85235 were used for Irish catches. The theoretical selectivity curve for Scottish vessels is illustrated in Figure 4.2.7.

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 Figure 4.2.8.

The proportion of fish discarded from catches at different sizes may be determined and modeled using logistic curve (Figure 4.2.9) described by the following equation:

$$PD_L = \frac{1}{1 + \exp(-b(L - DL_{50}))} \qquad (4.)$$

where *L* – size group, DL_{50} - fish length, under which 50% of this size fish caught are discarded and *b* – a constant, reflecting the angle of curve slope. The parameters were determined from research on discards by Scottish vessels (Table 4.2.9). The following values were used in subsequent calculations: DL_{50}=34.66 см, b= -0,87635. Logistic curve of discards may be described by formula (2) using coefficient values: S_1 = -15,4935, S_2 = -0,45646.

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 34cm) 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 (Figure 4.2.10).

Aboard Irish vessels larger fish are kept (Figure 4.2.11). The portion of discards was calculated by the formula (2) with coefficients S_1 = -10,0931, S_2 = -0,24587, from the combined 1995-2002 Irish discard trips.

Scottish and Irish vessels fishing for haddock at Rockall changed to a minimum mesh size of 100mm between 1987 and 1992. Due to these changes in gear, 1991 was used as the starting year for the assessment as it is considered that by this year the majority of vessels were using the new mesh size and therefore the discard ogive can be assumed to be the same for all years.

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 (Figure 4.2.5, Figure 4.2.8).

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 (Figure 4.2.7).

In 1998 and 2000, the trawl survey for haddock in the Rockall Bank area was not carried out. To determine the haddock length composition in these years, the length distribution was calculated from the survey data in the previous and following years.

For this purpose, the length-age matrices characterizing the stock status in the years before and after the missing data year were obtained. The length-age distribution from the year before the missing year was projected forward on the basis of mean growth increment at age and estimated total mortality. Similarly the distribution from the year after was projected backwards. The length composition in the missing year was then calculated from these two estimates.

The total loss (Z) used in the calculation described above was determined by minimization of values of deviation square sum between survey age group abundance values in previous and following years by the data from surveys and calculated data. At that, the factor of age effect (Sa) 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 WD 8 to $WGNSDS_{2004}$ and a spreadsheet showing the calculations is in the stock file.

Figures 4.2.12-4.2.13 and table 4.2.17 shows the resulting proportion of the total catch (by number and weight) which is discarded and landed tables 4.2.10 - 4.2.16.

4.2.5.3 Mean weights at age

The temporal dynamics of haddock mean weights at age in the catch (with regard for discards) are presented in Figure 4.2.14 and tables 4.2.10 - 4.2.13. The mean weights at age in the stock are assumed to be the same as the catch weights.

4.2.6 Natural mortality and maturity at age

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.

Natural mortality coefficient and portion of mature individuals by age used for estimation correspond to adopted by Working Group before. At present there are no estimates of haddock natural mortality on the Rockall Bank, therefore, M was taken as 0.2 for ages.

Previous Working Groups have adopted a maturity ogive with knife-edge maturity at age 3 for this stock. ACFM in 2001 encouraged the WG to investigate a more realistic maturity ogive for this stock. At the 2002 Working Group combined sex maturity ogives were presented to the WG for Russian sampling in 2000, 2001 and Scottish sampling in 2002. In 2003 new sex disaggregated maturity data were supplied to the Working Group for Russian sampling. The results of all these recent studies indicate that a high proportion of both females and males at age 2 were mature.

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 (WD 6). 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 state of postspawning 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 WD 6 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.

4.2.7 Catch at age analysis

4.2.7.1 Data screening and exploratory runs

Data on catches by age

Previously the calculation of catch at age data assumed that catches were equal to landings.

The landings of haddock aged 1 were not large and it was hard to consider the catch of this age fish. The results from Scottish and Irish investigations showed that the abundance in discards exceeded that of landings. Discarded fish are, primarily, haddock aged 1-2 (Tables 4.2.8-4.2.9). Figures of Ln of catch by age show that these values are much less variable when discards are included.(Figures 4.2.15-4.2.20). Data on catches by age are given in Tables 4.2.14-4.2.17.

Tuning data

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 4.2.21-4.2.23.

A SURBA 3.0 run was carried out to analyse the survey data. Previous working groups have concluded that the first three years of the survey should not be used in assessments and that age 0 data was a poor indicator of year class strength. Here 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 and residuals is shown in Figure 4.2.24. SSB shows a declining trend since 1995 but increasing in 2003-2004. The estimates of the temporal component of F are very noisy, but indicates a steep decline since 2000. Retrospective analysis showed consistent estimation of SSB and F (2-5) (See Figure 4.2.25a).

Comparative scatterplots of log index at age are shown in Figure 4.2.25b. The survey shows relatively good internal consistency in tracking year class strength through time.

Exploratory assessment runs

The following settings were adopted for exploratory XSA runs:

1.full year-range of tuning data (1991-2005); catchability independent of age for age classes 1 and over; q-plateau at age 5; shrinkage over last 3-5 years and 3 oldest age classes; shrinkage SE=0.5 -2.0.

2. full year-range of tuning data (1991-2005); catchability dependent on stock size for age classes younger 4; q-plateau at age 5; shrinkage over last 4 years and 3 oldest age classes; shrinkage SE=0.5 -1.0.

The use of the power model at ages 1-3 was indicated by significant slopes less than 1.0 at ages 2 and 3 , which is illustrated by the plots of adjusted survey CPUE against XSA population estimates in Figs. 4.2.29 – 4.2.31.

Log catchability residuals of the three runs using the constant catchability model at all ages show a period of reduced catchability from 1997 to 2002, increasing again in 2003 (Figs. 4.2.32 – 4.2.34). The use of the power model at ages 1-3 and shrinkage of 1.0 reduces the size of the residuals although the pattern of reduced values from 1997 to 2002 persists (Fig. 4.2.39). Stronger shrinkage (0.5) using the power model increases the magnitude of the residuals (Fig. 4.2.40).

A comparison of the temporal trends in the survey indices at age with the trends in XSA population numbers at age is given in Figures 4.2.26 – 4.2.28 for the XSA runs using constant catchability at all ages, and in Figures 4.2.36 for the XSA runs using the power model. All these plots show relatively low survey indices at ages 2-4 from around 1997 to the early 2000s compared with the XSA trends. This is the source of the low catchability values evident from the XSA runs. The reasons for this difference in trends are not clear.

Plots of adjusted survey CPUE against XSA population estimates for the two XSA runs using the power model are given in Figs. 4.2.29 – 4.2.31.

The XSA run using the power model at ages 1-3 and shrinkage SE of 1.0 was accepted as the final assessment model.

4.2.7.2 Final run XSA

The diagnostics file of the final XSA run is given in Table 4.2.18. The analysis of residuals and retrospective analysis (Figures 4.2.39 – 4.2.42 show that applying the chosen parameters for XSA improves the residual and retrospective patterns. However, there are still some trends apparent in the log catchability residuals. The results of retrospective analysis conducted at the Working Group in 2002 and 2003 indicated that using shrinkage values of more than 0.5 improved the retrospective curves and showed convergence. However, in this years analysis only 14 years of data were available and there is no convergence although the temporal trends are consistent in the earlier parts of the time series. Dynamics of fishing mortality at age are presented in Figure 4.2.43. Data shows a peak in fishing mortality and effort for 2000 and 2004. The final XSA results are given in Tables 4.2.19 – 4.2.21. Dynamics of fishing mortality at age are presented in Figure 4.2.43. The comparison final XSA and SURBA results are given in Figure 4.2.44 .

4.2.7.3 Estimation of recruit abundance

Individuals aged 1 were considered as recruits. Provisional results from the Scottish Autumn trawl survey showed abundance of the 2005 yearclass of haddock to be above the long-term mean of that series (Table 4.2.4). The geometric mean was used derived from XSA to estimate recruit abundance at age 1 in 2006 (Table 4.2.21).

4.2.7.4 Long term trends

Recruitment in the early 1990s was high and resulted in an increase in SSB which peaked in 1995. Recruitment in the mid 1990s was around average but the 1998 and 1999 year classes were weak. A combination of these weak year classes and high fishing mortality resulted in

SSB decreasing to the lowest in the time series in 2001. In 2003 and 2004 SSB increased somewhat due to the 2000 and 2001 year classes which were slightly above average.

4.2.7.5 Short- term forecast

For forecasting recruitment (age 1) the average recruitment was used (1991-2005).

The input data for the short-term forecast can be found in Table 4.2.22. Status quo fishing mortality is taken as the 3 year mean of the values over the period 2003-2005. Three year mean values were also used for stock weights and catch weights. The results obtained from the forecast are given in Tables 4.2.23 and 4.2.24.

For forecasting discards the proportion of discards/landings at age in 2004-2005 was used (Table 4.2.14- 4.2.16, 4.2.25). 2 year mean of the values over the period 2004-2005 discarding proportions were chosen because since 2004 a TAC for Division VIb and Divisions XII and XIV has been allocated separately from the TAC established for the rest of Division VI. The 2006 TAC for EC waters was set at 597 t for Divisions VIb, XII and XIV. In recent years the proportion of the total catch of haddock taken by vessels of nations which discard haddock has declined markedly. This has led to an overall reduction in the proportion of the total catch discarded. The results obtained from the forecast (including discards) are given in Tables 4.2.23 and 4.2.25. Short term forecast is shown in Figure 4.2.45.

The sensivity analysis of forecast is shown In Figure 4.2.46-4.2.47. There is a less than 15% probability of SSB in 2008 being below Bpa and Fsq.

4.2.7.6 Medium Term

Medium term projection were conducted using the MAR-Lab software. There appears to be little or no relationship between spawning biomass and recruitment levels at age 1 and no attempt to fit a stock recruitment relationship to these data has been made. Particularly high discard rates result in very poor estimation of the both the overall level and the inter-annual variability of recruitment. Significant year-to-year fluctuations of recruit abundance are noticed, at that, the link between adult haddock biomass and abundance of survived fingerlings and yearlings is absent. In the years when biomass is maximal poor year-classes are often observed. So, in 2001, when the stock was the lowest for recent years, one of the most abundant year-classes appeared. Strong year-classes appear on average once in 4-5 year period, although the available time series is relatively short. At status quo F there is a less than 5% probability of SSB falling below Bpa in the long term (See Figures 4.2.48-4.2.49).

4.2.7.7 Yield per recruit

Yield per recruit results, long-term yield and SSB (conditional on the current exploitation pattern) are shown in Figure 4.2.51. *Status quo* F (0.64) is around 48% of $\mathbf{F}_{max}$ (0.43) and is 5% greater than $\mathbf{F}_{0.1}$ (0.18). The stock-recruitment scatter plot is shown in Figures 4.2.50.

4.2.7.8 Reference Points

Biological reference points for this stock are given below:

$\mathbf{B}_{lim}$: 6,000 t (lowest observed SSB)

$\mathbf{B}_{pa}$: 9,000 t ($\mathbf{B}_{loss}$ * 1.4)

$\mathbf{F}_{pa}$: 0.4 (by analogy with other Haddock stocks).

Figure 4.2.52 shows the stock in 2005 is estimated to be above Bpa and less than Fpa.

4.2.7.9 Quality of the Assessment

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. There are concerns over the accuracy of landings statistics from Rockall in earlier years;
2. 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;
3. The method of estimating discards from survey data, although useful, is nonetheless another source of error;
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 Federation fleets), and survey data will be necessary to overcome these deficiencies.

4.2.7.10 Management Considerations

Historical perspectives of fishing mortality indicate that they have been high. 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.

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.

The 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 mis-reporting, high grading and discarding. In the case of Rockall haddock these may occur to a large extent due to the remote nature of the fishery and the processing of catches at sea by some fleets. The Expert Group concluded that effort regulation rather than TACs may be a better means of controlling fishing mortality on Rockall haddock in the long-term but that TAC regulation could be used in the future if more objective and accurate biological and fishery information are routinely provided (ICES CM 2004/ACFM:33). In circumstances where population is dominated by small individuals and differences in length of older and younger age groups are not great, the effectiveness of using selective properties of trawl gear is very low. Comparison of the discard practices of the national fleets operating at Rockall indicate that an increase of minimum mesh size does not result in considerable reduction of the proportion of small individuals in catches, however catch rates are decreased.

In 2004-2006, 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 in 2000-2001 of average year-classes, the haddock stock has increased. This is corroborated by Russian fishery statistics, biological research data, analytical calculations and Trawl Acoustic Survey in March 2005.
2. According to provisional survey data the 2005 yearclass is also a strong one that gives grounds to expect the fishable stock growth in the near future;
3. Discarding by Western European vessels has historically resulted in significant mortality of small haddock.
4. To develop and introduce into fisheries practice measures aimed at preventing discards of undersized haddock, which in particular may include a decrease of the minimum landing size.
5. From a biological perspective, a reduction in the minimum landings size to 25cm would ensure that virtually all the individuals landed would be mature.
6. An evaluation of the Rockall closure is presented in section 16 of the Report. A thorough scientific rationale is needed for elaboration of management measures.

Table 4.2.1. Nominal catch (tonnes) of HADDOCK in Division VIb, 1989–2005, as officially reported to ICES.

COUNTRY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003[1]	2004[1]	2005[1]
Faroe Islands	-	-	-	-	-	-	-	-	-	-	-	n/a	n/a				
France	…[2]	…[2]	…[2]	…[2]	…[2]	…[2]	…[2]	-	-	-[*]		5	2[*]	+	1		
Germany, Fed. Rep.	1	-	-	-	-	-	-	-	-	-	-	-	-				
Iceland	-	-	-	-	-	-	-	-	+	-	167	-	-	-			
Ireland	-	620	640	571	692	956	677	747	895	704	1,021	824	357	206	169	19[5]	105
Norway	47	38	69	47	68	75	29	24	24	40	61	152[*]	70[*]	49	60	32	2
Portugal	-	-	-	-	-	-	-	-	-	4	-	-	-				
Russian Federation	-	-	-	-	-	-	-	-	-	-	458	2,154	630	1,630	4.237	5,844	4708
Spain	337	178	187	51	-	-	28	1	22	21	25	47	51	7	19		
UK (E, W & NI)	272	238	165	74	308	169	318	293	165	561	288	36	-	-	56		
UK (Scotland)	5,986	7,139	4,792	3,777	3,045	2,535	4,439	5,753	4,114	3,768	3,970	2,470	1,205	1,145[3]	1.606	411[3]	375[3]
United Kingdom																	
Total	6,643	8,213	5,853	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	
Unallocated catch	85	-4,329	-198	800	671	1,998	-379	-543	-591	-599	-851	-357	-279	299	94	139	1
WG estimate	6,728	3,884	5,655	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	5,191

[1]Preliminary.

[2]Included in Division VIa.

[3]Includes UK England, Wales and NI Landings

[4]includes the total Russian catch

[5] nonofficial

n/a = Not available.

Table 4.2.2. Details of Russian fleet operations in fishery for the haddock on the Rockall Bank (Div. VIb) in 2005 (preliminary data)

MONTH	VESSEL TONNAGE CLASS	CATCH OF HADDOCK IN TONNES		
		Total	Catch per vessel/day	Catch per 1-hr haul
March	10[1]	509	9.6	0.55
	9[2]	408	8.0	0.51
April	10[1]	1180	9.1	0.54
	9[2]	1028	8.2	0.59
May	10[1]	820	8.4	0.44
	9[2]	466	7.8	0.44
June	10[1]	124	8.8	0.48
July	8[3]	4	0.1	-
August	10[1]	17	0.5	0.04
	9[2]	11	1.5	0.1
	8[3]	5	0.1	-
September	10[1]	84	2.4	0.1
	9[2]	52	1.0	0.1
Total		4708		

[1]84m, 2000hp

[2]62m, 2400hp

[3]54m, 1000hp

Table 4.2.3. Species composition of Russian catch (t) taken with bottom trawls on Rockall Bank (Div. VIb) in 2005 (preliminary data)

FISH SPECIES	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL
Haddock	917	2208	1286	124	-	28	136	-	-	-	4699
Grey gurnard	26	40	14	1	-	231	2087	-	-	-	2399
Blue whiting	427	711	585	94	-	191	120	-	-	-	2128
Saithe	5	14	1		-	1	1	-	-	-	22
Anglerfish		1	2		-	0.2		-	-	-	3
Flat fish		3	4		-	0.1		-	-	-	7
Others	10	70	40	14	-	-	42	-	-	-	176
Total	1385	3047	1932	233	-	515	2386	-	-	-	9498

Table 4.2.4. Haddock in VIb. Tuning data avaiable for Scottish groundfish survey in September.

HADDOCK WGNSDS 2006 ROCKALL
101
SCOGFS (Numbers per 10 hours fishing at Rockall)
1991 2005
1 1 0.66 0.75
0 6

1	14458	16398	4431	683	315	228	37	64	3
1	20336	44912	14631	6135	647	127	200	4	32
1	15220	37959	15689	3716	1104	183	38	73	21
1	23474	13287	11399	4314	696	203	30	12	4
1	16293	16971	6648	5993	1935	483	200	1	6
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

Table 4.2.5. Details of Scottish discard trips in the Rockall area. (Newton et al., 2003).

TRIP NO.	DATE	GEAR	NO. OF HAULS	HOURS FISHED	% (WEIGHT) HADDOCK LANDED OF CATCH	% (WEIGHT) DISCARDED OF HADDOCK
1	May 85	Heavy Trawl	20	89.08	74	17.3
2	Jun 85	Heavy Trawl	28	127.17	74	18.6
3	Jun 99	Heavy Trawl	21	110.83	41	74.9
4	Apr 01	Heavy Trawl	11	47.33	96	12.4
5	Jun 01	Heavy Trawl	35	163.58	58	47.5
6	Aug 01	Heavy Trawl	26	130.08	31	69.7

Table 4.2.6. 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/ 098/4	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	40,9	13,4	58,49	27%

Table 4.2.7. Scottish Landings and raised Discards haddock in 1999 estimates at Rockall from discard observer trips conducted aboard Scottish

	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 data estimates at Rockall from discard observer

[2] calculated data by logistic discard curve for 1999

Table 4.2.8. Scottish Landings and raised Discards haddock in 2001 estimates at Rockall from discard observer trips conducted aboard Scottish

	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 data estimates at Rockall from discard observer

[2] calculated data by logistic discard curve for 2001

Table 4.2.9. Values of DL_{50} by Scottish discard trips in the Rockall area.

Year	DL_{50}	b
1999	36.62	-0,5923
2001	31.20	-0,8238
Theoretical:	34.66	-1,2328

Table 4.2.10. International catch (landings and discards) weights at age (kg). Haddock VIb.

	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	0.142	0.194	0.233	0.310	0.458	0.614	0.806

Table 4.2.11. International landings weights at age (kg). Haddock VIb.

	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	0.83	0.82	0.972
1994	0.314	0.356	0.452	0.558	0.638	1.224	0.89
1995	0.377	0.311	0.414	0.479	0.64	0.699	1.236
1996	0.327	0.436	0.501	0.487	0.627	0.709	0.783
1997	-	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	0.39	0.44	0.505	0.601	0.665
2000	0.272	0.404	0.379	0.407	0.473	0.513	0.74
2001	0.274	0.426	0.383	0.518	0.426	0.518	0.677
2002	0.24	0.422	0.416	0.541	0.565	0.649	0.818
2003	0.100	0.164	0.246	0.350	0.388	0.423	0.757
2004	0.142	0.172	0.241	0.293	0.446	0.617	0.754
2005	0.120	0.182	0.228	0.309	0.461	0.628	0.824

Table 4.2.12. International discards weights at age (kg). Haddock VIb.

	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	0.297	0.357	0.390	0.482	0.507

Table 4.2.13.. Stock weights at age (kg). Haddock VIb.

	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	0.142	0.194	0.233	0.310	0.458	0.614	0.806

Table 4.2.14.. International catch (landings and discards) numbers (*10^{-3}) at age. Haddock VIb.**

1

Run title : HADDOCK LANDISC 2004 ROCKALL

At 15/05/2006 16:55

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1991	1992	1993	1994	1995
AGE					
1	21186	16084	11178	8170	2749
2	33847	24711	19375	20623	9831
3	15189	18584	15494	17868	21584
4	5341	5361	4938	8209	9756
5	1704	1761	1617	2449	2464
6	346	676	461	476	787
+gp	522	206	359	232	79
0 TOTALNUM	78134	67383	53423	58028	47251

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
1	12096	9957	14224	17282	8222	7667	13363	6576	932	1061
2	18811	10535	19807	21949	12581	1961	11119	23606	4112	3723
3	10911	5388	10173	12203	10697	1815	4536	14559	10282	7420
4	9612	4098	4763	5499	4917	1018	2445	2063	9212	8124
5	3299	5002	3740	3419	2050	1038	898	1285	1386	753
6	751	1758	2767	2684	1498	484	260	925	296	109
+gp	92	206	1391	2776	2066	601	444	483	474	193
0 TOTALNUM	55572	36945	56865	65811	42031	14583	33066	49496	26694	21382

1

Table 4.2.15. International landings numbers ($*10^{**-3}$) at age. Haddock VIb

1

Run title : HADDOCK LANDISC 2004 ROCKALL

At 15/05/2006 16:55

Catch numbers at age Numbers*10**-3

	YEAR	1991	1992	1993	1994	1995
	AGE					
	1	87	86	28	30	1
	2	6807	3642	1919	1160	146
	3	3011	5624	4740	5299	5205
	4	1344	964	1157	3665	4791
	5	558	580	489	1040	1319
	6	32	364	144	66	279
	+gp	464	160	290	141	43
0	TOTALNU	12302	11418	8767	11400	11784

Catch numbers at age Numbers*10**-3

	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	AGE										
	1	2	0	4	245	33	399	657	920	197	887
	2	5149	319	392	2600	3445	941	2983	8103	1765	2835
	3	1861	2102	1815	2994	5081	1232	3998	11001	9502	6866
	4	4149	2155	1340	1972	3006	752	2111	1846	9119	7913
	5	2347	3658	1898	1228	1295	988	809	1188	1364	725
	6	473	1540	2284	1600	1176	470	217	878	286	98
	+gp	85	192	1301	2291	1963	579	392	475	472	182
0	TOTALNU	14066	9965	9034	12930	15999	5361	11167	24409	22705	19505

Table 4.2.16. International discards numbers (*10^{-3}) at age. Haddock VIb.**

1

Run title : HADDOCK LANDISC 2004 ROCKALL

At 15/05/2006 16:55

Catch numbers at age Numbers*10**-3

YEAR	1991	1992	1993	1994	**1995***
AGE					
1	21099	15998	11151	8140	**2748**
2	27040	21069	17456	19464	**9685**
3	12178	12961	10755	12570	**16379**
4	3998	4397	3781	4545	**4965**
5	1146	1181	1128	1409	**1145**
6	313	312	317	410	**508**
+gp	58	46	69	91	**36**
0 TOTALNU	65832	55964	44656	46628	**35467**

Catch numbers at age Numbers*10**-3

YEAR	1996	**1997***	1998	**1999***	2000	**2001***	2002	2003	2004	2005
AGE										
1	12094	**9957**	14220	**17037**	8189	**7268**	12706	5655	735	174
2	13662	**10216**	19415	**19348**	9136	**1019**	8136	15503	2346	888
3	9051	**3286**	8357	**9209**	5616	**583**	539	3558	781	554
4	5463	**1944**	3423	**3526**	1912	**266**	334	217	93	210
5	952	**1344**	1842	**2191**	755	**50**	89	97	22	28
6	278	**218**	483	**1084**	322	**15**	43	48	10	11
+gp	7	**15**	91	**485**	103	**21**	51	8	2	11
0 TOTALNU	41506	**26980**	47831	**52881**	26033	**9222**	21899	25087	3989	1877

*** data calculated with use estimates at Rockall from discard observer trips**

Table 4.2.17. International landings, discards and total catch. Haddock VIb

		NUM (*1000)			WEIGHT, TONNES	
YEAR	**Landings**	**Discards**	**Total Catch[1]**	**Landing s**	**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

[1] Landings+ Discards

Table 4.2.18.. XSA diagnostics fof assessment Haddock VIb.

Lowestoft VPA Version 3.1

01,05,2006 19:18

Extended Survivors Analysis

HADDOCK LANDISC 2004 ROCKALL

CPUE data from file had6b.tun

Catch data for 15 years. 1991 to 2005. Ages 1 to 7.

Fleet	First year	Last year	First age	Last age	Alpha	Beta
SCOGFS	1991	2005	0	6	0.66	0.75

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Catchability dependent on stock size for ages < 4

Regression type = C
Minimum of 10 points used for regression
Survivor estimates shrunk to the population mean for ages < 4

Catchability independent of age for ages >= 5

Terminal population estimation :

Survivor estimates shrunk towards the mean F
of the final 4 years or the 3 oldest ages.

S.E. of the mean to which the estimates are shrunk = 1.000

Minimum standard error for population
estimates derived from each fleet = .300

Prior weighting not applied

Tuning converged after 24 iterations

1

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.241	0.166	0.244	0.499	0.389	0.128	0.148	0.159	0.033	0.038
2	0.57	0.342	0.58	0.738	0.856	0.149	0.276	0.422	0.141	0.179
3	0.491	0.313	0.654	0.895	1.049	0.272	0.605	0.71	0.327	0.407
4	0.536	0.344	0.506	0.941	1.245	0.243	0.724	0.619	1.603	0.468
5	0.675	0.599	0.611	0.86	1.243	1.015	0.351	1.146	1.214	0.504
6	0.612	0.989	0.808	1.339	1.308	1.245	0.773	0.754	0.927	0.258

1
XSA population numbers (Thousands)

YEAR	AGE 1	2	3	4	5	6
1996	6.25E+04	4.79E+04	3.11E+04	2.56E+04	7.43E+03	1.81E+03
1997	7.18E+04	4.02E+04	2.22E+04	1.56E+04	1.23E+04	3.09E+03
1998	7.25E+04	4.97E+04	2.34E+04	1.33E+04	9.04E+03	5.52E+03
1999	4.86E+04	4.65E+04	2.28E+04	9.97E+03	6.55E+03	4.02E+03
2000	2.82E+04	2.42E+04	1.82E+04	7.63E+03	3.18E+03	2.27E+03
2001	7.07E+04	1.57E+04	8.41E+03	5.22E+03	1.80E+03	7.52E+02
2002	1.07E+05	5.10E+04	1.10E+04	5.25E+03	3.35E+03	5.34E+02
2003	4.94E+04	7.58E+04	3.17E+04	4.94E+03	2.08E+03	1.93E+03
2004	3.17E+04	3.45E+04	4.07E+04	1.27E+04	2.18E+03	5.42E+02

Table 4.2.18 cont.

Estimated population abundance at 1st Jan 2006

0.00E+00	2.46E+04	1.72E+04	1.34E+04	1.23E+04	1.04E+03

Taper weighted geometric mean of the VPA populations:

6.32E+04	4.67E+04	2.61E+04	1.13E+04	4.11E+03	1.50E+03

Standard error of the weighted Log(VPA populations) :

0.473	0.5024	0.5027	0.5286	0.6002	0.8017

1

Log catchability residuals.

Fleet : SCOGFS

Age	1991	1992	1993	1994	1995
1	-0.31	0.41	0.13	-0.05	0.2
2	-0.4	0.31	0.23	-0.12	0.21
3	-0.31	0.44	0.19	0.03	-0.05
4	-0.08	0.7	0.54	0.27	0.92
5	-0.19	0.17	0.6	-0.44	0.94
6	0.04	0.21	-0.02	-0.12	0.11

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.38	-0.24	99.99	0.27	99.99	-0.52	-0.16	0.09	99.99	-0.19
2	0.28	-0.08	99.99	-0.08	99.99	0.04	-0.32	0.07	99.99	-0.14
3	-0.04	-0.37	99.99	-0.07	99.99	0.28	-0.11	-0.06	99.99	0.05
4	0.11	-1.04	99.99	-0.22	99.99	-0.65	-0.7	-0.45	99.99	0.59
5	0.04	-0.66	99.99	-0.34	99.99	-0.42	-1	0.44	99.99	0.85
6	-0.14	-0.38	99.99	-0.16	99.99	-0.41	-0.04	0.27	99.99	0.1

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	-2.5561	-2.5558	-2.5558
S.E(Log q)	0.6268	0.6126	0.2166

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	0.74	1.139	3.85	0.66	12	0.31	-1.32
2	0.5	3.556	6.47	0.83	12	0.24	-2.06
3	0.48	3.939	6.47	0.85	12	0.24	-2.4

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	0.62	2.118	5.1	0.76	12	0.34	-2.56
5	1.62	-1.284	-1.05	0.3	12	0.97	-2.56
6	0.99	0.135	2.66	0.93	12	0.22	-2.6

1

Table 4.2.18 cont.

Terminal year survivor and F summaries :

Age 1 Catchability dependent on age and year class strength

Year class = 2004

Fleet	Est Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	20284	0.368	0	0	1	0.589	0.046
P shrinkage mean	46698	0.5				0.328	0.02
F shrinkage mean	7710	1				0.083	0.117

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
24614	0.28	0.39	3	1.374	0.038

1

Age 2 Catchability dependent on age and year class strength

Year class = 2003

Fleet	Est Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	15002	0.3	0	0	1	0.652	0.203
P shrinkage mean	26112	0.5				0.278	0.121
F shrinkage mean	11952	1				0.07	0.248

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
17221	0.25	0.21	3	0.842	0.179

Age 3 Catchability dependent on age and year class strength

Year class = 2002

Fleet	Est Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	14263	0.222	0.016	0.07	2	0.726	0.386
P shrinkage mean	11305	0.53				0.214	0.466
F shrinkage mean	10834	1				0.06	0.482

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
13350	0.21	0.07	4	0.358	0.407

Table 4.2.18 cont.

1

Age 4 Catchability constant w.r.t. time and dependent on age

Year class = 2001

Fleet	Est Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	13614	0.22	0.19	0.87	3	0.879	0.432
F shrinkage mean	5939	1				0.121	0.805

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
12309	0.23	0.22	4	0.971	0.468

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

Year class = 2000

Fleet	Est Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	1385	0.327	0.326	1	4	0.751	0.4
F shrinkage mean	435	1				0.249	0.942

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
1038	0.35	0.38	5	1.082	0.504

1

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

Year class = 1999

Fleet	Est Surv	Int s.e	Ext s.e	Var Ratio	N	Scaled Weights	Estimated F
SCOGFS	359	0.253	0.06	0.24	4	0.911	0.243
F shrinkage mean	167	1				0.089	0.463

Weighted prediction :

Survivors at end of year	Int s.e	Ext s.e	N	Var Ratio	F
335	0.25	0.12	5	0.502	0.258

1

Table 4.2.19. Fishing mortality at age. Haddock VIb.

1

Run title : HADDOCK LANDISC 2004 ROCKALL

At 05/2006 19:18

Terminal Fs derived using XSA (With F shrinkage)

Table 8 Fishing mortality (F) at age

YEAR	1991	1992	1993	1994	1995
AGE					
1	0.2397	0.177	0.1064	0.141	0.0507
2	0.6003	0.4877	0.3354	0.2915	0.2517
3	0.8963	0.8023	0.6566	0.5958	0.5668
4	0.9328	0.9815	0.5098	0.918	0.7834
5	0.4199	0.97	0.9539	0.5155	0.8017
6	0.6287	0.2913	0.7424	0.8528	0.3076
+gp	0.6287	0.2913	0.7424	0.8528	0.3076
0 FBAR 2- 5	0.7123	0.8104	0.6139	0.5802	0.6009

Table 8 Fishing mortality (F) at age

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	FBAR **-**
AGE											
1	0.2406	0.1664	0.2444	0.4988	0.3887	0.1276	0.148	0.1592	0.033	0.0383	0.0768
2	0.57	0.3415	0.5798	0.7379	0.8558	0.1489	0.276	0.4219	0.1413	0.1787	0.2473
3	0.491	0.313	0.6542	0.8947	1.049	0.2724	0.6047	0.7098	0.3275	0.4074	0.4816
4	0.5358	0.3437	0.5057	0.941	1.2448	0.2428	0.7241	0.6188	1.6034	0.4682	0.8968
5	0.6754	0.5989	0.6109	0.8602	1.2435	1.0148	0.3511	1.1458	1.2142	0.5044	0.9548
6	0.6116	0.9889	0.8078	1.3393	1.3078	1.2449	0.7734	0.7538	0.9269	0.2579	0.6462
+gp	0.6116	0.9889	0.8078	1.3393	1.3078	1.2449	0.7734	0.7538	0.9269	0.2579	
0 FBAR 2- 5	0.568	0.3993	0.5876	0.8585	1.0983	0.4197	0.4889	0.7241	0.8216	0.3897	
1											

Table 4.2.20. Stock number (*10**$^{-3}$) at age. Haddock VIb.

Run title : HADDOCK LANDISC 2004 ROCKALL

At 05/2006 19:18

Terminal Fs derived using XSA (With F shrinkage)

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1991	1992	1993	1994	1995
AGE					
1	109837	109561	122439	68667	61483
2	82876	70758	75147	90130	48827
3	28360	37227	35572	43994	55132
4	9731	9475	13663	15104	19852
5	5492	3135	2907	6718	4938
6	818	2955	973	917	3285
+gp	1221	895	748	441	327
0 TOTAL	238336	234006	251450	225972	193844

Table 10 Stock number at age (start of year) Numbers*10**-3

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	GMST 91-**	AMST 91
AGE													
1	62520	71767	72492	48633	28217	70709	107341	49377	31747	31236	0	70385	75619
2	47850	40242	49749	46482	24180	15662	50955	75791	34477	25149	24614	50131	55281
3	31081	22155	23415	22809	18196	8413	11049	31657	40693	24507	17221	25359	28389
4	25608	15574	13264	9966	7632	5218	5245	4942	12745	24013	13350	10570	11944
5	7426	12269	9043	6550	3184	1800	3351	2082	2179	2100	12309	4550	5300
6	1814	3094	5519	4019	2269	752	534	1932	542	530	1038	1760	2222
+gp	219	357	2734	4061	3059	912	898	994	852	933	925		
0 TOTAL	176517	165458	176215	142519	86737	103466	179373	166774	123235	108466	69458		
1													

Table 4.2.21.. Summary table. Haddock VIb.

Run title : HADDOCK LANDISC 2004 ROCKALL

At 05/2006 19:18

Table 16 Summary (without SOP correction)

Terminal Fs derived using XSA (With F shrinkage)

	RECR	TOTALBIO	TOTSPBIC	LANDINGS	YIELD/SSB	FBAR 2- 5
	Age 1					
1991	109837	51162	15675	5655	0.3608	0.7123
1992	109561	50508	19025	5320	0.2796	0.8104
1993	122439	54582	19922	4784	0.2401	0.6139
1994	68667	55791	24284	5733	0.2361	0.5802
1995	61483	47352	29257	5587	0.191	0.6009
1996	62520	46996	25191	7075	0.2809	0.568
1997	71767	41082	21664	5166	0.2385	0.3993
1998	72492	43331	20673	4984	0.2411	0.5876
1999	48633	32846	16466	5221	0.3171	0.8585
2000	28217	23088	11710	4558	0.3892	1.0983
2001	70709	20112	6682	1918	0.287	0.4197
2002	107341	33684	7015	2571	0.3665	0.4889
2003	49377	35141	12201	5961	0.4886	0.7241
2004	31747	27109	15616	6400	0.4098	0.8216
2005	31236	24663	15261	5191	0.3402	0.3897
Arith.						
Mean	69735	39163	17376	5075	0.3111	0.6449
0 Units	(Thousands	(Tonnes)	(Tonnes)	(Tonnes)		
1						

Table 4.2.22. Haddock VIb. Input data for short-term catch forecasts.

MFDP version 1a
Run: mult
Time and date: 19:08 05,2006
Fbar age range: 2-5

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	70385	0.2	0	0	0	0.142	0.0768	0.142
2	24614	0.2	0	0	0	0.235	0.2449	0.235
3	17221	0.2	1	0	0	0.296	0.4804	0.296
4	13350	0.2	1	0	0	0.369	0.902	0.369
5	12309	0.2	1	0	0	0.452	0.959	0.452
6	1038	0.2	1	0	0	0.513	0.645	0.513
7	925	0.2	1	0	0	0.7773	0.645	0.7773

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	70385	0.2	0	0	0	0.142	0.0768	0.142
2	.	0.2	0	0	0	0.235	0.2449	0.235
3	.	0.2	1	0	0	0.296	0.4804	0.296
4	.	0.2	1	0	0	0.369	0.902	0.369
5	.	0.2	1	0	0	0.452	0.959	0.452
6	.	0.2	1	0	0	0.513	0.645	0.513
7	.	0.2	1	0	0	0.7773	0.645	0.7773

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
1	70385	0.2	0	0	0	0.142	0.0768	0.142
2	.	0.2	0	0	0	0.235	0.2449	0.235
3	.	0.2	1	0	0	0.296	0.4804	0.296
4	.	0.2	1	0	0	0.369	0.902	0.369
5	.	0.2	1	0	0	0.452	0.959	0.452
6	.	0.2	1	0	0	0.513	0.645	0.513
7	.	0.2	1	0	0	0.7773	0.645	0.7773

Input units are thousands and kg - output in tonnes

Table 4.2.23. Haddock VIb. Short-term forecasts.

MFDP version 1a
Run: mult
Had6b2006MFDP Index file 20,07,2005
Time and date: 19:08 05,2006
Fbar age range: 2-5

2006				
Biomass	SSB	FMult	FBar	Catch*
32618	16839	1	0.6466	9987

2007							2008	
Biomass	SSB	FMult	FBar	Catch*	**Landings**	Discards	Biomass	SSB
35065	12529	0	0	0	**0**	0	49320	25784
.	12529	0.1	0.0647	1111	**934**	177	48045	24611
.	12529	0.2	0.1293	2161	**1813**	349	46839	23509
.	12529	0.3	0.194	3155	**2639**	516	45699	22470
.	12529	0.4	0.2586	4096	**3417**	679	44619	21492
.	12529	0.5	0.3233	4988	**4150**	838	43596	20569
.	12529	0.6	0.3879	5835	**4842**	992	42625	19698
.	12529	0.7	0.4526	6639	**5495**	1143	41703	18875
.	12529	0.8	0.5173	7403	**6113**	1290	40828	18098
.	12529	0.9	0.5819	8130	**6697**	1433	39995	17362
.	12529	1	0.6466	8822	**7249**	1573	39202	16666
.	12529	1.1	0.7112	9482	**7773**	1709	38446	16007
.	12529	1.2	0.7759	10112	**8270**	1842	37726	15381
.	12529	1.3	0.8405	10713	**8741**	1972	37038	14788
.	12529	1.4	0.9052	11287	**9188**	2099	36381	14225
.	12529	1.5	0.9699	11836	**9613**	2223	35753	13690
.	12529	1.6	1.0345	12362	**10018**	2344	35152	13181
.	12529	1.7	1.0992	12866	**10404**	2462	34576	12696
.	12529	1.8	1.1638	13349	**10771**	2577	34024	12235
.	12529	1.9	1.2285	13812	**11122**	2690	33494	11796
.	12529	2	1.2932	14257	**11456**	2800	32986	11377

Input units are thousands and kg - output in tonnes
*Landings+ Discards

Table 4.2.24. Haddock VIb. Detailed short-term forecasts output.

MFDP version 1a
Run: mult
Time and date: 19:08 05,2006
Fbar age range: 2-5

Year:		2006	F multiplier:		1	Fbar:	0.6466				
Age		F	CatchNos	Yield		StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	1	0.0768	4722	671		70385	9995	0	0	0	0
	2	0.2449	4866	1143		24614	5784	0	0	0	0
	3	0.4804	6001	1776		17221	5097	17221	5097	17221	5097
	4	0.902	7297	2693		13350	4926	13350	4926	13350	4926
	5	0.959	6989	3159		12309	5564	12309	5564	12309	5564
	6	0.645	452	232		1038	532	1038	532	1038	532
	7	0.645	403	313		925	719	925	719	925	719
Total			30730	9987		139842	32618	44843	16839	44843	16839

Year:		2007	F multiplier:		1	Fbar:	0.6466				
Age		F	CatchNos	Yield		StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	1	0.0768	4722	671		70385	9995	0	0	0	0
	2	0.2449	10549	2479		53366	12541	0	0	0	0
	3	0.4804	5498	1627		15775	4669	15775	4669	15775	4669
	4	0.902	4767	1759		8721	3218	8721	3218	8721	3218
	5	0.959	2518	1138		4435	2005	4435	2005	4435	2005
	6	0.645	1682	863		3863	1981	3863	1981	3863	1981
	7	0.645	367	285		843	655	843	655	843	655
Total			30103	8822		157388	35065	33637	12529	33637	12529

Year:		2008	F multiplier:		1	Fbar:	0.6466				
Age		F	CatchNos	Yield		StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)
	1	0.0768	4722	671		70385	9995	0	0	0	0
	2	0.2449	10549	2479		53366	12541	0	0	0	0
	3	0.4804	11919	3528		34202	10124	34202	10124	34202	10124
	4	0.902	4367	1611		7989	2948	7989	2948	7989	2948
	5	0.959	1645	744		2897	1310	2897	1310	2897	1310
	6	0.645	606	311		1392	714	1392	714	1392	714
	7	0.645	880	684		2021	1571	2021	1571	2021	1571
Total			34688	10028		172252	39202	48501	16666	48501	16666

Input units are thousands and kg - output in tonnes

Table 4.2.25. Haddock VIb. Detailed short-term forecasts output (including discards).

Year: 2007 F multiplier: 0.7 Fbar: 0.4526

Age	F	CatchNos*	Yield*	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)	Wt	Proportion Discards	LandingNos	Landing (t)	DiscardsNos	Discards (t)
1	0.0538	3342	475	70385	9995	0	0	0	0	0.142	**0.476**	**1750**	**248**	**1592**	**226.126737**
2	0.1714	7642	1796	53366	12541	0	0	0	0	0.235	**0.405**	**4550**	**1069**	**3092**	**726.611459**
3	0.3363	4106	1215	15775	4669	15775	4669	15775	4669	0.296	**0.075**	**3797**	**1124**	**309**	**91.5610935**
4	0.6314	3739	1380	8721	3218	8721	3218	8721	3218	0.369	**0.018**	**3672**	**1355**	**67**	**24.8211128**
5	0.6713	1987	898	4435	2005	4435	2005	4435	2005	0.452	**0.026**	**1935**	**874**	**52**	**23.6625789**
6	0.4515	1281	657	3863	1981	3863	1981	3863	1981	0.513	**0.067**	**1196**	**613**	**85**	**43.7375155**
7	0.4515	280	217	843	655	843	655	843	655	0.777	**0.030**	**271**	**211**	**9**	**6.62245879**
Total		22377	6639	157388	35065	33637	12529	33637	12529			**17170**	**5495**	**5207**	**1143**

Year: 2007 F multiplier: 0.8 Fbar: 0.5173

Age	F	CatchNos*	Yield*	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)	Wt	Proportion Discards	LandingNos	Landing (t)	DiscardsNos	Discards (t)
1	0.0614	3805	540	70385	9995	0	0	0	0	0.142	**0.476**	**1992**	**283**	**1813**	**257.454289**
2	0.1959	8634	2029	53366	12541	0	0	0	0	0.235	**0.405**	**5141**	**1208**	**3493**	**820.93213**
3	0.3843	4591	1359	15775	4669	15775	4669	15775	4669	0.296	**0.075**	**4245**	**1257**	**346**	**102.376274**
4	0.7216	4111	1517	8721	3218	8721	3218	8721	3218	0.369	**0.018**	**4037**	**1490**	**74**	**27.2906111**
5	0.7672	2181	986	4435	2005	4435	2005	4435	2005	0.452	**0.026**	**2124**	**960**	**57**	**25.9728659**
6	0.516	1423	730	3863	1981	3863	1981	3863	1981	0.513	**0.067**	**1328**	**681**	**95**	**48.5858584**
7	0.516	311	242	843	655	843	655	843	655	0.777	**0.030**	**302**	**234**	**9**	**7.35565959**
Total		25057	7403	157388	35065	33637	12529	33637	12529			**19168**	**6113**	**5888**	**1290**

Year: 2007 F multiplier: 0.9 Fbar: 0.5819

Age	F	CatchNos*	Yield*	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)	Wt	Proportion Discards	LandingNos	Landing (t)	DiscardsNos	Discards (t)
1	0.0691	4265	606	70385	9995	0	0	0	0	0.142	**0.476**	**2233**	**317**	**2032**	**288.578855**
2	0.2204	9603	2257	53366	12541	0	0	0	0	0.235	**0.405**	**5718**	**1344**	**3885**	**913.065931**
3	0.4324	5055	1496	15775	4669	15775	4669	15775	4669	0.296	**0.075**	**4674**	**1384**	**381**	**112.723168**
4	0.8118	4453	1643	8721	3218	8721	3218	8721	3218	0.369	**0.018**	**4373**	**1614**	**80**	**29.5609562**
5	0.8631	2357	1065	4435	2005	4435	2005	4435	2005	0.452	**0.026**	**2295**	**1037**	**62**	**28.0687964**
6	0.5805	1557	799	3863	1981	3863	1981	3863	1981	0.513	**0.067**	**1453**	**746**	**104**	**53.1610552**
7	0.5805	340	264	843	655	843	655	843	655	0.777	**0.030**	**330**	**256**	**10**	**8.04155711**
Total		27630	8130	157388	35065	33637	12529	33637	12529			**21075**	**6697**	**6555**	**1433**

Year: 2007 F multiplier: 1 Fbar: 0.6466

Age	F	CatchNos*	Yield*	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)	Wt	Proportion Discards	LandingNos	Landing (t)	DiscardsNos	Discards (t)
1	0.0768	4722	671	70385	9995	0	0	0	0	0.142	**0.476**	**2472**	**351**	**2250**	**319.500435**
2	0.2449	10549	2479	53366	12541	0	0	0	0	0.235	**0.405**	**6281**	**1476**	**4268**	**1003.01286**
3	0.4804	5498	1627	15775	4669	15775	4669	15775	4669	0.296	**0.075**	**5084**	**1505**	**414**	**122.601776**
4	0.902	4767	1759	8721	3218	8721	3218	8721	3218	0.369	**0.018**	**4681**	**1727**	**86**	**31.6454252**
5	0.959	2518	1138	4435	2005	4435	2005	4435	2005	0.452	**0.026**	**2452**	**1108**	**66**	**29.9860964**
6	0.645	1682	863	3863	1981	3863	1981	3863	1981	0.513	**0.067**	**1570**	**805**	**112**	**57.4289626**
7	0.645	367	285	843	655	843	655	843	655	0.777	**0.030**	**356**	**277**	**11**	**8.68015135**
Total		30103	8822	157388	35065	33637	12529	33637	12529			**22895**	**7249**	**7208**	**1573**

Year: 2007 F multiplier: 1.1 Fbar: 0.7112

Age	F	CatchNos*	Yield*	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)	Wt	Proportion Discards	LandingNos	Landing (t)	DiscardsNos	Discards (t)
1	0.0845	5175	735	70385	9995	0	0	0	0	0.142	**0.476**	**2709**	**385**	**2466**	**350.151366**
2	0.2694	11474	2696	53366	12541	0	0	0	0	0.235	**0.405**	**6832**	**1605**	**4642**	**1090.96308**
3	0.5284	5920	1752	15775	4669	15775	4669	15775	4669	0.296	**0.075**	**5474**	**1620**	**446**	**132.012098**
4	0.9922	5055	1865	8721	3218	8721	3218	8721	3218	0.369	**0.018**	**4964**	**1832**	**91**	**33.5572948**
5	1.0549	2665	1205	4435	2005	4435	2005	4435	2005	0.452	**0.026**	**2595**	**1173**	**70**	**31.7366747**
6	0.7095	1800	923	3863	1981	3863	1981	3863	1981	0.513	**0.067**	**1680**	**862**	**120**	**61.4578673**
7	0.7095	393	305	843	655	843	655	843	655	0.777	**0.030**	**381**	**296**	**12**	**9.29509395**
Total		32482	9482	157388	35065	33637	12529	33637	12529			**24635**	**7773**	**7847**	**1709**

Year: 2007 F multiplier: 1.2 Fbar: 0.7759

Age	F	CatchNos*	Yield*	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)	Wt	Proportion Discards	LandingNos	Landing (t)	DiscardsNos	Discards (t)
1	0.0922	5625	799	70385	9995	0	0	0	0	0.142	**0.476**	**2945**	**418**	**2680**	**380.599311**
2	0.2939	12376	2908	53366	12541	0	0	0	0	0.235	**0.405**	**7369**	**1732**	**5007**	**1176.72644**
3	0.5765	6324	1872	15775	4669	15775	4669	15775	4669	0.296	**0.075**	**5848**	**1731**	**476**	**141.021032**
4	1.0824	5319	1963	8721	3218	8721	3218	8721	3218	0.369	**0.018**	**5223**	**1927**	**96**	**35.3098419**
5	1.1508	2800	1265	4435	2005	4435	2005	4435	2005	0.452	**0.026**	**2726**	**1232**	**74**	**33.3443487**
6	0.774	1911	980	3863	1981	3863	1981	3863	1981	0.513	**0.067**	**1784**	**915**	**127**	**65.2477691**
7	0.774	417	324	843	655	843	655	843	655	0.777	**0.030**	**404**	**314**	**13**	**9.86273328**
Total		34772	10112	157388	35065	33637	12529	33637	12529			**26299**	**8270**	**8473**	**1842**

Year: 2007 F multiplier: 1.3 Fbar: 0.8405

Age	F	CatchNos*	Yield*	StockNos	Biomass	SSNos(Jan)	SSB(Jan)	SSNos(ST)	SSB(ST)	Wt	Proportion Discards	LandingNos	Landing (t)	DiscardsNos	Discards (t)
1	0.0998	6072	862	70385	9995	0	0	0	0	0.142	**0.476**	**3179**	**451**	**2893**	**410.844269**
2	0.3184	13258	3116	53366	12541	0	0	0	0	0.235	**0.405**	**7894**	**1855**	**5364**	**1260.58816**
3	0.6245	6710	1986	15775	4669	15775	4669	15775	4669	0.296	**0.075**	**6204**	**1837**	**506**	**149.628577**
4	1.1726	5562	2052	8721	3218	8721	3218	8721	3218	0.369	**0.018**	**5462**	**2015**	**100**	**36.9229819**
5	1.2467	2922	1321	4435	2005	4435	2005	4435	2005	0.452	**0.026**	**2845**	**1286**	**77**	**34.7972096**
6	0.8385	2015	1034	3863	1981	3863	1981	3863	1981	0.513	**0.067**	**1881**	**965**	**134**	**68.7986681**
7	0.8385	440	342	843	655	843	655	843	655	0.777	**0.030**	**427**	**332**	**13**	**10.406721**
Total		36978	10713	157388	35065	33637	12529	33637	12529			**27891**	**8741**	**9088**	**1972**

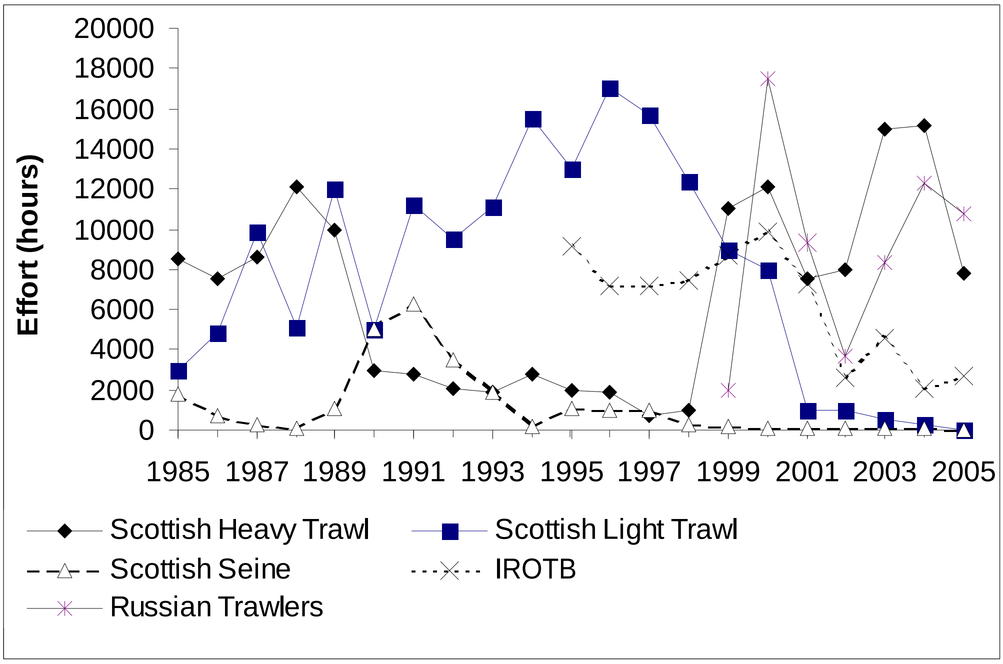
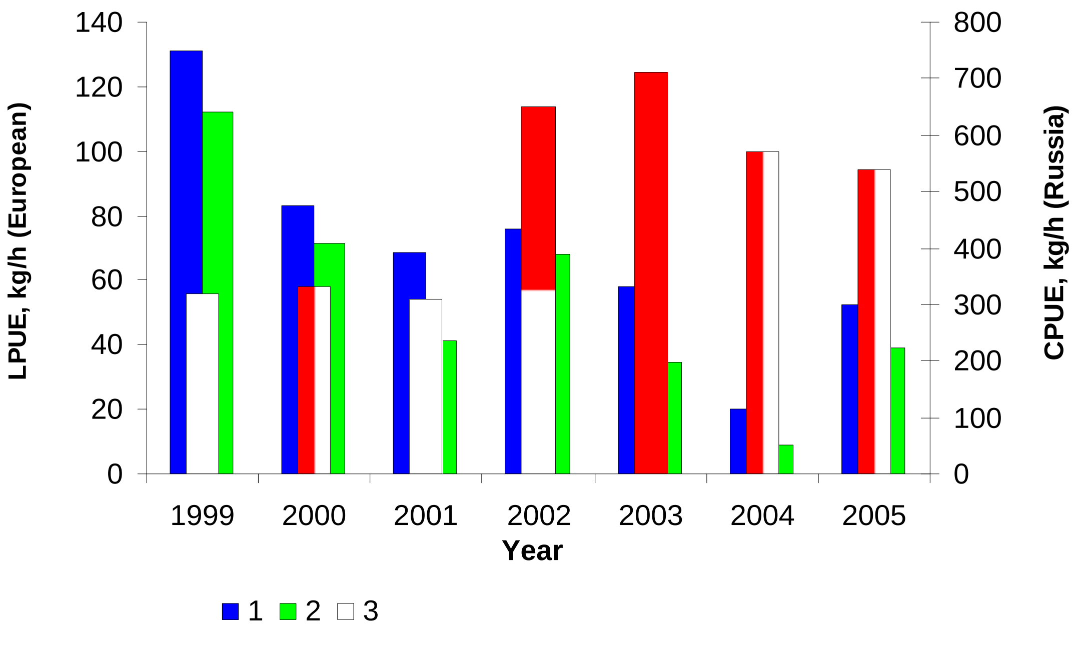


Figure 4.2.1. Rockall haddock VIb: Scottish, Irish and Russian efforts since 1985.



1 – Scottish LPUE (all gears)

2 - Irish trawlers LPUE

3 – CPUE of Russian trawlers (BMRT type, 10 th tonnage class)

Figure 4.2.2. LPUE and CPUE of the fleets fishing for Rockall haddock VIb

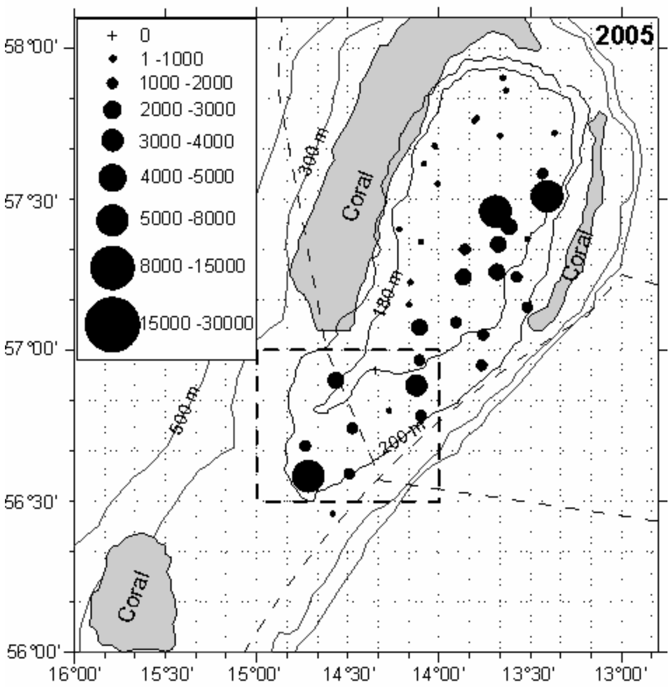
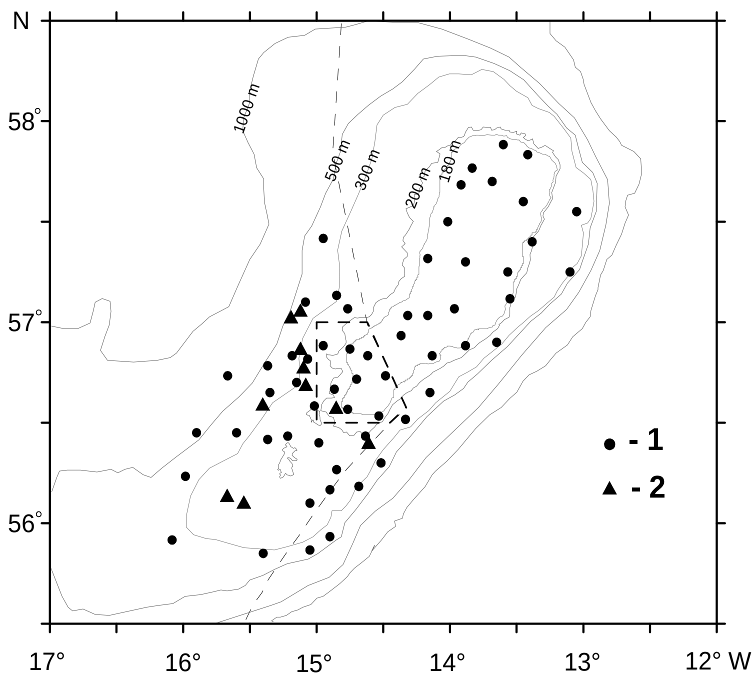


Figure 4.2.3a. Distribution of haddock (catch per 30-min. haul, fish) on the Rockall Bank in 2005 from data of Scottish trawl surveys.



1- bottom haulings

2 – pelagic haulings

Figure 4.2.3b. Trawl stations in Russian TAS for haddock in March 2005

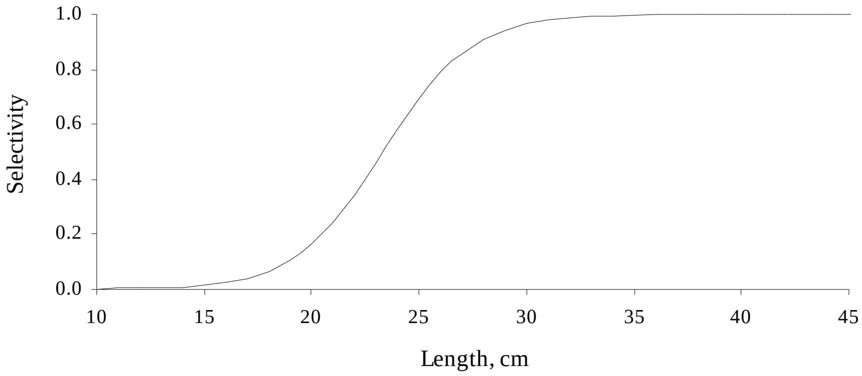


Figure 4.2.4. Theoretical haddock selectivity curve used to estimate the proportion of haddock lifted onboard Russian trawlers.

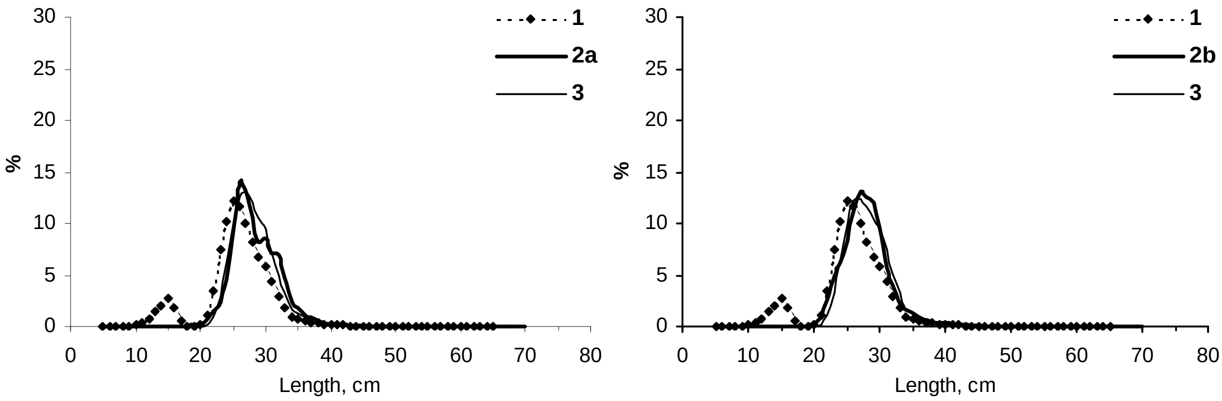


Figure 4.2.5. Length distribution of haddock in 2003: 1- by Scottish groundfish survey, 2a- by commercial Russian trawlers in June, 2b- by commercial Russian trawlers in July, 3-theoretically-derived.

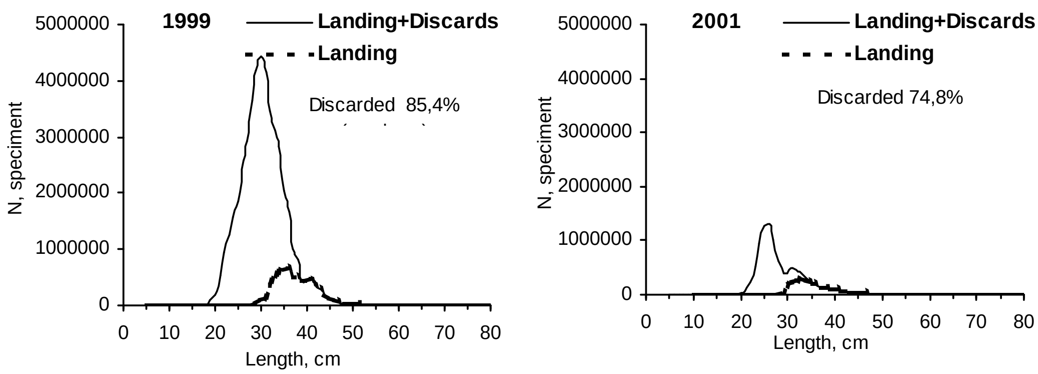


Figure 4.2.6 Length distribution and quantity of haddock lifted onboard and landings by Scottish trawlers in 1999 and 2001 (unpublished data, Newton, 2004).

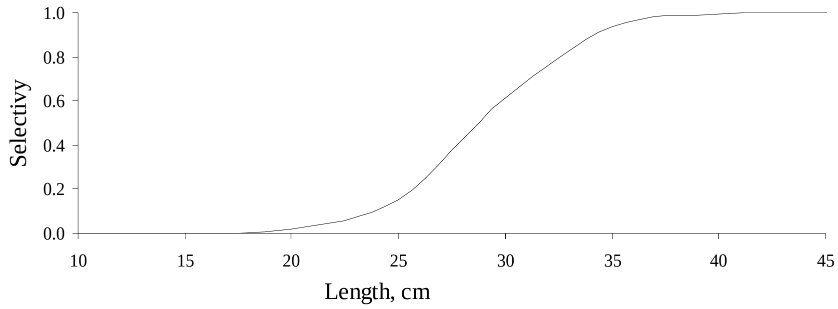


Figure 4.2.7. Theoretical haddock selectivity curve used to estimate the proportion of haddock lifted onboard Scottish trawlers.

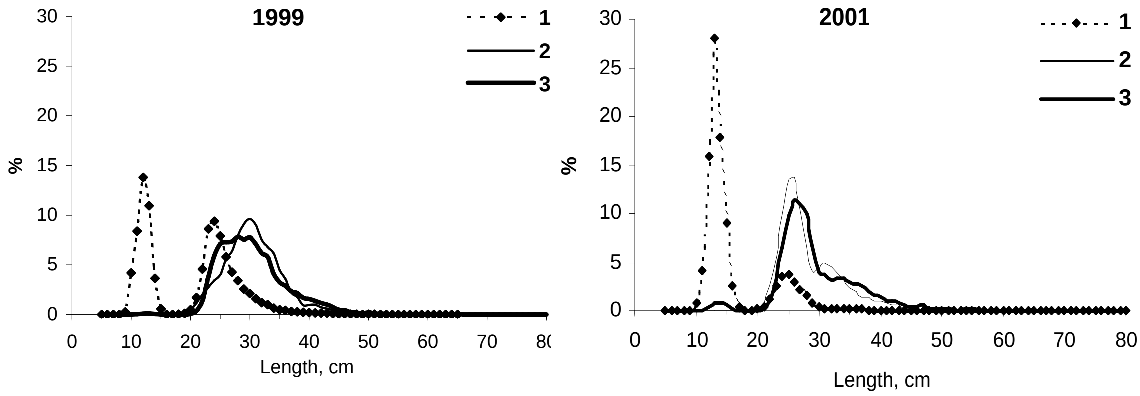


Figure 4.2.8. Length distribution of haddock in 1999 and 2001: 1- by Scottish groundfish survey, 2- by commercial Scottish trawlers, 3- theoretically-derived

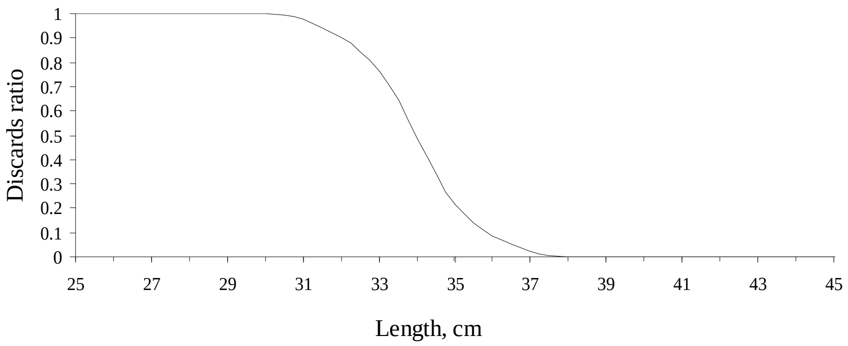


Figure 4.2.9. Selectivity curve used to estimate the proportion of discarded haddock in catches Scottish trawlers.

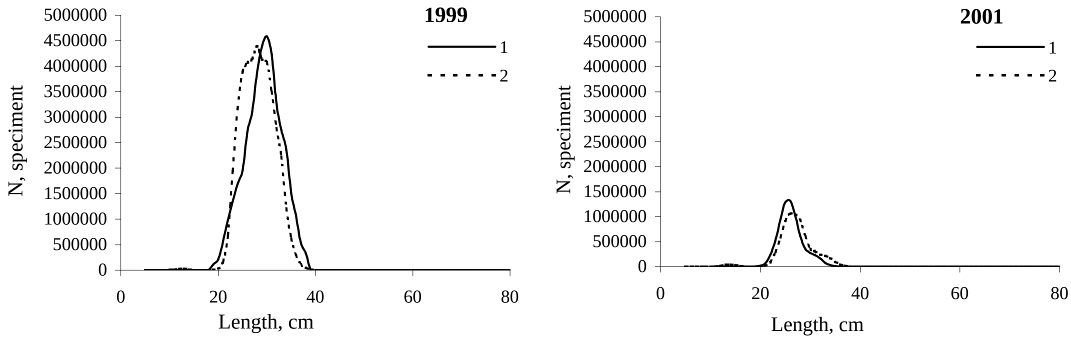


Figure 4.2.10. Length distribution of discarded haddock in catches Scottish trawlers in 1999 and 2001: 1- research data; 2- theoretically-derived.

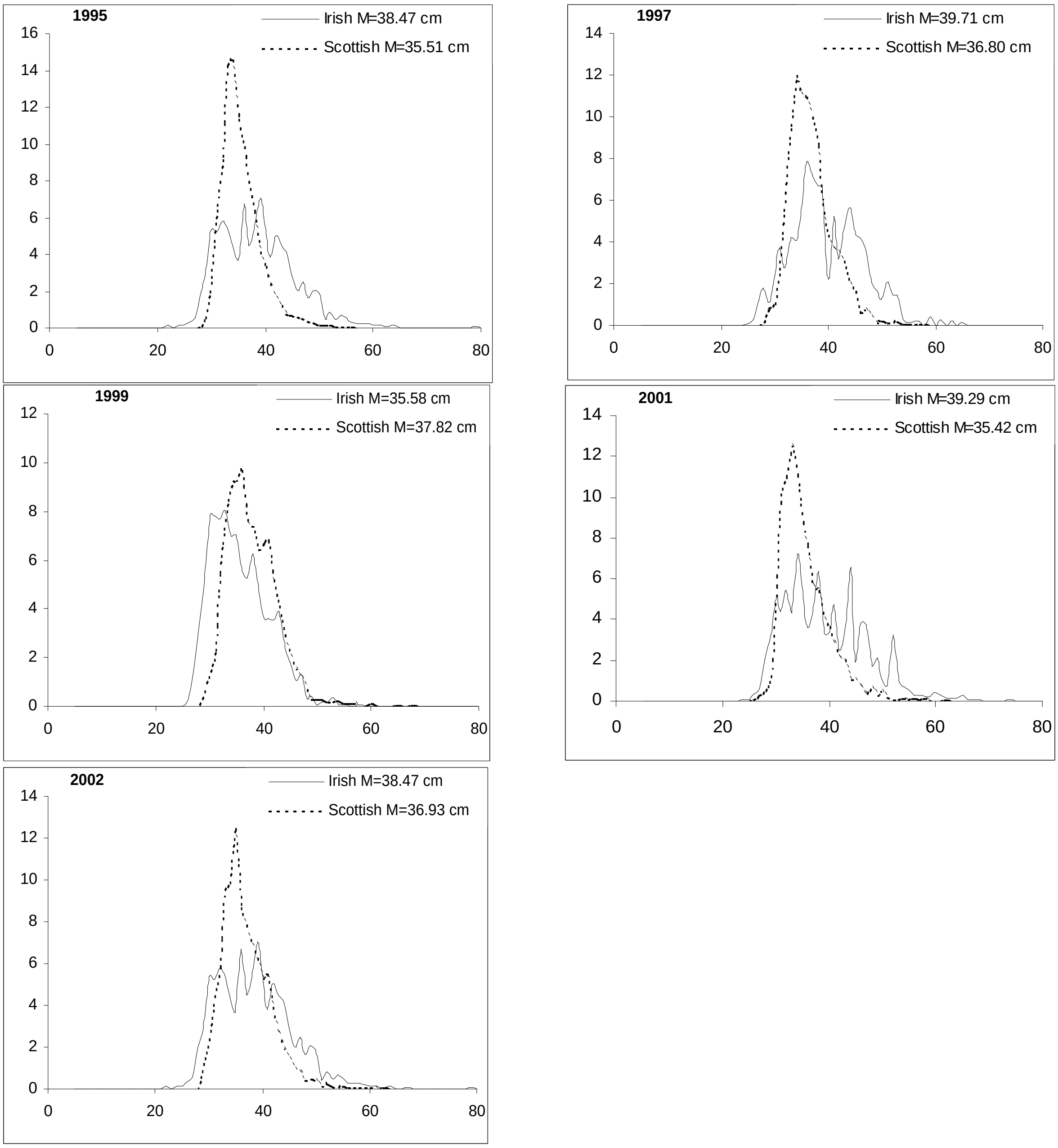


Figure 4.2.11. Length distribution of haddock landings in VI b (Scottish and Irish data).

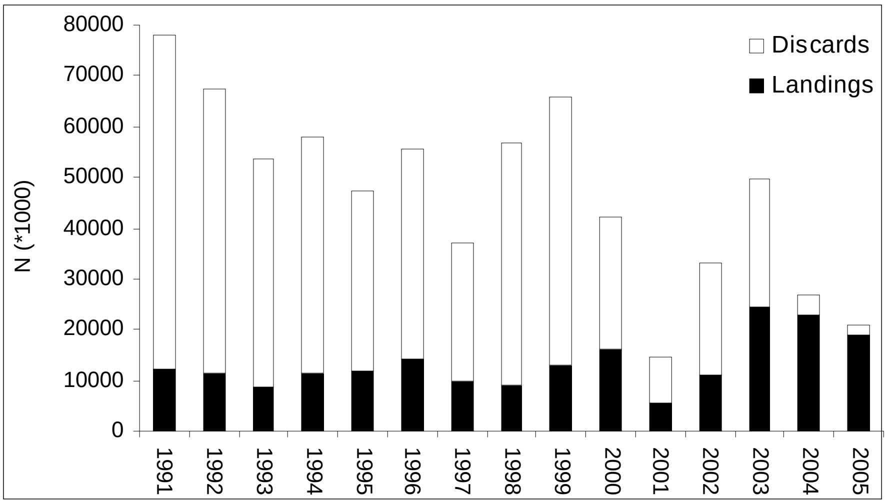


Figure 4.2.12. Total landings and discards of the Rockall haddock (individual '000)

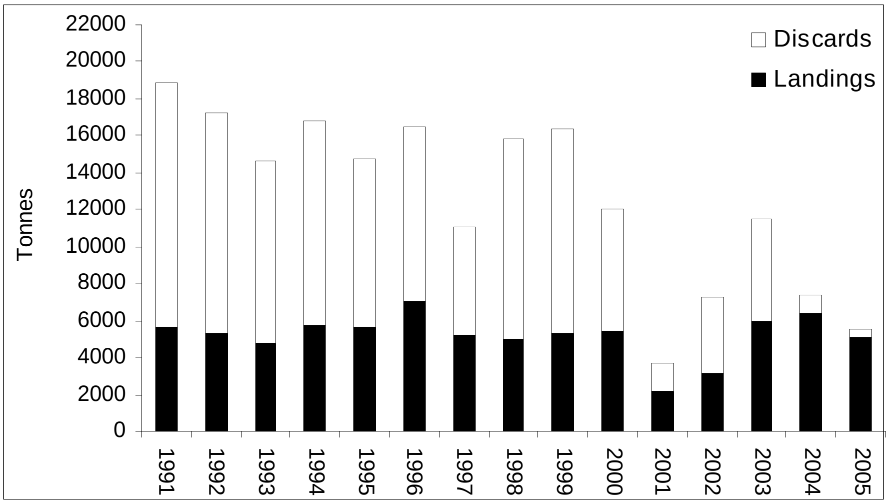


Figure 4.2.13. Total landings and discards of the Rockall haddock (tonnes).

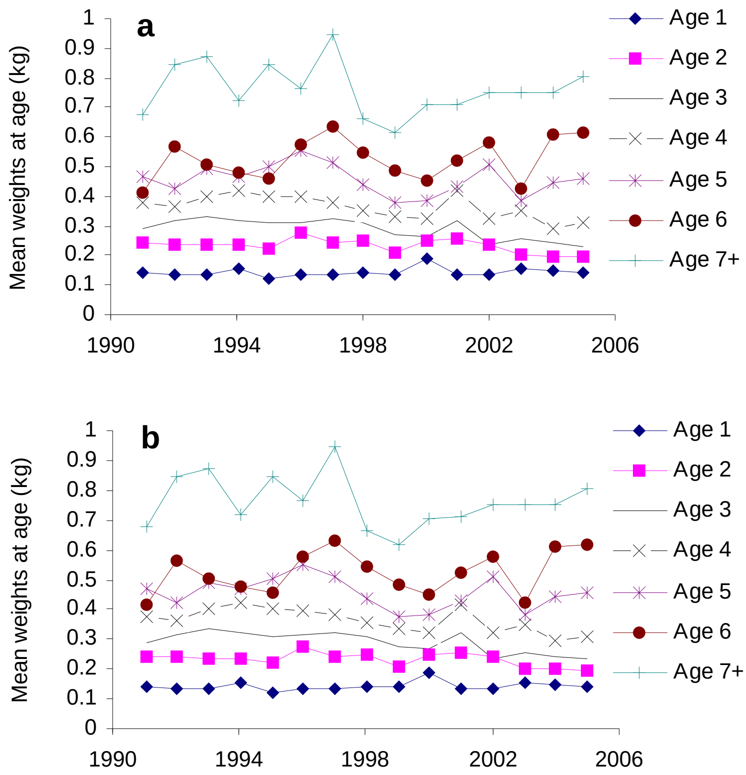


Figure 4.2.14. Haddock VIb a) mean catch weights and b) mean stock weights at age.

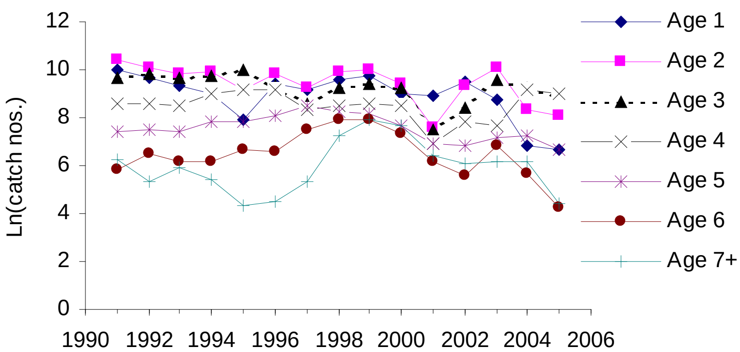


Figure 4.2.15. Haddock VIb. Ln (Catch with discards nos.) at age, by year.

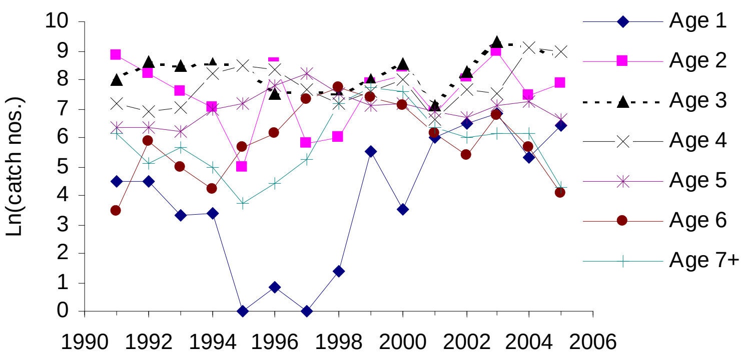


Figure 4.2.16. Haddock VIb. Ln (Landings nos.) at age, by year.

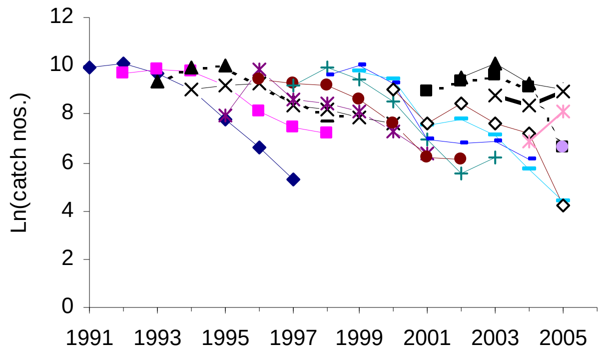


Figure 4.2.17. Haddock VIb. Ln (Catch with discards nos.) at age, by year class.

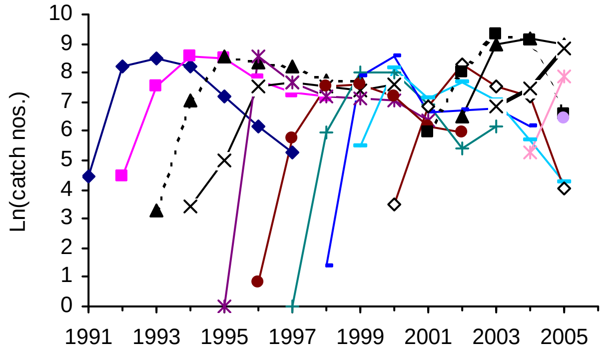


Figure 4.2.18. Haddock VIb. Ln (Landings without registration of discards nos.) at age, by year class.

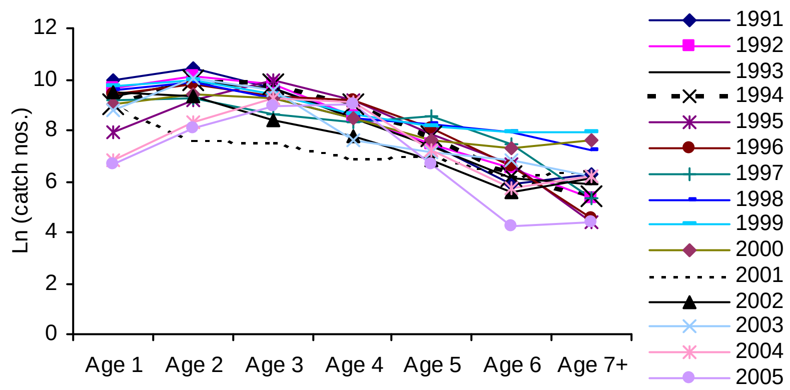


Figure 4.2.19. Haddock VIb. Catch curves (with registration of discards).

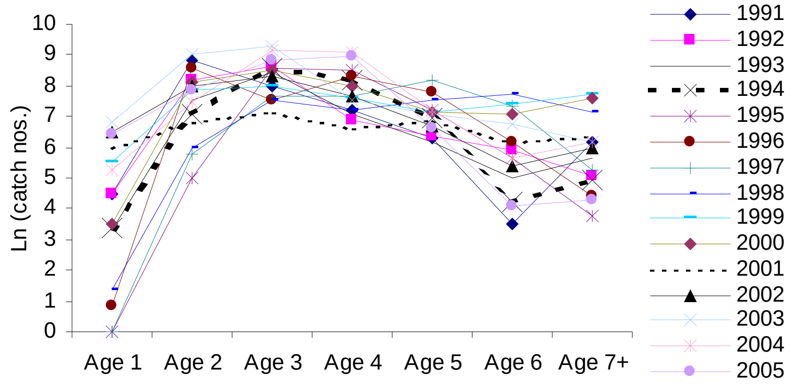


Figure 4.2.20. Haddock VIb. Catch curves (Landings without registration of discards).

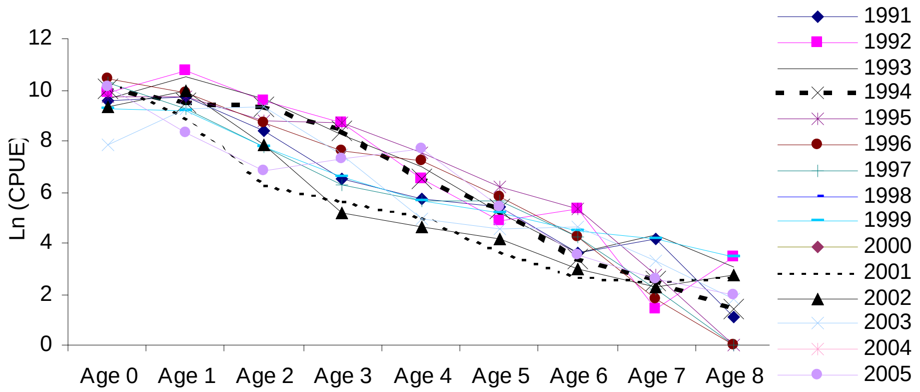


Figure 4.2.21. Haddock VIb. Ln survey CPUE at age, by year.

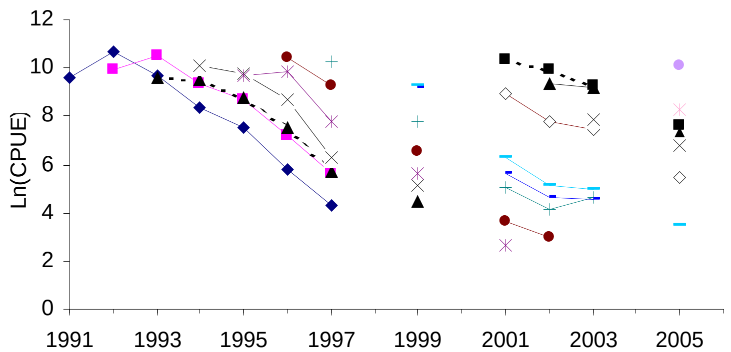


Figure 4.2.22. Haddock VIb. Ln survey CPUE by year class

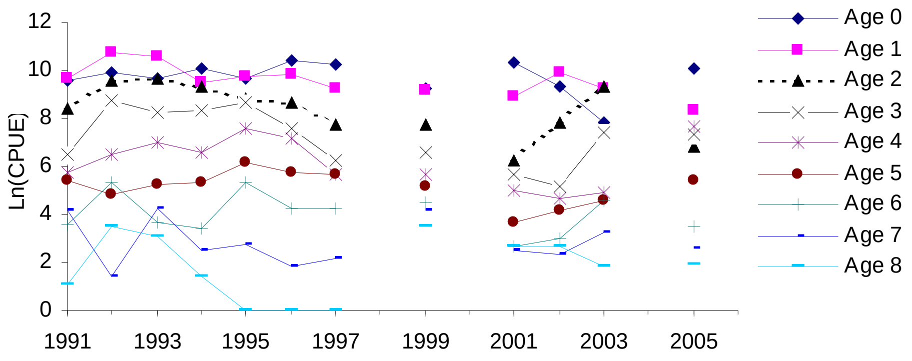


Figure 4.2.23. Haddock VIb. Ln Survey CPUE at age

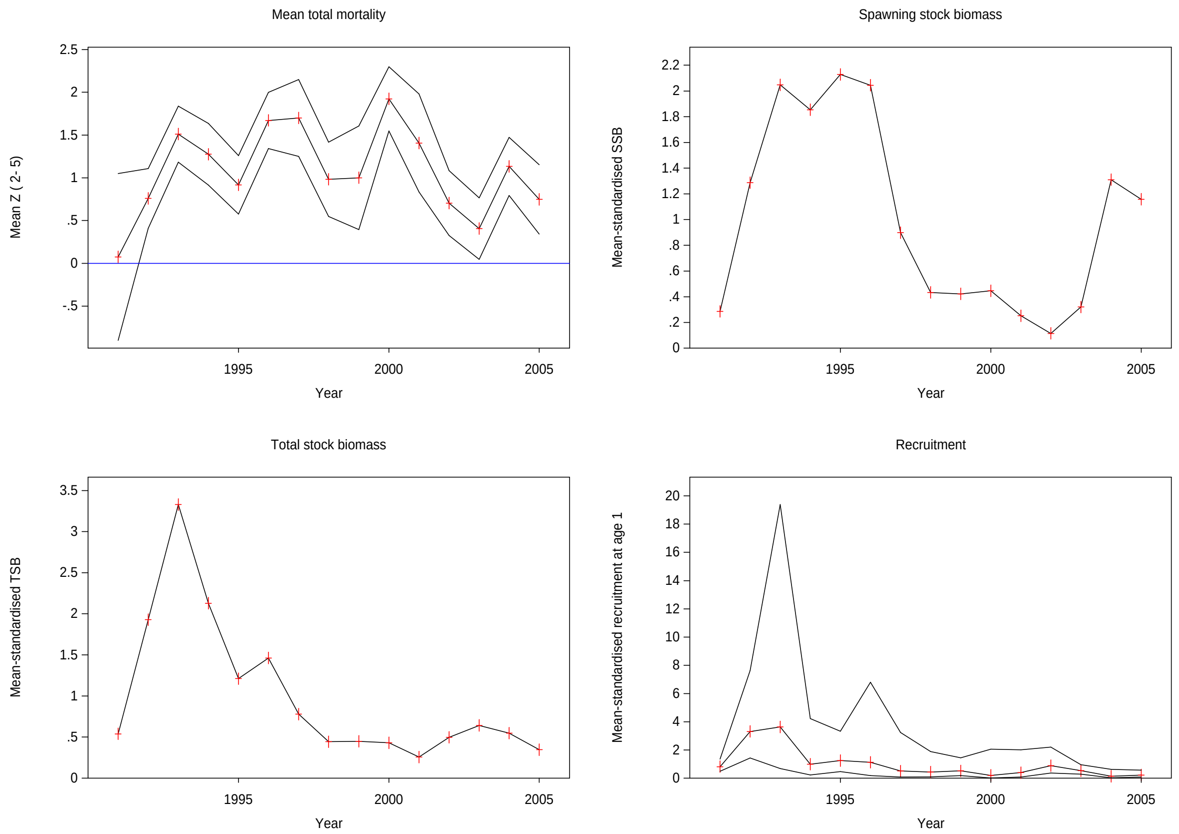


Figure 4.2.24 SURBA Analysis for Rockall Haddock

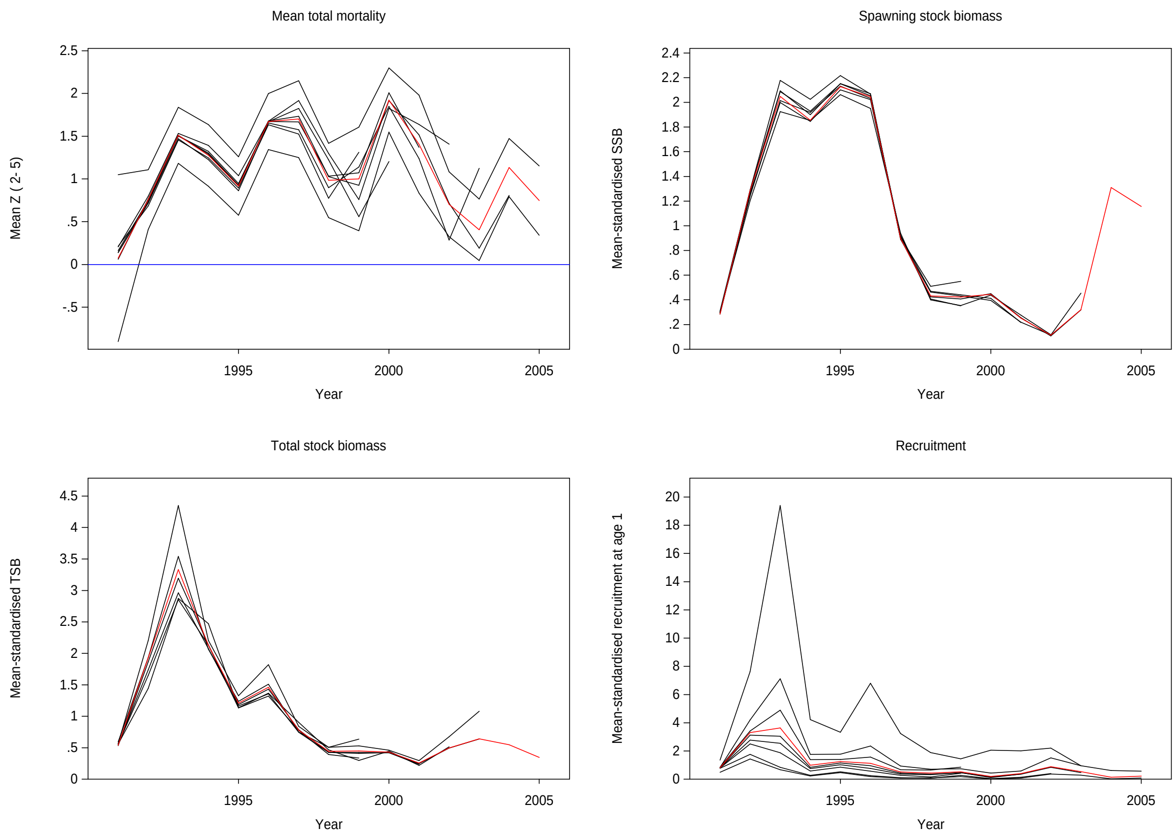


Figure 4.2.25a SURBA Rockall Haddock Retrospective plots.

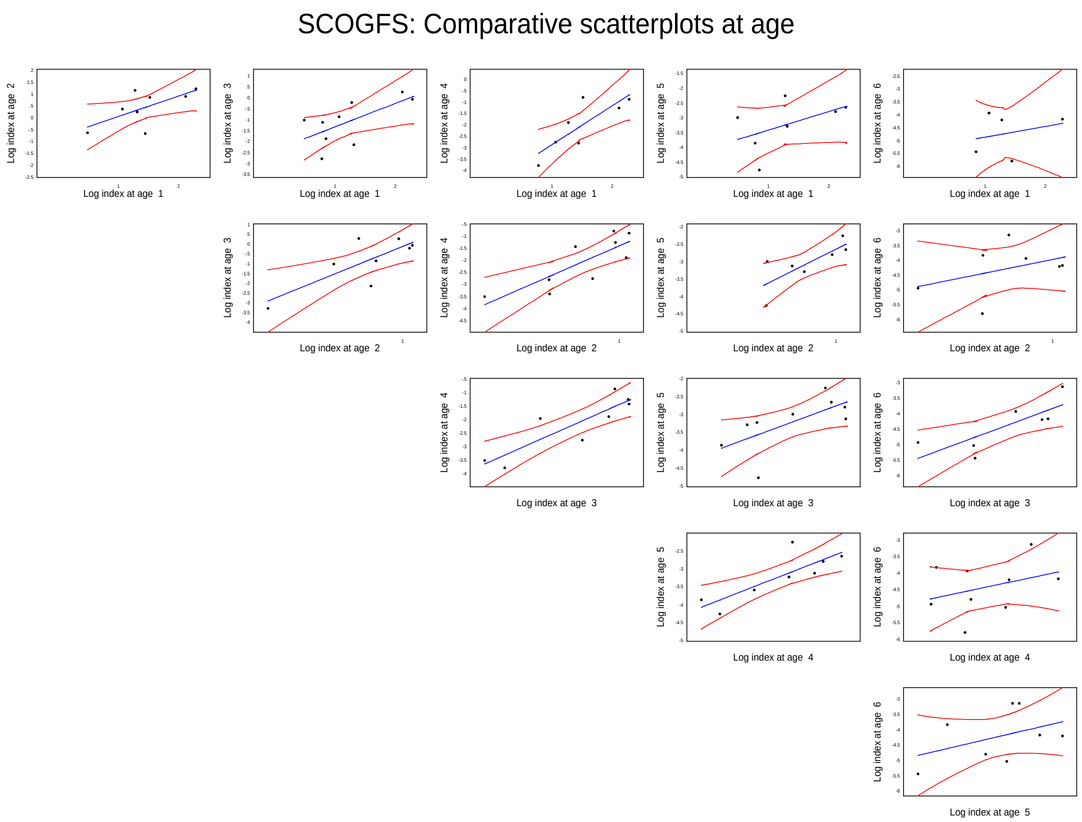


Figure 4.2.25b Haddock VIb SURBA Comparative scatterplots at age

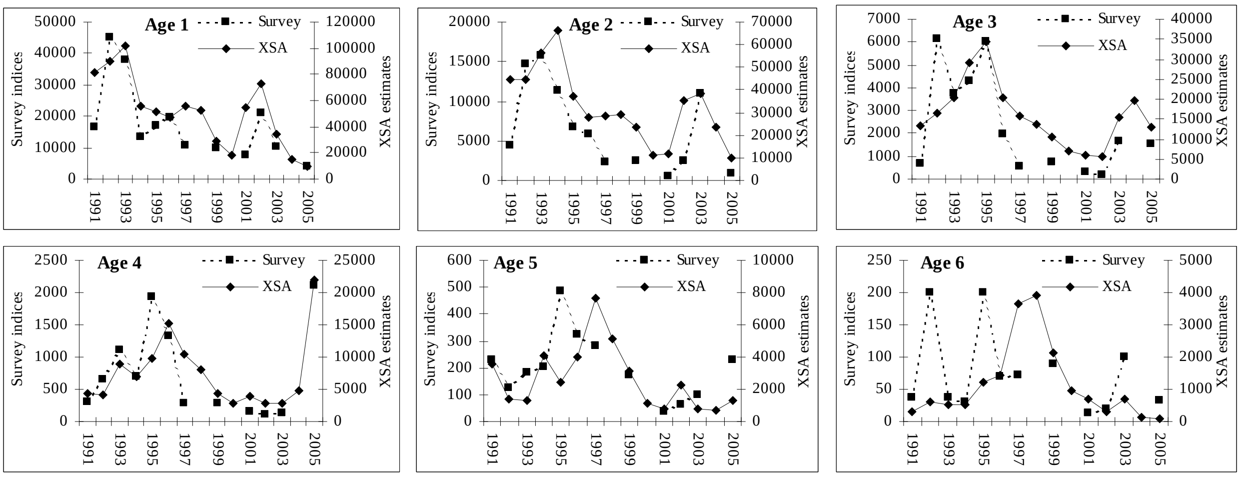


Figure 4.2.26. Haddock VIb. Survey indices and XSA estimates (Shrink 0.5) at age. Catchability independent of stock size for all ages.

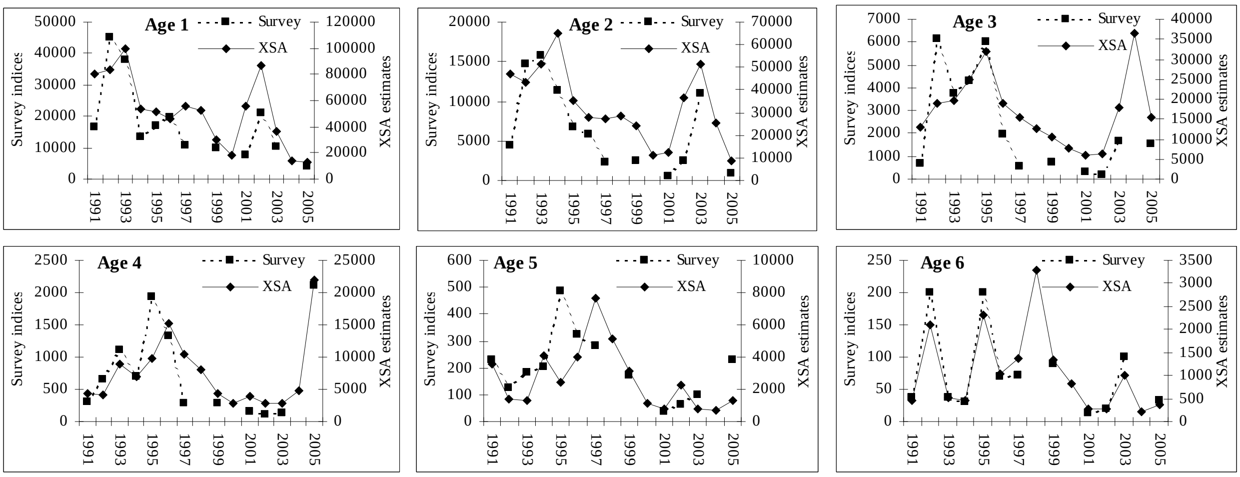


Figure 4.2.27. Haddock VIb. Survey indices and XSA estimates (Shrink 1.0) at age. Catchability independent of stock size for all ages.

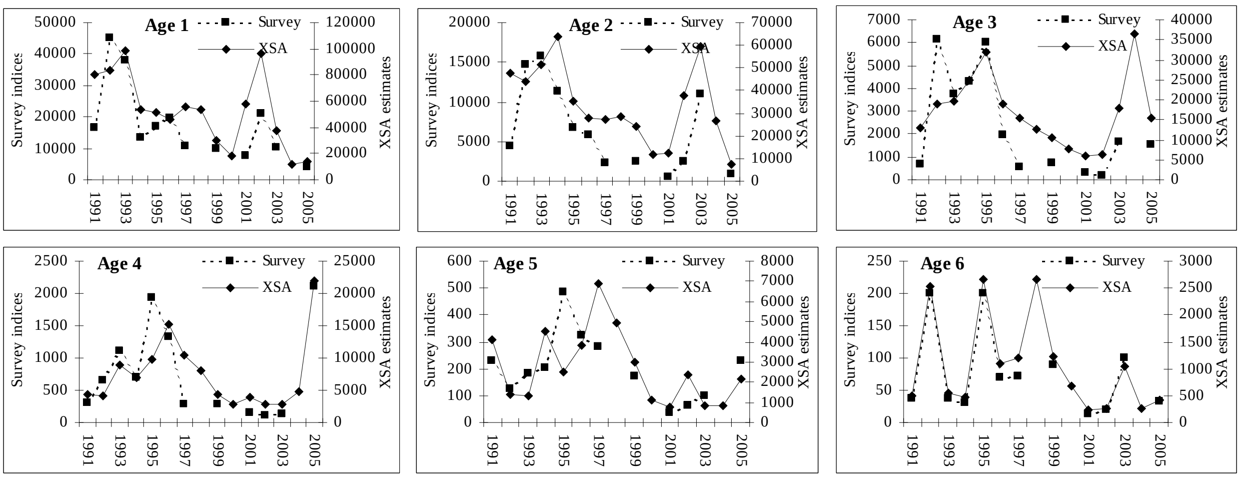


Figure 4.2.28. Haddock VIb. Survey indices and XSA estimates (Shrink 2.0) at age. Catchability independent of stock size for all ages.

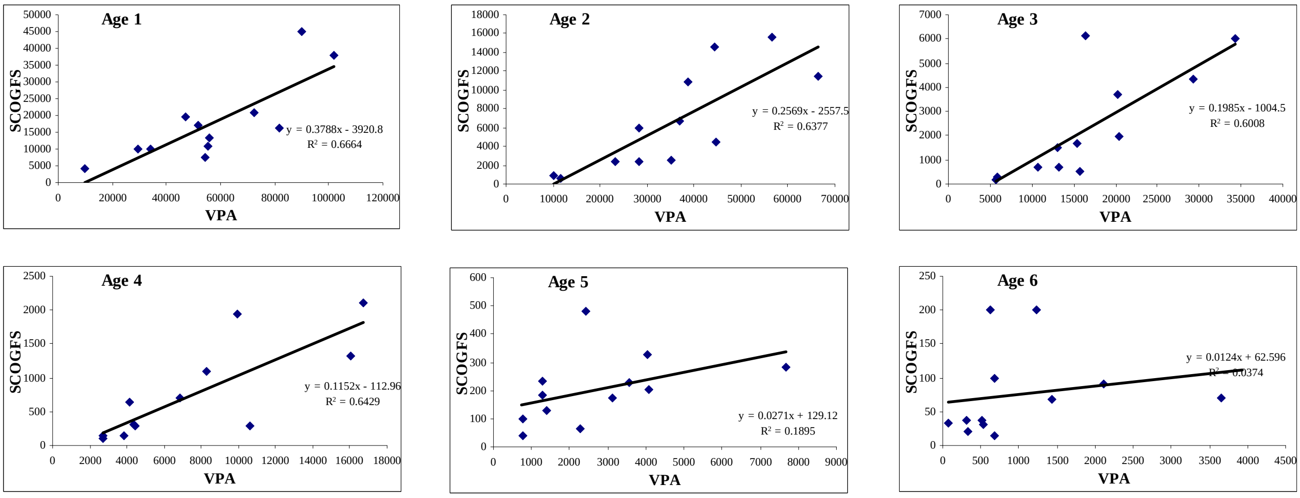


Figure 4.2.29. Haddock VIb. Scottish groundfish survey adjusted CPUE values from the final XSA run plotted against VPA numbers (Shrink 0.5) at age. Catchability independent of stock size for all ages.

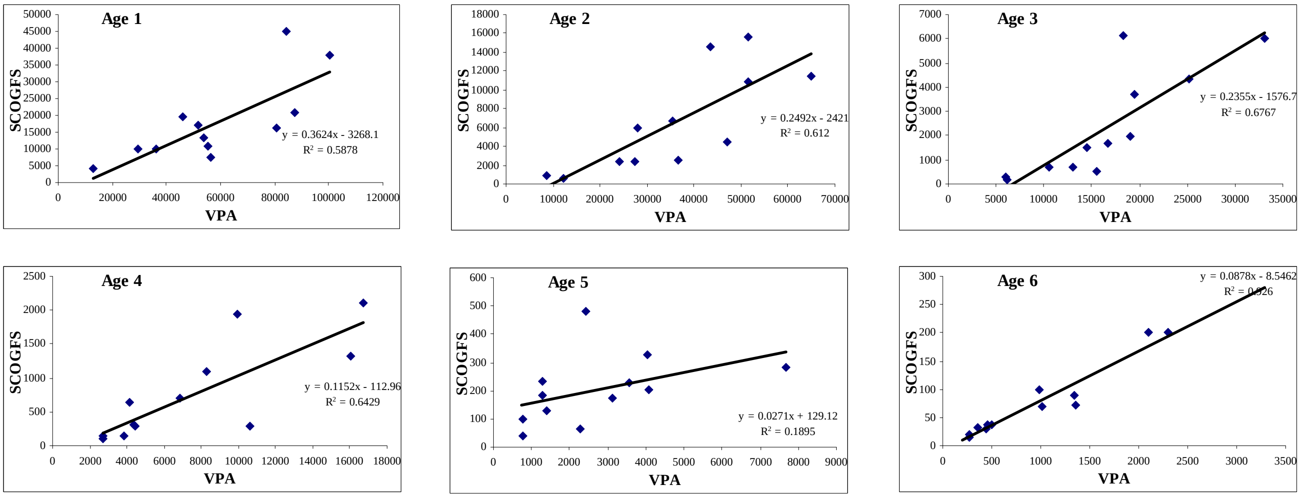


Figure 4.2.30. Haddock VIb. Scottish groundfish survey adjusted CPUE values from the final XSA run plotted against VPA numbers (Shrink 1.0) at age. Catchability independent of stock size for all ages.

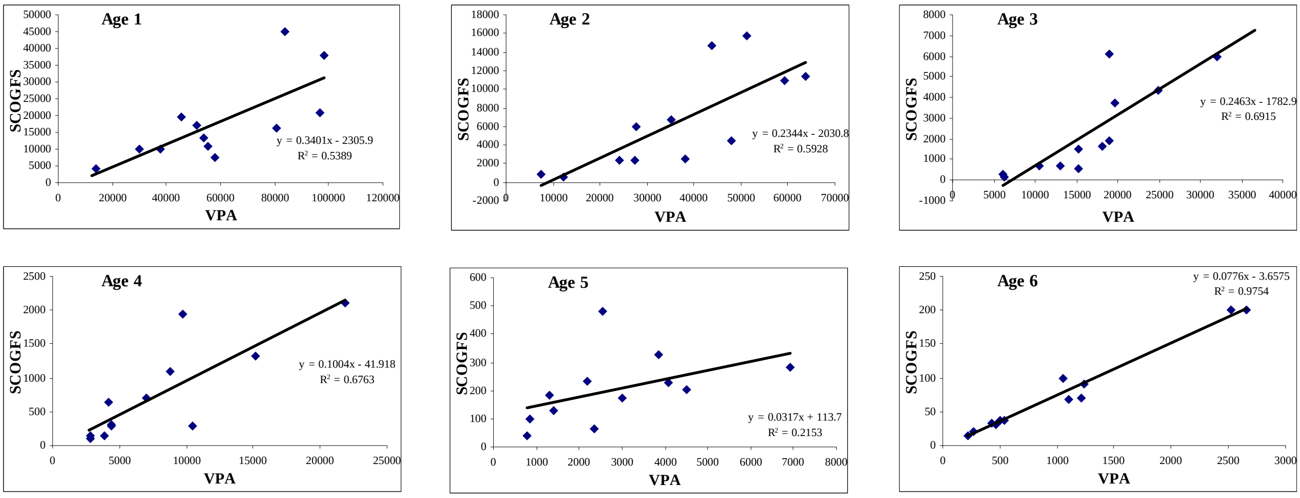


Figure 4.2.31. Haddock VIb. Scottish groundfish survey adjusted CPUE values from the final XSA run plotted against VPA numbers (Shrink 2.0) at age. Catchability independent of stock size for all ages.

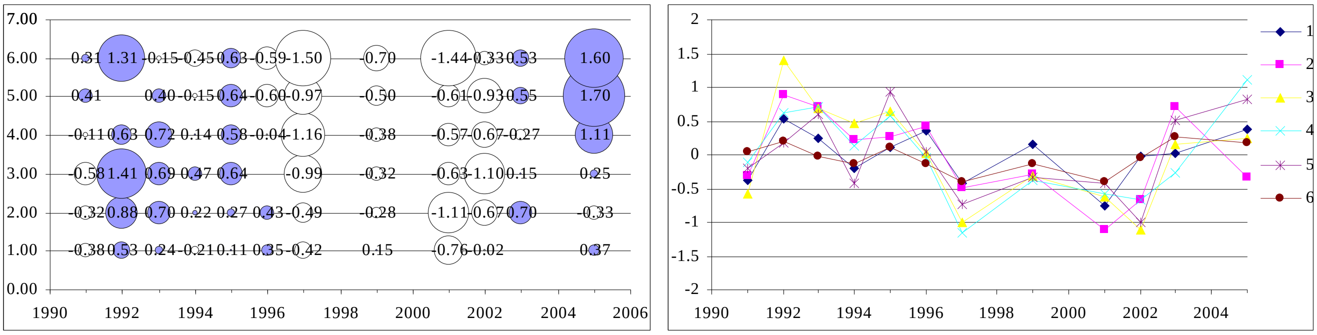


Figure 4.2.32. Haddock VIb. Log catchability residual plots (Shrink 0.5). Catchability independent of stock size for all ages.

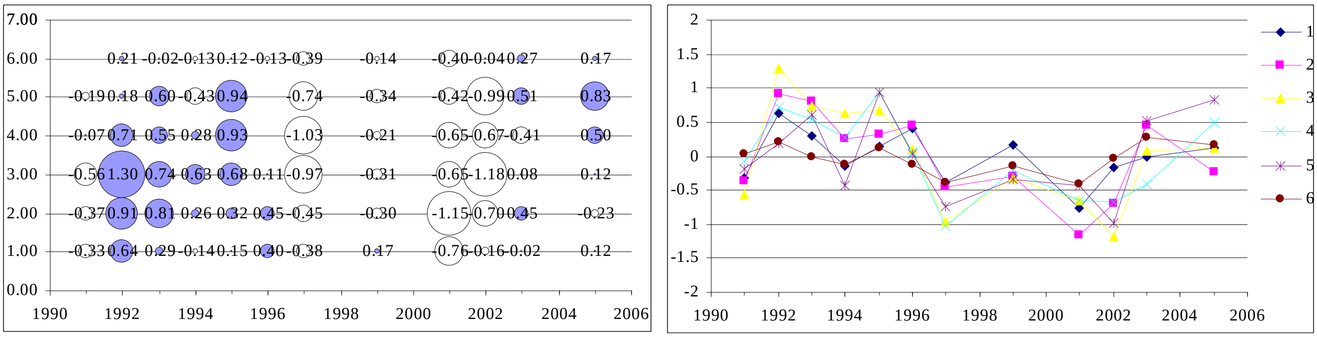


Figure 4.2.33. Haddock VIb. Log catchability residual plots (Shrink 1.0). Catchability independent of stock size for all ages.

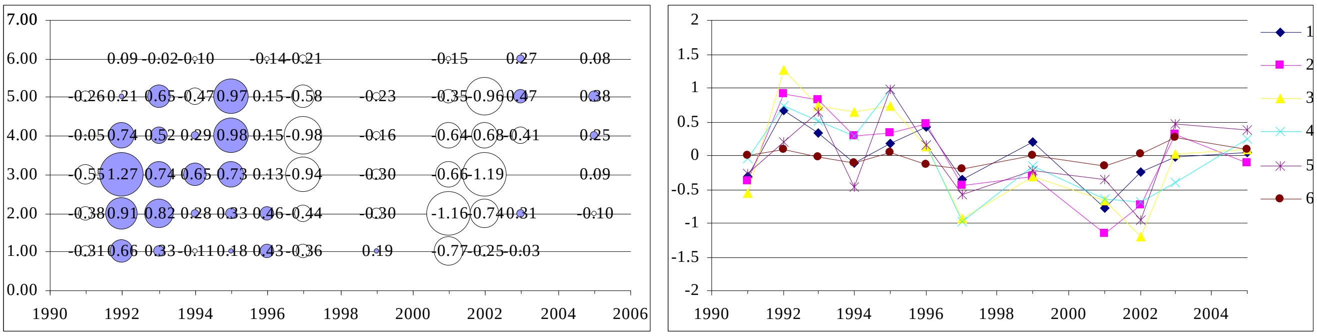


Figure 4.2.34. Haddock VIb. Log catchability residual plots (Shrink 2.0). Catchability independent of stock size for all ages

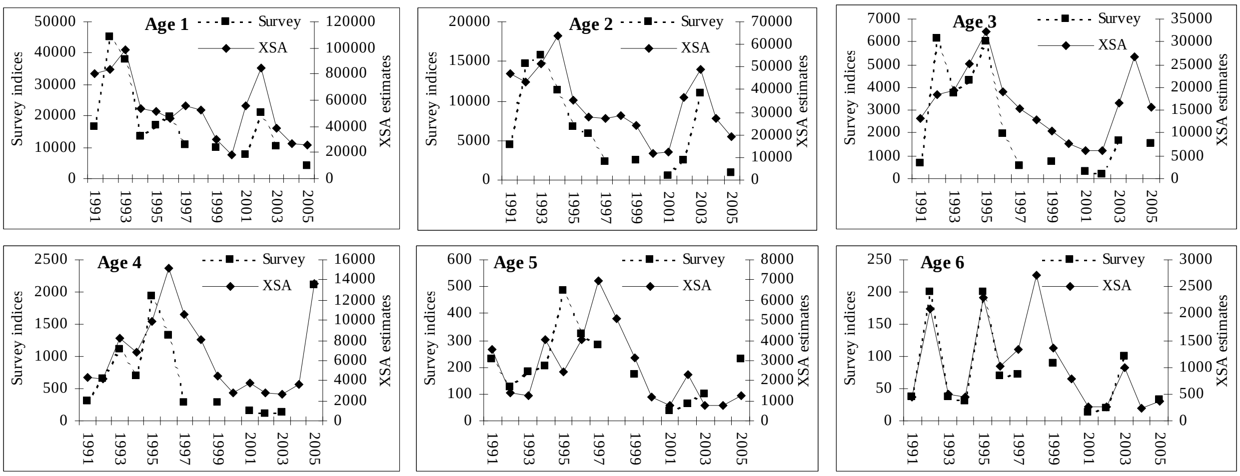


Figure 4.2.35. Haddock VIb. Survey indices and XSA estimates (Shrink 1.0) at age. Final XSA: catchability dependent on stock size at ages < 4.

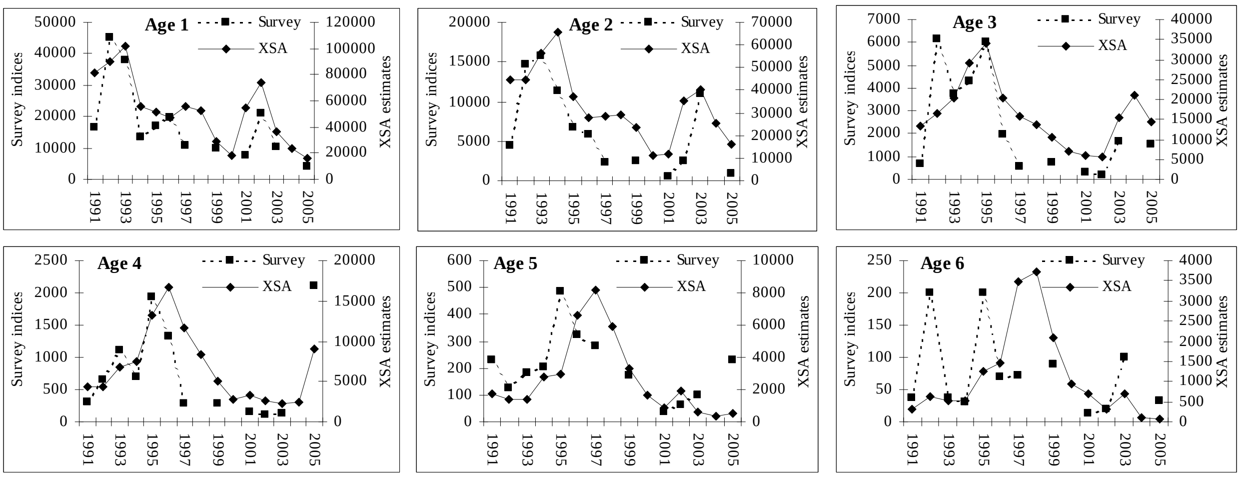


Figure 4.2.36. Haddock VIb. Survey indices and XSA estimates (Shrink 0.5) at age. Explanatory XSA: catchability dependent on stock size at ages < 4.

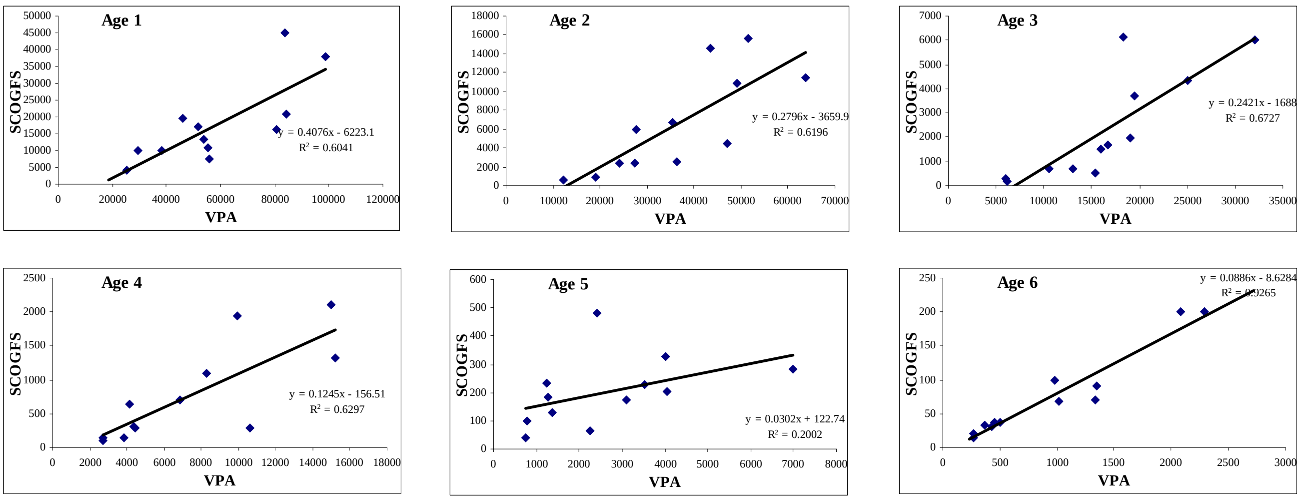


Figure 4.2.37. Haddock VIb. Scottish groundfish survey adjusted CPUE values from the final XSA run plotted against VPA numbers (Shrink 1.0) at age. Catchability dependent on stock size at ages < 4.

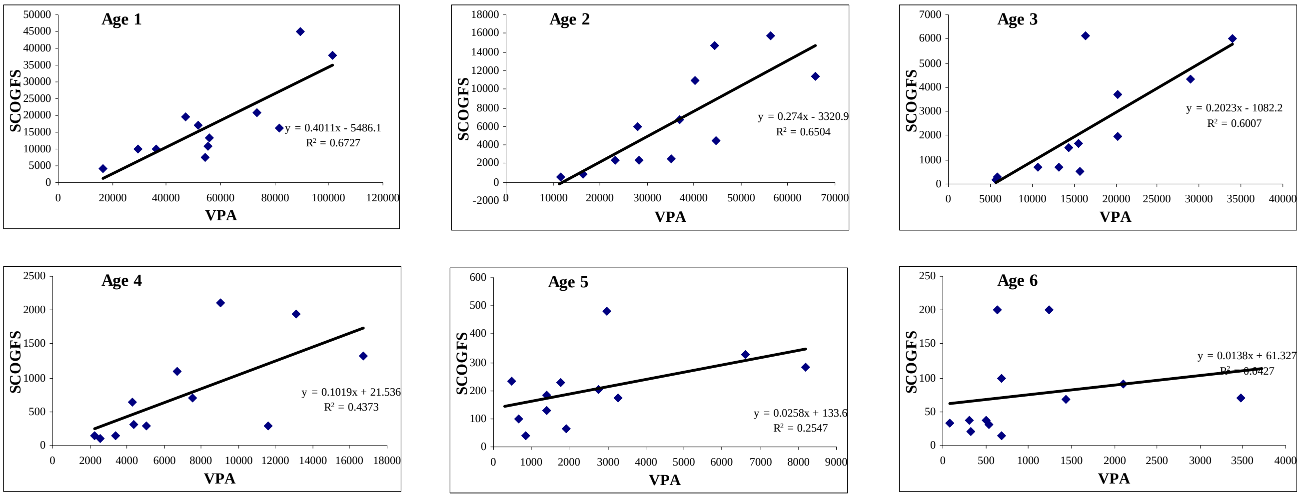


Figure 4.2.38. Haddock VIb. Scottish groundfish survey adjusted CPUE values from the XSA run plotted against VPA numbers (Shrink 0.5) at age. Explanatory XSA: catchability dependent on stock size at ages < 4.

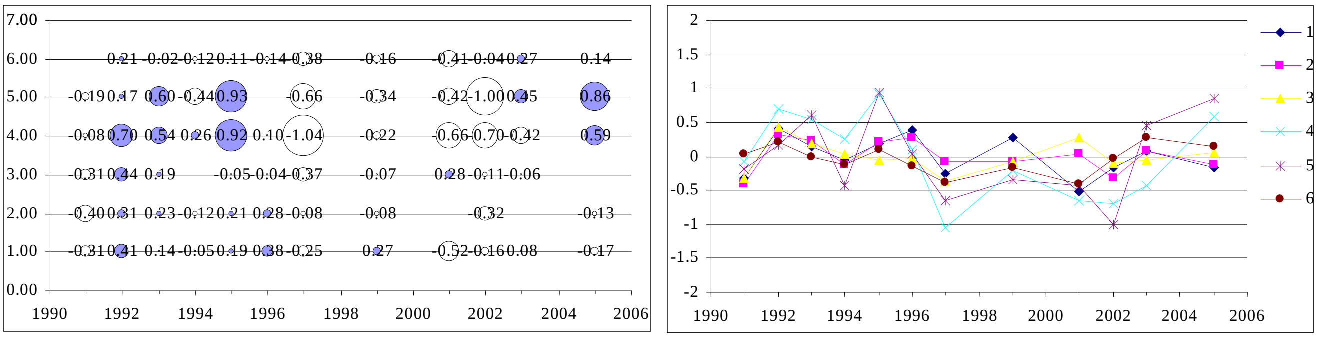


Figure 4.2.39. Haddock VIb. Log catchability residual plots (Shrink 1.0). Final XSA: catchability dependent on stock size at ages < 4.

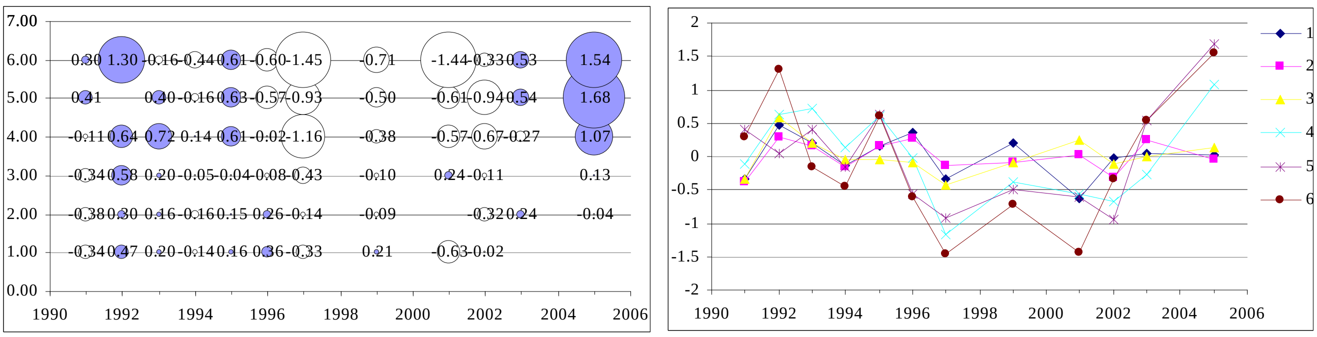


Figure 4.2.40. Haddock VIb. Log catchability residual plots (Shrink 0.5). Explanatory XSA: catchability dependent on stock size at ages < 4.

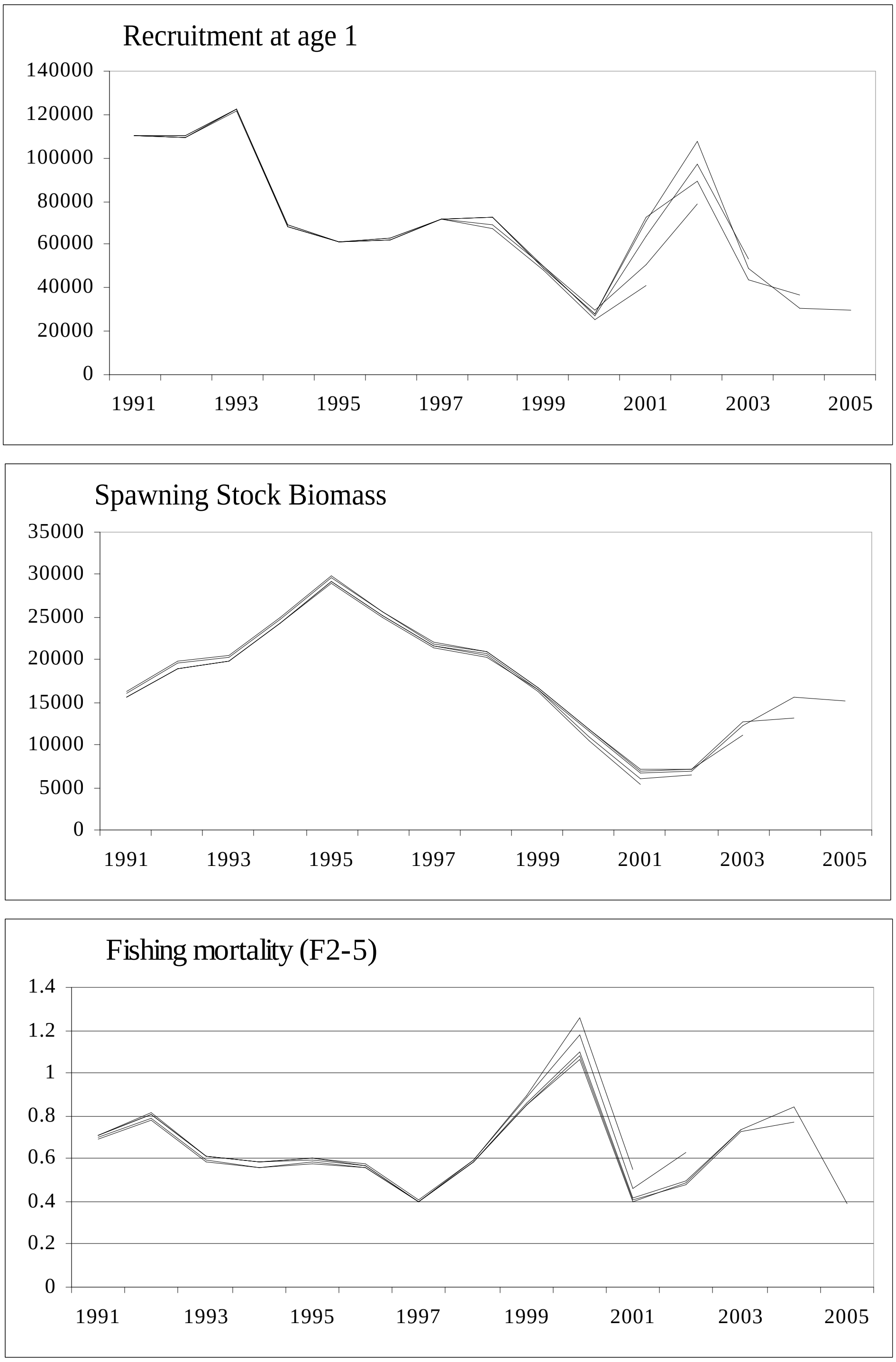


Figure 4.2.41. Haddock VIb. Retrospective analyses (F shrinkage 1.0)

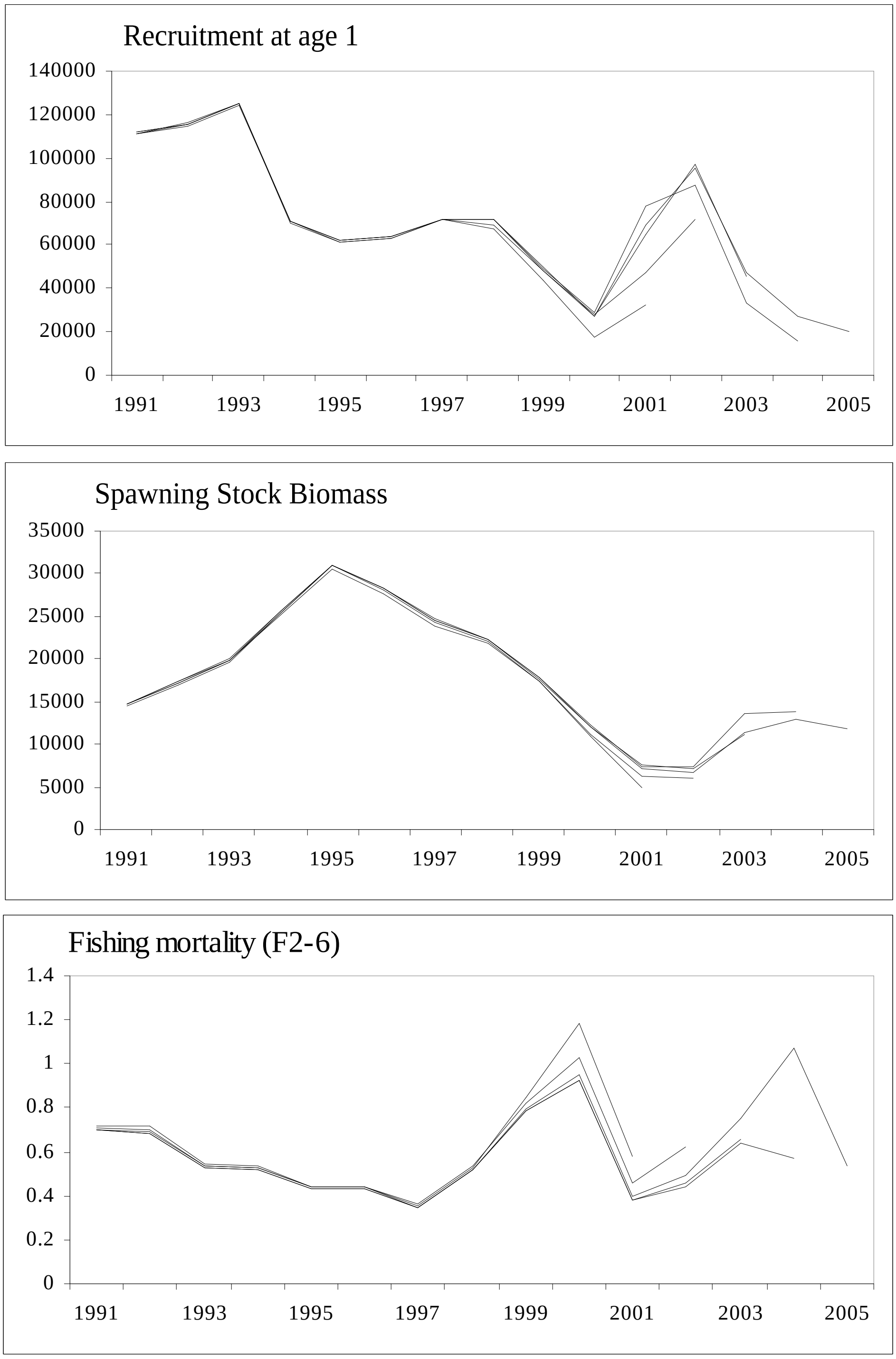


Figure 4.2.42. Haddock VIb. Retrospective analyses (F shrinkage 0.5)

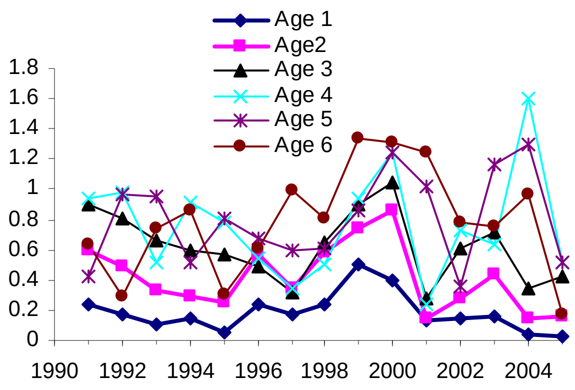


Figure 4.2.43. Haddock VIb. F at age (F shrinkage 1.0)

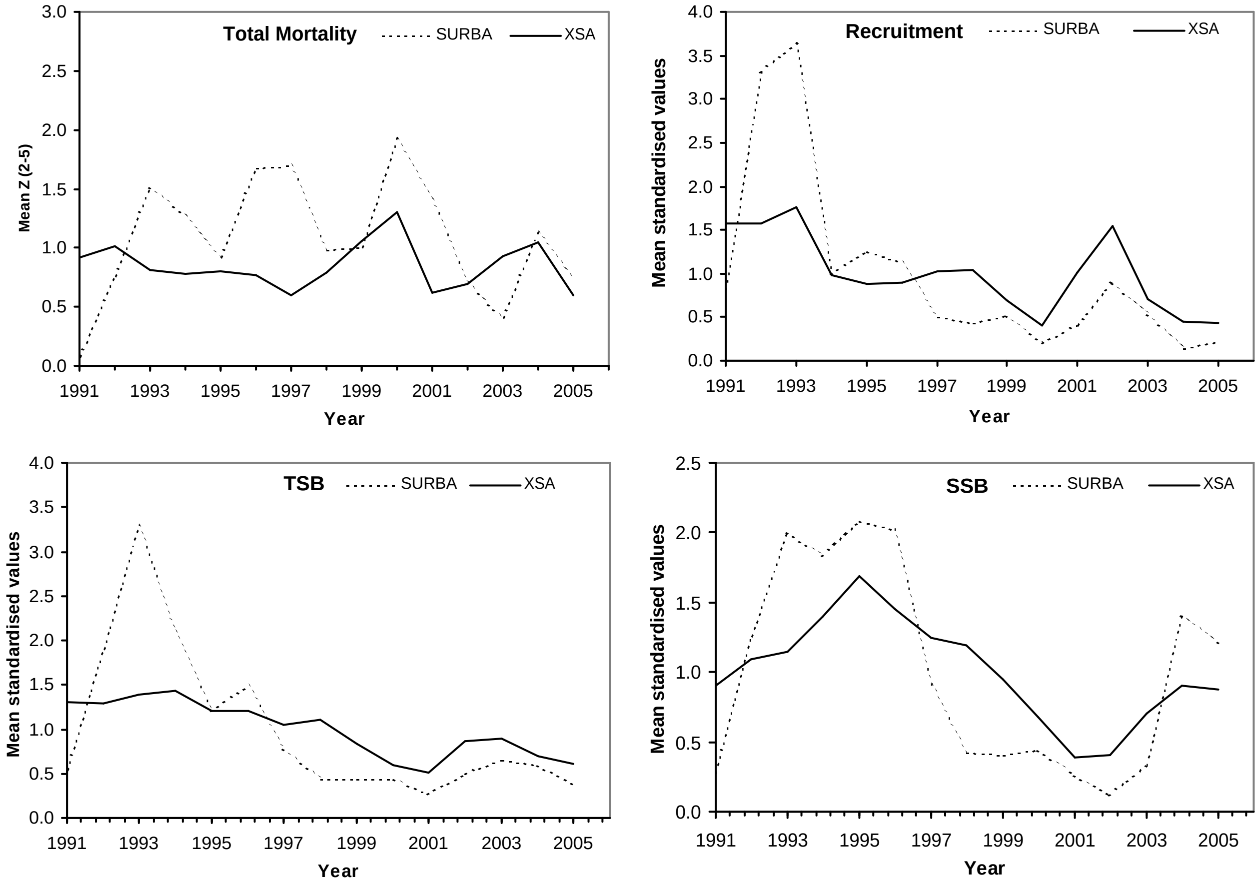


Figure 4.2.44. Haddock VIb. XSA and SURBA analysis.

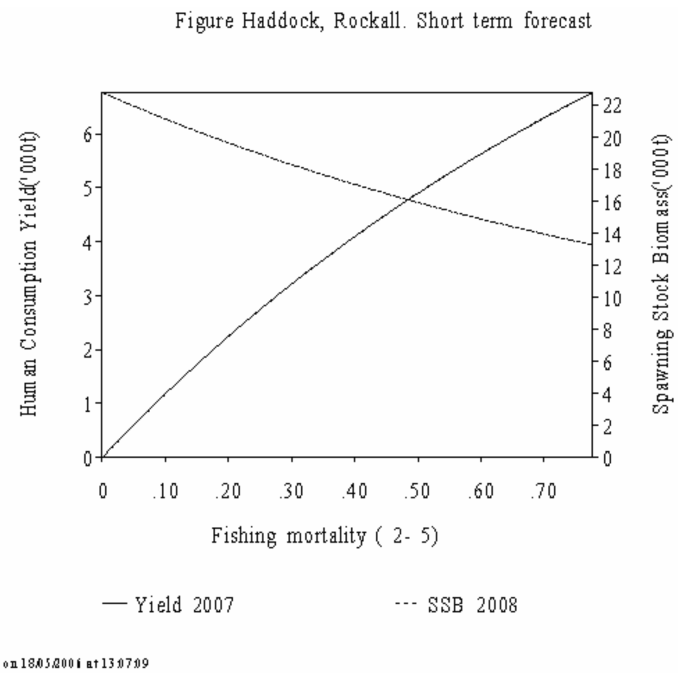


Figure 4.2.45. Haddock VIb. Short term forecast.

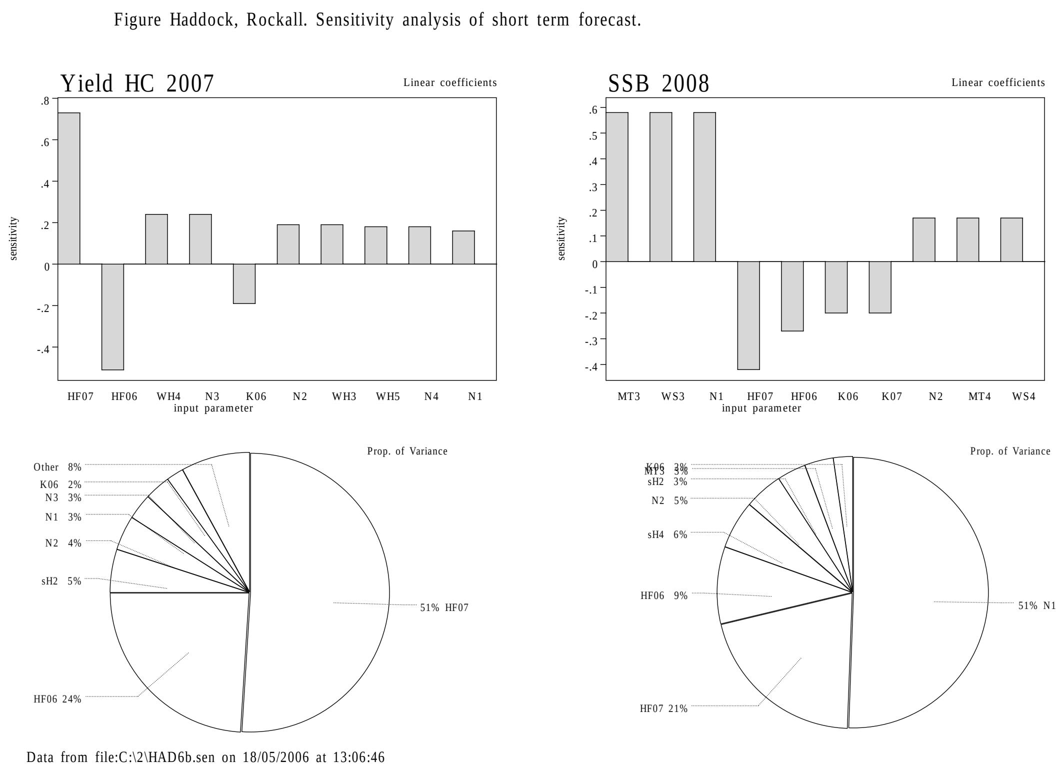


Figure 4.2.46. Haddock VIb. Delta plots from selectivity analysis

Figure 4

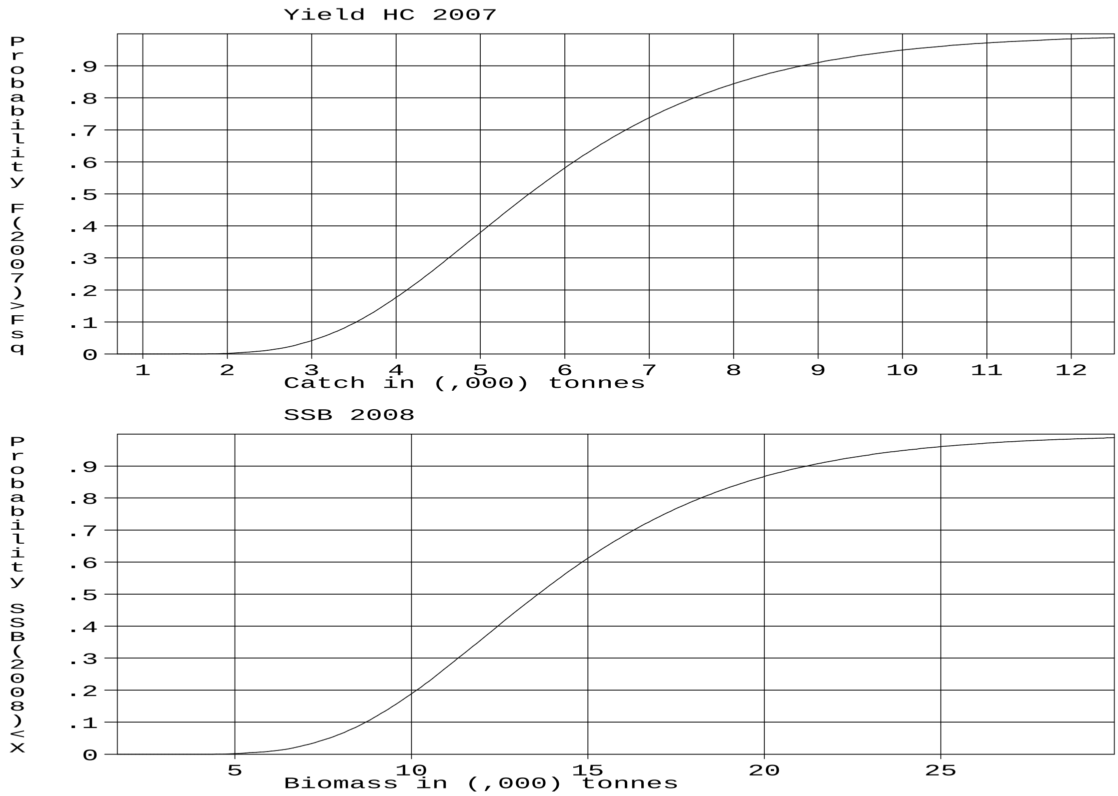


Figure 4.2.47. Haddock VIb. Probability plots for yield in 2007 and SSB in 2008.

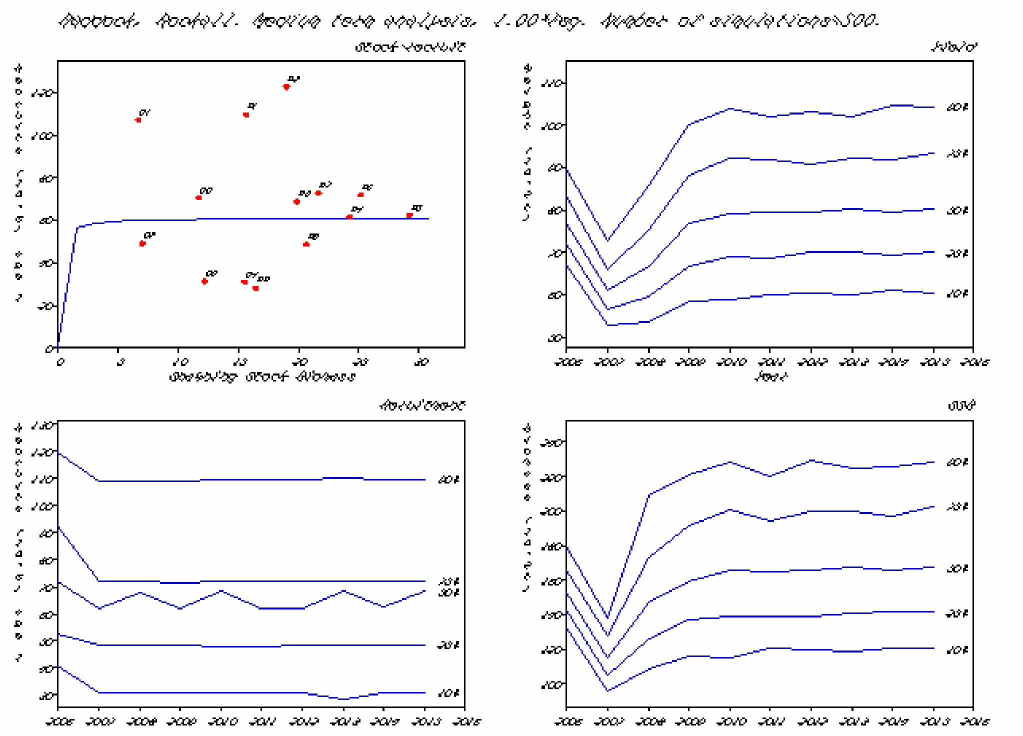


Figure 4.2.48. Haddock VIb. Medium term analysis.

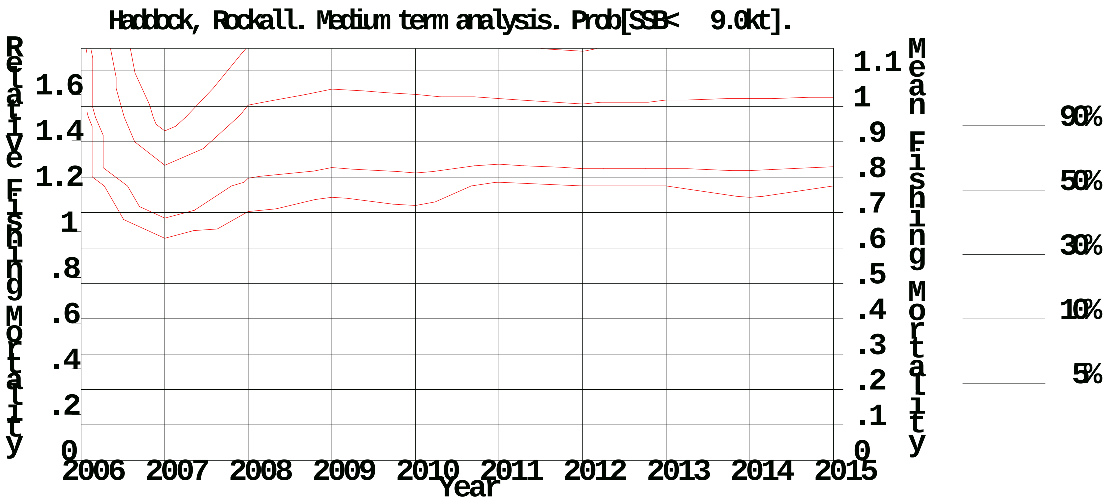


Figure 4.2.49. Haddock VIb. Medium term analysis.

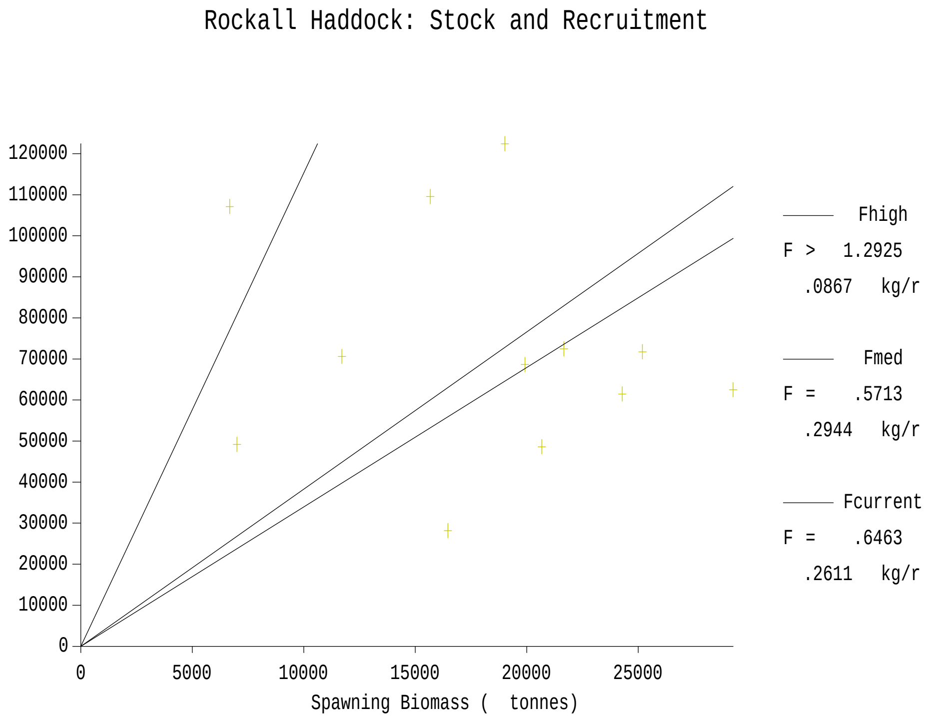


Figure 4.2.50. Haddock VIb. Stock and Recruit.

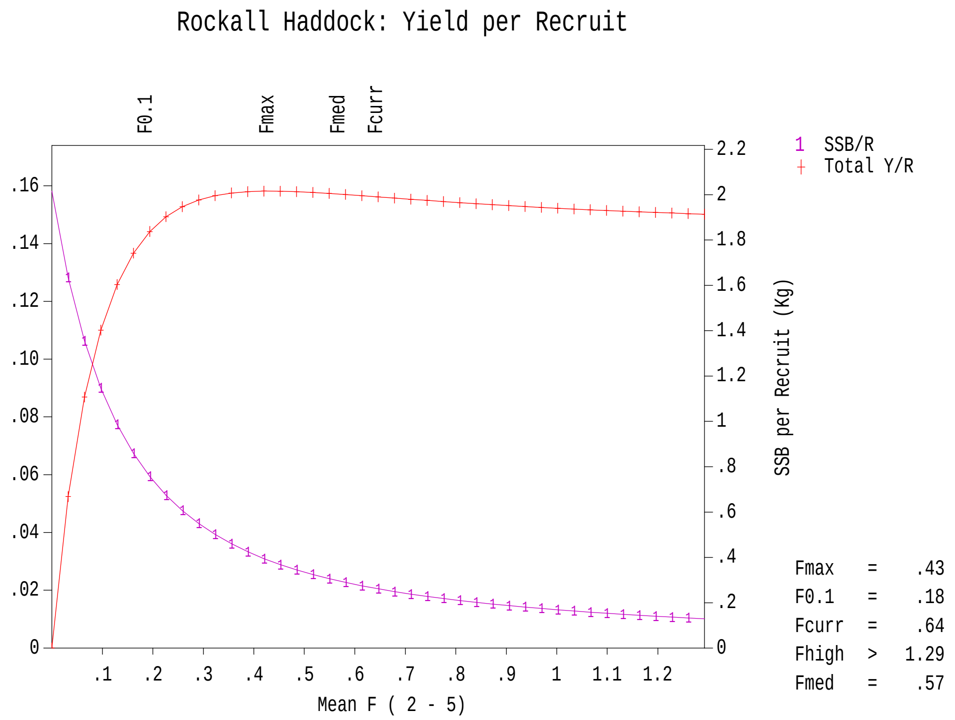


Figure 4.2.51. Haddock VIb. Yield per Recruit.

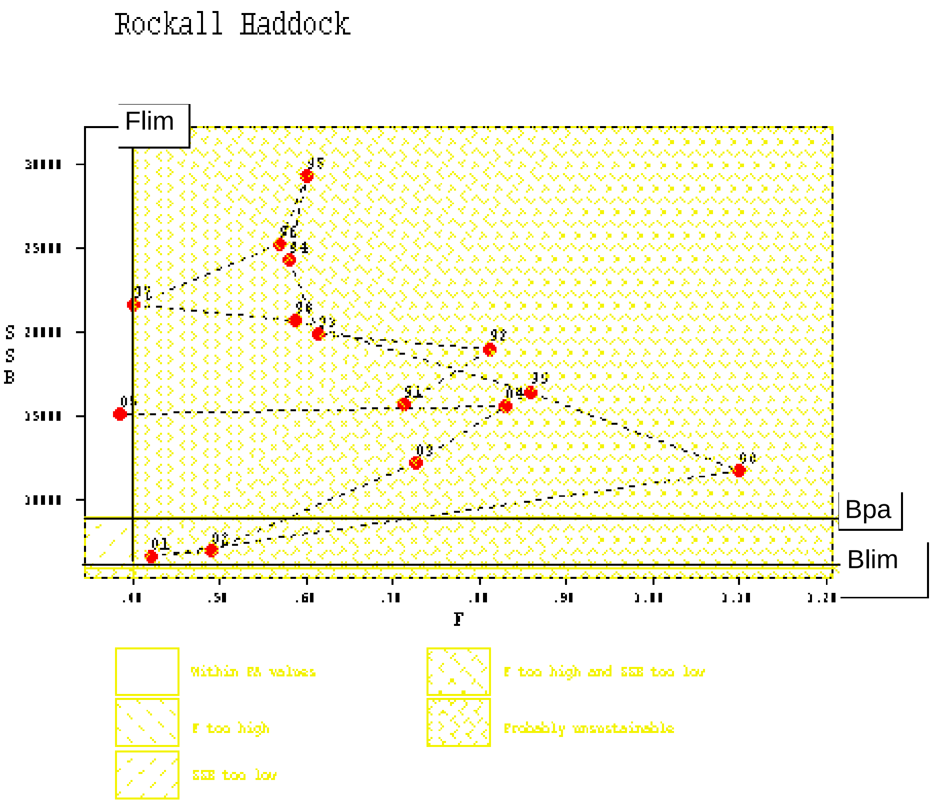


Figure 4.2.52. Haddock VIb. Biological reference points.

5 WHITING IN SUB-AREA VI

5.1 Whiting in Division VIa

The ACFM review group of $WGNSDS_{05}$ (RGNSDS) commented on the various data problems associated with this stock: including noisy survey and discard data which need to be re-worked. Their recommendation therefore was that:

- The next assessment in 2006 should be classified as experimental and as such, would not require a repeat of a catch-at-age analysis.

5.1.1 Stock definition and the fishery

General information is now located in the stock annex.

5.1.1.1 ICES advice applicable to 2005 and 2006

The advice in 2004 for the fishery in 2005 (Single Stock Exploitation Boundaries) was as follows:

"Survey and catch at age data are inconsistent, indicating substantial unaccounted removals. Based on the survey data the stock is at a low level similar to the one in the early 1990s but official catches are now much lower than during this period; however, the exact catch level is not known. Exploitation should not be allowed to increase. Lacking the link between fishing mortality and the TAC, the best approximation is that the 2005 TAC should not be more than that agreed (1,600t) for 2004."

In 2005, the ICES advice for 2006 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
"There will be no gain in the long-term yield by having fishing mortalities above $\mathbf{F}_{max}$ (0.23). Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits."

Exploitation boundaries in relation to precautionary limits
"Catches in 2006 should be reduced to the lowest possible level. Survey and catch-at-age data are inconsistent, indicating substantial unaccounted removals. Based on the survey data the stock is at a low level similar to the one in the early 1990s but official catches are now much lower than during this period; however, the exact catch level is not known."

Mixed fisheries advice for 2006:

"Demersal fisheries in Subarea VI should in 2006 be managed according to the following rules, which should be applied simultaneously. They should fish:

- without catch or discards of cod in Subarea VI;
- without catch or discards of spurdog;
- no directed fishery for haddock in Division VIb;
- concerning deep water stocks fished in Subarea VI, Volume 10;
- within the biological exploitation limits for all other stocks.

Furthermore, unless ways can be found to harvest species caught in mixed fisheries within precautionary limits for all those species individually then fishing should not be permitted."

5.1.1.2 Management applicable

The following table summarises ICES advice and actual management applicable for whiting in Division VIa during 2001–2006:

YEAR	SINGLE SPECIES EXPLOITATION	BASIS FOR SINGLE SPECIES	TAC FOR VB, VI, XII, XIV (TONNES)	% CHANGE IN F ASSOCIATED WITH TAC[1]
2001	< 4,200	Reduce F below F_{pa}	4,000	-40%
2002	< 2,000	SSB > B_{pa} in short term	3,500	-40%
2003	-	SSB > B_{pa} in short term	2,000	-60%
2004	-	SSB > B_{pa} in 2005	1,600	(no assessment)
2005	-	-	1,600	(assessment in relative trends only)
2006	-	-	1,360	

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

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

5.1.1.3 The fishery in 2005

Tables and figures of total effort by the fleets operating in Division VIa can be found in Section 17.

Reported effort in the Scottish light trawl fleet has declined rapidly from 35,698h in 2001 to 3063h in 2005. The Scottish seine fleet reported declines in effort too and the 2005 figure (476h) is by far the lowest in the series . The Scottish *Nephrops* fleets reported a more gradual decline in effort with 221,000h recorded in 2005 as opposed to 230,000h in 2004. Due to Scottish reporting problems, however, these effort data may be underestimates.

Information on the number of vessels operating in the cod recovery zone to have been decommissioned in Division VIa was available at this working group for the Scottish fleet between 2001 and 2004, as follows:

	TOTAL VIA 2001	DECOMM. TO 2004	PERCENTAGE
Number of vessels > 10m	298	96	30.2%

The effect that this decommissioning has had on actual fishing effort is difficult to quantify as it will depend on the size and power of the boats which have been taken out of the fishery.

5.1.2 Catch data

5.1.2.1 Official catch statistics

Total officially reported landings in 2005 were 175 t (Table 5.1) compared to 820 t in 2004. This reduction is due to the combination of greatly reduced UK landings, but also missing Irish landings in 2005. Minor revisions have been made to the officially reported landings prior to 2005. The total estimated international catch (including discards) in 2005 was approximately 1200 t of which almost 900t were discards (Table 5.2). The downward trend in reported landings and estimated catch is continuing with the 2005 values being the lowest in the time series.

Mandatory increases in mesh size to 120mm for vessels fishing in the mixed demersal fishery to the West of Scotland may account partly for the decline in landings of whiting.

5.1.2.2 Quality of catch data

There have been concerns that the quality of landings data is deteriorating, giving a possible reason for the different stock dynamics implied by the commercial fleet and the annual survey (ScoGFS) used in recent years, (see section 5.1.6.1.3 in last year's report).

5.1.3 Commercial catch-effort data and research vessel surveys

Four commercial catch-effort data series were available for the assessment period, uncorrected for changes in fishing power and incorporating discard estimates from the Scottish sampling program. As noted in the report of the WGNSSK for 2000 (ICES CM 2001/ACFM:07), the 1999 effort data for the Scottish commercial fleets are not consistent with the historical series. This problem persists through to 2005. Although the reporting and collation methodology was updated during 2001, future CPUE indices from the Scottish commercial fleet may not be useable as effort reporting in terms of hours fished is still not mandatory. Therefore commercial CPUE data are not used in this assessment. They are presented here for completeness:

- 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); ages1-7,years 1995-2005.

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

- Scottish west coast groundfish survey (ScoGFSQ1): ages 1–7, years 1985-2006.
- Irish west coast groundfish survey (IreGFS): ages 0–5, year 1993-2002.
- Scottish fourth-quarter west coast groundfish survey (ScoGFSQ4): ages 0–8, years 1996–2005.
- Irish groundfish survey (IRGFS): ages 0-6; years 2003-2005

For the ScoGFS survey, 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 a comparatively short series, was discontinued in 2003 and has been replaced. The replacement survey (IRGFS) has only been running for three years and is not yet suitable for tuning. The Scottish quarter four survey was presented for the first time to WGNSDS_{2005}.

The survey series are described in Appendix 1 and the commercial fleets in Appendix 2 of the report for the 1999 meeting of the Working Group (ICES CM 2000/ACFM:1). For all survey series, the oldest age given represents a true age, rather than a plus group. The effort series for both commercial and survey tuning fleets are shown in Table 5.3.

5.1.4 Age composition and mean weights at age

Annual numbers at age in the total catch are given in Table 5.6. Annual mean weights-at-age in the total catch are given in Table 5.9. As in previous meetings, the catch mean weights-at-age were also used as stock mean weights-at-age (see stock annex).

5.1.4.1 Landings age composition and mean weights-at-age

Details on nations which supply data are given in Table 2.2. Sampling levels are shown in Table 2.3. Age distributions were estimated from market samples, with additional samples for age determination collected during research vessel surveys. Annual numbers at age in the landings are given in Table 5.4. Annual mean weights-at-age in the landings are given in Table 5.7 and shown in Figure 5.1

5.1.4.2 Discards age composition

Annual numbers at age in the discards are given in Table 5.5 Annual mean weights-at-age in the discards are given in Table 5.8 and shown in Figure 5.1.

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). Historically discard age compositions from Scottish sampling have been applied to unsampled fleets. The revision of the Irish discard data and the provision of a time series will require that the time series of discard estimates is recalculated. 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. A working document set out the methodology of this work at $WGNSDS_{2004}$.

5.1.5 Natural mortality and maturity at age

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 meeting. As last year, the proportion mature before spawning and the proportion fished before spawning, are both set to be zero.

5.1.6 Survey based assessment

5.1.6.1 Data screening and exploratory runs

5.1.6.1.1 Commercial catch data

The year range previously used for catch-at-age analyses for this stock is from 1978 onwards, because independent discard estimates for the pre-1978 period are not available. Owing to uncertainties in catch at age data the WG only used commercial catch data to provide stock weights at age for this year’s assessment.

5.1.6.1.2 Survey data

Of the four survey series available, only the 2 Scottish surveys were considered further. The new Irish survey (IRGFS) is currently too short (3 years data) to give any useful information on stock trends while the Irish west coast grounfish survey (IreGFS) has been discontinued. In addition, the sub-sampling protocol of the IreGFS was altered mid-way through the survey and therefore there are doubts about the consistency of this series. These two series were therefore not considered further.

Scatterplots of the raw indices of one survey against each other (ScoGFSQ1 & ScoGFSQ4) show positive correlations in all cases (Figure 5.2). For age 1 and age 4 there is relatively good correlation, but, for some of the other age classes particularly ages 2, 3 and 6 there are a number of outliers.

Log mean-standardised survey indices by year class and by year, and scatter-plots of indices within year classes are shown in Figure 5.3, Figure 5.4 and Figure 5.5. The year-class plots for both are quite noisy and the ability of these surveys to reliably track year class strength is uncertain. There is some evidence that individual year-classes have been picked up well by both surveys (for example 1999), but this does not occur consistently over the survey period. In addition some of the correlations for the older ages in the ScoGFSQ1 scatterplot are negative, while the confidence bounds for the equivalent plots of the ScoGFSQ4 survey are very wide. Age 0 in ScoGFSQ4 appears to be a particularly poor measure of year-class strength (some negative correlations and wide confidence intervals) and is therefore excluded in further analysis of this survey. There are no marked year effects.

The log catch curves for these surveys are shown in Figure 5.6. The curves for both ScoGFSQ1 and ScoGFSQ4 are relatively linear and not very noisy, and show a fairly steep and consistent drop in abundance.

5.1.6.1.3 Exploratory assessment runs

The trawl survey data (ScoGFSQ1 and ScoGFSQ4) for West of Scotland whiting was extensively analysed by last year's WGNSDS 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. The SURBA 3.0 runs this year therefore used the model settings that were chosen in last year's final comparison runs which were:

- ScoGFSQ1: lambda=1, equal catchabilities at age, ages 1-6, all available years
- ScoGFSQ4: lambda=1, equal catchabilities at age, ages 1-5, all available years

The summary output of mean Z (2-5), recruitment and biomass from the SURBA 3 run for ScoGFSQ1 is shown in Figure 5.7 with the residuals illustrated in Figure 5.8. Model residuals, although large for some age classes in some years, do not show any particular trends or non-randomness. No retrospective bias is apparent in the stock trends although the estimates for recruitment show some variability (Figure 5.9). The peculiar estimates of total mortality in the final year are a result of the estimation procedure used in SURBA: final year estimates of Z are assumed to be equal to the mean of the previous 3 years. Therefore if there is an increasing trend in mortality, the final year value is always lower than the year before and vice-versa for decreasing trend in mortality.

The WG also attempted to apply the SURBA model to the ScoGFSQ4 survey. However, all attempts to fit the model (using alternative catchability assumptions, weightings, lambdas) gave very poor convergence and consequently unreliable estimated stock trends. The ScoGFSQ4 survey is a relatively short time series (in comparison to ScoGFSQ1) without particular good internal consistency (See section 5.1.6.2) and this may be the reason why SURBA has difficulty finding an optimum model fit. The ScoGFSQ4 was therefore not considered further in this assessment.

5.1.6.2 Final assessment run

The SURBA 3 run using ScoGFSQ1 data for ages 1-6 was chosen as the final assessment model. The SURBA model settings for the final run are given below:

Year range:	1985-2006
Age range:	1-6
Catchability at age:	1.0, 1.0, 1.0, 1.0, 1.0, 1.0
Age weighting:	1.0, 1.0, 1.0, 1.0, 1.0, 1.0
Lambda:	1.0

The output file from this run is given in Table 5.10 Trends in Z, recruitment and SSB from this run are shown in Figure 5.10 with empirical estimates from the surveys included for comparison. The empirical results highlight the level of noise in the raw survey indices. For mean Z and SSB the general agreement between the empirical estimate and the model result is good. The level of SSB estimated in 2006 is the lowest in the time series and recruitment is also estimated to have fallen in recent years following a short period of enhanced recruitment. The level of mean Z is higher in the second half of the time period than the first and appears to be increasing.

Residuals from the final assessment run and retrospective plots are shown in Figure 5.8 and Figure 5.9 and are discussed in section 5.1.6.3.

5.1.6.3 Comparison with last year's assessment

The survey based assessment presented this year uses SURBA 3.0 with a single survey fleet and has the same settings as that presented last year. A comparison of this year and last year's assessments is available on the retrospective plot in Figure 5.9. In previous years, assessments based on commercial catch-at-age composition have been presented but these were not repeated this year.

5.1.6.4 Long-term trends in biomass, fishing mortality and recruitment

Considering Figure 5.10, the SSB for whiting in VIa appears to have reached an all time low. During the time period over which the survey data are available there was an apparent period of higher abundance and relatively lower mortality during the mid 1990s, since when SSB has gradually been declined and mortality increased. Recruitment for VIa whiting appears quite variable. There was a period from 1992-2000 showing higher recruitment values, but current estimates indicate that recruitment has been low in the two most recent years.

The mean standardised plot of mean Z shows mean Z to be higher in the last decade than in the preceding one.

5.1.7 Short-term stock predictions

No short-term predictions were made by this WG.

5.1.8 Medium-term predictions

Stochastic medium term predictions were not made at this WG.

5.1.9 Yield and biomass per recruit

No catch-based assessment was presented at the WG this year and the previous TSA assessment presented in 2004 was not accepted as the basis for advice. Therefore no yield and biomass per recruit analyses were conducted at this meeting.

5.1.10 Reference points

ICES's PA reference points are:

$\mathbf{F}_{\mathrm{lim}}$ = 1.00; $\mathbf{F}_{\mathrm{pa}}$ = 0.60; $\mathbf{B}_{\mathrm{lim}}$ = 16,000t; $\mathbf{B}_{\mathrm{pa}}$ = 22,000t

5.1.11 Quality of the assessment

Landings

In the recent past, 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. Furthermore, both TSA and XSA are strongly influenced by catch data. Thus a survey based assessment was used.

Effort

Commercial effort data for Division VIa in terms of hours fished is considered very uncertain and was not used in the assessment.

Discards

Discard estimates are used in the assessment of this stock, derived from Scottish and Irish sampling programmes. There are currently problems with the Scottish sampling design which is significantly over-stratified. Work on the development of a new Scottish estimate-collation scheme has been completed for Area VI and work is underway on Area IV. Once completed a full revision of the Scottish discard data will be carried out and consideration given to redesign of the sampling scheme.

Surveys

The survey used for this assessment changed vessel and tow duration in 1999. Although a correction has been made for this using comparative tows there will be an additional variance associated with this correction factor which will affect the survey series indices. The raw survey indices do not show good internal consistency as tracking of year classes is poor. Whether this is related to relatively limited dynamic range of year classes or simply a function of survey design or age estimation problems is worthy of further investigations.

Model formulation

Despite the noise in the survey data the temporal trends of Z in this stock are quite robust to the SURBA model assumptions which were explored extensively at this WG last year. For this and other stocks, measures of mean SSB and recruitment have shown themselves to be robust to SURBA model assumptions.

5.1.12 Management considerations

Recruitment during the 1990's appears to have been high while more recently recruitment has been below average.

This year's assessment shows SSB to be at its lowest value over the 20 years in the assessment. The increasing trend in total mortality seen in last year's assessment has also continued and is now at its highest estimated value. The perception of the state of this stock (as estimated from this assessment) appears to have changed very little 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 (see section 15). 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 120mm.

Whiting are also caught and heavily discarded in small meshed fisheries for Nephrops. 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.

5.2 Whiting in Division VIb

Officially reported catches are given in Table 5.11.

Table 5.1. Nominal catch (t) of WHITING in Division VIa, 1989–2005, as officially reported to ICES.

COUNTRY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005[1]
Belgium	1	-	+	-	+	+	+	-	1	1	+	+	-		-		
Denmark	1	+	3	1	1	+	+	+	+	-	-	-	-		0	0	
France	199[1,2]	180	352[1,2]	105	149	191	362	202	108	82	300	48	52	21	11	6	6
Germany	+	+	+	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	
Netherlands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Spain	-	-	-	-	-	-	1	-	1	2	+	-	2	n/a	n/a		
UK (E&W)[3]	44	50	218	196	184	233	204	237	453	251	210	104	71	73	35	13	
UK (N.I.)	…	…	…	…	…	…	…	…	…	…	…	…	…	…	…		
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	
UK (total)																	169
Total landings	7,669	6,026	6,908	6,010	6,751	5,786	6,278	6,642	6,178	4,657	4,677	3,203	2,543	1,735	1,365	819	175

[1]Preliminary.

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

[3]1989–2001 N. Ireland included with England and Wales.

n/a = Not available.

Table 5.2. Whiting in Division VIa. Annual weight and numbers caught, years 1978–2005.

YEAR	WEIGHT (TONNES)			NUMBERS (THOUSANDS)		
	Total	Human consumption	Discards	Total	Human consumption	Discards
1978	20452	14677	5775	93931	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	23135	11352	11784	141314	40681	100633
1989	11598	7531	4068	54634	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	68350	23246	45105
1994	14771	5901	8870	87881	20060	67821
1995	13657	6076	7581	77932	18763	59169
1996	14057	7156	6902	71396	22329	49067
1997	11193	6285	4907	50459	19250	31209
1998	10476	4631	5845	56583	14387	42196
1999	7734	4613	3121	38260	15970	22290
2000	9714	3010	6705	78815	10118	68697
2001	4850	2438	2412	20803	8477	12325
2002	3848	1709	2120	25179	5765	19414
2003	2936	1356	1580	15403	4124	11279
2004	3437	811	2626	21749	2571	19178
2005	1239	341	898	6153	1051	5103
Min	1239	341	898	6153	1051	5103
GM	11273	5901	4750	56653	19957	32653
AM	13551	8013	5537	67635	27491	40144
Max	24118	17081	11784	141314	61393	100633

Table 5.3. Whiting in VIa. Available catch-effort and survey tuning series.

ScoLTR : Scottish light trawl - Effort in hours - numbers at age (thousands)							
1965	2005						
1	1	0	1				
1	7						
37387	2012	469	3513	393	15	5	1
40538	1036	926	163	5508	333	33	6
80916	2540	4968	1637	101	2457	134	12
65348	1931	3404	1868	677	51	844	59
106856	47	8823	2212	578	279	28	517
129741	95	5276	8515	713	143	36	3
137728	1567	4472	1027	9818	338	63	25
154288	13451	4637	1716	335	5435	310	30
93992	4614	12778	680	149	43	479	39
88651	7453	15917	1774	159	17	6	79
132353	10598	6685	10432	837	80	12	3
139225	10858	15482	3551	5483	413	13	5
143574	18222	4277	5983	773	1127	75	2
127387	9805	5888	1562	1815	128	244	4
99803	1846	9530	2447	368	291	32	57
121211	1857	4385	4359	1053	171	172	11
165002	983	13544	4618	1331	505	153	63
135280	8249	2593	10935	1900	317	75	62
112332	4809	4323	2549	8292	1696	254	54
132217	29865	4084	2582	1150	5207	593	221
142815	9244	11578	2515	664	361	918	83
126533	3187	6006	2694	622	98	51	94
131720	12328	6005	2767	1229	148	43	32
158191	5359	15325	2988	1334	317	47	3
217443	3161	1641	5226	1473	435	130	14
169667	4110	4152	972	1381	387	51	6
209901	7019	2968	3982	337	423	73	6
189288	9762	6549	1727	2100	114	102	11
189925	2624	10106	4393	1170	1702	52	47
174879	3251	6504	5364	1740	334	292	14
175631	1776	5662	5311	1995	569	114	108
214159	2738	8044	4648	2543	833	213	24
179605	3107	3974	5099	1859	533	95	39
142457	3998	3171	2548	2328	655	150	80
98993	560	3274	1709	815	793	122	35
76157	4363	2325	2203	627	170	202	9
35698	575	2604	1359	783	118	38	5
15174	390	848	1566	375	167	17	5
9357	565	208	273	578	100	42	0
7116	1770	1216	243	200	221	28	3
3063	218	400	269	23	27	14	2

(cont) Whiting in VIa. Available catch-effort and survey tuning series.

ScoSEI: Scottish seine - Effort in hours - numbers at age (thousands)							
1965	2005						
1	1	0	1				
1	6						
153103	8571	4535	19454	1413	62	15	
156511	2872	12671	1491	13028	736	68	
158208	7059	23605	5805	363	5529	305	
150094	11818	14129	4897	1410	135	1651	
140718	1314	19167	4024	1039	421	45	
95629	979	2065	9178	816	177	51	
98748	3281	6459	2467	14808	484	73	
70741	20564	7287	1144	589	3139	113	
59596	16428	16410	1995	373	97	886	
56448	8764	28089	3578	289	22	9	
56420	15931	9162	13094	585	38	9	
57090	7559	30719	6226	4888	284	18	
41920	14523	4874	6784	584	1036	43	
33599	9881	4708	812	1086	66	152	
38465	3779	13497	3740	473	392	16	
38700	2223	3686	4278	1081	273	119	
37208	790	9230	3128	1025	427	90	
36689	1146	1977	9664	1184	230	68	
38080	3804	3110	1943	5805	1182	138	
29561	3966	2170	1220	382	2025	219	
26365	18814	6473	1249	328	171	557	
19960	1424	4902	1816	359	54	25	
26332	8665	3706	2069	917	142	19	
21383	7392	8211	1658	1079	218	22	
39350	2182	1845	4489	1283	272	187	
27664	2699	2964	688	941	280	35	
25787	4160	2319	3286	306	291	53	
20273	7514	5371	1342	1623	102	101	
24315	1510	6046	2292	675	789	23	
21305	1725	3311	2499	701	108	140	
21950	722	2616	2261	970	299	83	
15205	1270	2354	1372	820	297	68	
11449	1096	1273	1933	696	187	34	
11166	4251	1659	1010	614	266	62	
8638	823	2152	707	295	179	43	
6431	2601	888	756	153	67	20	
5893	729	1007	454	241	40	22	
3817	336	583	482	132	41	3	
2370	3130	261	133	290	35	9	
1173	7323	759	165	83	77	2	
476	676	225	143	10	15	3	

(cont) Whiting in VIa. Available catch-effort and survey tuning series.

ScoNTR: Scottish nephrops trawl - Effort in hours - numbers at age (thousands)						
1965	2005					
1	1	0	1			
1	6					
101975	1660	454	1101	102	5	1
116972	614	952	155	786	45	4
135811	1789	2003	444	16	323	18
166713	1761	1850	637	159	13	191
155131	737	2707	437	155	44	4
144704	439	645	1379	128	32	13
127638	1072	444	236	1406	60	11
185397	3745	1909	232	71	730	46
186342	3463	5445	487	168	25	351
186342	1934	5428	650	87	12	4
203053	5917	2730	2847	319	35	9
224347	4061	4343	894	1143	125	4
196403	3574	1394	1431	168	290	17
219562	6053	2596	418	571	110	109
273713	660	3413	935	207	217	39
254147	1439	1529	1378	282	45	46
286461	1091	5251	1199	431	105	21
288902	2882	422	2553	440	96	55
293396	2703	1290	465	1258	206	48
312947	15763	731	415	133	871	85
384215	14885	3109	505	226	91	275
368971	2231	1259	708	246	9	23
395355	12049	1562	799	376	44	3
397682	19927	12752	540	138	32	1
379169	9855	485	444	152	72	13
390391	7435	1408	59	64	9	1
414817	13746	1280	295	27	44	5
391325	15245	3122	453	212	20	30
406753	6064	2833	611	159	113	2
380688	22785	4821	2175	613	18	26
333756	14759	5645	494	363	33	45
345007	14700	1317	634	193	44	25
354884	7854	1894	387	177	17	1
350882	13269	1926	620	117	63	3
337585	7208	1906	476	93	81	24
332659	31208	935	360	101	29	11
305743	1743	1272	189	80	15	15
258169	7282	1291	483	30	9	1
255729	4468	586	192	198	42	3
232356	3881	1311	240	158	102	6
220936	1739	830	258	41	17	8

(cont) Whiting in VIa. Available catch-effort and survey tuning series. For ScoGFSQ1, numbers are standardised to catch-rate per 10 hours. "+" indicates value less than 0.5 after standardising. For IreGFS, effort is given as minutes towed, numbers are in units.

SCOGFSQ1 : SOTTISH GROUNDFISH SURVEY - EFFORT IN HOURS - NUMBERS AT AGE - YEAR							
1985	2006						
1	1	0	0.25				
1	7						
10	3140	1792	380	85	23	156	18
10	1456	1526	403	68	10	9	10
10	6938	1054	584	143	36	2	1
10	567	3469	653	189	42	5	1
10	910	505	586	237	48	3	0
10	1818	572	122	216	61	4	1
10	3203	277	298	22	39	9	1
10	4777	1597	410	517	56	18	0
10	5532	6829	644	91	30	11	2
10	6614	2443	1487	174	56	15	6
10	5598	2831	1160	370	70	17	32
10	9384	2238	635	341	135	30	5
10	5663	2444	1531	355	102	17	4
10	9851	1352	294	195	50	14	1
10	6264	5065	500	105	16	1	0.5
10	13148	481	155	35	10	12	0
10	4653	1954	242	41	8	1	1
10	5542	1028	964	86	15	1	1
10	6934	746	436	300	32	2	4
10	5888	1566	189	131	44	9	1
10	1308	723	183	35	8	11	2
10	1441	466	282	77	+	3	+
IreGFS : Irish groundfish survey - Effort in minutes - numbers at age - Year							
1993	2002						
1	1	0.75	0.79				
0	5						
1849	14403	32643	11419	1464	231	13	
1610	264	11969	4817	2812	78	57	
1826	34584	5609	6406	734	186	80	
1765	376	7457	3551	374	232	5	
1581	1550	13865	8207	1022	524	50	
1639	1829	4077	3361	663	121	5	
1564	3337	3059	1965	322	11	12	
1556	682	10102	2126	109	109	4	
755	1118	5201	2903	149	70	3	
798	594	8247	9348	820	280	0	

Irish Groundfish survey 2003-2005. For IRGFS, numbers are standardized to catch rate per hour.

IRGFS: IRISH GROUNDFISH SURVEY – EFFORT IN MINUTES – NUMBERS AT AGE							
2003	2005						
1	1	0.79	0.92				
0	6						
1127	1101	12886	2894	512	290	102	1
1200	6924	3114	1312	104	35	16	1
960	910	2228	1126	91	5	4	0

(cont). Whiting in VIa. Irish Otter Trawl. Available catch-effort and survey tuning series. For IreOTB effort is given as reported hours fished per year, numbers landed are in thousands.

IREOTB : IRISH OTTER TRAWL - EFFORT IN HOURS - NUMBERS AT AGE (THOUSANDS) - YEAR								
1995	2005							
1	1	0	1					
1	7							
56335	222	298	530	461	92	28	98	1995
60709	165	531	670	281	175	33	12	1996
62698	99	358	515	282	339	133	89	1997
57403	51	1092	552	312	186	218	232	1998
53192	98	315	437	266	198	109	123	1999
46913	50	131	188	303	158	76	65	2000
48358	14	304	144	101	126	100	44	2001
37231	31	162	388	27	65	97	47	2002
39803	90	294	604	492	131	30	0	2003
35140	33	387	266	245	200	28	21	2004
30941	23	159	188	78	41	19	2	2005

(cont). Whiting in VIa. Available catch-effort and survey tuning series. For ScoGFSQ4, numbers are standardised to catch-rate per 10 hours. "+" indicates value less than 0.5 after standardising.

SCOGFSQ4 : QUARTER FOUR SCOTTISH GROUNDFISH SURVEY - EFFORT IN HOURS - NUMBERS AT AGE									
1996	2005								
1	1	0.75	1.0						
0	8								
10	5154	1908	1116	570	188	51	6	1	0
10	8001	2869	951	323	160	46	12	1	0
10	1852	2713	1124	149	100	20	1	0	+
10	8203	2338	582	141	33	24	1	1	0
10	4434	4055	789	160	9	7	1	0	0
10	9615	1957	1420	155	40	12	2	0	0
10	14658	1591	621	479	30	9	5	0	0
10	9932	3446	567	338	83	27	4	0	0
10	5923	1758	940	83	57	62	1	0	0
10	2297	308	318	76	9	4	0	0	0

Table 5.4. Whiting in Division VIa. Landings at age (thousands)

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

Table 5.5. Whiting in Division VIa. Discards at age (thousands).

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	17205	4322	12237	16394	1983	1776	5505	39192	30521	23101
2	4968	8946	20791	12612	20494	6704	6719	8930	26995	40590
3	11437	515	2674	2137	2093	7494	969	850	1225	2362
4	531	3317	84	377	292	382	3906	152	147	123
5	14	79	629	13	51	33	57	610	14	7
6	2	3	12	82	2	4	4	14	77	1
7+	0	0	1	3	26	0	1	1	2	7
	1975	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**
1	37295	24891	48148	27942	3450	2376	1017	17837	15069	68241
2	13541	35812	8675	10505	10722	6172	22014	4577	8173	3951
3	8485	3360	5432	889	1619	3206	2763	15938	1964	1085
4	310	1940	301	206	533	651	148	1189	4271	572
5	12	63	212	1	76	156	101	55	176	1577
6	1	1	5	20	0	9	4	1	102	59
7+	0	0	0	0	0	0	0	0	0	4
	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
1	59783	10459	46876	46421	17778	16406	30355	46463	14618	39697
2	17426	20085	13689	51395	3660	5791	2874	15041	22281	18403
3	3134	2491	1518	2472	5796	860	4432	2224	5966	7775
4	663	117	180	292	401	571	173	908	921	1634
5	61	6	1	54	111	95	140	0	1317	183
6	446	2	0	0	11	3	36	0	0	125
7+	3	61	0	0	0	0	0	0	2	4
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
1	28557	28620	18182	31183	13623	63789	5514	14166	9331	14667
2	20921	14617	9037	7304	7256	3556	5861	3235	1107	3557
3	8483	4398	3431	2418	933	1206	738	1749	427	536
4	961	1395	466	991	369	117	208	130	371	305
5	246	18	93	184	79	15	4	124	34	107
6	0	1	0	51	29	14	0	8	7	4
7+	0	18	0	64	0	0	0	1	2	2
	2005									
1	2923									
2	1578									
3	534									
4	37									
5	19									
6	7									
7+	4									

Table 5.6. Whiting in Division VIa. Total catch at age (thousands).

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	24143	6007	17406	23659	2856	2506	7891	55969	44599	32185
2	11054	19490	46815	29096	45668	13128	15336	20958	63137	91625
3	54967	2744	13293	11376	10737	35559	5090	4863	6817	12412
4	5334	31502	781	4034	2858	3623	38690	1514	1608	1289
5	402	1940	15204	337	1257	703	1395	15406	371	188
6	105	189	801	5118	120	218	245	807	4369	53
7+	22	53	144	372	2358	550	224	149	313	856
	1975	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**
1	52213	33392	64268	45612	9784	14026	4610	20829	18487	75450
2	30319	82233	22051	28680	44943	17551	46409	10360	15266	16716
3	44804	19117	30576	7571	14901	18065	14060	45032	10004	9306
4	3129	19363	3428	9606	3940	4806	4758	8010	27029	4959
5	293	1571	4931	942	3565	1400	1618	2098	6246	16403
6	58	67	297	1452	276	1093	456	804	1541	2011
7+	245	57	24	68	384	190	201	348	540	863
	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
1	63922	13133	53305	48263	20307	19609	33648	49158	15669	40606
2	36946	34909	27624	71982	9547	13819	11700	24481	32460	23292
3	11708	12260	15506	12110	17685	3252	14478	6697	12259	16933
4	4014	2770	5621	6460	5168	4580	1381	5691	3594	5241
5	2058	539	839	2002	1377	1421	1531	396	4055	896
6	5210	293	330	290	479	208	322	373	163	840
7+	825	591	259	207	71	37	51	106	149	73
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
1	28772	29611	19059	32023	14636	64273	5975	14228	9501	14721
2	25243	20027	12695	10808	13387	6508	9132	4859	1817	4281
3	14999	12073	11946	6695	5479	5417	3368	4767	1538	1079
4	6615	6447	4782	4689	2408	1687	1775	929	2044	825
5	1643	2479	1534	1626	1853	500	405	351	381	730
6	377	584	338	389	384	343	131	31	119	82
7+	283	175	106	352	112	89	17	13	4	31
	2005									
1	2951									
2	1854									
3	988									
4	178									
5	118									
6	53									
7+	11									

Table 5.7. Whiting in Division VIa. Landings weights-at-age (kg).

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	0.218	0.238	0.204	0.206	0.178	0.205	0.209	0.211	0.196	0.193
2	0.249	0.243	0.24	0.263	0.223	0.203	0.247	0.258	0.235	0.215
3	0.308	0.325	0.319	0.366	0.335	0.274	0.276	0.345	0.362	0.317
4	0.452	0.374	0.424	0.444	0.5	0.382	0.316	0.368	0.479	0.444
5	1.208	0.61	0.412	0.554	0.57	0.519	0.426	0.426	0.485	0.591
6	0.72	0.72	0.639	0.538	0.649	0.619	0.551	0.494	0.532	0.641
7+	0.778	0.828	0.821	0.735	0.63	0.683	0.712	0.638	0.666	0.584
	1975	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**
1	0.209	0.201	0.2	0.199	0.218	0.172	0.192	0.184	0.216	0.216
2	0.245	0.242	0.244	0.235	0.232	0.242	0.228	0.22	0.249	0.259
3	0.305	0.309	0.296	0.286	0.306	0.33	0.289	0.276	0.28	0.313
4	0.471	0.361	0.392	0.389	0.404	0.42	0.382	0.352	0.34	0.371
5	0.651	0.497	0.431	0.516	0.536	0.492	0.409	0.505	0.409	0.412
6	0.615	0.687	0.629	0.549	0.678	0.595	0.409	0.513	0.494	0.458
7+	0.717	0.856	0.819	0.612	0.693	0.817	0.547	0.526	0.51	0.458
	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
1	0.185	0.174	0.188	0.176	0.171	0.225	0.199	0.193	0.186	0.161
2	0.238	0.236	0.237	0.215	0.22	0.251	0.22	0.23	0.242	0.217
3	0.306	0.294	0.304	0.301	0.279	0.324	0.291	0.288	0.314	0.29
4	0.402	0.365	0.373	0.4	0.348	0.359	0.354	0.349	0.361	0.371
5	0.43	0.468	0.511	0.483	0.459	0.417	0.391	0.388	0.412	0.451
6	0.461	0.482	0.52	0.567	0.425	0.582	0.442	0.397	0.452	0.482
7+	0.538	0.499	0.576	0.6	0.555	0.543	0.761	0.51	0.474	0.483
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
1	0.19	0.195	0.198	0.215	0.181	0.205	0.173	0.213	0.228	0.193
2	0.225	0.245	0.245	0.236	0.225	0.241	0.234	0.258	0.264	0.251
3	0.296	0.288	0.297	0.301	0.28	0.298	0.303	0.303	0.309	0.295
4	0.381	0.365	0.384	0.364	0.365	0.336	0.37	0.364	0.362	0.345
5	0.469	0.483	0.522	0.438	0.44	0.419	0.395	0.462	0.374	0.382
6	0.473	0.526	0.629	0.5	0.524	0.488	0.376	0.648	0.436	0.403
7+	0.528	0.569	0.661	0.646	0.594	0.617	0.595	0.709	0.717	0.342
	2005									
1	0.189									
2	0.261									
3	0.313									
4	0.378									
5	0.44									
6	0.482									
7+	0.356									

Table 5.8. Whiting in Division VIa. Discard weights-at-age (kg).

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	0.122	0.122	0.122	0.128	0.121	0.121	0.12	0.121	0.123	0.119
2	0.177	0.178	0.178	0.179	0.178	0.175	0.177	0.177	0.176	0.177
3	0.213	0.212	0.213	0.213	0.214	0.213	0.211	0.213	0.215	0.214
4	0.249	0.248	0.248	0.249	0.249	0.249	0.248	0.248	0.252	0.25
5	0.287	0.29	0.29	0.291	0.29	0.29	0.29	0.289	0.288	0.285
6	0.303	0.297	0.295	0.298	0.295	0.299	0.299	0.301	0.301	0.299
7+	0.287	0.286	0.289	0.287	0.285	0.284	0.284	0.281	0.285	0.288
	1975	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**
1	0.119	0.116	0.118	0.135	0.173	0.14	0.108	0.096	0.141	0.087
2	0.176	0.177	0.177	0.167	0.188	0.179	0.16	0.18	0.186	0.199
3	0.213	0.213	0.214	0.199	0.208	0.208	0.195	0.209	0.228	0.246
4	0.25	0.249	0.249	0.288	0.215	0.22	0.298	0.243	0.237	0.26
5	0.286	0.288	0.289	0.32	0.281	0.271	0.286	0.283	0.267	0.259
6	0.301	0.3	0.299	0.238	0	0.386	0.295	0.44	0.267	0.303
7+	0.278	0.28	0.282	0	0	0	0	0	0	0.227
	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
1	0.102	0.092	0.085	0.076	0.099	0.124	0.085	0.109	0.118	0.087
2	0.191	0.17	0.182	0.143	0.177	0.171	0.169	0.173	0.197	0.157
3	0.237	0.196	0.233	0.203	0.205	0.214	0.205	0.219	0.225	0.22
4	0.286	0.245	0.249	0.227	0.209	0.219	0.223	0.227	0.242	0.283
5	0.326	0.258	0.225	0.262	0.294	0.237	0.226	0	0.256	0.297
6	0.312	0.33	0	0	0.305	0.264	0.281	0	0	0.253
7+	0.316	0.263	0	0	0	0	0	0	0.436	0.299
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
1	0.075	0.095	0.112	0.098	0.077	0.075	0.094	0.073	0.077	0.086
2	0.154	0.18	0.182	0.179	0.168	0.164	0.154	0.162	0.177	0.186
3	0.189	0.203	0.221	0.225	0.217	0.203	0.196	0.212	0.231	0.236
4	0.246	0.229	0.235	0.254	0.205	0.233	0.203	0.245	0.242	0.246
5	0.278	0.302	0.243	0.282	0.266	0.282	0.381	0.24	0.213	0.304
6	0.597	0.421	0.422	0.264	0.268	0.25	0	0.298	0.3	0.349
7+	0.493	0.26	0.819	0.245	0	0	0	0.276	0.78	0.314
	2005									
1	0.088									
2	0.149									
3	0.223									
4	0.214									
5	0.315									
6	0.292									
7+	0.373									

Table 5.9. Whiting in Division VIa. Total catch weights-at-age (kg).

	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
1	0.15	0.155	0.146	0.152	0.138	0.146	0.147	0.148	0.146	0.14
2	0.217	0.213	0.212	0.226	0.203	0.189	0.216	0.223	0.21	0.198
3	0.288	0.304	0.297	0.337	0.311	0.261	0.264	0.322	0.335	0.297
4	0.432	0.361	0.405	0.425	0.474	0.368	0.309	0.356	0.459	0.425
5	1.177	0.596	0.407	0.544	0.559	0.508	0.421	0.42	0.477	0.579
6	0.713	0.713	0.633	0.534	0.643	0.613	0.547	0.491	0.528	0.636
7+	0.777	0.824	0.817	0.731	0.626	0.683	0.71	0.635	0.663	0.581
	1975	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**
1	0.145	0.138	0.139	0.16	0.202	0.166	0.174	0.108	0.155	0.099
2	0.214	0.214	0.218	0.21	0.221	0.22	0.196	0.202	0.215	0.245
3	0.288	0.292	0.282	0.276	0.296	0.308	0.271	0.252	0.27	0.306
4	0.449	0.35	0.38	0.386	0.379	0.393	0.38	0.336	0.324	0.358
5	0.635	0.489	0.425	0.515	0.531	0.467	0.401	0.5	0.405	0.397
6	0.609	0.68	0.624	0.545	0.678	0.594	0.409	0.512	0.479	0.454
7+	0.717	0.855	0.816	0.612	0.693	0.817	0.547	0.526	0.51	0.457
	1985	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**
1	0.107	0.109	0.098	0.08	0.108	0.14	0.097	0.113	0.122	0.089
2	0.216	0.198	0.21	0.164	0.204	0.217	0.207	0.195	0.211	0.17
3	0.288	0.274	0.297	0.281	0.255	0.295	0.265	0.265	0.271	0.258
4	0.383	0.36	0.369	0.392	0.337	0.341	0.337	0.329	0.331	0.344
5	0.427	0.466	0.51	0.477	0.446	0.405	0.376	0.388	0.361	0.419
6	0.449	0.481	0.52	0.567	0.422	0.577	0.424	0.397	0.452	0.448
7+	0.537	0.475	0.576	0.6	0.555	0.543	0.761	0.51	0.474	0.474
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
1	0.076	0.098	0.116	0.101	0.085	0.076	0.1	0.073	0.08	0.086
2	0.167	0.197	0.2	0.197	0.194	0.199	0.182	0.193	0.211	0.197
3	0.235	0.257	0.275	0.274	0.27	0.277	0.28	0.269	0.288	0.265
4	0.362	0.335	0.369	0.341	0.34	0.329	0.35	0.347	0.341	0.308
5	0.44	0.482	0.505	0.42	0.433	0.415	0.395	0.383	0.36	0.371
6	0.473	0.526	0.629	0.469	0.504	0.478	0.376	0.553	0.428	0.401
7+	0.528	0.537	0.662	0.572	0.593	0.617	0.589	0.686	0.526	0.34
	2005									
1	0.089									
2	0.166									
3	0.265									
4	0.343									
5	0.42									
6	0.455									
7+	0.362									

Table 5.10. Whiting in Division VIa. : Summary of SURBA indicies of abundance at age, SSB and total mortality Z, based on data from ScoGFSQ1.

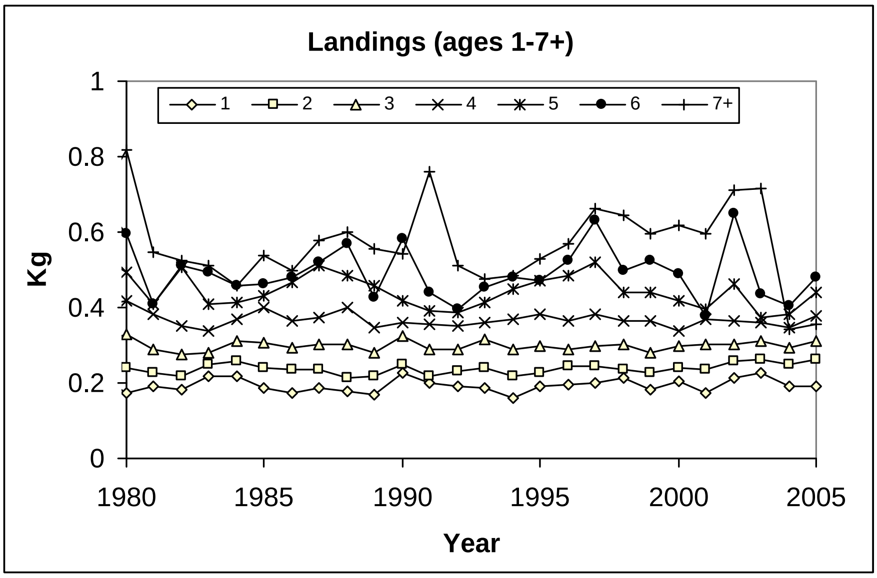
ABUNDANCE AT AGE						
	Age					
Year	**1**	**2**	**3**	**4**	**5**	**6**
1985	3.5845	1.218	0.3185	0.0557	0.0277	0.1465
1986	3.2151	1.2595	0.3489	0.0922	0.0093	0.0064
1987	4.5941	1.3305	0.4388	0.1226	0.0203	0.0027
1988	0.9084	1.8635	0.4525	0.1506	0.0261	0.0057
1989	1.464	0.3306	0.5567	0.1366	0.0266	0.0063
1990	1.0573	0.5817	0.1097	0.1865	0.0281	0.0073
1991	2.0485	0.4706	0.2211	0.042	0.0465	0.009
1992	5.3083	1.3292	0.2806	0.1324	0.02	0.0254
1993	5.3962	2.7605	0.6084	0.1293	0.0431	0.008
1994	4.3676	2.6003	1.1535	0.2561	0.037	0.0155
1995	8.1696	2.002	1.0235	0.4576	0.0672	0.0124
1996	5.6568	3.4746	0.7205	0.3716	0.1056	0.0203
1997	5.206	2.175	1.1085	0.2321	0.0722	0.0277
1998	6.4925	1.4757	0.482	0.2488	0.0267	0.0124
1999	5.5108	1.6204	0.2809	0.093	0.023	0.0038
2000	10.6286	1.3047	0.2896	0.0509	0.0079	0.0031
2001	3.8279	2.8896	0.2751	0.0619	0.0055	0.0013
2002	1.2963	1.4015	0.8695	0.0836	0.011	0.0013
2003	5.2308	0.5418	0.494	0.3092	0.0187	0.0033
2004	5.1555	1.7951	0.1509	0.1391	0.0494	0.0042
2005	1.7382	1.2469	0.3291	0.0281	0.0122	0.0068
2006	1.3405	0.3254	0.1683	0.0452	0.0016	0.0012

	REC		SSB	TSB	MEAN Z (2-5)	
year	**Est**	**Se log**	**Est**	**Est**	**Est**	**Se**
1985	3.584	0.358	0.454	0.837	1.428	0.271
1986	3.215	0.322	0.386	0.736	1.204	0.203
1987	4.594	0.32	0.467	0.917	1.232	0.197
1988	0.908	0.325	0.508	0.58	1.38	0.194
1989	1.464	0.322	0.27	0.428	1.26	0.194
1990	1.057	0.321	0.238	0.386	1.105	0.195
1991	2.049	0.306	0.191	0.39	0.59	0.198
1992	5.308	0.312	0.395	0.995	0.893	0.196
1993	5.396	0.314	0.809	1.468	0.997	0.196
1994	4.368	0.315	0.85	1.239	1.065	0.196
1995	8.17	0.317	0.776	1.397	1.167	0.196
1996	5.657	0.32	1.056	1.61	1.305	0.196
1997	5.206	0.335	0.879	1.483	1.721	0.194
1998	6.492	0.342	0.525	1.18	1.895	0.192
1999	5.511	0.347	0.434	0.902	1.967	0.19
2000	10.629	0.34	0.361	1.169	1.778	0.191
2001	3.828	0.323	0.627	1.01	1.372	0.195
2002	1.296	0.328	0.541	0.636	1.191	0.197
2003	5.231	0.355	0.37	0.789	1.46	0.197
2004	5.156	0.401	0.456	0.9	1.937	0.192
2005	1.738	0.467	0.312	0.467	2.287	0.238
2006	1.341	0.588	0.124	0.238	1.895	0.037

Table 5.11. Nominal catch (t) of WHITING in Division VIb, 1988–2004, as officially reported to ICES.

COUNTRY	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005[1]
France																	
Ireland	-	-	-	-	32	10	4	23	3	1	-	-	10		2	3	
Spain	-	-	-	-	-	-	-	-	-	-	+	-	-				
UK (E.& W)[3]	16	6	1	5	10	2	5	26	49	20	+	+	-				
UK (N.Ireland)	…	…	…	…	…	…	…	…	…	…	…	…		…			
UK (Scotland)	18	482	459	283	86	68	53	36	65	23	44	58	4	7	11	1	
UK (all)																	1
Total	34	488	460	288	128	80	62	85	117	44	44	58	14	7	13	4	1

[1]Preliminary.



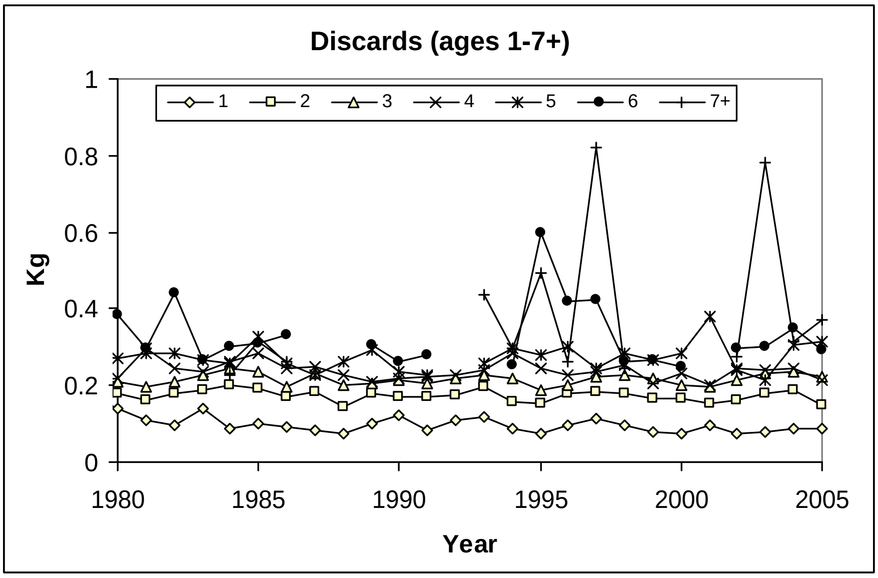


Figure 5.1. Whiting in Division VIa. Mean weights at age in the landings and discards.

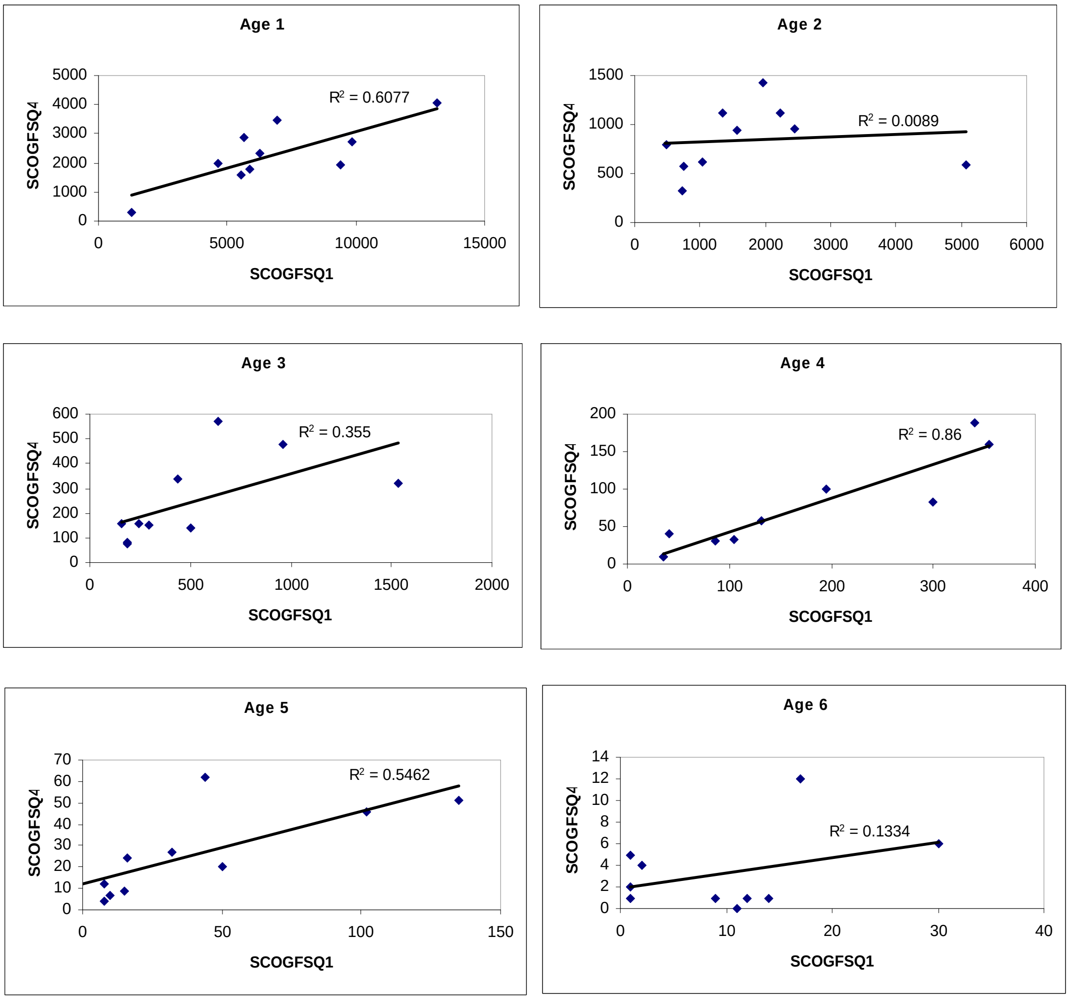


Figure 5.2. Whiting in Division VIa. Comparative scatterplots of raw survey indices from ScoGFSQ1 and ScoGFSQ4by age.

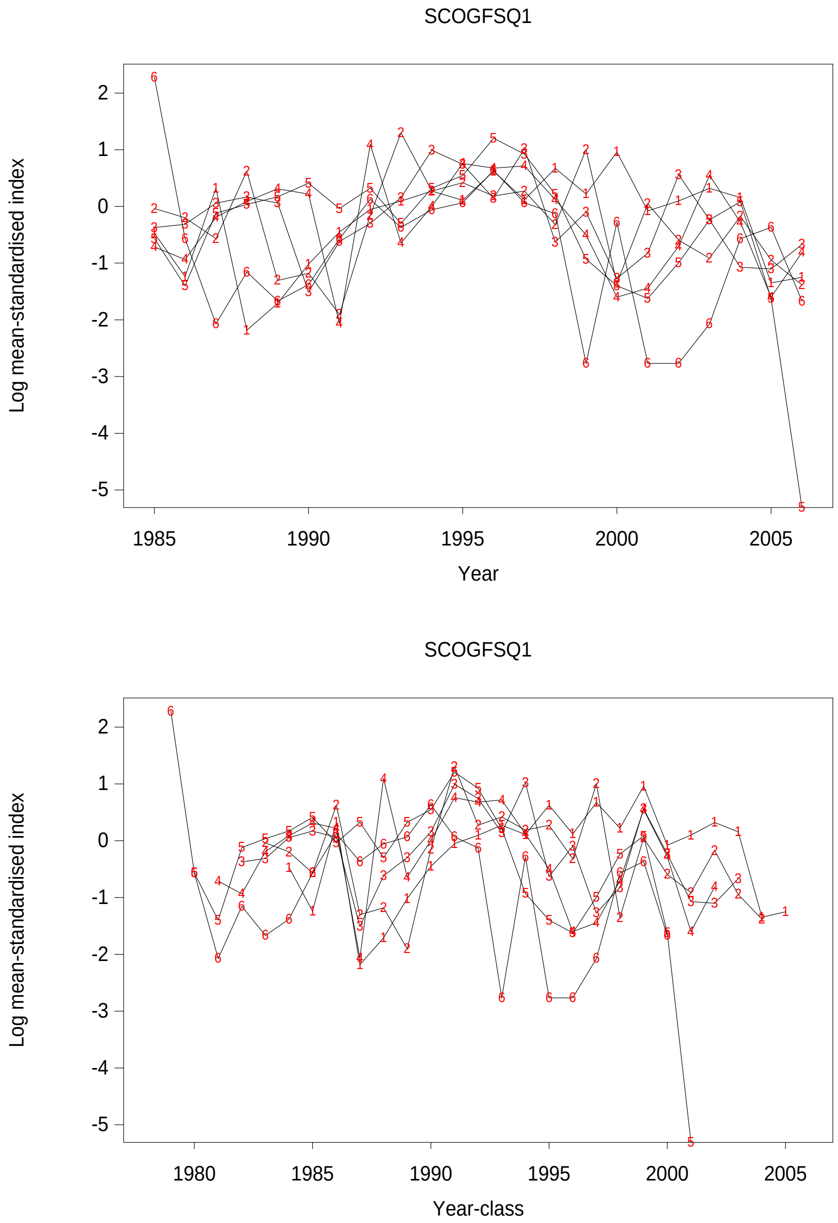
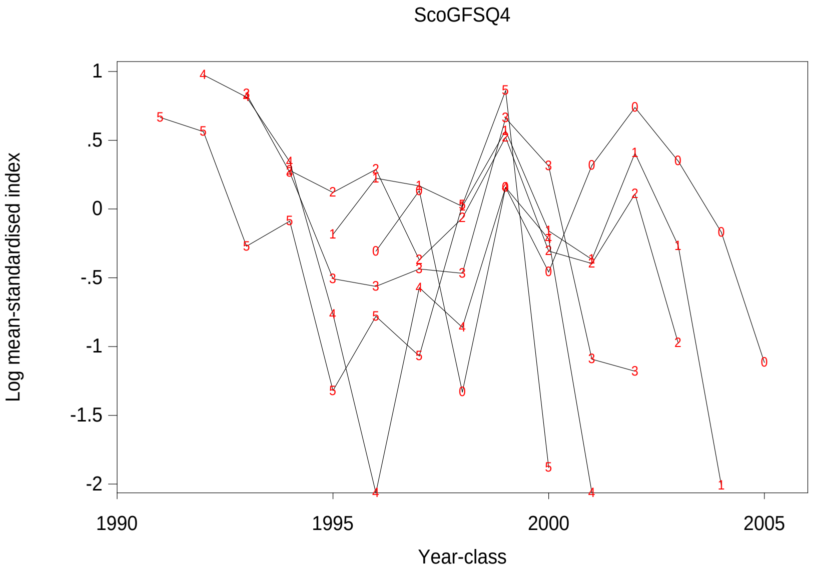
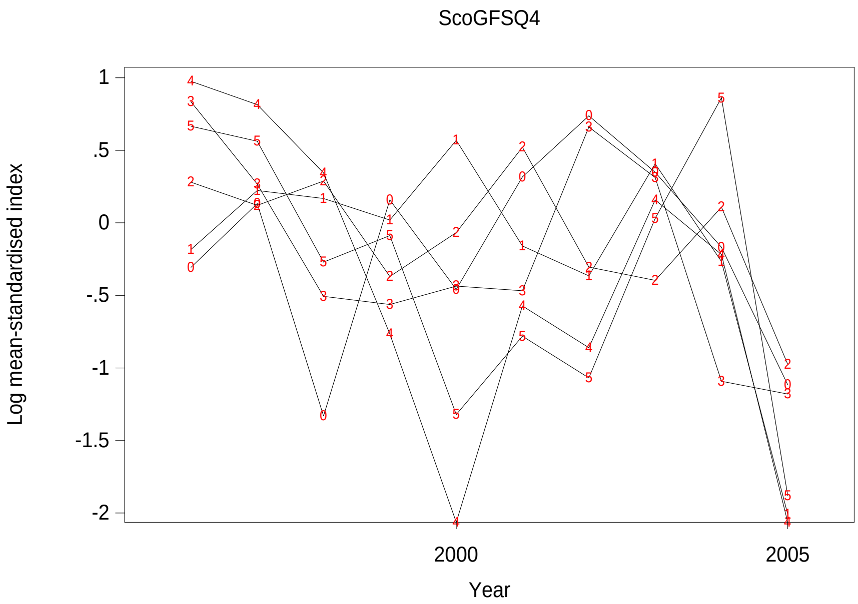


Figure 5.3. Whiting in Division VIa. Log mean standardised survey index across all available ages. Scottish ground fish survey (ScoGFSQ1) and Scottish quarter four ground fish survey (ScoGFSQ4).





(cont): Whiting in Division VIa. Log mean standardised survey index across all available ages. Scottish ground fish survey (ScoGFSQ1) and Scottish quarter four ground fish survey (ScoGFSQ4).

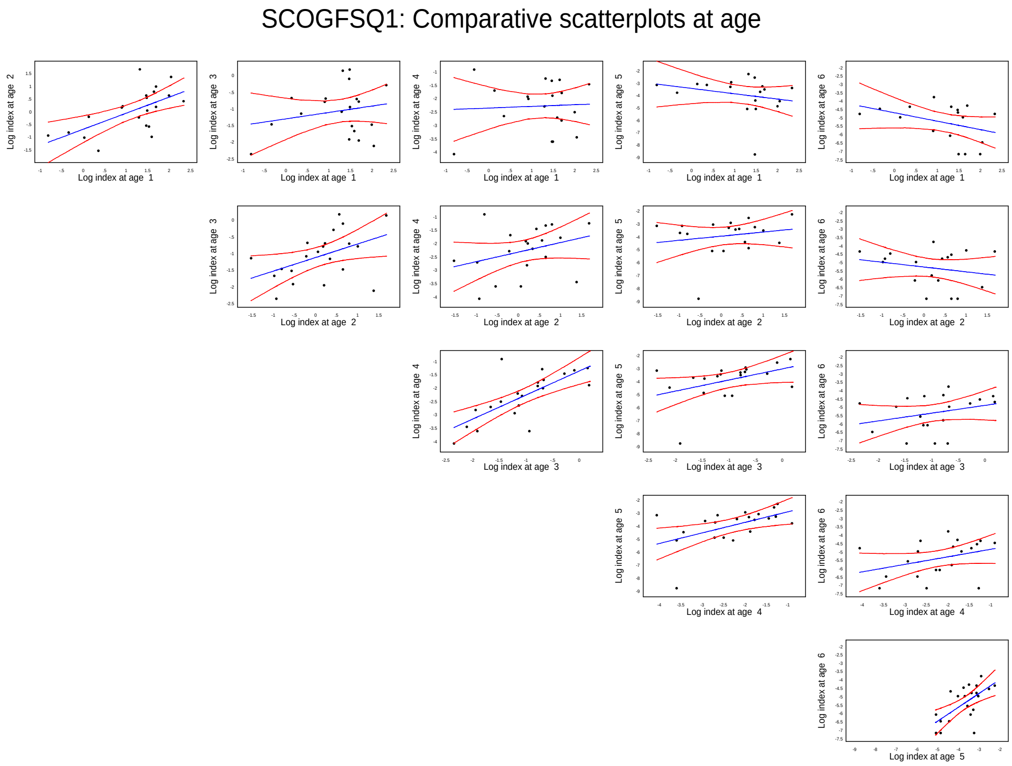


Figure 5.4. Whiting in Division VIa. Comparative scatterplots at age for Scottish ground fish survey (ScoGFSQ1).

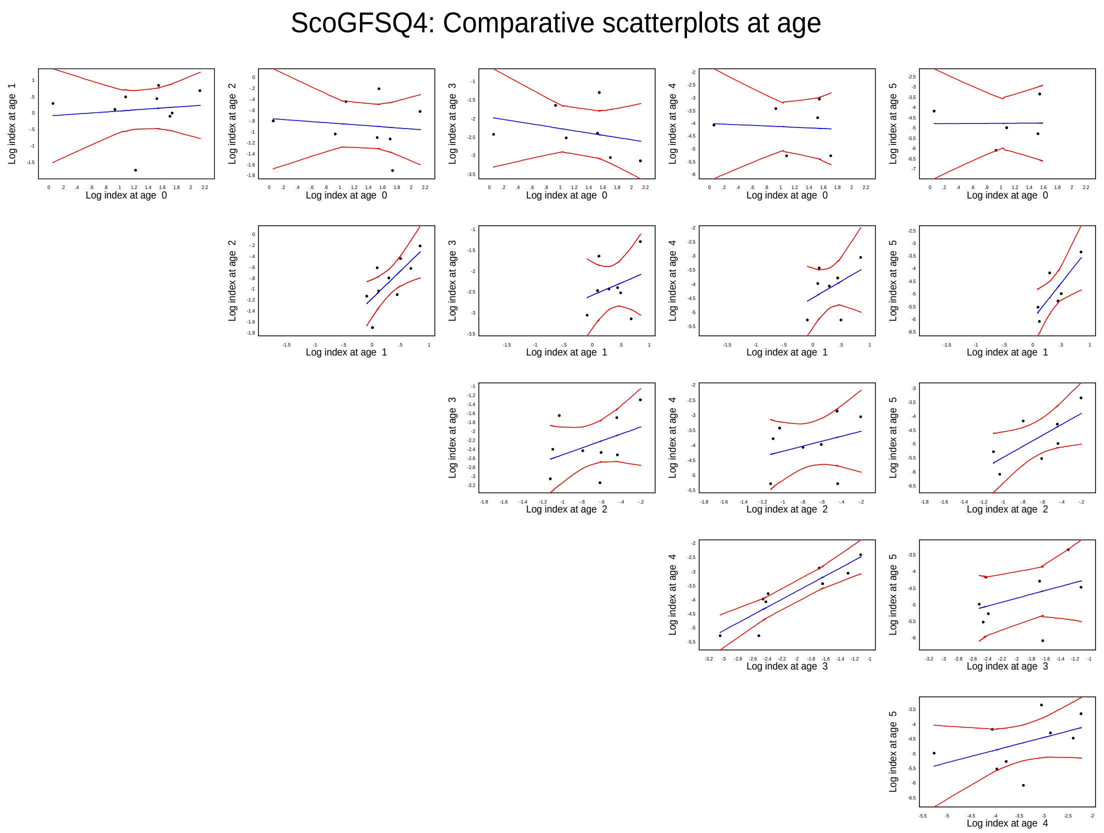
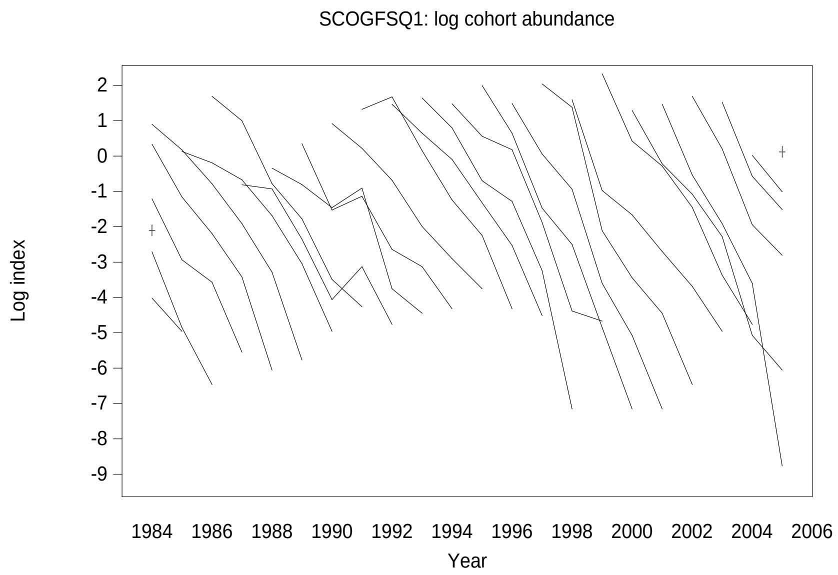


Figure 5.5. Whiting in Division VIa. Comparative scatterplots at age for Scottish quarter four ground fish survey (ScoGFSQ4).



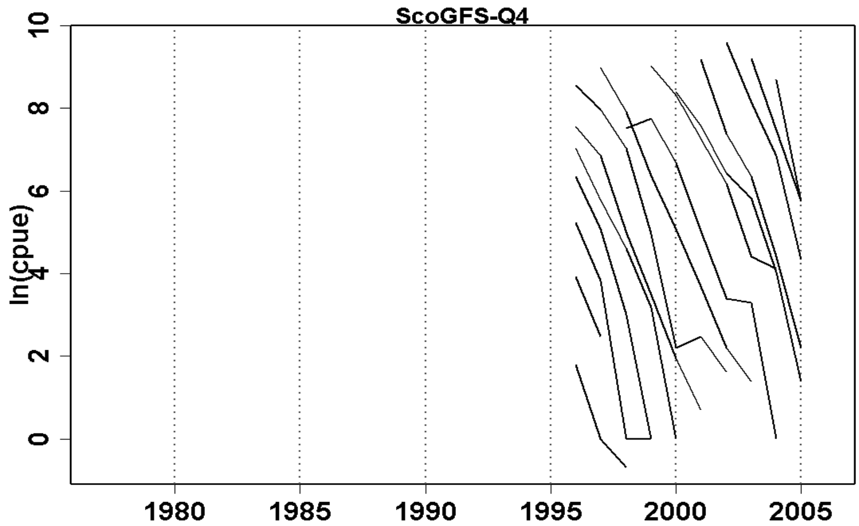


Figure 5.6. Whiting in Division VIa. Log catch curves from Scottish ground fish survey (ScoGFSQ1) and scottish quarter four ground fish survey (ScoGFSQ4).

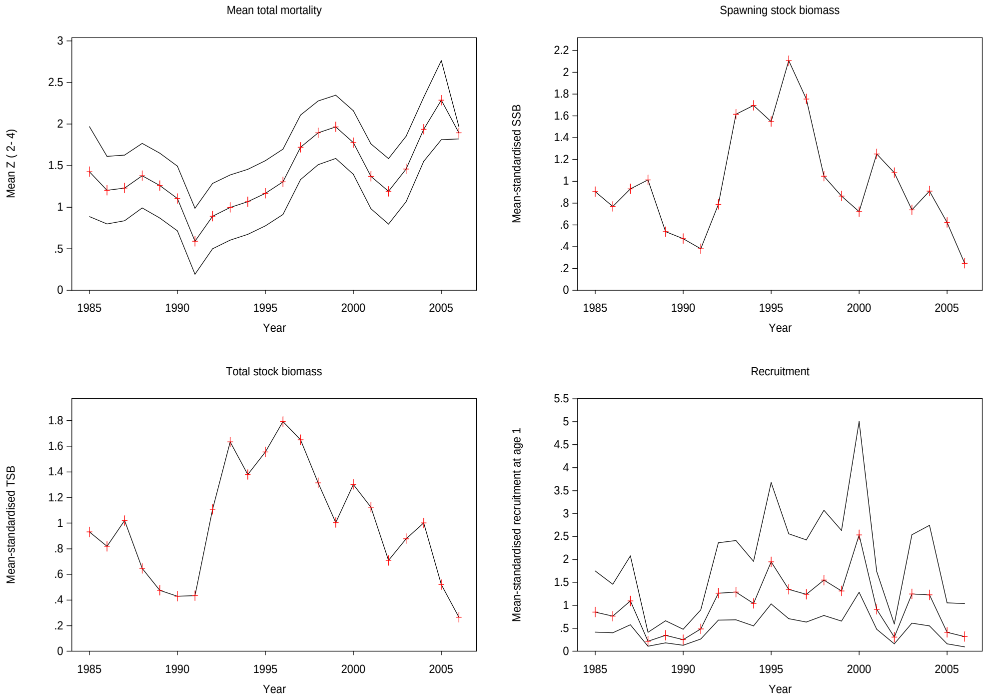


Figure 5.7. Whiting in Division VIa. Results of SURBA 3 run using ScoGFSQ1 data. Z estimates are given as absolute; biomass and recruitment are mean-standardised. Mean Z and recruitment are shown with +/-1 standard errors.

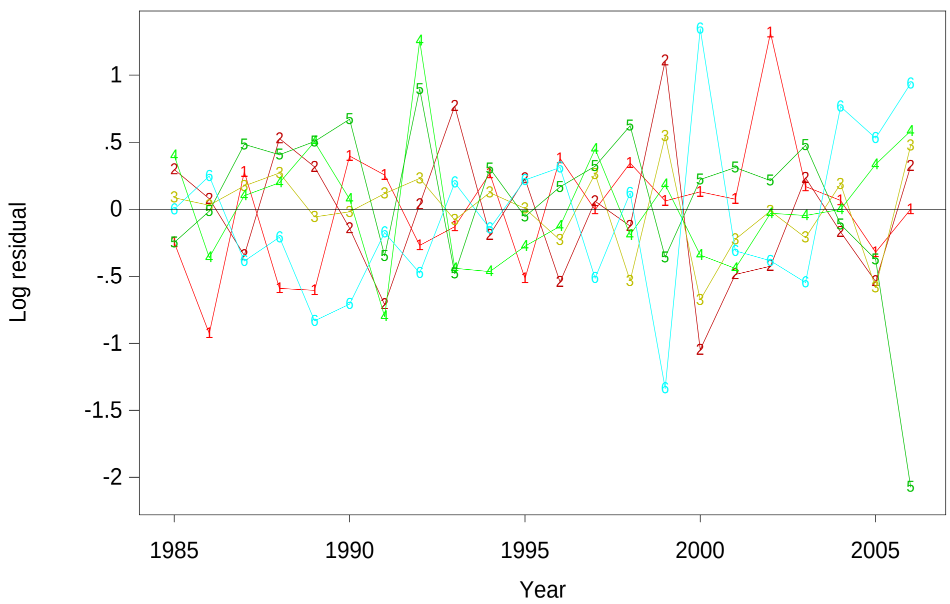


Figure 5.8. Whiting in Division VIa. Residuals from SURBA run using ScoGFSQ1.

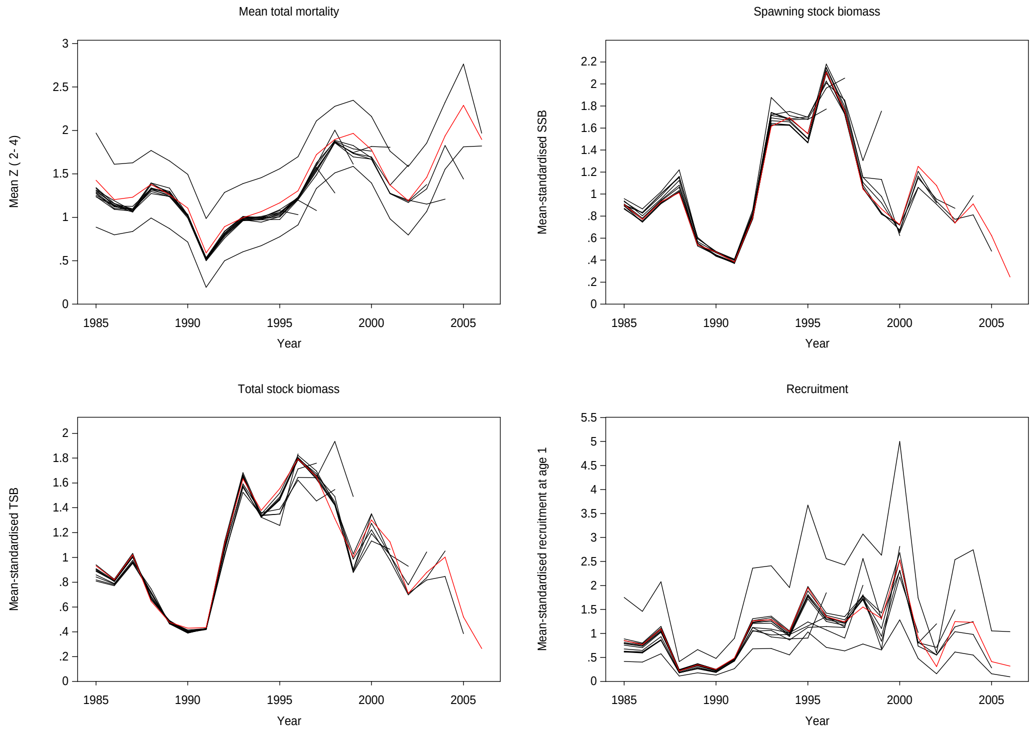


Figure 5.9. Whiting in Division VIa. SURBA 3 final run residuals at age plots.

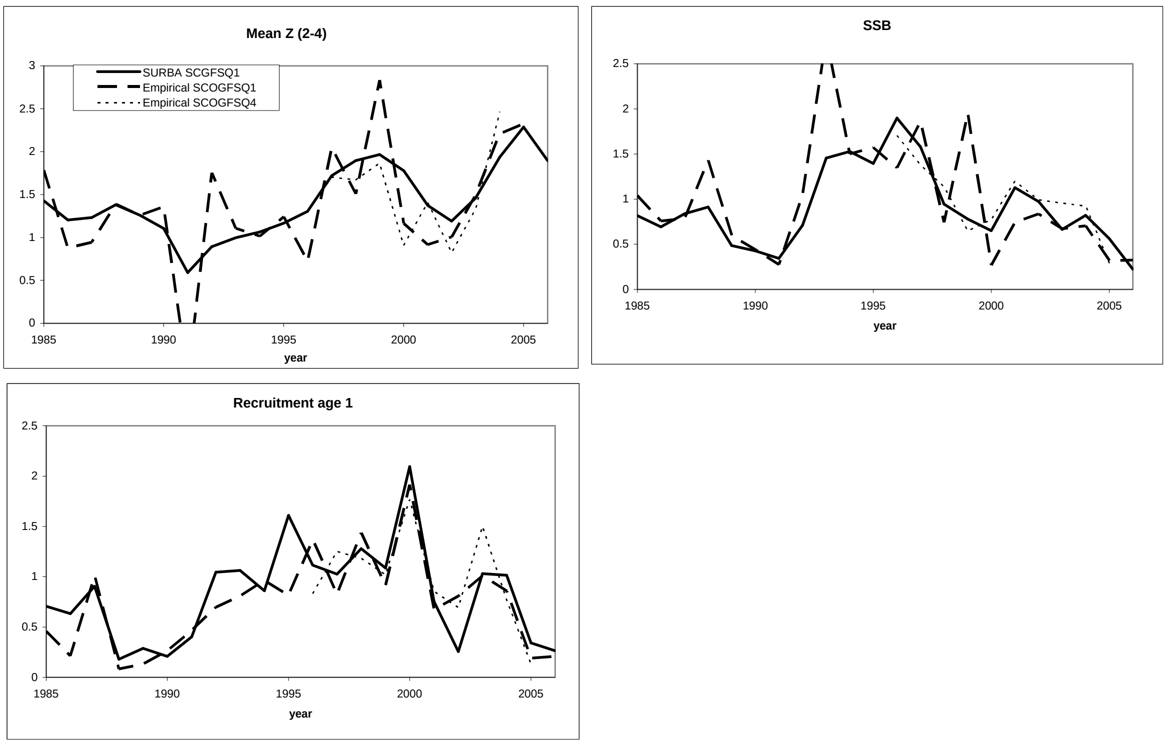


Figure 5.10. Whiting in Division VIa. Comparison of SURBA final run outputs with empirical estimates from the 2 Scottish surveys. Biomass and recruitment are mean standardized over 1996-2005 (the length of the shortest survey).

6 ANGLERFISH (on the NORTHERN SHELF & IIa)

For the purposes of this section, the Northern Shelf is considered to comprise Division IIIa (Skagerrak & Kattegat), Sub-area IV (the North Sea) and Sub-area 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 has been included in the ToR for this WG since last year.

Descriptions of the particular fisheries and management advice applicable to the individual Northern Shelf areas are given in Sections 6.1 and 6.2, and Section 6.3 contains details applicable to the combined Northern Shelf. Division IIa is considered in Section 6.4.

The decision to include descriptions of each area separately and then consider a combined Northern Shelf area assessment means that this chapter contains extensive text. In addition, an STECF meeting to review the TAC for Northern Shelf anglerfish (SGRST-06-03) met earlier this year and collated substantial amounts of extra data which are also presented in this report. Consequently, the WG wishes to highlight four specific issues at an early point:

- The rapid development of the fishery in Divisions VIa and IVa in terms of the increase in reported landings from 1991 to 1996, was matched by an equally rapid decline in the following years (Figures 6.1.6 & 6.2.8) although the continued decline in reported landings may have been due to restrictive TACs and is not necessarily representative of actual catches.

- It has previously been hypothesised that the deeper waters of the shelf edge to the west of Scotland may provide a refuge for mature female anglerfish. However, very few have been observed by scientific observers on commercial vessels fishing in this area in 1999 and 2000, or by targeted research vessel surveys undertaken during the same years, as part of an EU-funded research project entitled 'Distribution and biology of anglerfish and megrim in the waters to the West of Scotland' (EC study contract 98/096, Anon 2001). More recent surveys (see section 6.3.3) have also failed to observe any large spawning locations.

- The *status quo* catch forecast for the Northern Shelf for 2003 was 16,300 t, but there was a reduction of the TAC for this area for 2003 to 10,180 t (2/3 of that in 2002) based on the advice that F should be below $\mathbf{F}_{pa}$. This involved a large reduction in fishing mortality and anecdotal evidence from the fishery indicates that this, and the subsequent 2004 and 2005 TACs have been particularly restrictive, implying that reported landings are unlikely to reflect actual catches in these years.

- Previous analyses using models based on dynamic pool assumptions highlight that fishing mortality on anglerfish in this area has been well above what may be considered sustainable.

6.1 Anglerfish in Sub-Area VI

6.1.1 The fishery

Details can now be found in Section A.2 of the Stock Annex.

At the recent STECF anglerfish review group meeting, attempts were made to define specific anglerfish fisheries. A number of nations presented information on the composition of landings associated with anglerfish based on official logbook records. The STECF database was also available for interrogation.

Data extracted from the provisional STECF database indicate that most of the officially reported landings of anglerfish in Division VIa in recent years were from otter trawlers with mesh sizes >=100mm (Figure 6.1.1). There is also a seasonal pattern in the landings with lower values in quarter 3. The picture for Rockall looks rather different with the majority of the landings appearing to be reported by the gillnet fleet (Figure 6.1.2), although it is known that there is trawling activity in this area. The data should be treated as very preliminary as it appears that not all nations have contributed complete datasets to the database.

In the UK (E&W), anglerfish have been a relatively minor component of the total landings associated with anglerfish in recent years in Sub-area VI. In Division VIa, saithe and Nephrops (and ‘Others’) make up the largest component of the landings by weight of vessels other than gillnetters, while in Division VIb, which makes up the largest proportion of the landings. For gillnet vessels, red crab make up a large proportion of the landings along with ‘Other’ species in both Divisions VIa and VIb. (Figure 6.1.3)

Species composition of the Scottish fisheries catching anglerfish across the Northern Shelf are described in Section 6.3.

No catch composition information from other nations was available for this area.

6.1.1.1 ICES advice applicable to 2005 and 2006

The ICES advice for 2005 (Single Stock Exploitation Boundaries) was as follows, and applies to Subarea VI, Subarea IV and Division IIIa:

“The effort in this fishery should not be allowed to increase and the fishery must be accompanied by mandatory programmes to collect catch and effort data on both target and bycatch fish.”

The advice for 2006 in terms of single stock exploitation boundaries is the same as that for 2005.

Mixed fisheries advice for 2006:

“Demersal fisheries in Subarea VI should in 2006 be managed according to the following rules, which should be applied simultaneously. They should fish:

- without catch or discards of cod in Subarea VI;
- without catch or discards of spurdog;
- no directed fishery for haddock in Division VIb;
- concerning deep water stocks fished in Subarea VI, Volume 10;
- within the biological exploitation limits for all other stocks.

Furthermore, unless ways can be found to harvest species caught in mixed fisheries within precautionary limits for all those species individually then fishing should not be permitted.”

6.1.1.2 Management applicable

YEAR	SINGLE STOCK EXPLOITATION BOUNDARY (VB(EC), VI, XII AND XIV)	BASIS	TAC (VB(EC), VI, XII AND XIV)	% CHANGE IN F ASSOCIATED WITH TAC	WG LANDINGS
2003	<6700[1)]	Reduce F below $\mathbf{F}_{pa}$	3180	49% reduction	4126
2004	<8800[2)]	Reduce F below Fpa[2)]	3180	48% reduction	*3296*
2005	-	No effort increase	4686	-	n/a
2006	-	No effort increase	4686[3)]	-	

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)] Subject to in year review.

There is no minimum landing size for this species.

6.1.1.3 The fishery in 2005

The Scottish fishery for anglerfish in Division VIa comprises two main fleets targeting mixed round-fish. The Scottish Light Trawl Fleet (SCOLTR) takes around 60% of landings and the Scottish Heavy Trawl Fleet (SCOTRL) over 20%. The majority of these landings come from the shelf edge area to the north and west of the Outer Hebrides, with a smaller proportion of the reported landings (around 15%) being by-catch from the *Nephrops* trawlers operating on the shelf. In recent years there has been decommissioning of Scottish boats exploiting anglerfish in Division VIa: out of a total of 298 demersal trawlers (mesh size >=100mm) active in 2001, 96 were decommissioned by the end of 2004. This is likely to have reduced fishing effort, however, it is not known to what extent effort has actually been reduced as this clearly depends on the size and the power of the boats which have been decommissioned. The Scottish fleet operating in VIb consists mainly of large otter trawlers (SCOTRL) targeting haddock and anglerfish at Rockall.

The landings of Anglerfish by Irish vessels in VIa are primarily taken by the otter trawl fleet. Reported landings in 2005 were mainly taken on the slope in the southern part of VIa with some landings also reported from the Stanton Bank area. The number of vessels participating in the fishery has declined substantially in recent years. Similarly, the Irish fleet fishing at Rockall has declined substantially since the late 1990s as have reported landings.

The report of the 2006 WG on Fish Technology and Fish Behaviour also highlights a number of issues relating to recent changes in fishing technology and fleet behaviour which are relevant to this WG:

- *there is evidence of Scottish whitefish boats moving between Divisions IVa and VIa to retain haddock and monkfish quotas and create track record in both areas. There is evidence of mis-reporting of haddock and other species caught in VIa & b landed as IVa. (UK, Scotland. Implication: Inaccurate landings data)*
- *there is increasing concern in the fishing industry in the rising cost of fuel, with many vessel owners seriously considering leaving the industry. Several twin-rig vessels targeting monkfish have reverted to single rigging. (UK, Ireland. Implication: Change in CPUE).*

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. It is not known to what extent the increased restrictions to deepwater fisheries have affected the French fishery for anglerfish.

In addition to these demersal trawl fisheries, a deepwater gillnet fleet also operates 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. The fishery is conducted in depths between 200 and 1200 metres, with the main target species being anglerfish and deepwater sharks. 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 (Hareide et al., 2006). In 2005, there were around 16 vessels participating in the fishery, 12 UK registered and 4 German registered.

6.1.2 Catch data

6.1.2.1 Official catch statistics and revisions to catch data

The official landings for each country are shown in Table 6.1.1. The data have been updated to incorporate revised landings for France, Ireland and the UK in 2004. Total landings (Sub-area VI) as reported to ICES in 2005 were 3,848 t, which is approximately 700 t higher than the value for 2004. This is due almost entirely to the increase in officially reported UK landings for 2005. The official landings from Division VIa account for approximately 75% of the total for Sub-area VI in 2005. Many of the official landings for 2005 are still preliminary. Minor updates have been made to the officially reported landings for the years prior to 2004.

Figure 6.1.4 shows the trend in total international reported landings for the Northern Shelf Stock by ICES Division. The spatial distribution of reported landings from 1999 to 2004 is shown in Figure 6.1.5.

6.1.2.2 Quality of the catch data

For a number of years, anglerfish in Sub-areas 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 for 2005 has been increased to 4686 t. At the Working Group in 2003, it was highlighted that the reduction of the TAC in 2003 to just two-thirds of that in 2002 would likely imply an increased incentive to mis-report 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 appears to suggest that the TAC has been 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 the adjacent Sub-area IV prior to 1998, means that prior to 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 Sub-area VI. The area misreporting practices have thus become institutionalised and the statistical rectangles immediately east of the 4^{o}W boundary (E6 squares) have accounted for a disproportionate part of the combined VIa/North Sea catches of anglerfish.

The Working Group has traditionally provided estimates of the actual Division VIa landings by adjusting the reported data for Division VIa to include a proportion of the landings declared from Division IVa in the E6 ICES statistical rectangles. The correction has been applied by first estimating a value for the true catch in each E6 square 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 re-allocation 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. Working Group estimates of the actual Division VIa landings are also presented in Table 6.1.1 for the years to 2004. Due to technical problems associated with changes to the Scottish Executive database (See section 2.13), Scottish official landings by statistical rectangle are unavailable for 2005 and so it has not been possible to make this area correction in 2005. Figures 6.1.6 & 6.1.7 show the development of the fishery in Sub-area VI in terms of WG estimates of landings for the years to 2004.

In addition to accounting for area misreporting, the 'unallocated' figure also includes differences between landings data officially reported to ICES and that provided to the Working Group by national scientists. These estimates indicate that the percentages of the catch taken in (Division IIIa, Sub-area IV) and (Divisions VIa & VIb) over 1993-2004 average 60% and 40% respectively. In recent years (2001-2003) the split between these two areas has been more in the region of 70% (Division IIIa, Sub-area IV) to 30% (Sub-area VI). However, given the concerns about the veracity of the recent reported landings data, such a proportionate split may no longer be appropriate.

6.1.3 Commercial catch-effort data

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 effort recording 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, in terms of 'days absent' associated with anglerfish landings for the Scottish trawl fleets operating in this area is illustrated in Figure 6.1.8 for a range of gear types for the years 1999-2004. In Division VIa, there has been a general decline in 'days absent' for all gears while in Division VIb an initial decline has been followed in 2003 and 2004 by a slight increase. This apparent 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. Fishing at Rockall keeps 'days at sea' elsewhere intact (as there are no 'days at sea' restrictions at Rockall) and it is possible that vessels are working extra days in VIb because of restrictions in other areas. The equivalent officially reported landings data are shown in Figure 6.1.9 which indicate a decline in Division VIa, but a slight upturn in Division VIb in 2004. LPUE are not presented due to concerns over the accuracy of the official reported landings.

Trends in official landings, effort in hours fished and LPUE by gear from the Irish fleets are shown in Figure 6.1.10. The majority of effort and landings is from the OTB fleet. The effort declines over the time series while the landings decline to 2004 but show a slight increase in 2005.

Officially reported UK (E&W) effort in terms of number of days fished in association with anglerfish landings is shown in Figure 6.1.11 broken down by gear category: gillnet and all other gears. Effort in gears other than the gillnet fishery has shown a decline since 1993 (although most of this is in the central north sea) and the gillnet effort has generally decreased since 1997.

No effort data were available for the Spanish and French fleets in Sub-area VI.

Attempts have recently been made to obtain more reliable data on catch and effort from the Scottish anglerfish fishery. Last year 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, FRS (in consultation with the fishing industry) have recently established a new monkfish tallybook project. Illustrations of the spatial and depth distributions of haul by haul data collected so far for 2006 can be found in Figures 6.1.12 and 6.1.13. A fuller description of these data can be found in Section 6.3.2 which covers anglerfish on the whole Northern Shelf.

Ahead of the recent STECF review group meeting on Northern Shelf anglerfish (SGRST-06-03), an enhanced Scottish observer scheme for anglerfish has been operating and has collated information on commercial catch rates in the Scottish anglerfish fisheries. Further details can be found in Section 6.3.2 which covers the whole Northern Shelf.

6.1.4 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, FRS, Scotland began a new joint science/industry survey in 2005. The survey was conducted in Sub-area VI and sub-area IV and further description and illustration of the preliminary results can be found in Section 6.3.3 which considers anglerfish across the whole Northern Shelf.

6.1.5 Commercial length compositions

Ireland and Scotland provided landings length frequency data for 2005, and national sampling levels can be found in Table 2.3. These data do not appear to be particularly useful in helping identify strong year classes although it is not known to what extent these landings length frequencies are representative of the length frequencies of the actual catch due to lack of discard information and possible mis-reporting by size category. Furthermore, the coarse spatial resolution of these data may mean that if recruits congregate in particular locations then pulses of recruitment may not be picked up in the overall length frequency distribution. The data are therefore not presented in this report but can be found in the stock file. Mean lengths from the Scottish market sampling length frequency data are shown in Figures 6.1.14 and 6.1.15. There do not appear to have been any significant changes in the average size of large and small individuals being caught (officially landed) over the time series of data available.

Scottish discard estimates from an EU funded study of the fishery (Kunzlik et al. 1995) were available for two complete years during 1992 QII to 1994 QI. Assessments both including and excluding the discard data were presented in ICES CM 1998/Assess:1. Due to a constant discard ogive being applied to each year’s data, the difference in assessments was essentially a scaling factor on population and yield per recruit estimates.

More recent observer trips aboard Scottish vessels fishing for anglerfish (Anon, 2001) and records obtained from the current Scottish tallybook scheme indicate generally very low levels of discarding.

6.1.6 Natural mortality and maturity

A value of 0.15 is assumed for natural mortality for all lengths and years. Length at 50% maturity is estimated to be 93 cm for females and 57 cm for males (Anon, 2001). More details can be found in Section B2 of the Stock Annex.

6.2 Anglerfish in the North Sea & Skagerrak

6.2.1 The fishery

Details can now be found in Section A.2 of the Stock Annex.

Data extracted from the provisional STECF database indicate that most of the officially reported landings of anglerfish in Sub-area IV in recent years are from otter trawlers with mesh sizes >=100mm (Figure 6.2.1a) with smaller amounts taken by small meshed otter trawlers and gillnets. Landings in this short time series are generally lower in quarters 3 & 4. These data should be treated as very preliminary as not all nations have contributed complete datasets to the database.

Norwegian landings by gear type are shown in Figure 6.2.1b. The largest proportion of the landings is taken by coastal gillnetters in the years 2003-2005. There has been an apparent reduction in the landings by shrimp trawlers over this time period.

In UK (E&W), where anglerfish are caught they are a relatively minor component of the total landings (associated with anglerfish) in recent years in Sub-area IV. In the North Sea, plaice make up the largest component of the landings of vessels other than gillnetters, while for gillnet vessels, anglerfish and in 2005, red crab are the most important species by weight (Figure 6.1.3).

Species composition of the Danish anglerfish fisheries in the North Sea is described in section 6.2.1.3 (‘The fishery in 2005’) while the species composition Scottish fisheries catching anglerfish across the Northern Shelf are described in Section 6.3.

6.2.1.1 ICES advice applicable to 2005 and 2006

The ICES advice applicable to anglerfish in the North Sea in 2005 and 2006 has been the same as that for Sub-area VI.

The ICES advice for 2005 (Single Stock Exploitation Boundaries) was as follows, and applies to Subarea VI, Subarea IV and Division IIIa:

“The effort in this fishery should not be allowed to increase and the fishery must be accompanied by mandatory programmes to collect catch and effort data on both target and bycatch fish.”

The advice for 2006 in terms of single stock exploitation boundaries is the same as that for 2005.

The mixed demersal fisheries advice for this area is that they should fish:

- with minimal bycatch or discards of cod;
- within the precautionary exploitation limits for all other stocks (see text table above);
- where stocks extent beyond this area, e.g. into Division VI (saithe and anglerfish) or are widely migratory (Northern hake), taking into account the exploitation of the stocks in these areas so that the overall exploitation remains within precautionary limits.
- with minimum by-catch of spurdog (see Volume 9, section 1.4.6), porbeagle and thornback ray and skate.

6.2.1.2 Management applicable

Year	Single stock exploitation boundaries (North Sea)	Basis	TAC (IIa(EC) & IV)	% change in F associated with TAC	WG landings
2002	5700	2/3 of the catches in 1973-1990	10500	-	10289
2003	<6700[1)]	Reduce F below $\mathbf{F}_{pa}$	7000	49% reduction	8268
2004	<8800[2)]	Reduce F below Fpa[2)]	7000	48% reduction	9027
2005	-	No effort increase	10,314		n/a
2006	-	No effort increase	10,314[3)]		

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)] Subject to in year review.

6.2.1.3 The fishery in 2005

Scottish vessels account for more than 70% of the reported landings from the Northern North Sea. The Danish and Norwegian fleets are the next most important exploiters of this stock. A brief description of the fisheries of these three countries follows:

The U.K. (Scottish) fishery for Anglerfish in the North Sea

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. The fishery to the north and west of Shetland operates as an extension to that in Division VIa and is mainly by light trawlers targeting mixed round-fish. The highest reported landings in 2005 come from the statistical rectangles around Shetland. The landings from the fishery at the Fladen are lower with anglerfish caught as a by-catch in the *Nephrops* fishery which consists of approximately 200 vessels in 2005.

The Danish fishery for Anglerfish in the North Sea and Skagerrak (IIIa)

According to the most recent information (logbook records for 2005), the geographical distribution of the Danish fishery for anglerfish is as shown in Fig. 6.2.2 for 2005 (quantity of landings by ICES rectangle). The majority of Danish anglerfish landings are taken in the north-eastern North Sea, in the part constituting the Norwegian Deeps, situated in the Norwegian EEZ of the North Sea. The other main fishing areas for anglerfish are the Fladen Ground (also in IVa) and in the Skagerrak (IIIa). From Table 6.2.3 and Figure 6.2.3, it appears that almost 90% of the Danish landings come from ICES Divisions IVa and IIIa. The remaining part is from the northern part of Division IVb.

The majority of the Danish vessels taking anglerfish with demersal trawls are trawlers, which can be distributed according to length group as shown in Figure 6.2.4.

Table 6.2.3 A shows the distribution of Danish landings in the North sea and IIIa according to fishery defined by gear type and mesh size as currently used by Danish Fisheries Directorate for the North Sea, see text table below.

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

This classification of the Danish fisheries is not as detailed as recommended by the most recent EU Expert WG on management of fishing effort 13-17 March 2006 (SGRST 06-01). However, in relation to evaluations and management of the Danish fisheries for anglerfish it is sufficient at present, with the further specification that the main Danish catches of anglerfish are taken by fisheries in the Norwegian zone of IVa applying demersal trawls with mesh size >= 120 mm. In recent years the fishery with demersal trawl in the Norwegian Deeps (in the Norwegian zone) has accounted for around 70 % of total Danish landings by all gears from the entire North Sea. In the Skagerrak (IIIa) the main fishery taking anglerfish is the *Nephrops* fishery, but the demersal trawl fishery also takes a significant part of the landings here. In IIIa the by-catch from the shrimp (*Pandalus*) fishery is the 3rd largest component of the total in this area.

Information on the species composition of the landings from Danish fisheries taking anglerfish is available from the Danish logbook records. Table 6.2.4 shows the species composition in landings from the Norwegian Deeps by the main gear used in this fishery (trawls with mesh size >= 120 mm) for 2004 and 2005. The relative species composition appears to be rather similar for these two recent years. Anglerfish constitutes around 13% by weight of the landings, while the most important species by weight is saithe.

In addition to the logbook information, more detailed information of the composition of the catch, including the discard component is available for 2005 from the Danish at-sea-samples conducted in the 1st and 2nd quarter of 2005 in fishing trips for anglerfish and other demersal species (mesh size = 122 mm). In these samples anglerfish constituted around 25% by weight of the landed component of total catch. This is a much higher fraction than recorded by logbooks. However, the logbook records also include many trips directed more at other species including Nephrops and therefore the overall percentage here is smaller. It is however noted that the overall patterns in species composition are similar, see Figs.6.2.5 and 6.2.6. Cod, saithe and Nephrops and to a lesser extent haddock, ling and witch flounder seem to be the other important components of the landings. The logbook data on landings composition are also available. The at-sea-samples also provide data on corresponding discards as shown in Figure 6.2.7. Note here the dominating ‘other species’ component. Cod also appears to be a significant component of the discards. One must be cautious to extrapolate to total discards corresponding to total landings from these few samples (Table 2.3).

The Norwegian fishery for Anglerfish in the North Sea

This overview is based on Norwegian sale slips data. The majority of the Norwegian anglerfish landings from Sub-division IVa are taken in the directed, coastal, gillnetting fishery (Figure 6.2.1b). The remaining 30-40% of the Norwegian landings from IVa is mostly taken as bycatch in different trawl fisheries. A similar pattern is found for Skagerrak (IIIa) (Table 6.2.5), but some of the directed fishery is carried out further from the coast. The third quarter has, in recent years, been the most important season for the directed fishery, while the second quarter seems to be more important for other gears.

6.2.2 Catch data

The official landings for each country are shown in Table 6.2.1. Minor updates have been made to reported landings for the years prior to 2005. Landings in 2005 as reported to ICES for the total North Sea were around 9,400 t, which is about 400 t lower than that in 2004. This is due to the absence of officially reported landings from Denmark who in previous years have taken around 1500 t from the northern North Sea (Danish landings as supplied by national scientists are shown in Table 6.2.3). The official landings from the Northern North Sea account for approximately 90% of the total North Sea figure. The UK are still by far the largest exploiter of the Northern North Sea fishery accounting for around 70% of official landings in 2004. Denmark and Norway are the next most important exploiters of this stock, with landings of approximately 20% and 10% respectively, of the total reported to ICES.

There has been substantial misreporting of catches into the North Sea in recent years, due to the existence of a restrictive precautionary TAC in the adjacent VIa fishery (See Sections 6.1.2.2 and 2.1.2 for further details). A precautionary TAC was first set for the North Sea and Division IIa (EU) in 1999 and by 2002 had been reduced to 10,500 t. The TAC for 2003 & 2004 was set at 7000 t (a substantial reduction on 2002), but has been increased in 2005 & 2006 to 10,314 t. Table 6.2.1 also includes the Working Group estimates of landings from Sub-area IV which have been adjusted to incorporate this misreporting from Division VIa. The unallocated catches do not just include misreporting by area, but also account for differences between landings statistics officially reported to ICES and those obtained by national scientists. The historical trend in WG estimates of landings in the North Sea is shown in Figure 6.2.8 for the years to 2004. Due to technical problems associated with changes to the Scottish Executive database (See section 2.13), Scottish official landings by statistical rectangle are unavailable for 2005 and so it has not been possible to make this area correction in 2005. Landings of Anglerfish in Division IIIa as officially reported to ICES are given in Table 6.2.2, with landings figures for a longer time period given in Figure 6.2.9. Over 1975-1990, annual landings were close to 550 t. After this period there was a sharp increase to a peak of 938 t in 1992, since when landings gradually declined to 500 t in 2004. The officially reported landings in 2005 are 163t which is approximately 350t less than in 2004. This is mainly due the absence of Danish official landings in this year. Denmark usually take the highest proportion of the landings (over 50%), followed by Norway. The post-1990 increase in landings is attributable to increases in the landings by both of these nations. Landings from Division IIIa represent only a small proportion of the total Northern Shelf landings, with the proportion varying between 1% and 9% over 1973-2005.

6.2.3 Commercial catch-effort data

Denmark

Danish logbook data for Anglerfish landings and corresponding effort by main fishery in the North Sea and IIIA for the period 1996-2005 are shown in Table 6.2.3. and Figure 6.2.10 specified on the main fisheries (defined by gear). Trends in LPUE based on the logbook records are presented in Figure 6.2.11 and Table 6.2.6 and are further discussed in Section 6.2.7.

Norway

Available logbook data from Norwegian trawlers were examined for the possibility of establishing a CPUE time series for anglerfish. However, several problems were encountered in the dataset, and it was at present considered insufficient for providing any reliable information on trends in stock abundance.

In late 2005, six gillnetters were included in a self-sampling scheme established along the Norwegian coast within IVa and IIIa. Detailed information about effort, catch and length distribution is provided through this scheme, and will potentially be valuable in future assessments of anglerfish in this area.

U.K. (Scotland)

Reliable logbook based effort data (in terms of hours fished) were not available from the Scottish trawl fleets due to changes in the practices of effort recording and non-mandatory effort recording in recent years. Further details can be found in Section B4 of the Stock Annex and the report of the $WGNSSK_{2000}$ (ICES, 2001). Effort, in terms of 'days absent' for the Scottish trawl fleets operating in this area is illustrated in Figure 6.1.8 for a range of gear types for the years 1999-2004. The bottom otter trawler category contribute most to the effort in the North Sea, but most gears seem to have shown a slight decline in reported 'days absent' over this time period. The equivalent officially reported landings data are shown in Figure 6.1.9 which in indicate a decline in reported landings over the years 2001-2003 with a leveling off in 2004. LPUE are not presented due to concerns over the accuracy of the official reported landings.

The catch rate information from the Scottish tallybook and observer schemes is further discussed in section 6.3.2 which covers the whole of the Northern Shelf.

UK (E &W)

Officially reported UK (E&W) effort in terms of number of days fished in association with anglerfish landings is shown by area in Figure 6.1.11 broken down by gear category. Total effort in gears other than the gillnet fishery has shown a decline since 1993. This is largely driven by the effort trend in the central and southern North Sea. Reported effort in the UK (E&W) North Sea gillnet fishery has also shown a decline in recent years.

6.2.4 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 and are not considered further in this section. As a result of this conclusion, and the urgent requirement for fishery independent data, FRS, Scotland began a new joint science/industry survey in 2005. The survey was conducted in Sub-area VI and sub-area IV and further description and illustration of the preliminary results can be found in Section 6.3.3 which considers anglerfish across the whole Northern Shelf.

6.2.5 Length compositions

The countries supplying relevant data this year are shown in Table 2.2, with levels of sampling in Table 2.3. North Sea Scottish market sampling data by gear category were presented to the WG, but were not considered useful in identifying any population trends (see section 6.1.5) and are not presented here, but retained in the stock file. Mean lengths from the Scottish market sampling length frequency data are shown in Figures 6.2.12. There do not appear to have been any significant changes in the average size of large and small individuals being caught (officially landed) over the time series of data available.

Danish samples of landed catch in the port of Hirtshals for size (length) measurements are available for 2002-2005 and shown in Figure 6.2.13. It seems that the 2002 samples indicate more large individuals in the landings, However, sample size is small (anglerfish is an expensive species), and the samples do not indicate any significant changes in size composition of the landings during this period.

Data on the size composition in the catch are available for the 3 years 2003-2005. The data include Norwegian at-sea-samples of Danish bottom trawlers fishing in the Norwegian Deep

(Figure 6.2.14a). Note the recruiting size-(age-) group in 2003 and even more conspicuously in 2005. The size composition of the catch in these 2 years could indicate a large recruiting size (age) groups in the stock. This interpretation is qualitatively confirmed by the fishing industry's information of large amounts of small specimens in the catches in 2005 and 2006. Additional data on size composition in offshore fisheries in the eastern part of Div. IVa are provided from the Norwegian at-sea-sampling during 2005 (Figure 6.2.14b). The main Norwegian fishery in IVa, coastal gillnetting, was not sampled during 2005, but qualitative information from the fisheries indicates a similar size composition as seen in IIa (see section 6.4).

6.2.6 Natural mortality and maturity

A value of 0.15 is assumed for natural mortality for all lengths and years. Length at 50% maturity is set to 93 cm for females and 57 cm for males. More details can be found in Section B2 of the Stock Annex.

6.2.7 Analysis of LPUE data

The Danish LPUEs are based on logbook records. Figure 6.2.11 shows the trends in LPUEs for the main fisheries as mentioned in Sect. 6.2.3. Of relevance is the series for the demersal trawl fishery in the North Sea and in particular the series for this fishery in the Norwegian Deep as this is the fishery where most anglerfish is taken. Note the upwards trend, especially from 2003 to 2004 for all fisheries and the subsequent stabilisation or even slight decline of the LPUE level in 2005. Similar patterns can be seen in time series for III A (Skagerrak).

The LPUE in a number of the fisheries had shown an increase in 2002-2004. However, this trend seems to have levelled off in 2005. Anecdotal information from Danish fishermen suggests that this apparent levelling off is due to the TAC constraints on the Danish fishery in the Norwegian EEZ in 2005 which was not in evidence in previous years. In 2005 a TAC of 1800 t was negotiated for Danish landings from the Norwegian zone. Danish landings for IIIa and the North Sea in 2005 amounted to 1884 t (Table 6.2.3) but the WG was unable to partition these into landings from the EU and Norwegian zones separately and therefore was unable to confirm this suggestion.

Scottish LPUE as estimated from officially reported landings and effort are not considered to be a good indicator of trend in stock abundance due to the inaccuracy of the official statistics. However attempts have been made in recent years to obtain more reliable fishery data directly from the fishing industry and this is discussed in further detail in Section 6.3.2.

6.3 Anglerfish on the Northern Shelf (combined IIIa, IV and VI)

The fishery

Working Group estimates (which do not account for underreporting) of the total landings (up to 2004) of anglerfish from the Northern Shelf are given in Table 6.3.1. WG estimates cannot be made for 2005 due to technical difficulties with the Scottish Executive fisheries database (see section 2.13). During the 1970s landings were fairly stable at around 9,000 t, but from about 1983 they increased steadily to a peak of 35,100 t in 1996, since when there has been a sharp drop to the 2004 landings of 12,823 t which are very similar to those from 2003. This overall trend is driven by the catches in the Northern North Sea and West of Scotland. Together these two areas account on average for 75% of the total landings over 1973-2004. The catch trends in these two areas are similar, with a steady increase in landings from 1984 onwards resulting from Scottish vessels starting to fish specifically for anglerfish where previously the species had only been taken as a by-catch. A more detailed description of the fishery and management advice for the separate Sub-areas can be found in sections 6.1 & 6.2 and Section A.2 of the Stock Annex.

The main fleets catching anglerfish in Scotland consist of mixed demersal trawl fisheries operating along the shelf-edge in both Divisions VIa and IVa and a more inshore Nephrops fishery in which anglerfish is an important by-catch. 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 fishing trip records. An ‘anglerfish fishery’ area was defined as the combined area of high abundance (catch-rates) from the FRS/industry survey (section 6.3.3) 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 the in ICES WGs. Figure 6.3.1 shows the distributions of the Nephrops areas in relation to the anglerfish area described above. The areas are mostly separate but where overlaps occur (usually statistical rectangles on the outer margins of Nephrops areas, shown in black) 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 metier has a mixed species catch composition with haddock being the most important species and anglerfish and cod the next most important (Figure 6.3.2). In the Nephrops area the largest overall landings associated with anglerfish come from the <100mm gear category with the dominant species being Nephrops, followed by haddock and anglerfish. The picture is fairly consistent between 2003 and 2004.

Anglerfish appear to contribute relatively low proportions to the landings in most of the metiers described and as such it is difficult to identify an ‘anglerfish fishery’. Discussion with individual Scottish skippers suggests that even within a single statistical rectangle, catch composition can vary a great deal particularly where the bathymetry changes rapidly and therefore using statistical rectangles to define fisheries may be inappropriate. The cluster analysis performed on individual landing records from ICES area IV (Clarke, 2004) showed that a relatively clean anglerfish fishery in terms of catch composition could be identified. Further analysis of the main, large mesh trawl metier operating in the ‘anglerfish area’ is required to provide a more comprehensive picture of catch composition. This was beyond the scope of this WG.

6.3.1 Commercial CPUE analysis

Given the recent concerns over the official fishery data (catch and effort) and a lack of reliable information from surveys, the WG was again unable to present an analytical assessment for anglerfish. Prior to last year’s WG, information from Scottish fishermen’s diaries was collected in an attempt to improve the quality of available commercial information. An analysis was presented at last year’s WG which indicated increasing catch rates across all areas of the Northern Shelf. Although the analysis proved useful, the diary data were provided by a relatively small number of vessels and it was not known to what extent these were representative of the fisheries as a whole.

Tallybook data

In order to expand this information, FRS (in consultation with the fishing industry) have recently established a new monkfish tallybook project. The project is being operated in conjunction with fisher’s organisations who are responsible for distributing the tallybooks, co-ordinating the returns and allocating a vessel code before the data 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.

So far, the time series is short, with the first returns from fishing trips at the end of December 2005 and the most recent from the first week of April 2006. Returns have so far been received from 36 vessels (over 3000 hauls in total) with a wide spatial coverage (Figure 6.1.12) and different target species. Of the 36 vessels which have so far supplied information, 2 are French and these are operating towards the southern end of the shelf edge in Division VIa northwest of Ireland. The depth distribution of the haul information collated so far is shown in Figure 6.1.13. Most hauls are taken in depths between 100 & 400m although there are a significant number of hauls from depths between 600 & 800m. 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 calculated from the diary data provided last year and range from around 10 Kg/hr for boats targeting Nephrops to over 100 Kg/hr for some whitefish boats.

Some of the vessels which provided diary data are now participating in the tallybook scheme and it has been possible with the help of the fisher's organisations involved, to match up the data from the two collection schemes for these vessels. Mean first quarter catch rates from these vessels are shown in Figure 6.3.3. It is difficult to conclude whether there has been any overall change in catch-rate in the most recent year: some vessels appear to have experienced an increase in catch rate in the 1st quarter of 2006 compared to the years prior to 2005, while others have experienced a decrease or no change. It should be emphasized here that the data presented for these vessels in quarter 1 of 2006 are not necessarily complete as analysis has only been conducted of data which were actually received prior to April 1st 2006.

Observer data

FRS Marine Laboratory has conducted an on-board commercial vessel observer programme for over 30 years and these data are regularly fed into the ICES assessment Working Groups. Data on anglerfish observed catches are available since 1999 and were included in analysis of catch rates for the STECF review group meeting including data collected as recently as the first quarter 2006. As part of the enhanced programme of work on anglerfish, including survey work and the collection of tally book data from fishermen, additional sampling was begun in 2005 by the Shetland Fishery College (under contract to FRS). This has continued and been further enhanced in 2006 and the total number of trips undertaken in the first quarter is shown in the text table below. FRS routinely carries out around 14 observer trips in the first quarter so the additional sampling represents a doubling of observer effort.

FRS Demersal Observer Trips	14
FRS Nephrops Observer Trips	2
Extra FRS Anglerfish Observer Trips	4
NAFC Anglerfish Observer Trips*	6
SFF Observer Trips+	2
	Total Trips 28

*** fully funded by FRS**

+ part funded by FRS/part by SFF

Figure 6.3.4 shows the spatial distribution of all observer trips between 1999 and 2006 together with the catch rates. Results suggest an increase in catch rate in recent years, particularly along the continental shelf edge although the inter-year spatial variability in sampling and the changing sampling numbers confound the interpretation.

Figure 6.3.5 shows the distribution and catch rates observed in the first quarter of 2006. Despite some variability between samples taken in the same statistical square, there is nevertheless a pattern of higher catch rate close to the continental shelf and lower values in shallower water. This distributional pattern is further shown in Figure 6.3.6 which plots average catch rates by statistical square for the entire data series. It is possible to subdivide the data into the different gears operating in different parts of the overall anglerfish distribution. Figure 6.3.7 shows the results for light and heavy trawl while Figure 6.3.8 shows Nephrops trawl results. The former operate widely over the northern North Sea and offshore west of Scotland where catch rates were highest while the latter are restricted to areas of soft mud bottom and tend to have lower catch rates.

Annual catch rates were initially calculated using all data from all years. However, catch rates are known to vary seasonally (with generally lower rates occurring in the second and third quarters) so the data were split by quarter so that the 2006 data (quarter 1 only) could be more appropriately compared to the earlier part of the time series. In 2006, the Scottish observer programme has intentionally concentrated extra sampling in the areas of known higher densities of anglerfish (in order to obtain more information on the main fisheries) and therefore the data are further sub-divided into 'anglerfish fishery' and 'nephrops fishery' areas for appropriate comparison. Figure 6.3.9 shows the trends in catch rates in quarter 1 from these two areas. Although the data are noisy, increases in catch rate are apparent in recent years in both the 'anglerfish fishery' and 'Nephrops fishery' area. Absolute catch rates are, as expected much higher in the 'anglerfish fishery' area than in the 'Nephrops fishery' fishery.

As noted earlier, the spatial coverage of the Scottish observer programme has changed over the years. In recent years, observed catch rates have generally gone up, but it is yet unclear whether this was restricted to the core distribution area, and to what extent the change in spatial coverage of the observer programme might have blurred our view.

At the recent STECF review group meeting on anglerfish, a preliminary statistical analysis of these data was carried out and the results are summarised in the following discussion. The data used in the analysis consisted of mean landing per unit effort (LPUE) by year, quarter, gear type (heavy trawl, light trawl, Nephrops trawl, pair trawl and seine) and ICES rectangle. Data by haul were already aggregated by rectangle, so the number of hauls per rectangle was used as a weighting factor in the analysis. The number of hauls and observations is shown in Table 6.3.2. A generalized linear model assuming Poisson error and a log link function was used to model LPUE as a function of year, quarter, gear type and rectangle. Potential density dependence was analysed by 'Mandel's bundle of straight lines' model (Mandel 1959, Milliken and Johnson 1989) which allows for the estimation of density dependent trends, but using a limited number of parameters. The model explained around 80% of the total deviance and although density dependent changes in the distribution pattern of catch rates were statistically significant they explained only 1% of the total deviance (Table 6.3.3).

The predicted spatial distribution of the LPUE (corrected for gear and temporal trends) is shown in Figure 6.3.10 and the annual trends predicted by the model are shown in Figure 6.3.11. The mean observed LPUE (Table 6.3.4) differs substantially from the mean predicted LPUE (Table 6.3.5 and 6.3.6). Most notable is that the pronounced rise in mean LPUE observed since 2003 (three-fold or more) is not completely reflected in the predicted LPUE. This indicates that during these years the sampling programme has unintentionally concentrated on the rectangles of high anglerfish catches. To conclude, after accounting for temporal and spatial changes in sampling intensity a doubling in catch rate remains (Table 6.3.6). The predicted LPUEs from this analysis are remarkably similar to those observed in the main Danish fisheries in Division IIIa and the Norwegian Deeps for the years since 2000. (Compare Figures 6.2.11 and 6.3.11).

The lower bounds to the 95% confidence intervals per year and quarter are listed in Table 6.3.7. On average, the lower bounds of the 95% confidence intervals for the years from 2004 onwards are approximately equal to the best estimate of the preceding years, that is: the increase is not statistically significant.

Some further exploratory statistical analyses, using the previously defined Scottish anglerfish fishery areas (‘anglerfish area’, ‘nephrops area’ and ‘other area’) to subset the observer data were conducted at this WG (not presented). Year trends from a GLM were similar to those obtained from the analysis described above, and again the confidence intervals for the more recent years included the estimates of the previous years.

It should be noted that all the analysis presented here is based on data aggregated at the rectangle level. Furthermore, no account has been taken of fishing depth or changes in vessel size/power (although a vessel type effect has been modelled). Re-analysis using the more detailed haul by haul data may yield different results.

6.3.2 Research vessel surveys

This WG has previously concluded that the traditional groundfish surveys do not provide a reliable indication of anglerfish stock size and as a result, FRS Marine Laboratory began a series of specific anglerfish surveys in November 2005 in collaboration with the fishing industry. The survey protocol was drawn up by an industry-science planning group which means that fishermen’s expertise has been incorporated in various aspects of the survey such as: gear and duration and position of hauls. The survey area was split into four areas, each covered by a different vessel, with the perimeter of the survey area being defined by the bathymetry of the sea bed. The survey has a stratified random design: 3 depth strata (0-200m, 200-500 m and 500-1000 m) with different sampling intensities (per unit area) in each stratum. Figure 6.3.14 shows the area which was surveyed by the three chartered fishing vessels and RV Scotia. All vessels used the same fishing gear which is illustrated and described in Figures 6.3.12-13 and Table 6.3.9.

Figure 6.3.14 shows the survey density in terms of Kg/km^2. The highest density is located along the shelf edge to the north and west of Scotland, and at Rockall. In addition there are likely to be other areas of high density further to the south in areas fished by Ireland and France but not covered in the Scottish survey. Survey density by statistical rectangle is shown in Figure 6.3.15 along with a histogram showing the distribution of densities from the survey. There appears to be a relatively high number of low density areas. Using the distribution of survey densities presented by statistical rectangle, those rectangles with density above the median (Figure 6.3.15) were defined as areas important for anglerfish and included in the ‘anglerfish fishery’ area for the purposes of the definitions used in section 6.3.1.

The aim of the survey in the first year was to obtain a swept area estimate of the total abundance of anglerfish on the Northern Shelf. However, until the results from an associated project on anglerfish catchability are available such estimates cannot yet be provided. As the time series increases, the length (and possibly age-) structured data will be analysed using survey based assessment methods. It is also anticipated that the survey will provide further useful information on the biology and stock structure anglerfish. The next survey is scheduled for November 2006.

6.3.3 Reference points for Management evaluation

ICES has proposed $F_{35\%SPR}$ = 0.3 be chosen as $\mathbf{F}_{pa}$ (derivation unknown). There are uncertainties in the calculation of F as it is not know to what extent models based on dynamic pool assumptions are appropriate for anglerfish.

6.3.4 Quality of the assessment

This WG has previously attempted assessments of the anglerfish stock(s) within its remit using a number of different approaches. As yet none have proved entirely satisfactory. The catch at length analysis used in previous years appears to have addressed a number of the suspected problems with the data due to the rapid development of the fishery, and has also provided a satisfactory fit to the catch-at-length distribution data. However, this year, as last year, the WG has been unable to present an 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 traditional assessment model are valid for anglerfish.

6.3.4.1 Commercial data

For a number of years the WG has expressed concerns over the quality of the commercial catch-at-length data because of:

- Lack of French length distribution data for Division VIa in recent years. French vessels now account for more than half of the officially reported landings from this area;

- Lack of information on total catch and catch composition of gillnetters operating on the continental slope to the north west of the British Isles (See Section 6.1.1.3), and,

- Accuracy of landings statistics due to species and area misreporting.

As discussed in Section 6.1.2.2, the TAC across the Northern Shelf has apparently been very restrictive in the years 2003-2005, implying an increased incentive to misreport or discard catches. The TAC for 2005 was increased, but there are still problems in obtaining reliable effort information due to non-mandatory effort (in terms of hours fished) reporting in some of the main fleets in recent years.

The recent Scottish tallybook has been implemented as part of a long term approach to provide better information on the fishery. Although the time series of data is currently short, the scheme has the potential to deliver relatively extensive information on spatial and depth distribution of catch rates provided that participation remains high. In addition to total catch rate information, the fishermen are also asked to provide information on landings by size category, discards, catches of mature females and by-catches of other species.

6.3.4.2 Survey data

In addition to obtaining estimates of abundance from swept area methods (and in future a times series of data for use in survey based assessments), it is hoped that on future FRS/industry anglerfish surveys, a visual count method will be developed to provide alternative estimates of anglerfish density. Initial trials with UWTV gear used in Nephrops surveys proved unsatisfactory because the current TV camera setup can only be towed at a very slow speed which means that only a very small area can be covered, making sightings of anglerfish very unlikely. In addition, the equipment needs to be modified so that it can be deployed in the often poor weather conditions encountered on surveys which take place during winter. It is also anticipated that the new FRS/industry survey will provide further useful information on the biology and stock structure of anglerfish. During the survey, 24 live anglerfish were tagged with data storage tags which when recovered will provide information on the vertical migration, depth distribution and temperature regime of individuals.

The more southerly regions of the Northern Shelf stock of anglerfish are not covered by the Scottish survey and the participation of other nations in a collaborative survey would be particularly valuable.

6.3.4.3 Biological information

Despite a recent EU funded report, the biology and distribution of anglerfish on the Northern Shelf is still not well understood. It has been highlighted at previous WGNSDS meetings that some of the basic biological parameters used in the assessments should be regarded as quite uncertain. New growth parameters obtained from a survey in Division VIa have been used in previous length-based assessments of this stock last year and although these should still be regarded as uncertain, the analysis showed that the outcome of the assessment was relatively insensitive to the changes. Recent growth studies by Laurenson and Johnson (In press) have obtained similar growth parameters to those previously used. A further discussion of the biology can be found the sections below.

6.3.4.4 Stock Structure

Currently, anglerfish on the Northern Shelf are split into Sub-area VI (including Vb(EC), XII and XIV) and the North Sea (& IIa (EC)) for management purposes. However, recent genetic studies have found no evidence of separate stocks over these 2 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 (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 (Sub-area VII) could also be part of the same stock.

Following the recent expansion of the anglerfish fishery in ICES Divs. IIa and V, last year the WG group was asked to consider the stock structure on the wider Northern European scale (Section 16 of the WGNSDS_{2004} report). It was concluded that there was currently insufficient information to conclusively define new stock areas for assessment and further co-ordinated work is still required. Given the request to also assess anglerfish in Division IIa and that there may be an extension to include ICES Division V in the near future, the likely spatial disaggregation of the stock (drift of larvae and possible migration of mature fish back into deeper water) means that any assessment model would need to be spatially structured, possibly supported by assessments for each of the stock units separately. Given the problems with data quality in the current Northern Shelf anglerfish assessment, the WG wishes to highlight fundamentals required for a wider area assessment

- Accurate information on the spatial distribution of catch and effort;
- Data on movement and migration of mature and immature individuals; and,
- An internationally co-ordinated, dedicated anglerfish survey over the wider Northern European area to include deeper waters, waters further east and previously unsurveyed areas in order to obtain information on spatial abundance.

6.3.4.5 Model Formulation

Although the catch-at-length analysis which has previously been used to assess anglerfish tackled a number of the problems associated with this stock (uncertainty in age-reading and rapid development of the fishery), it is still not known whether the dynamic pool assumptions made in this, and other more traditional assessment methods are appropriate for this stock.

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 U.K. landings only (in sub-divs. 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 U.K.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 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).

6.3.5 Management considerations

TAC development

The reduction of the TAC for 2003 to almost two thirds of that in 2002 (15,270 t) was based on the advice that F should be below $\mathbf{F}_{pa}$ This TAC was retained in 2004 and anecdotal information suggests that these reduced TACs were highly restrictive, and resulted in high levels of misreporting. The TAC was increased in 2005 (although considered still to have been restrictive) and has remained at the same level in 2006, but subject to an in year review. These data deficiencies prevent reliable estimation of the current level of fishing mortality and appropriate TACs.

The SGRST review group on anglerfish was unable to suggest an exact figure for the updating of catch limits for 2006 based on rising trends in catch rates. They instead decided to recommend to increase the current TAC by a modest 10% conditional on a re-evaluation of the upward trend in the abundance of the stock in one year (spring 2007). It was also stated that if and when the higher catch rates, observed in the past-2003 period in comparison to the preceding years, are discontinued or there is inadequate evidence to prove this beyond reasonable doubt (statistical significance), the raise in TAC should be discontinued. When a comprehensive assessment of the stock becomes available, this should of course override the current advice.

Perception of the state of the stock based on available information

The analysis presented this year and last (diary data, Danish LPUE & observer data) indicate increased commercial catch rates in recent years. The diary data analysis presented last year was based on limited data set and the WG had reservations about concluding that this was a reflection of increasing stock size. However, these increased catch rates are also evident (although somewhat uncertain) in the analysis of Scottish observer data presented this year and the stock certainly does not appear to be exhibiting a decline. In addition, there is no sign of a reduction in mean size of the stock (calculated from landings length frequencies) and there are indications from the Danish fishery at least, that recruitment is still relatively strong (Fig 6.2.14).

Mixed fishery and technical considerations

The advice provided by ICES last year for this stock was that effort should not be allowed to increase in this fishery until more reliable information can be obtained about the level of catches. (Section 17 gives more details of fishery effort). However, recent attempts (SGRST-06-03 and this report) at actually defining anglerfish fisheries have shown that the vast majority of the catch of anglerfish stems from mixed fisheries, catching sole, saithe, plaice, megrim, *Nephrops*, haddock and cod, amongst others, with the landings of anglerfish actually being a relatively low percentage of the total. Optional effort restrictions aiming at a recovery of these other species will have a side-effect for the anglerfish too, but a shift from anglerfish-poor areas to anglerfish-rich areas might annihilate this effect. However, the statistical analysis of Scottish observer data did not show evidence for such shifts in the recent past.

The length-distributions obtained from sampling the Scottish and Irish landings indicate that the fishery is mainly conducted on the immature part of the stock, and therefore any management should ensure that enough fish are left to contribute to spawning. The body shape of anglerfish means that even at small sizes, they are easily retained by minimum mesh sizes currently in operation.

Length-frequency samples obtained from Norwegian and Danish fisheries operating in the deeper waters of the North Sea (mainly in the Norwegian deeps)) contain a higher proportion of larger fish.

In addition, if the deep water off the edge of the continental shelf is acting as a refuge to the spawning component of the stock, then further expansion of the fishery into deeper water is undesirable. Given the spatial development of the fishery, it cannot be ruled out that serial depletion of fishing grounds is occurring.

Largely as a result of the DEEPNET report, which raised concerns about the deepwater tangle net fisheries for monkfish (section 6.1.1.3) and deepwater sharks, EU Regulation 51/2006 has banned the use of gillnets outside 200m depth. This ban may have caused a shift in effort to other areas. The ban is not considered permanent and the EU have indicated that they are willing to open the fisheries again if a management framework can be agreed.

Stock structure

As the fishery operates primarily across VI and the North Sea, and there is no evidence to indicate that these comprise separate stocks (see EC 98/096 and Sullivan et al., 2005), the WG suggests that in the future it provides assessments based only on the combined area stock unit. This does not necessarily preclude the use of assessment methods which may take account of finer-scale spatial effects, or of the setting of separate area TACs.

Since there is also no evidence to suggest that the area to the south and west (Division VIIb) is part of a separate stock either (Section 6.3.4.4), the WG considers that it may be more appropriate to consider the assessment of Northern Shelf anglerfish within the remit of the WGHMM.

6.4 Anglerfish in Division IIa

6.4.1 The fishery

The fishery for anglerfish in Division IIa expanded during the 1990s, when a Norwegian gillnet fishery was developed in coastal areas which has normally been carried out by one-man vessels operating with 360 mm gillnet. Further descriptions of the fishery were given in WD 11 of the 2004 WGNSDS. The current Stock Annex for anglerfish only applies to anglerfish in IIIa, IV and VI. A separate Stock Annex could be included for anglerfish in IIa before the next WGNSDS.

6.4.1.1 ICES advice applicable to 2005 and 2006

There was no ICES advice applicable to anglerfish in Division IIa in 2005 and 2006.

6.4.1.2 Management applicable in 2005 and 2006

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 that 360 mm gillnets, a discard ban on anglerfish regardless of size, a maximum of 10 % bycatch of anglerfish in the shrimp trawl fishery, maximum 30 % bycatch of anglerfish in the trawl and Danish seine fishery, 48 hours maximum soak time in the gillnet fishery, 500 gillnets (each net being 27.5 m) pr vessel, a closure of the gillnet fishery from 1 March to 20 May.

6.4.1.3 The fishery in 2005

There has been an expansion of the fishery in recent years. This is largely due to a northward expansion of the Norwegian gillnet fishery (Figure 6.4.1). The official landings from the areas north of 64° account for approximately 45% of the total figure for Division IIa in 2004. Norway is by far the largest exploiter of the IIa fishery accounting for over 95% of official landings. Germany is the next most important exploiter in this area, with landings of approximately 2% of the total reported to ICES (Table 6.4.1). The coastal gillnetting accounts for 85% of the landings, while 4% is taken as bycatch in different offshore gillnet fisheries (Table 6.4.2).

6.4.2 Catch data

The official landings for each country are shown in Table 6.4.1. Landings in 2005 as reported to ICES for the total Division IIa were 2,672 t, which is 350 t lower than the year before. No information suggests that the official landing figures from Norway give a biased estimate of the actual landings. The absence of a TAC in Norwegian waters probably reduces the incentive to underreport landings. Anecdotal evidence from the industry suggests that a small percentage of the catch (not marketable) might be discarded. This happens when the soaking time is too long, mostly due to bad weather.

6.4.3 Commercial catch-effort data

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, catch and length distribution is provided through this scheme, and will potentially be valuable in future assessments of anglerfish in this area.

6.4.4 Research vessel surveys

Anglerfish appears in demersal trawl surveys along the Norwegian shelf, but in very low numbers. There has been a change in the surveys, going from single species- to multispecies surveys, during recent years. The procedures for data collection on anglerfish have varied and, at present, no time series from surveys in Division IIa yields reliable information on the abundance of anglerfish.

6.4.5 Length and age compositions and mean weights at age

Some length distributions are available from the directed gillnetting during the period 1992-2005, but data are lacking 1997-2001 (Figure 6.4.2). The length data indicates a decrease in mean length of 15-20 cm in during the period without length samples. The mean length has increased somewhat during the last two years, but is still well below the level seen during the 1990s (Figure 6.4.3). One third of the anglerfish measured during the 1990s were above 100 cm, this proportion is 2% for the 2000s. For 2004 and 2005, some length data from anglerfish caught as bycatch in offshore gillnets are presented in Figure 6.4.4, showing somewhat smaller individuals being caught in these smaller meshed gillnets.

6.4.6 Natural mortality and maturity

Natural mortality and length at 50% maturity for anglerfish in Division IIa are believed to be similar to what has been used in the North Sea. Length at 50% maturity is probably around 90 cm for females and 57 cm for males (Dyb 2003, Woll et al. 1995).

6.4.7 Management considerations

The WG is concerned by 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. 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.

Stock structure

As the fishery operates primarily across VI and the North Sea, and there is no evidence to indicate that these comprise separate stocks (see EC 98/096 and Sullivan et al., 2005), the WG suggests that in the future it provides assessments based only on the combined area stock unit. This does not necessarily preclude the use of assessment methods which may take account of finer-scale spatial effects, or of the setting of separate area TACs.

Since there is also no evidence to suggest that the area to the south and west (Division VIIb) is part of a separate stock either (Section 6.3.4.4), the WG considers that it may be more appropriate to consider the assessment of Northern Shelf anglerfish within the remit of the WGHMM.

Table 6.1.1 Anglerfish in Sub-area 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*
Belgium	3	2	9	6	5	+	5	2	-	-	-	-	-	-	
Denmark	1	3	4	5	10	4	1	2	1	-	-	.	-	-	
Faroe Is.														2	2
France	1,910	2,308	2,467	2,382	2,648	2,899	2,058	1,634	.	1,132	943	739	1,212	1,191	1,193
Germany	1	2	60	67	77	35	72	137	50	39	11	3	27	39	
Ireland	250	403	428	303	720	717	625	749	617	515	475	304	322	219	
Netherlands	-	-	-	-	-	-	27	1	-	-	-	.	.	.	
Norway	6	14	8	6	4	4	1	3	1	3	2	1	-	-	1
Spain	7	11	8	1	37	33	63	86	53	82	70	101	196	110	
UK(E,W&NI)	270	351	223	370	320	201	156	119	60	44	40	32	31	30	
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	
UK (total)															1754
Total	5,061	5,479	5,553	5,273	6,354	6,408	5,330	4,506	2,470	3,311	2,660	2,280	2,493	2,453	2,950
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	6,269	6,425	4,728	4,162	3,478	4,391	

***Preliminary. [1]Includes VIb.**

Anglerfish in Division VIb (Rockall)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005*
Estonia														+	
Faroe Is.	-	2	-	-	-	15	4	2	2		1				
France	-	-	29	-	-	-	1	1	…[1]	48	192	43	191	175	221
Germany	-	-	103	73	83	78	177	132	144	119	67	35	64	66	
Ireland	272	417	96	135	133	90	139	130	75	81	134	51	26	13	
Norway	18	10	17	24	14	11	4	6	5	11	5	3	6	5	4
Portugal	-	-	-	-	-	-	-	+	429	20	18	8	4	19	
Russia	-	-	-	-	-	-	-	-	-	-	1	-	-		2
Spain	333	263	178	214	296	196	171	252	291	149	327	128	59	43	
UK(E,W&NI)	99	173	76	50	105	144	247	188	111	272	197	133	133	54	
UK(Scot)	201	224	182	281	199	68	156	189	344	374	367	317	160	294	
UK (total)															671
Total	923	1,089	681	777	830	602	899	900	1401	1074	1309	718	643	669	898
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	790	

***Preliminary. [1]Included in VIa.**

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*
Total official	5,984	6,568	6,234	6,050	7,184	7,010	6,229	5,406	3,871	4,385	3,969	2,998	3,136	3,122	3,848
Total ICES	6,280	9,206	10,050	8,816	12,296	18,158	13,735	10,640	9,475	7,516	5,875	4,832	4,126	3,296	

***Preliminary.**

Table 6.2.1 Nominal catch (t) of ANGLERFISH in the North Sea, 1991–2005, as officially reported to ICES.

Northern North Sea (IVa)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005*
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	^
Faroes	1	-	10	18	20	-	15	10	6	.	2	-	3	11	7
France	124	151	69	28	18	7	7	3	.	8	9	8	8	8	4
Germany	71	68	100	84	613	292	601	873	454	182	95	95	65	20	
Netherlands	23	44	78	38	13	25	12	-	15	12	3	8	9	38	
Norway	587	635	1,224	1,318	657	821	672	954	1,219	1,182	1,212	928	771	999	880
Sweden	14	7	7	7	2	1	2	8	8	78	44	56	8	6	4
UK(E,W&NI)	129	143	160	169	176	439	2,174	668	781	218	183	98	104	83	…
UK (Scot)	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	…
UK (total)															8,108
Total	9,235	10,209	12,309	14,505	17,891	25,176	23,421	16,859	13,321	12,326	12,861	11,040	8,524	8,987	9,003

*** Preliminary. [1]Includes IVb,c.**

^ Danish landings were not available from the ICES website. Landings, as supplied by Danish national scientists are available in Table 6.2.3.

Central North Sea (IVb)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005*
Belgium	357	538	558	713	579	287	336	371	270	449	579	435	180	260	207
Denmark	345	421	346	350	295	225	334	432	368	260	251	255	191	274	^
Faroes	-	-	2	-	-	-	-	-	-	-		9			
France	-	1	-	2	-	-	-	-*	…[2*]	-	-	-	-		+
Germany	4	2	13	15	10	9	18	19	9	14	9	17	11	11	
Ireland													1		
Netherlands	285	356	467	510	335	159	237	223	141	141	123	62	42	25	
Norway	17	4	3	11	15	29	6	13	17	9	15	10	13	22	16
Sweden	-	-	-	3	2	1	3	3	4	3	2	9	2	1	3
UK(E,W&NI)	669	998	1,285	1,277	919	662	664	603	364	423	475	236	167	120	…
UK (Scotland)	845	733	469	564	472	475	574	424	344	318	378	210	241	138	…
UK (total)															205
Total	2,522	3,053	3,144	3,447	2,627	1,847	2,172	2,088	1,517	1,617	1,832	1,243	848	851	431

*** Preliminary. [1]Includes 2 tonnes reported as Sub-area IV. [2]Included in IVa.**

^ Danish landings were not available from the ICES website. Landings, as supplied by Danish national scientists are available in Table 6.2.3.

Southern North Sea (IVc)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005*
Belgium	13	12	34	37	26	28	17	17	11	15	15	16	9	5	4
Denmark	2	-	-	-	-	-	-	+	+	+	+	+	+	+	^
France	-	-	-	-	-	-	-	10	-	+	-	+	-		+
Germany	-	-	-	-	-	-	-	-	-	+	-	+	+		
Netherlands	5	10	14	20	15	17	11	15	10	15	6	5	1	-	
Norway	-	-	-	-	+	-	-	-	+	-	+	-	-*	-	
UK(E&W&NI)	6	17	18	136	361	256	131	36	3	1	+	+	10	3	…
UK (Scotland)	-	-	-	17	-	3	1	+	+	+	+	+	-	7	…
															+
Total	26	39	66	210	402	304	160	78	24	31	21	21	20	15	4

*** Preliminary. [1]Included in IVa.**

^ Danish landings were not available from the ICES website. Landings, as supplied by Danish national scientists are available in Table 6.2.3.

Total North Sea

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005*
Total	11,783	13,301	15,519	18,162	20,920	27,327	25,753	19,025	14,862	13,974	14,714	12,304	9,392	9,853	9,438
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	-7,536	-4,998	-3,143	-2,410	-2,037	-1,970	-1,119	-826	

*** Preliminary.**

Table 6.2.2 Nominal catch (t) of Anglerfish in Division IIIa, 1991–2005, as officially reported to ICES.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005*
Belgium	15	48	34	21	35	-	-	-	-	-	-	.	.	.	
Denmark	493	658	565	459	312	367	550	415	362	377	375	369	215	311	^
Germany	-	-	1	-	-	1	1	1	2	1	-	1	-	1	
Netherlands							-	-	-	-	-	.	3	.	
Norway	64	170	154	263	440	309	186	177	260	197	200	242	187	130	100
Sweden	23	62	89	68	36	25	39	33	36	27	46	55	71	73	63
Total	595	938	843	811	823	702	776	626	660	602	621	667	476	515	163

***Preliminary.**

^ Danish landings were not available from the ICES website. Landings, as supplied by Danish national scientists are available in Table 6.2.3.

Tables 6.2.3. Distribution of Danish Anglerfish landings and effort by fishery.

A. Landings by fishery (from log book data)

Year			North Sea	tons						IIIA	tons				IIIa & IV
	Other gear	Beam trawls	dem trawl	Neph trawl	ind trawl	Shrimp trawl	total	Other gear	Beam trawls	dem trawl	Neph trawl	ind trawl	Shrimp trawl	total	(tons)
1996	48	17	756	280	129	234	1464	40	70	125	90	2	41	367	1831
1997	47	64	1132	56	103	88	1489	58	137	183	139	8	25	550	2039
1998	76	153	996	40	91	100	1456	58	86	167	89	2	13	415	1871
1999	75	116	1106	39	84	76	1496	82	41	121	105	1	12	362	1858
2000	52	88	1066	16	68	56	1347	61	47	116	140	0	13	377	1724
2001	52	18	1343	7	67	53	1540	44	18	86	211	4	11	375	1915
2002	41	59	1269	86	53	55	1563	35	41	116	162	1	15	371	1934
2003	28	40	1508	59	30	42	1707	27	4	27	147	1	10	217	1924
2004	57	45	1525	91	42	50	1809	31	13	40	189	0	37	311	2120
2005	14	48	1412	96	26	17	1612	18	5	83	135	0	30	272	1884

B. Effort by fishery (from log book data)

Year	Total Danish effort in IV (days)							Total Danish effort in IIIA (days)							IIIa & IV
	Other gear	Beam trawls	dem trawl	Neph trawl	ind trawl	Shrimp trawl	total	Other gear	Beam trawls	dem trawl	Neph trawl	ind trawl	Shrimp trawl	total	(days)
1996	462	117	2865	2022	1587	2361	9414	417	737	1264	1763	29	824	5034	14448
1997	636	268	4778	727	1535	1387	9332	520	980	1820	2207	106	473	6107	15438
1998	733	566	4413	376	1257	1636	8982	376	665	1446	1454	14	276	4231	13213
1999	748	687	5084	428	1043	1200	9190	621	475	1462	2304	23	237	5121	14311
2000	695	787	6297	285	808	1102	9974	437	567	1330	3004	6	314	5658	15632
2001	780	250	8164	182	1039	1137	11552	426	361	1047	3941	42	296	6112	17665
2002	676	537	7415	741	1155	1025	11548	362	434	1284	3131	22	256	5489	17037
2003	309	445	7917	711	528	810	10720	220	79	414	2505	9	237	3463	14183
2004	522	419	6212	448	517	606	8725	358	191	245	2762	5	458	4020	12744
2005	166	401	6077	436	240	268	7588	189	123	691	2344	4	526	3877	11465

Table 6.2.4. Species composition of Danish landings from the Norwegian Deep in the main fishery where anglerfish is taken (see also Figures 6.2.2 and 6.2.3)

	2004		2005	
Speies	**tons landed**	**% of total**	**tons landed**	**% of total**
Tusk	98	1.1	80	0.8
Nephrops	730	8.2	910	9.7
Anglerfish	1200	13.4	1254	13.3
Hake	127	1.4	215	2.3
Haddock	616	6.9	545	5.8
Ling	447	5.0	543	5.8
Saithe	3442	38.5	2920	31.0
Plaice	480	5.4	556	5.9
Lemon sole	161	1.8	217	2.3
Witch	333	3.7	424	4.5
Cod	794	8.9	1081	11.5
Others	505	5.7	676	7.2
Grand Total	**8933**	**100.0**	**9421**	**100.0**

Table 6.2.5. Anglerfish in IV and IIIa. Norwegian landings (tonnes) by fishery in 2005.

FLEET	DIVISION IIIA	DIVISION IVA
Coastal gillnetting	61	526
Offshore gillnetting	1	16
Coastal shrimp trawling	22	50
Offshore dem trawling	5	102
Offshore shrimp trawling	3	68
Other gears	7	119
Total	100	880

Table 6.2.6. Danish LPUE (Kg/day) for anglerfish. Logbook records

ÅR	IV			NORWEGIAN DEEPS (IVA)		IIIA		
	Dem trawl	**Neph trawl**	**Shrimp trawl**	**Dem trawl**		**Dem trawl**	**Neph trawl**	**Shrimp trawl**
1996	264	139	99	304		99	51	49
1997	237	77	63	268		101	63	52
1998	226	107	61	259		115	61	48
1999	218	90	64	243		83	46	51
2000	169	57	51	198		88	46	40
2001	164	39	47	181		83	54	38
2002	171	116	54	195		91	52	59
2003	191	83	51	197		66	59	40
2004	245	204	82	273		162	69	82
2005	232	220	62	245		121	58	56

Table 6.3.1. Anglerfish on the Northern Shelf (IIIa, IV & VI). Working Group estimates of landings (tonnes).

Year	Skagerrak & Kattegat	North Sea				Sub-Area VI			Total
		Northern	Central	Southern	Total	W. Scotland	Rockall	Total	N shelf
	IIIa	IVa	IVb	IVc	IV	VIa	VIb	VI	
1973	140	2,127	726	41	2,894	9,221	127	9,348	12,382
1974	202	2,811	1,381	39	4,231	3,217	435	3,652	8,085
1975	291	2,887	2,160	59	5,106	3,122	76	3,198	8,595
1976	641	3,644	1,579	49	5,272	3,383	72	3,455	9,368
1977	643	3,264	1,536	54	4,854	3,876	78	3,954	9,451
1978	509	3,111	1,444	72	4,627	3,524	103	3,627	8,763
1979	687	2,972	1,787	112	4,871	3,166	29	3,195	8,753
1980	652	3,451	1,637	175	5,263	2,634	200	2,834	8,749
1981	549	2,472	958	132	3,562	1,387	331	1,718	5,829
1982	529	2,214	856	99	3,169	3,154	454	3,608	7,306
1983	506	2,467	1,757	181	4,405	3,417	433	3,850	8,761
1984	568	3,875	2,033	188	6,096	3,935	707	4,642	11,306
1985	578	4,570	2,154	77	6,801	4,043	1,013	5,056	12,435
1986	524	5,596	1,965	47	7,608	3,090	1,326	4,416	12,548
1987	589	7,379	1,768	66	9,213	4,311	1,294	5,605	15,407
1988	347	7,738	2,061	95	9,894	6,003	1,730	7,733	17,974
1989	334	7,135	2,121	86	9,342	6,979	313	7,292	16,967
1990	570	7,280	2,177	34	9,491	5,799	822	6,621	16,682
1991	595	8,018	2,522	26	10,566	5,357	923	6,280	17,441
1992	938	8,636	3,053	39	11,728	8,117	1,089	9,206	21,872
1993	843	9,868	3,144	66	13,078	9,369	681	10,050	23,971
1994	811	11,775	3,447	210	15,432	8,039	777	8,816	25,059
1995	823	12,765	2,627	402	15,794	11,466	830	12,296	28,913
1996	702	14,089	1,847	304	16,240	17,556	602	18,158	35,100
1997	776	15,885	2,172	160	18,217	12,836	899	13,735	32,728
1998	626	11,861	2,088	78	14,027	9,740	900	10,640	25,293
1999	660	10,178	1,517	24	11,719	8,083	1,392	9,475	21,854
2000	602	9,916	1,617	31	11,564	6,425	1,091	7,516	19,682
2001	621	10,824	1,832	21	12,677	4,728	1,147	5,875	19,173
2002	667	9,070	1,243	21	10,334	4,155	677	4,832	15,833
2003	475	7,372	845	20	8,237	3,431	695	4,126	12,838
2004	500	8,177	835	15	9,027	2,823	473	3,296	12,823
Min	140	2,127	726	15	2,894	1,387	29	1,718	5,829
Mean	578	6,982	1,840	94	8,917	5,825	679	6,503	15,998
Max	938	15,885	3,447	402	18,217	17,556	1,730	18,158	35,100

Table 6.3.2. Anglerfish on the Northern Shelf. Number of hauls/observations by year and quarter in the Scottish observer programme.

	quarter				
Year	**1**	**2**	**3**	**4**	**sum**
1999	203 / 022	290 / 021	250 / 022	196 / 023	939 / 088
2000	184 / 014	276 / 022	220 / 019	308 / 024	988 / 079
2001	162 / 015	431 / 034	368 / 029	396 / 036	1357 / 114
2002	232 / 023	321 / 024	281 / 024	177 / 022	1011 / 093
2003	247 / 017	246 / 019	173 / 018	143 / 018	809 / 072
2004	127 / 015	390 / 027	237 / 020	149 / 019	903 / 081
2005	183 / 022	280 / 025	200 / 019	336 / 039	999 / 105
2006	422 / 069				(422 / 069)

Table 6.3.3. Anglerfish on the Northern Shelf. Analysis of variance of the landings per unit of effort in the Scottish observer programme. The analysis is developed as a type-1 model: terms were added to the analysis in the order specified.

Source	**Deviance**	**%**	**df**	**MS**	**F**	**p**
Year	26,719	19	7	3817.06	81.899	0.000
Quarter	3,719	3	3	1239.52	26.595	0.000
Gear	46,194	32	4	11548.45	247.783	0.000
Rectangle	40,800	28	121	337.19	7.235	0.000
Mandel(rectangle)*year	879	1	7	125.58	2.694	0.009
Explained	118,311	82	142	833.18	17.877	0.000
Unexplained	26,007	18	558	46.61		
Total	144,318	100	700	206.17		

Table 6.3.4. Anglerfish on the Northern Shelf. Average observed landing per unit of effort (kg/hr), by year and quarter, averaged over all rectangles visited in the observer programme.

	quarter				
Year	**1**	**2**	**3**	**4**	**mean**
1999	4.78	6.69	4.21	8.18	5.98
2000	10.98	7.41	3.23	3.61	5.88
2001	5.51	3.53	2.87	4.33	3.87
2002	7.89	4.45	3.55	4.02	4.97
2003	6.82	6.22	3.54	9.3	6.46
2004	10.39	10.76	10.6	5.26	9.36
2005	15.96	6.69	7.66	21.94	14.47
2006	33.82				

Table 6.3.5. Anglerfish on the Northern Shelf. Average predicted landing per unit of effort (kg/hr), by year and quarter, averaged over all rectangles in the data set. Predictions based on the simple, density-independent model.

	quarter				
Year	**1**	**2**	**3**	**4**	**mean**
1999	15.66	11.16	9.98	13.00	12.45
2000	19.05	12.22	11.04	14.56	14.20
2001	15.63	9.86	9.19	11.57	11.51
2002	19.87	13.86	12.29	16.13	15.52
2003	19.82	13.40	12.18	15.85	15.31
2004	39.24	24.64	22.70	30.60	29.24
2005	31.03	21.49	19.78	24.42	24.20
2006	28.24				

Table 6.3.6. Anglerfish on the Northern Shelf. Average predicted landing per unit of effort (kg/hr), by year and quarter, averaged over all rectangles in the data set. Predictions based on «Mandel`s bundle of straight lines» model.

	quarter				
Year	**1**	**2**	**3**	**4**	**mean**
1999	15.89	11.07	9.77	12.45	12.30
2000	18.56	11.59	10.34	13.42	13.46
2001	15.18	9.33	8.62	10.61	10.88
2002	19.32	13.19	11.54	14.86	14.71
2003	20.30	13.42	11.98	15.32	15.25
2004	39.57	24.23	22.04	29.26	28.72
2005	33.66	22.85	20.76	24.99	25.57
2006	26.83				

Table 6.3.7. Anglerfish on the Northern Shelf. Lower 95% confidence bounds of the predicted landing per unit of effort (kg/hr), by year and quarter, averaged over all rectangles in the data set. Predictions based on «Mandel`s bundle of straight lines» model.

	quarter				
Year	**1**	**2**	**3**	**4**	**mean**
1999	7.50	5.30	4.66	6.00	5.86
2000	9.42	5.85	5.18	6.81	6.80
2001	7.30	4.52	4.18	5.14	5.26
2002	9.43	6.42	5.62	7.21	7.16
2003	9.43	6.16	5.53	7.13	7.06
2004	19.72	12.02	10.98	14.75	14.34
2005	17.40	11.88	10.87	13.36	13.38
2006	15.28				

Table 6.3.8. Anglerfish on the Northern Shelf. Basic features of the new joint FRS/industry anglerfish survey trawl.

1. Ground gear length of 150ft.
2. Rockhopper discs in the centre of 16” diameter.
3. Rockhoppers rigged on 19mm chain.
4. To ensure no anglerfish pass over the headline the design incorporates a ‘ballooned’ top sheet (approximately 20% more) similar to that already supplied to the fleet.
5. A mesh size in the lower wings of 120mm to ensure small anglerfish and megrims are retained.
6. The cod end consists of a 20 mm mesh blinder inside 100 mm mesh.
7. 90 mm square mesh panels will NOT be fitted.
8. High tenacity twine is used throughout the trawls construction.
9. Both the headline and footrope are wrapped with rope and include selvedge ropes.
10. Design incorporates measures to give added strengthening to weak points around the mouth and belly of the trawl. This strengthening is similar to that which is normally built into commercial scraper trawls (i.e. top and bottom guard meshes and tearing strips etc).
11. Includes a tickler chain of 19mm chain as per standard length to suit this gear.
12. The wire rig consists of 6 x 20fm lengths of 26mm wire single spreaders, 2 x 10fms of 22mm chain and 20fm double spreaders, 18 mm wire for the top and 19mm chain on the bottom.

Table 6.4.1 Nominal catch (t) of Anglerfish in Division IIa, 1992–2005, as officially reported to ICES.

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005**
Denmark	+	+	+	+	+	+	+	+	+	2	+	-	1	^
Faroes	+	+	+	+	+	+	+	+	-	1	1	2	5	3
France	-	-	-	-	-	-	-	+	-	-	-	-	-	+
Germany	1	2	3	1	4	20	53	4	17	65	59	55	70	N/a
Norway	488	3,044	1,026	526	893	576	1,488	1,731	2,952	3,552	2,000	2,404	2,905**	2,649
Russia	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Sweden	-	-	-	-	+	+	+	+	+	+	-	-	-	N/a
UK (total)	1	1	2	74	15	5	7	6	30	2	10	15	18	19
Total	490	3,047	1,031	601	912	601	1,548	1,741	2,999	3,622	2,070	2,476	2,999	2,672

****Preliminary**

^ Danish landings were not available from the ICES website. Landings, as supplied by Danish national scientists are available in Table 6.2.3.

Table 6.4.2. Anglerfish in IIa. Norwegian landings (tonnes) by fishery in 2005.

Fleet	Division IIa
Coastal gillnetting	2,301
Offshore gillnetting	115
Offshore dem trawling	77
Coastal Danish seine	54
Other gears	102
Total	2,649

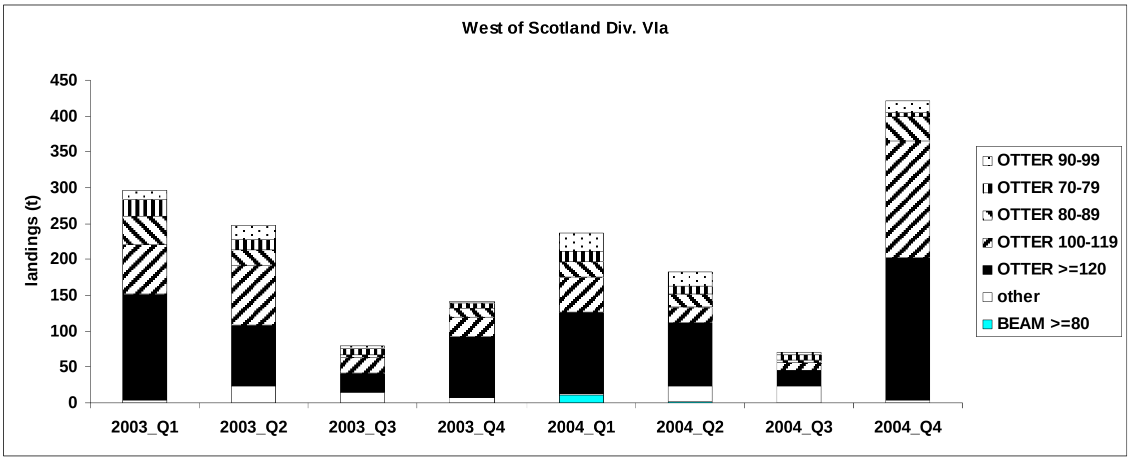


Figure 6.1.1 Anglerfish in Division VIa. Officially reported landings by main gear type and quarter in 2003 and 2004. Data from the STECF database which is provisional and not yet validated.

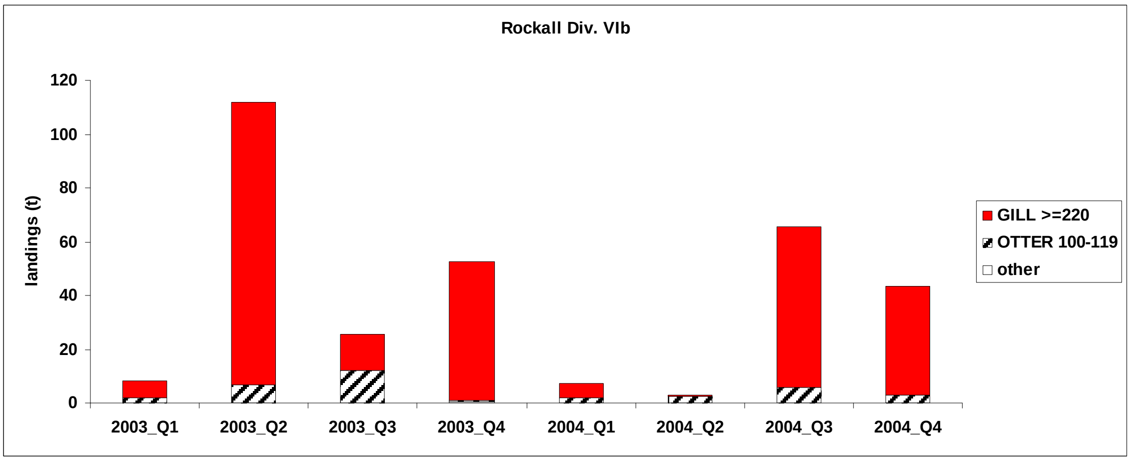
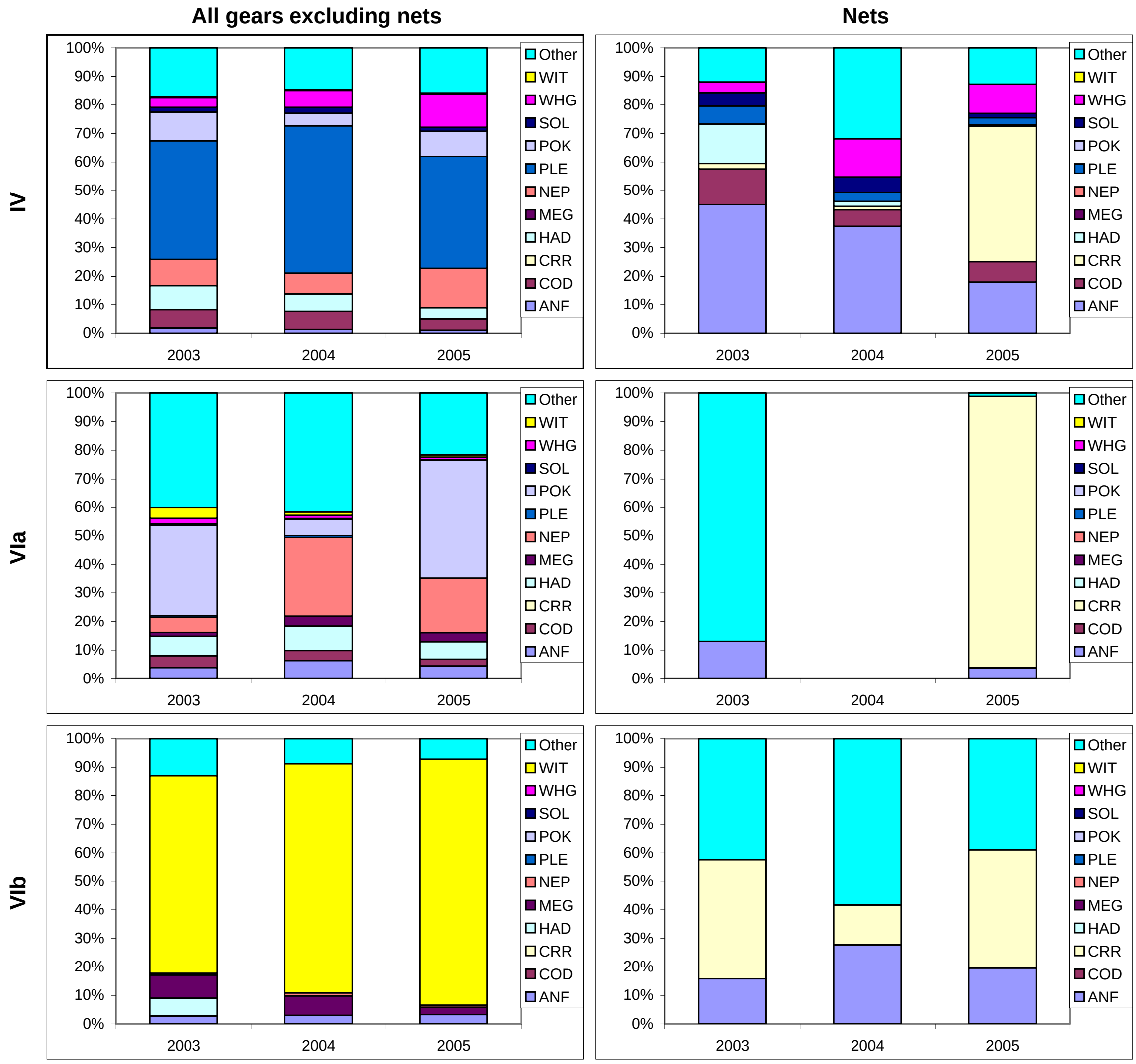


Figure 6.1.2. Anglerfish in Division VIb. Officially reported landings of Anglerfish in the area West of Scotland, main gear type and quarter in 2003 and 2004. Data from the STECF database which is provisional and not yet validated.



Figur 6.1.3. Species composition (by weight) of landings by sub-division and gear grouping for 2003-5. Data are for landings that included anglerfish by UK vessels landing into EW&NI, and EW&NI vessels landing abroad. Anglerfish has the species code "ANF".

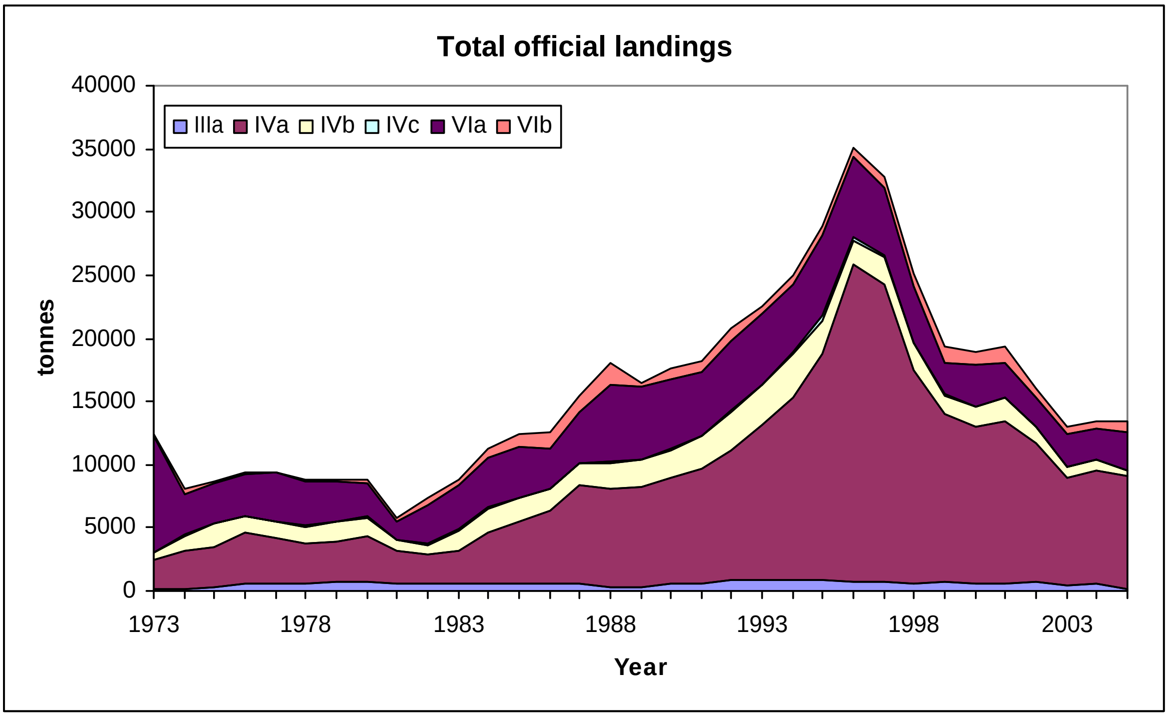


Figure 6.1.4 Trend in international landings of anglerfish per fishing area (as officially reported to landings).

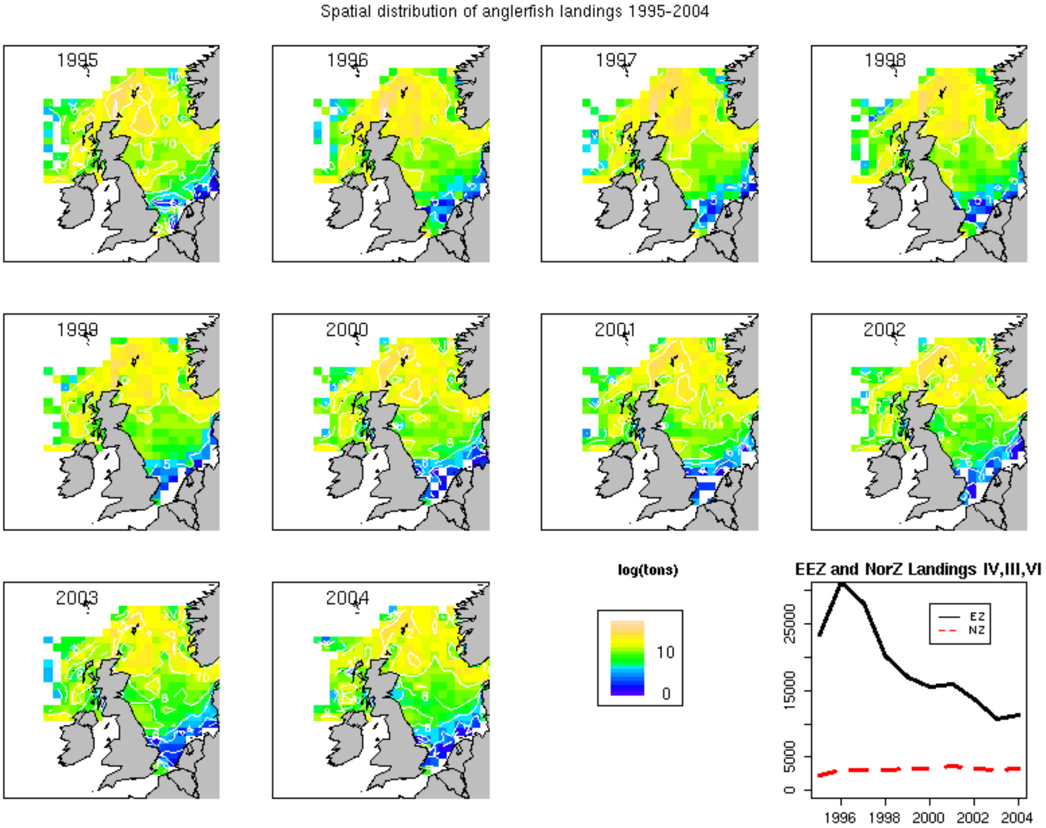


Figure 6.1.5. Anglerfish. Spatial (by ICES statistical rectangles) distribution of official total landings (tonnes) within IIIa, IVa and VIa for the period 1995-2004.

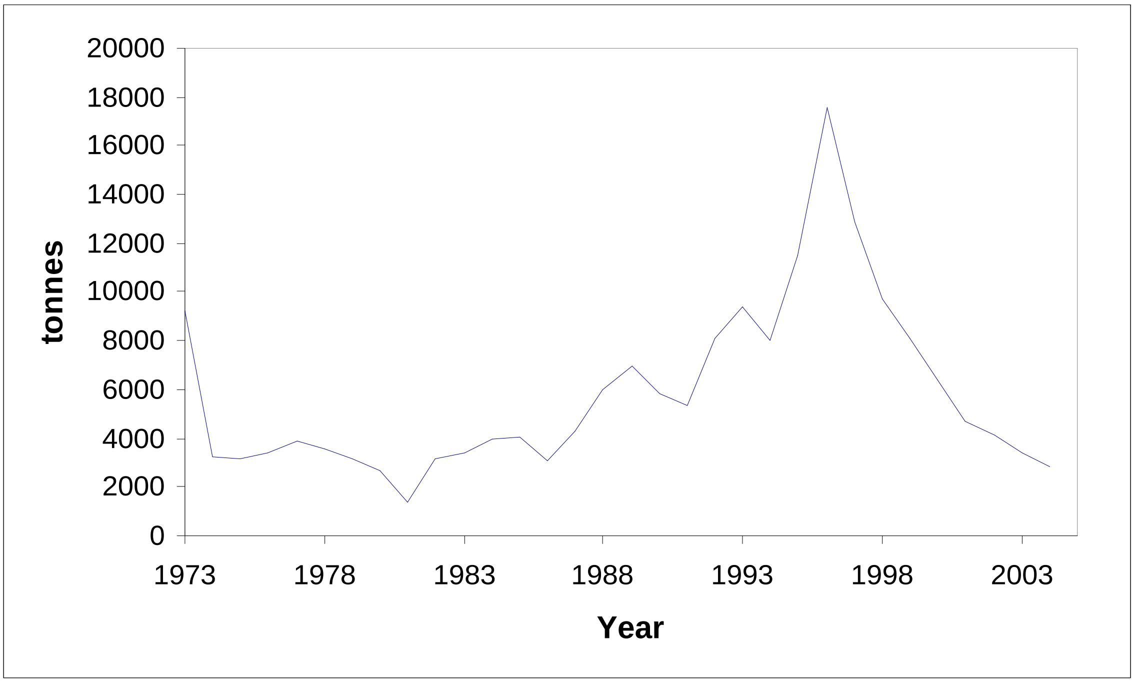


Figure 6.1.6. Landings of Anglerfish in Division VIa from 1973-2004. (Including a WG correction for area misreporting but not underreporting)

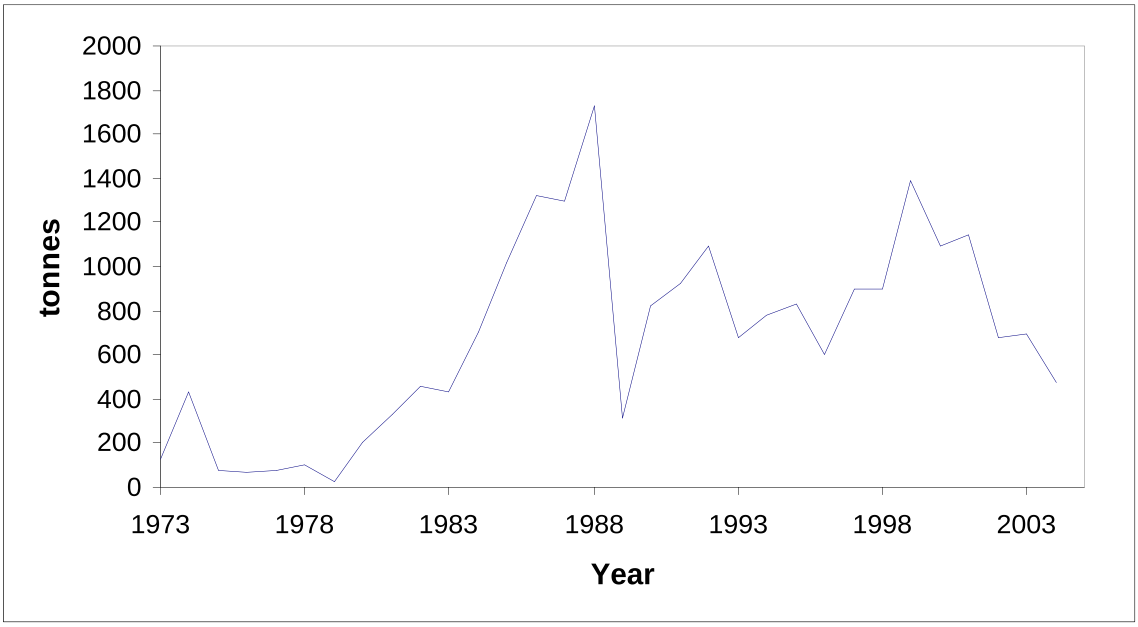


Figure 6.1.7. Landings of Anglerfish in Division VIb (including a WG correction for area misreporting but not underreporting).

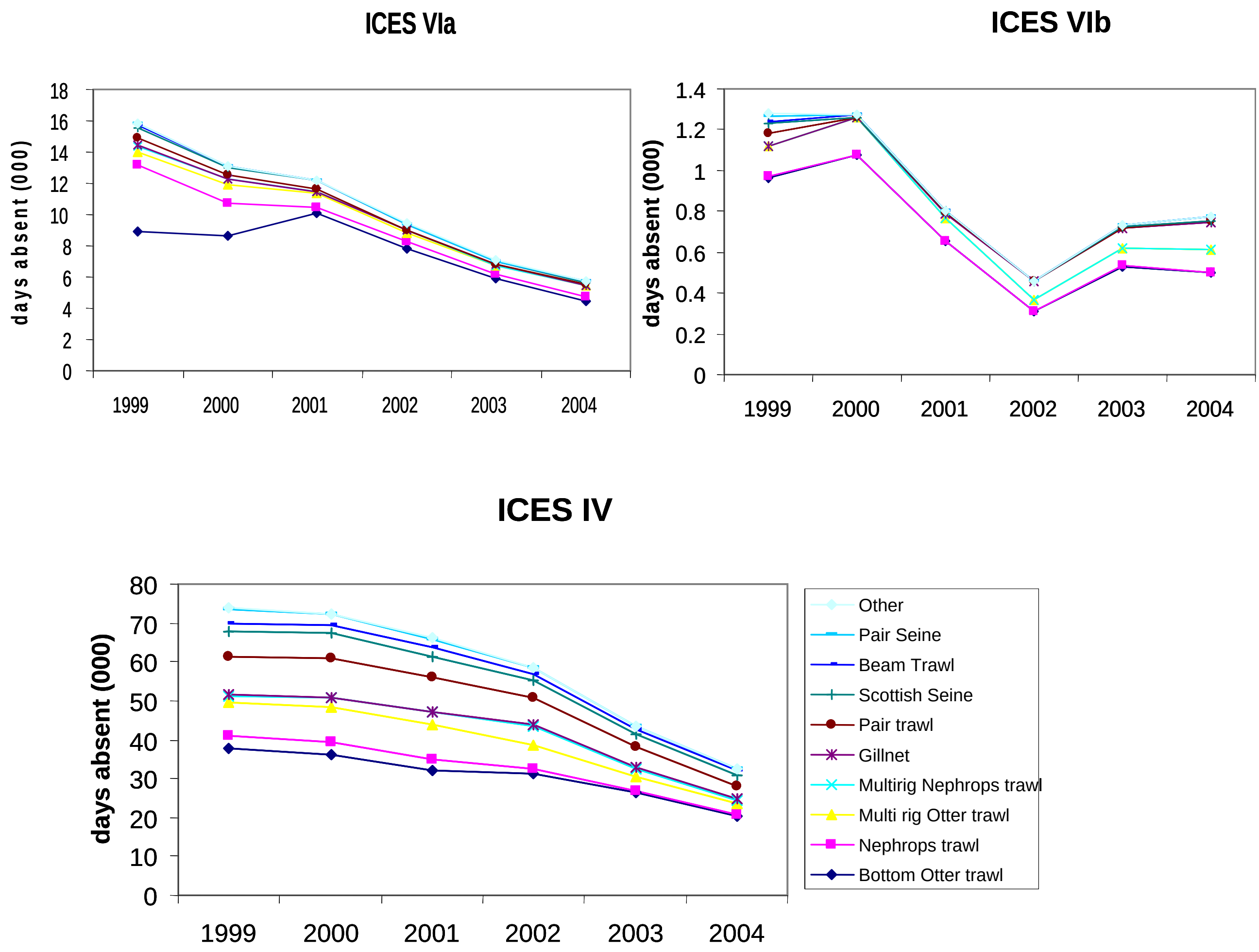


Figure 6.1.8. **Stacked line graphs to show trends in UK effort for trips where anglerfish were landed into Scotland from ICES areas IV, VIa and VIb by different gears.**

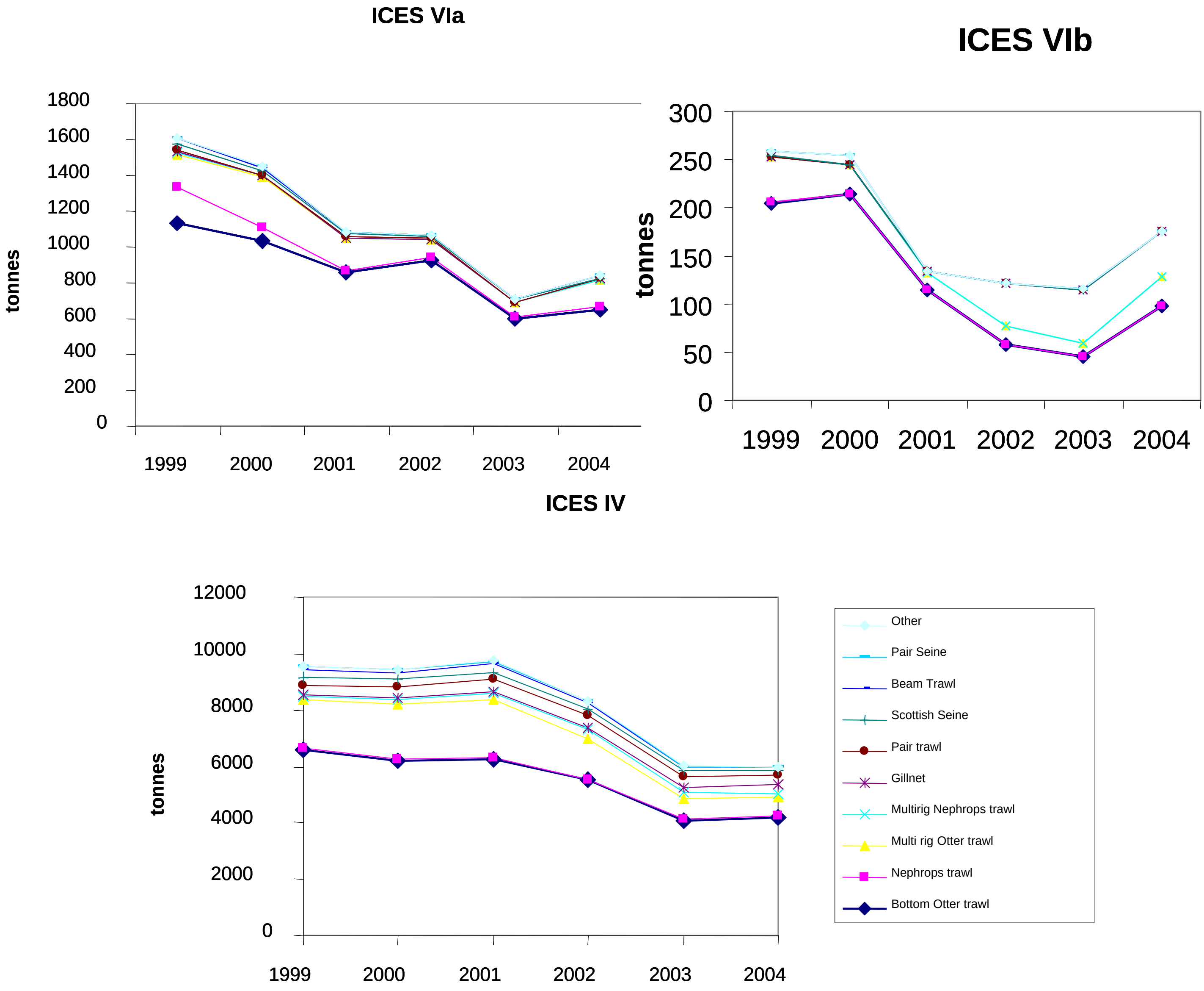


Figure 6.1.9. Stacked line graphs to show trends in UK landings of anglerfish into Scotland from ICES areas IV, VIa and VIb by different gears contributing anglerfish landings

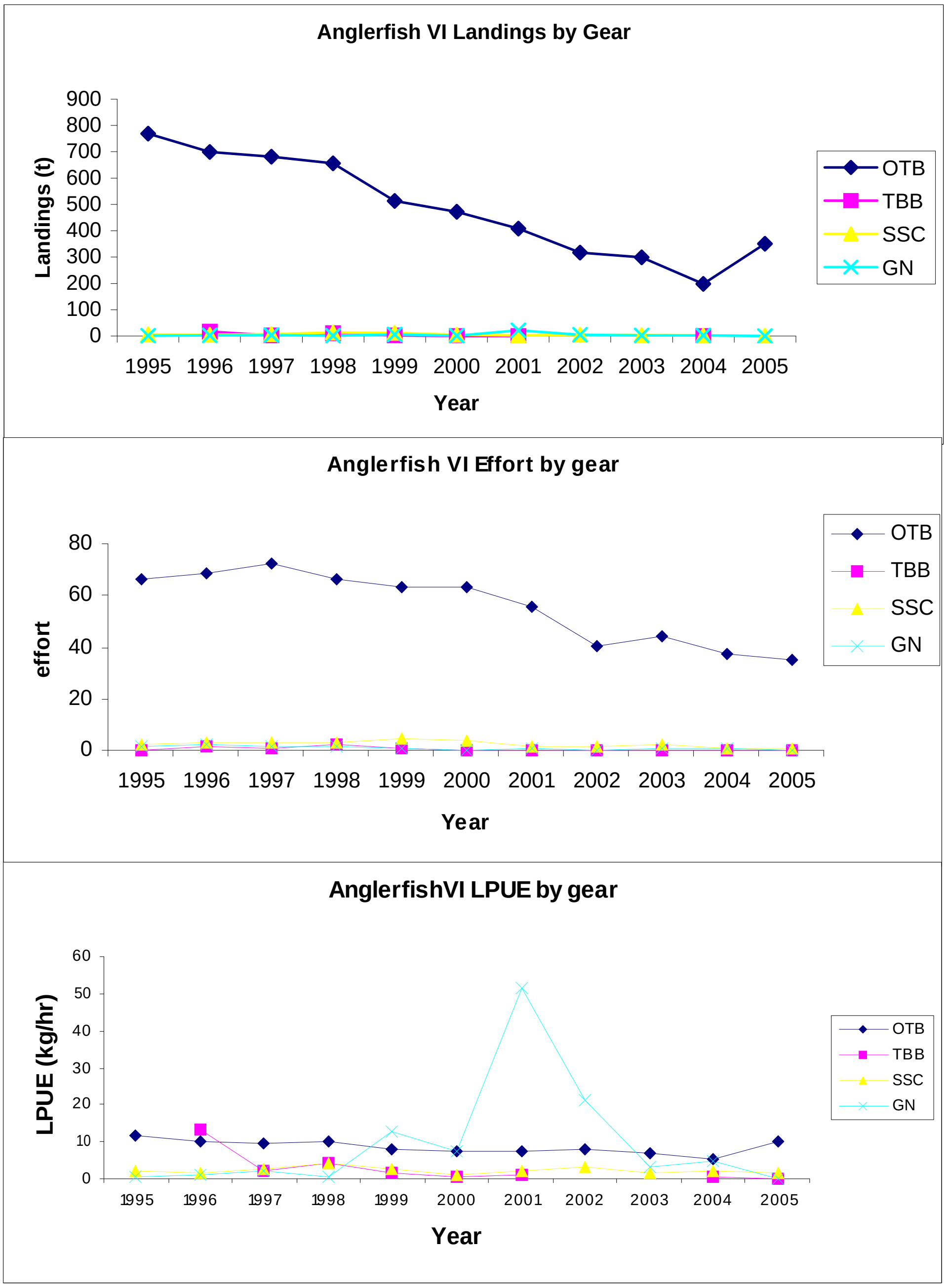


Figure 6.1.10. Anglerfish in Area VI. Landings, effort and LPUE of Irish Fleets

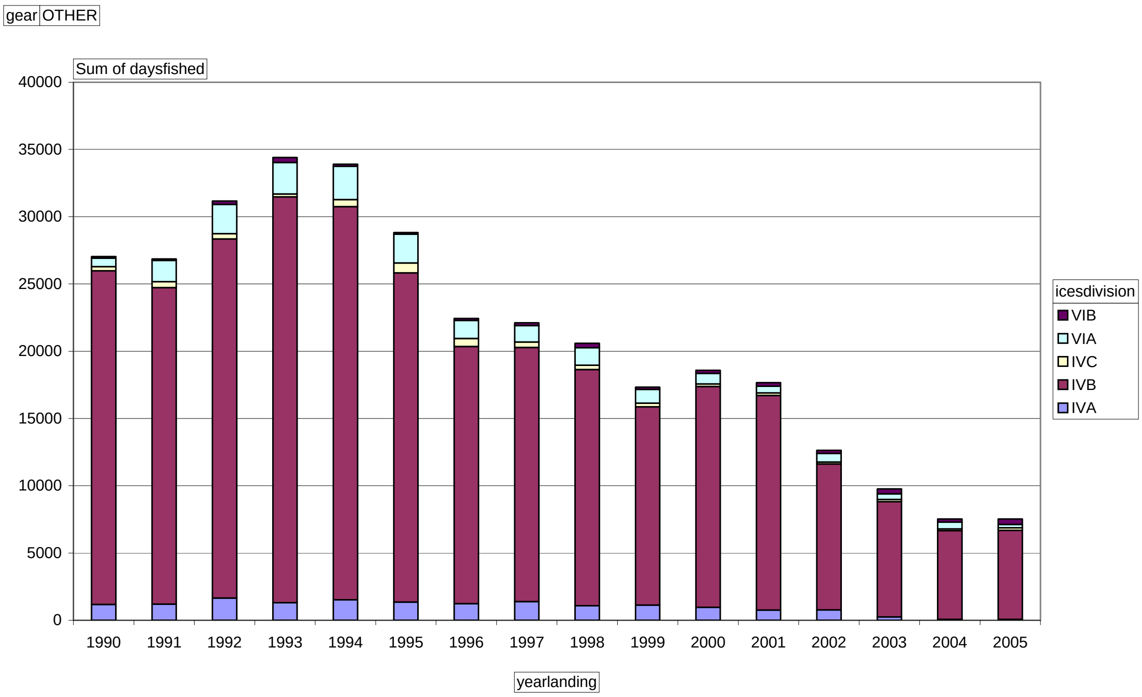


Figure 6.1.11a UK (E&W) effort (number of days fished) associated with landings that included anglerfish, for all gears, excluding nets, given by ICES sub-division.

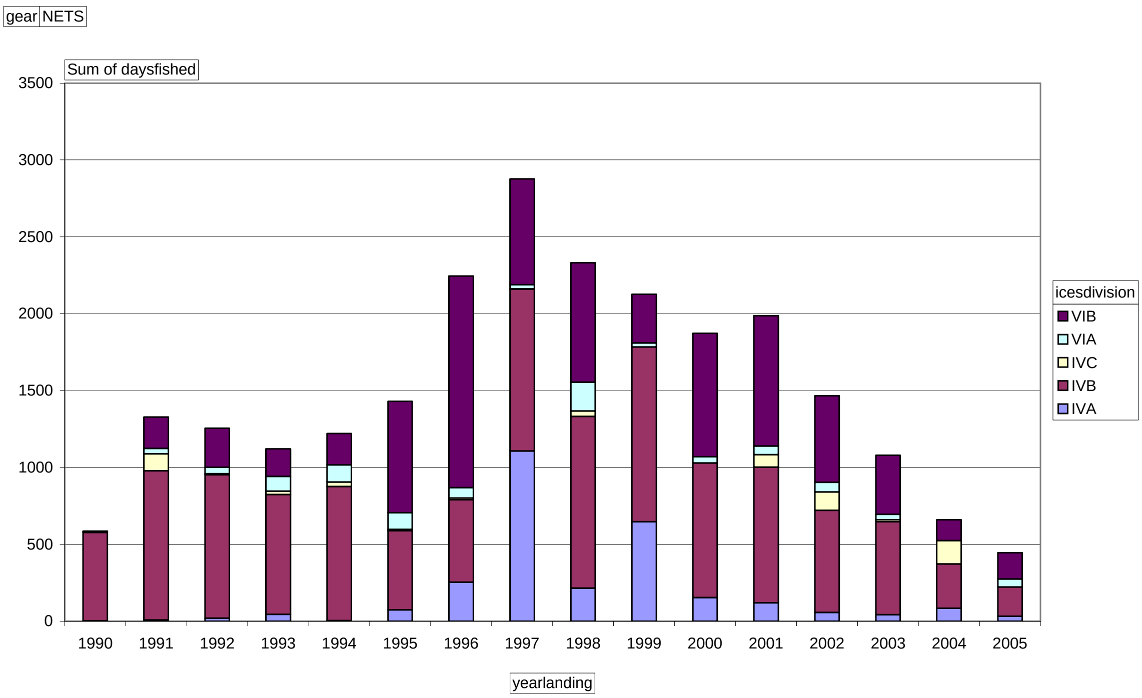


Figure 6.1.11b. UK (E&W) effort (number of days fished) associated with landings that included anglerfish, for nets, given by ICES sub-division.

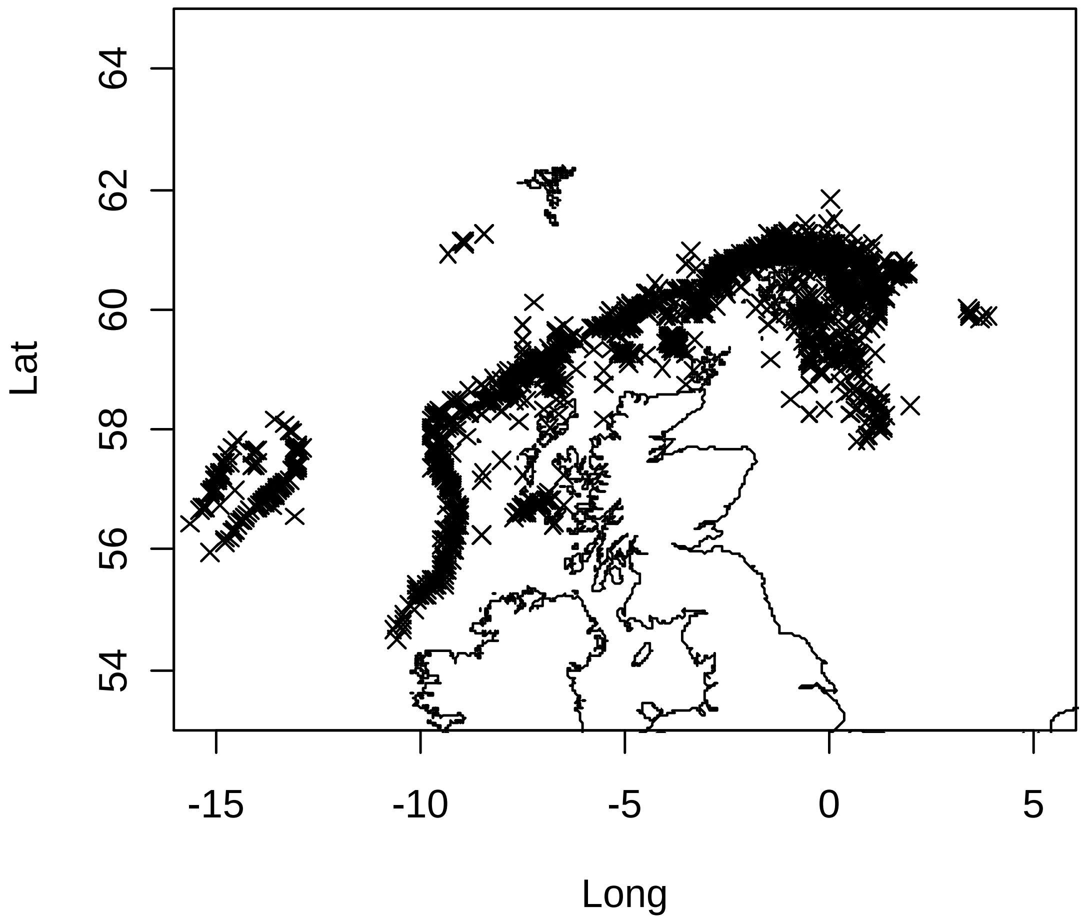


Figure 6.1.12. Spatial distribution of haul information from Scottish tallybook data for 2006.

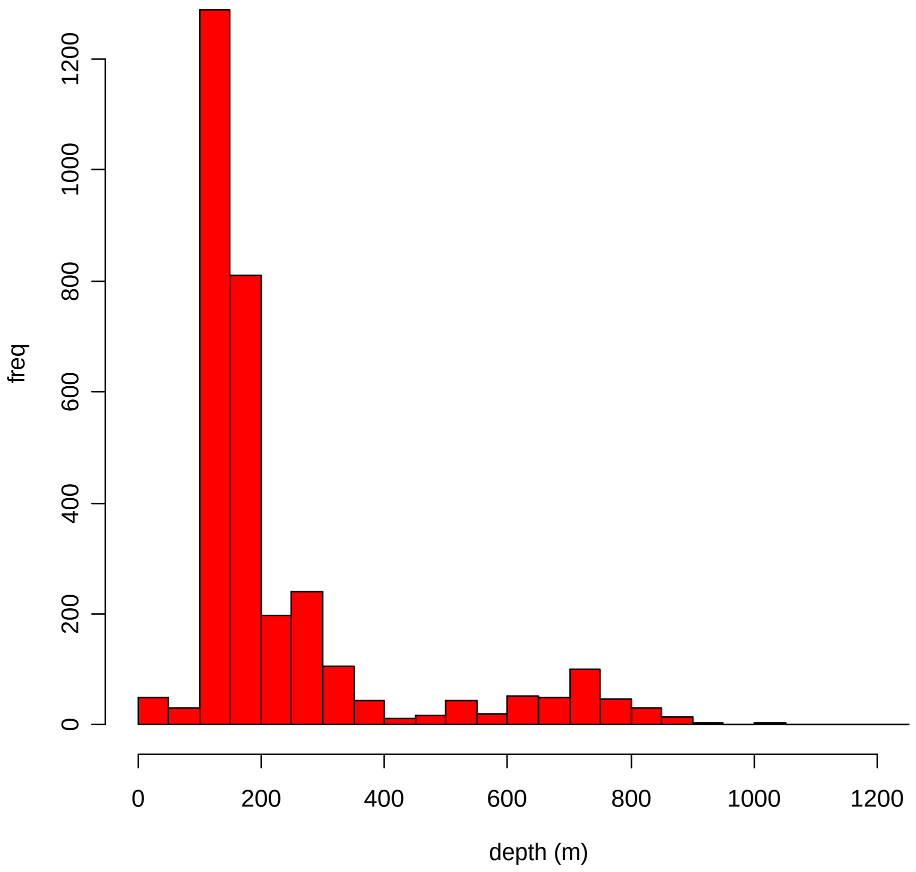


Figure 6.1.13. Depth distribution of haul information from Scottish tallybook data for 2006.

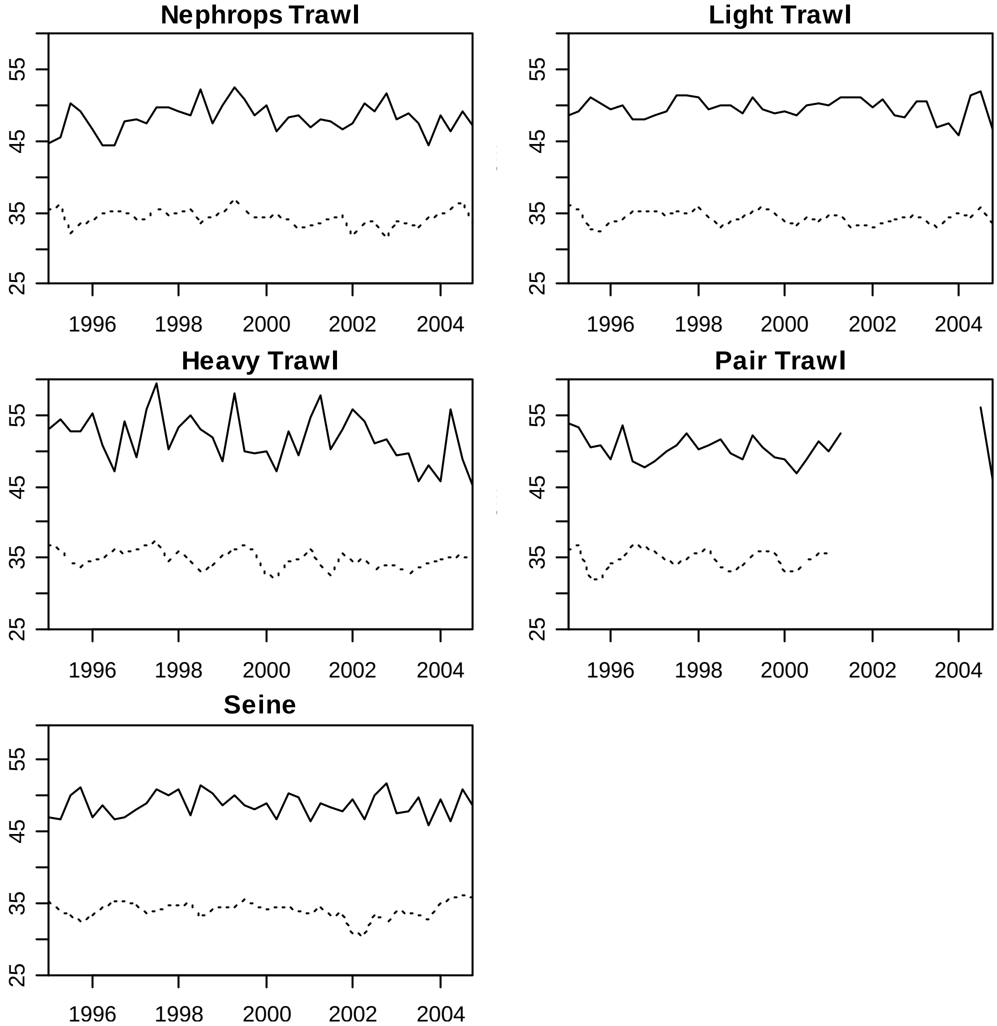


Figure 6.1.14. Anglerfish in Division VIa. Trends in mean length of small (<40cm) and large (>=40cm) anglerfish from the Scottish market sampling data by gear category. (Pair trawl not sampled 2001-2004)

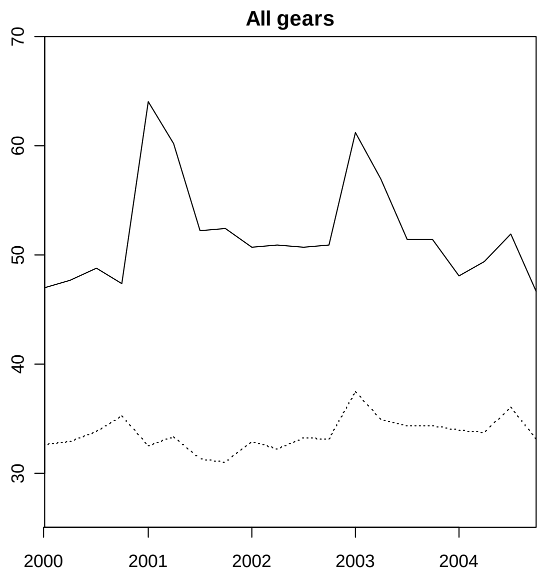


Figure 6.1.15. Anglerfish in Division VIb. Trends in mean length of small (<40cm) and large (>=40cm) anglerfish from the Scottish market sampling data by all gear categories combined.

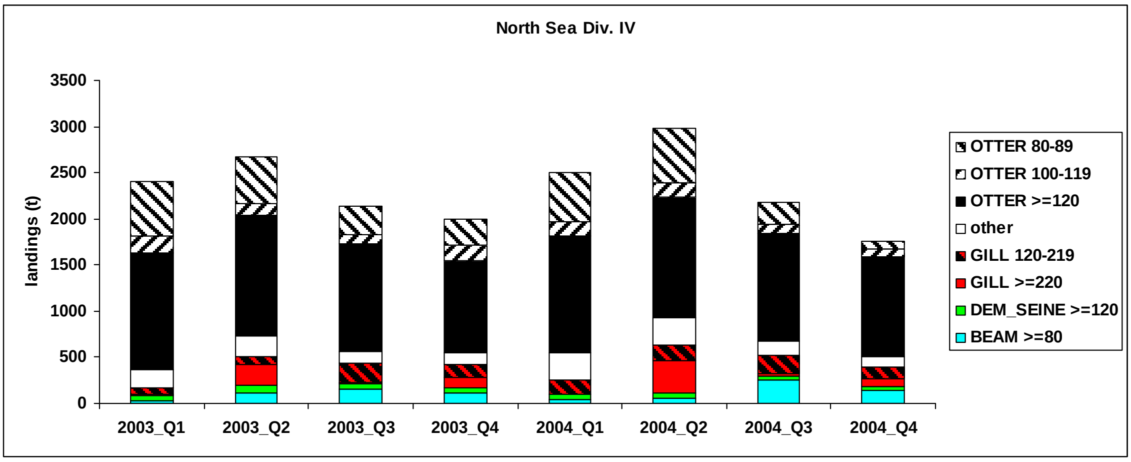


Figure 6.2.1a. Officially reported landings of anglerfish in the North Sea, main gear type and quarter in 2003 and 2004. Data from the STECF data base which is provisional and not yet validated.

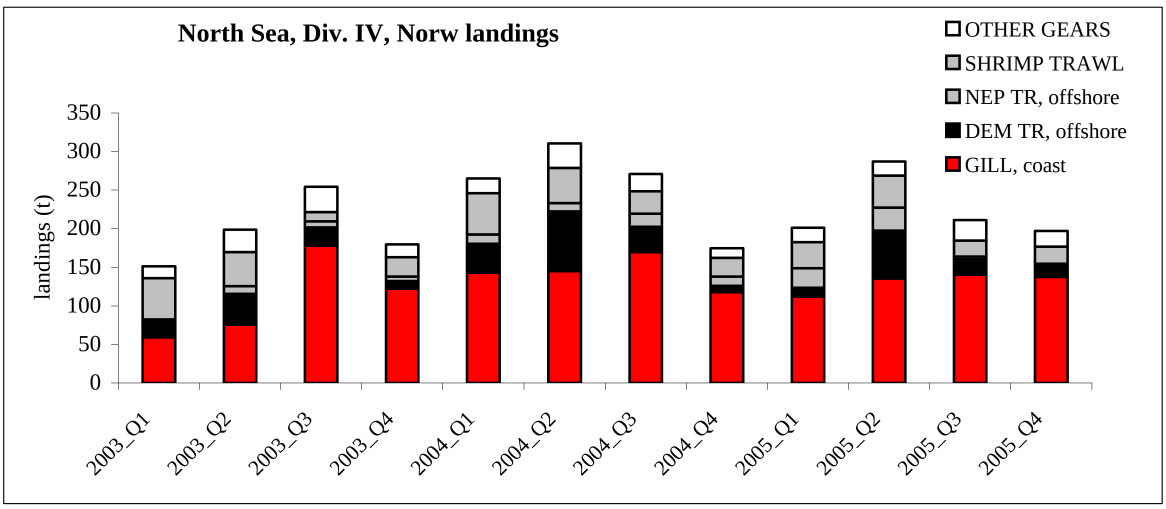


Figure 6.2.1b. Anglerfish IVa. Norwegian landings by quarter and fleet during 2003-2005.

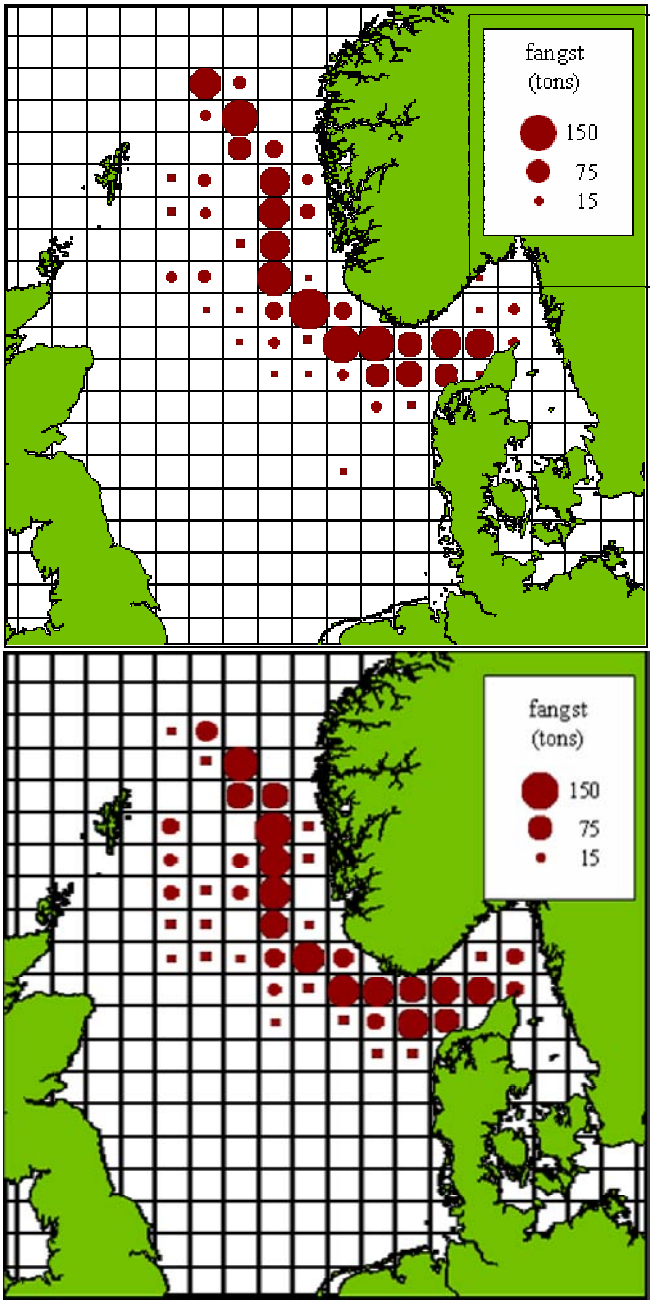
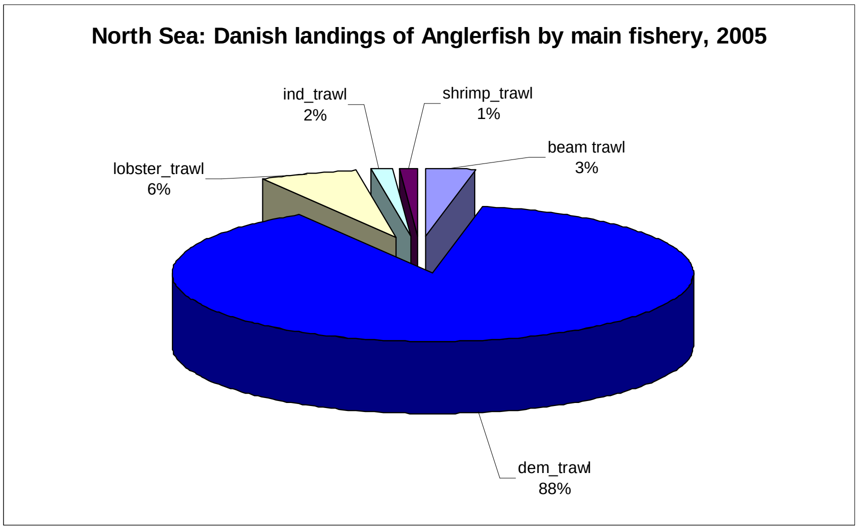


Figure 6.2.2. Anglerfish in the North Sea. Distribution of Danish landings (tonnes) by ICES square in 2004 and 2005.



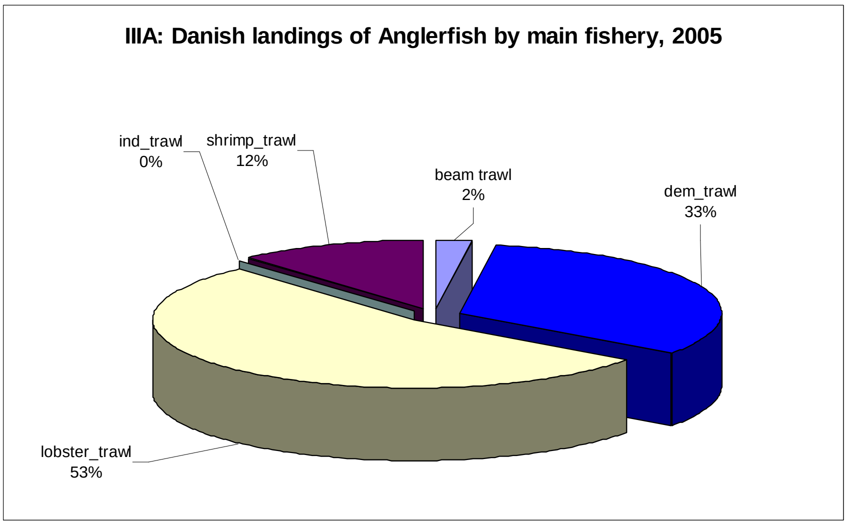


Figure 6.2.3. Anglerfish in the North Sea & Division IIIa. Danish landings by fishery.

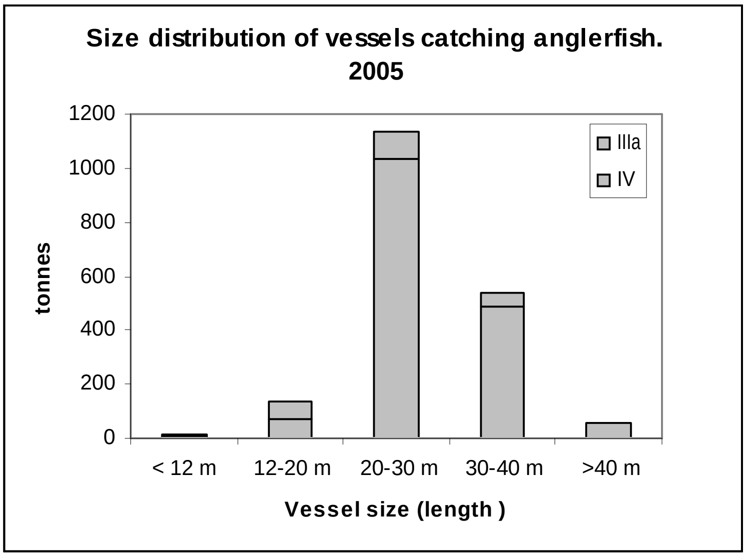


Figure 6.2.4. **Anglerfish in the North Sea. Danish vessel categories (by size) catching anglerfish**

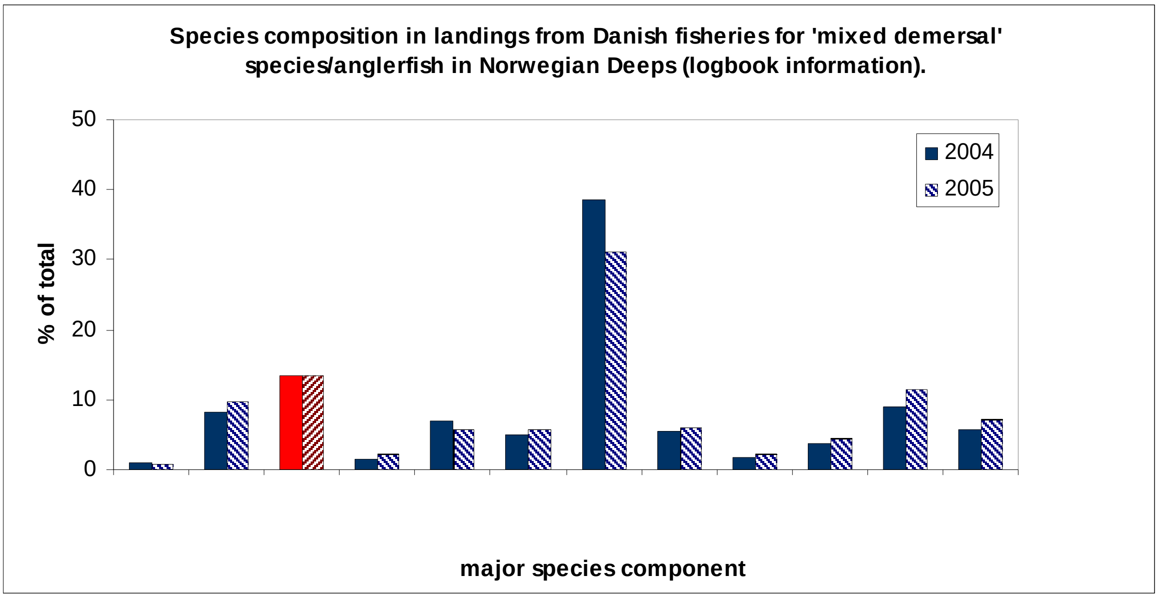


Figure 6.2.5. **Anglerfish in the North Sea. Species composition in Danish landings with anglerfish. Data from logbooks (% by weight).**

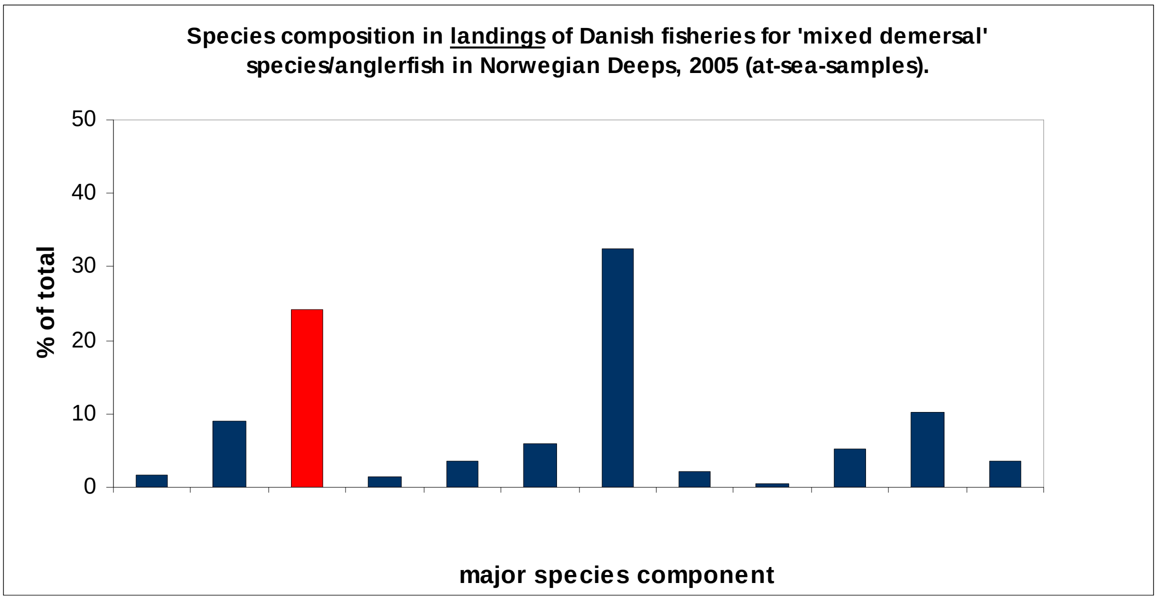


Figure 6.2.6. Anglerfish in the North Sea. Species composition in Danish landings with anglerfish. Data from observer programmes (% by weight).

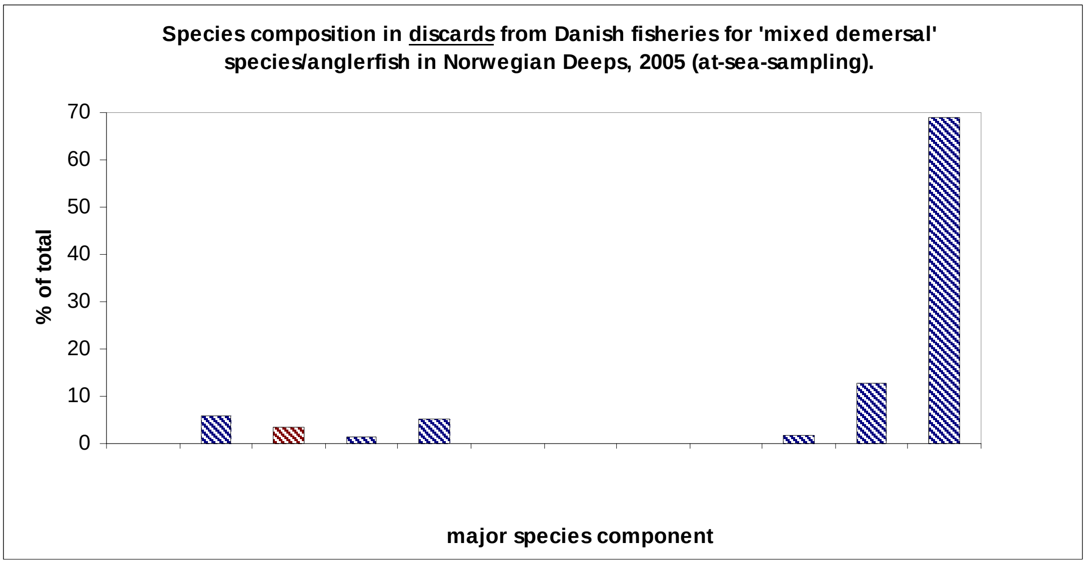


Figure 6.2.7. Anglerfish in the North Sea. Species composition of discards in fisheries for anglerfish. Data from observer programmes (% by weight).

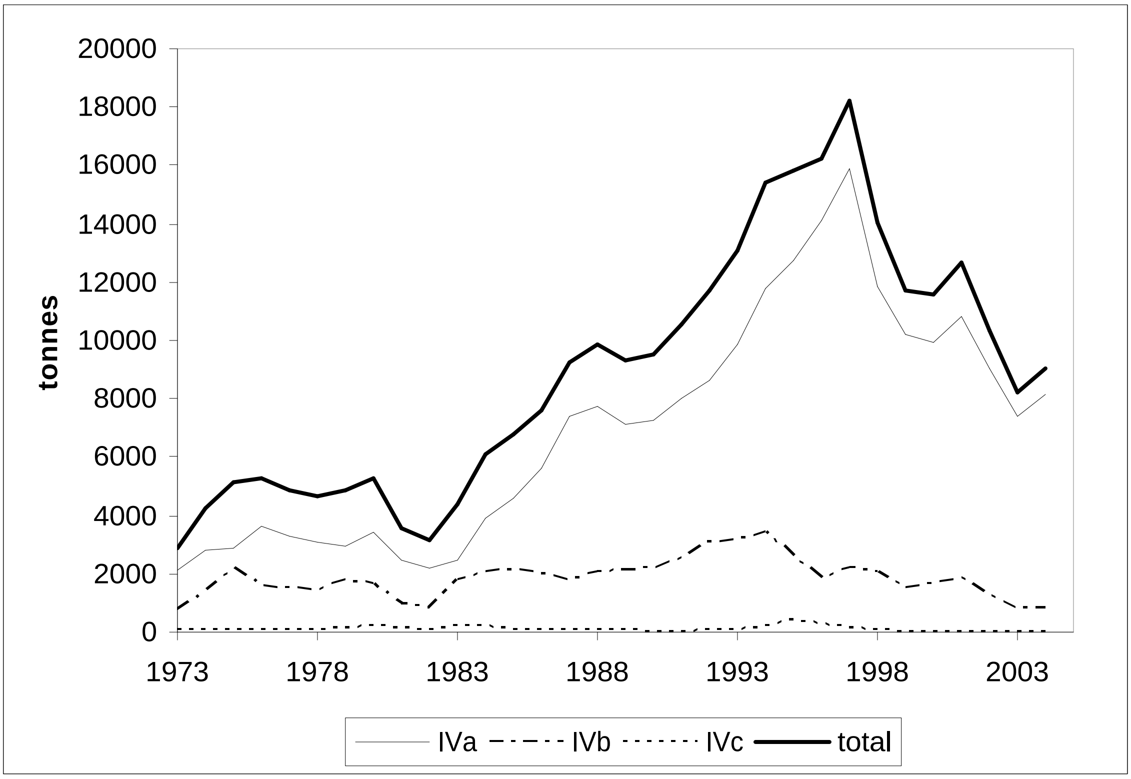


Figure 6.2.8. Landings of anglerfish in the North Sea (including WG estimates of area misreporting but not underreporting)

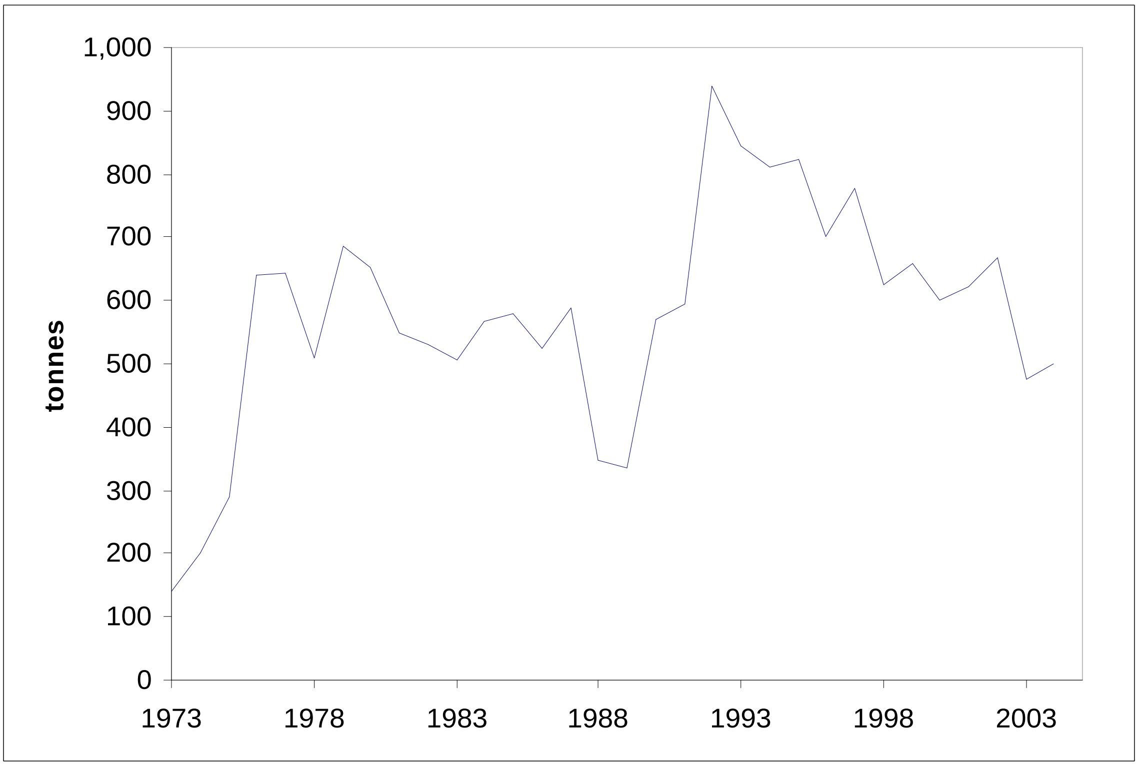


Figure 6.2.9. Landings of anglerfish in Division IIIa.

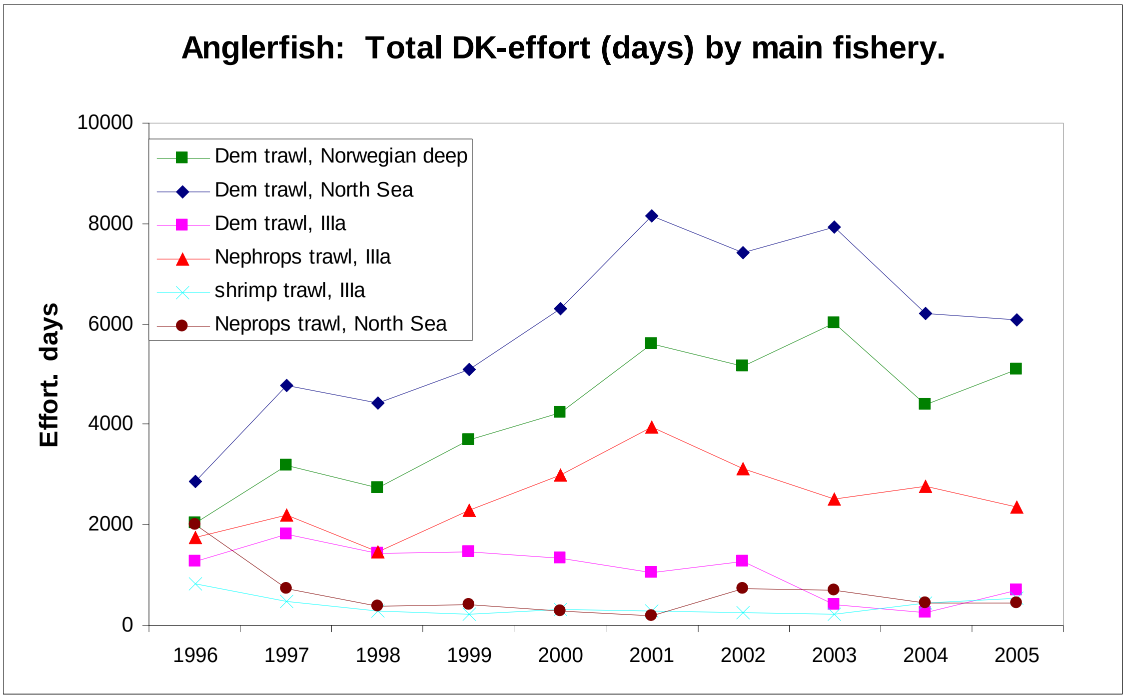


Figure 6.2.10. Anglerfish in the North Sea & Division IIIa. Danish effort from logbooks.

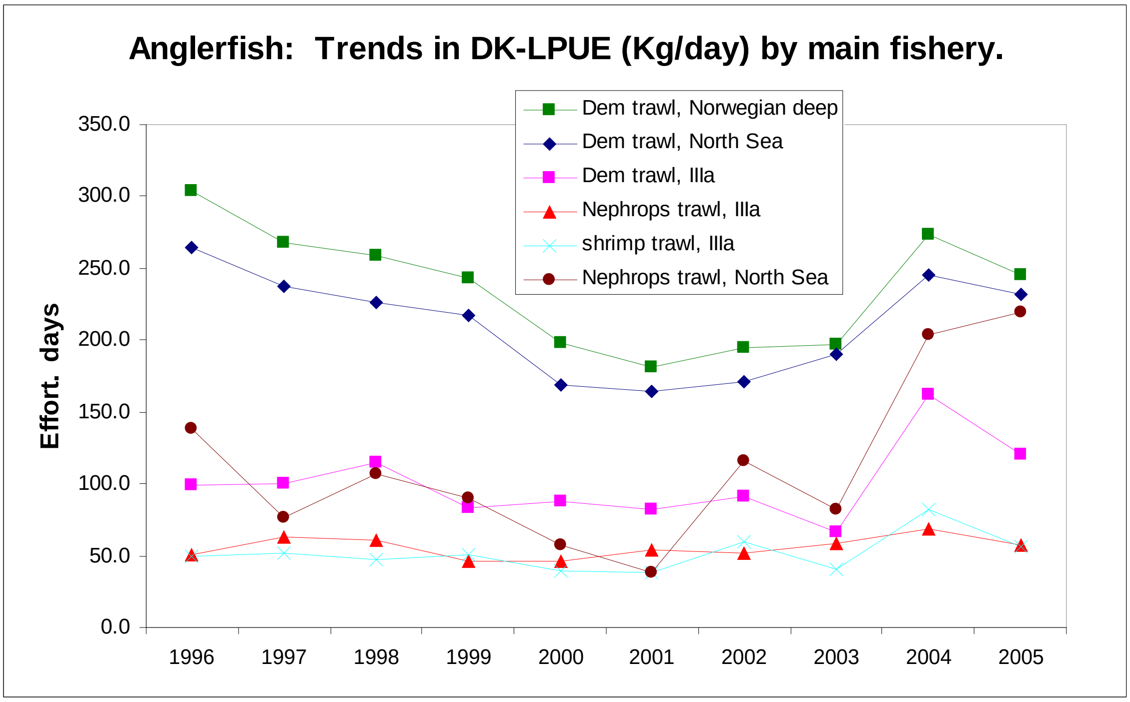


Figure 6.2.11. Anglerfish in the North Sea & Division IIIa. Logbook estimates of Danish LPUE by fishery.

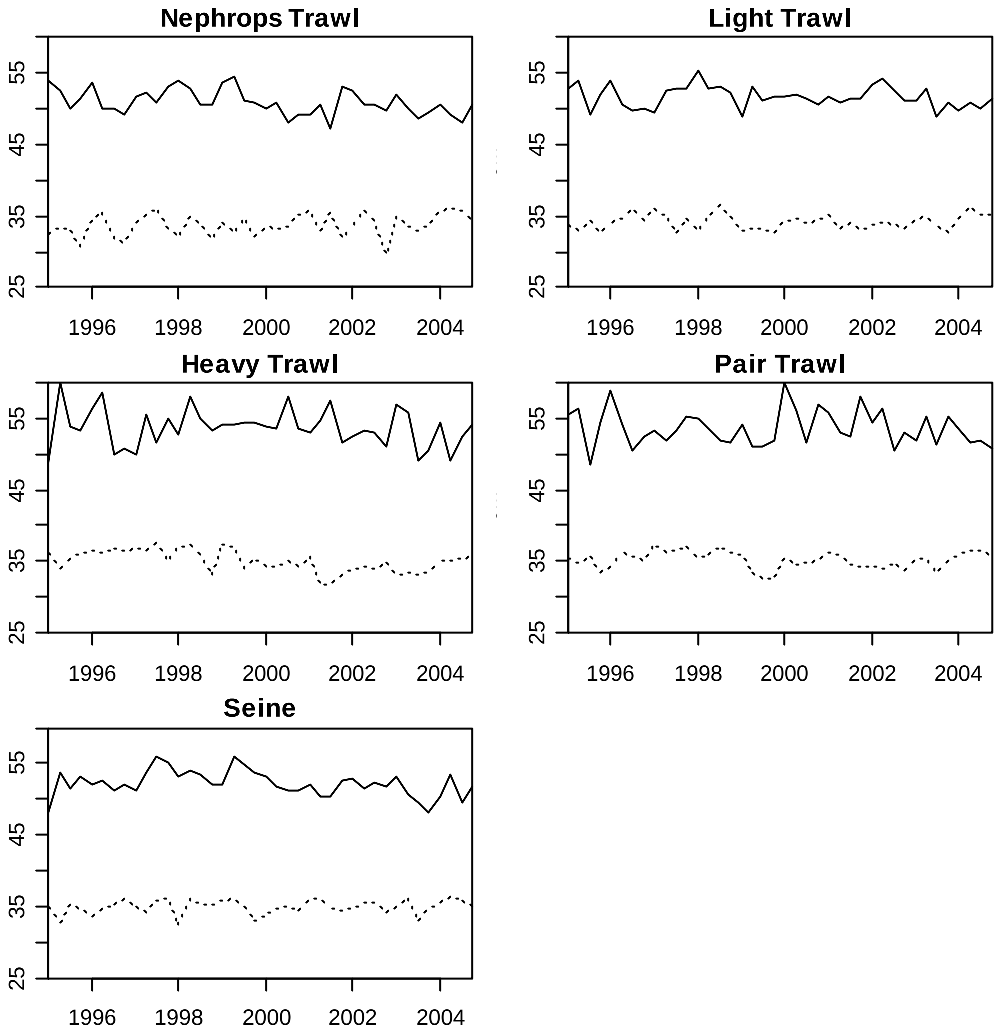


Figure 6.2.12. Trends in mean length of small (<40cm) and large (>=40cm) anglerfish from the Scottish market sampling data by gear category.

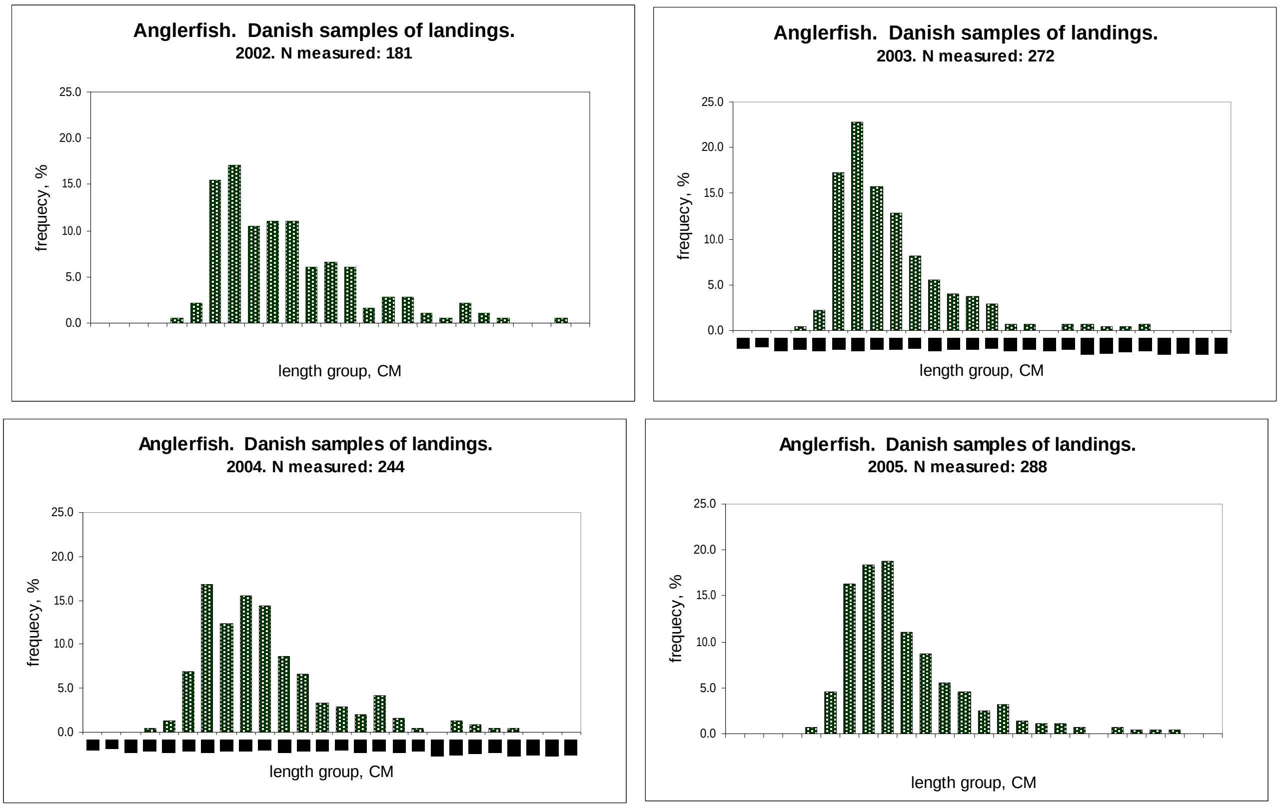


Figure 6.2.13. **Anglerfish in the North Sea. Length distributions from Danish landings (market sampling data)**

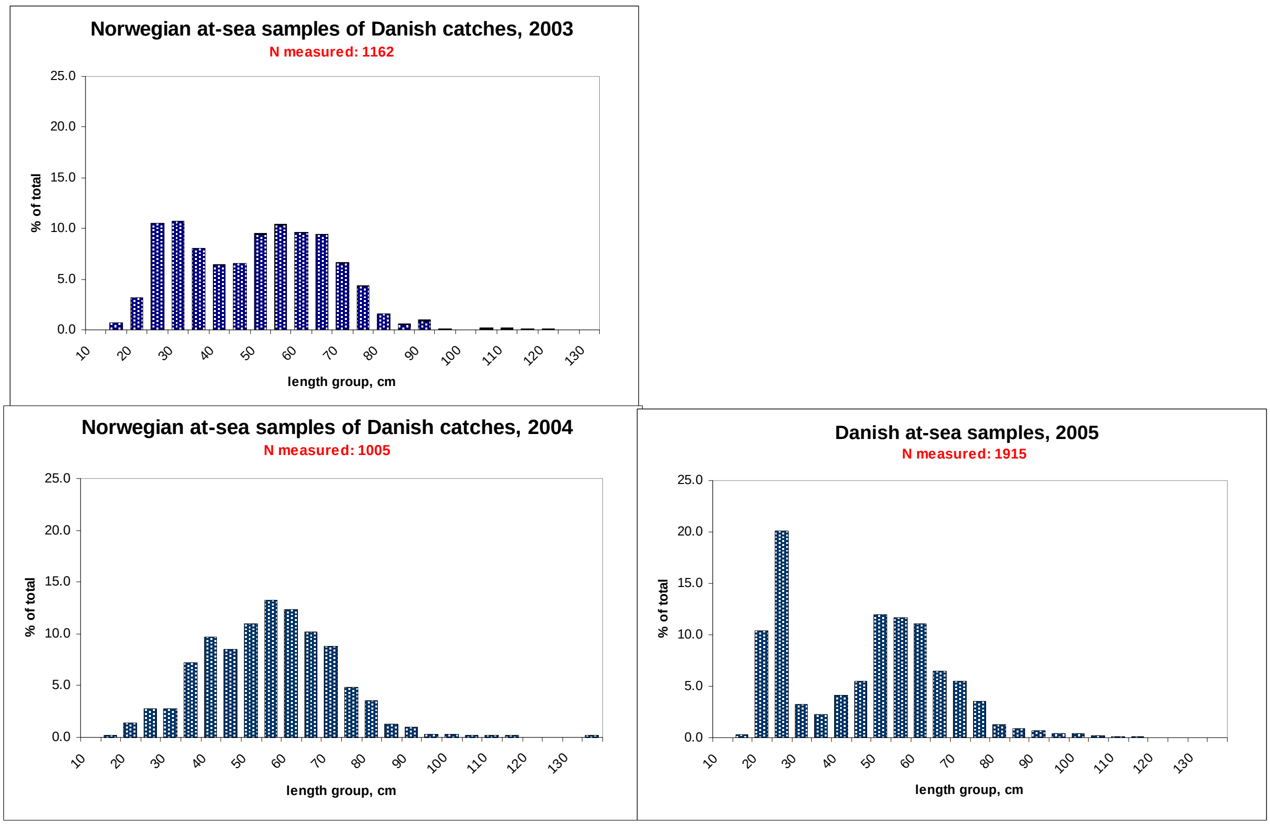


Figure 6.2.14a. **Anglerfish in the North Sea. At-sea samples from the Danish catches in the Norwegian Deeps.**

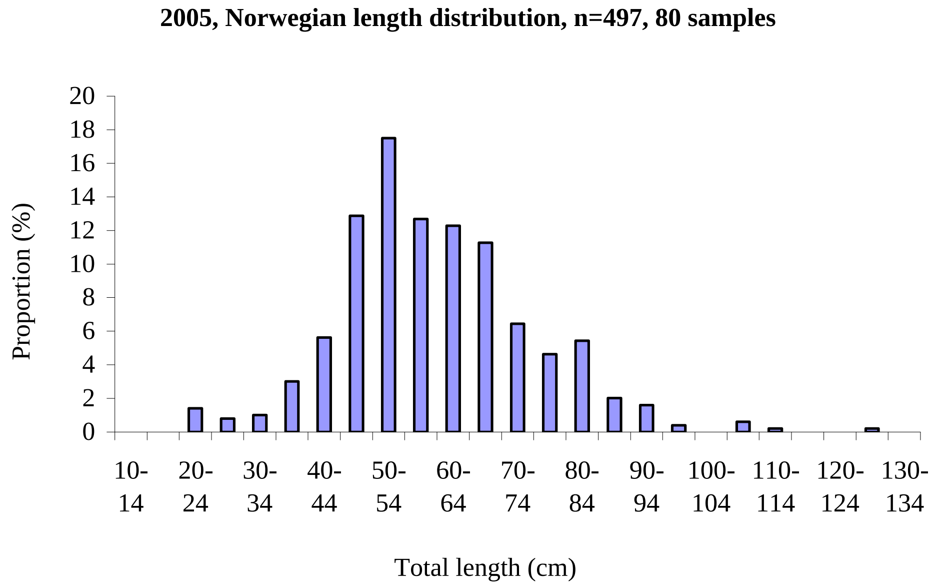


Figure 6.2.14b. Anglerfish in Division IVa. Length distribution from Norwegian at-sea sampling of anglerfish caught as bycatch in offshore trawling for saithe and gillnetting for cod. Includes 6 samples from Danish vessels fishing in the Norwegian EZ.

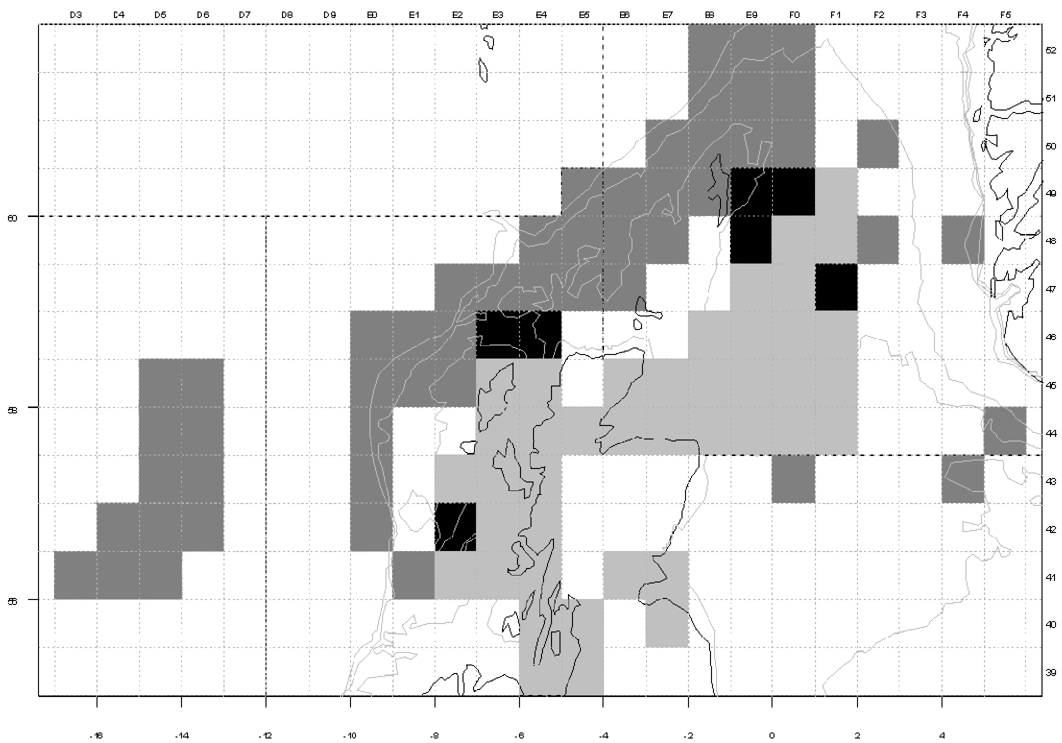


Figure 6.3.1. Anglerfish on the Northern ShelfStatistical rectangle definition of the Scottish anglerfish fishery areas: ‘Anglerfish fishery area’ (grey), ‘Nephrops fishery area’ (light grey) and ‘other’ (all other rectangles). Black rectangles indicate overlap between the anglerfish area and Nephrops area – these rectangles were subsequently included as part of the anglerfish area.

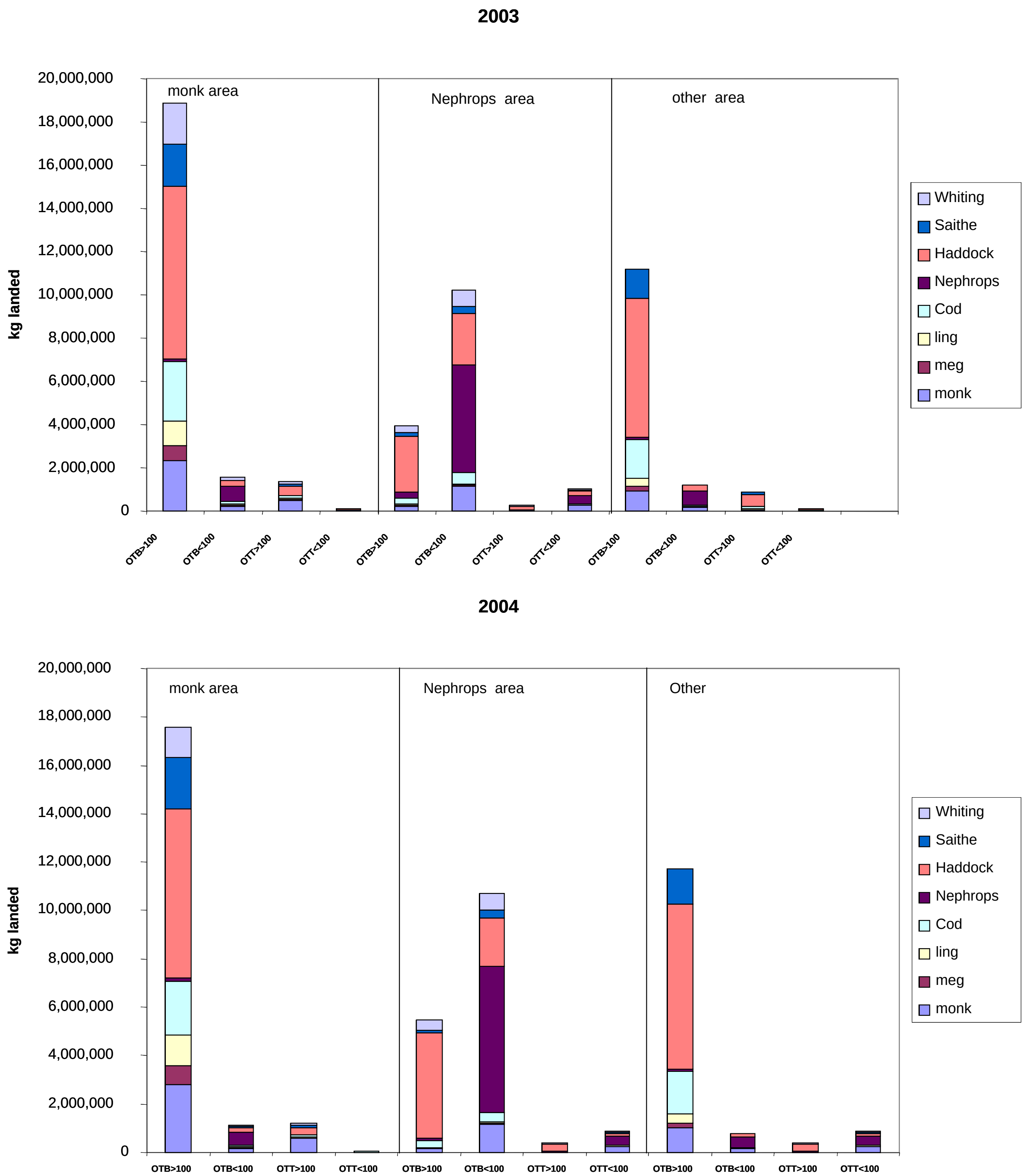


Figure 6.3.2. Landings (kg) of species caught in association with Anglerfish in each of three main fishery areas and by principle metiers in 2003 (upper panel) and 2004 (lower panel). Results shown as a stacked histogram of UK landings into Scotland.

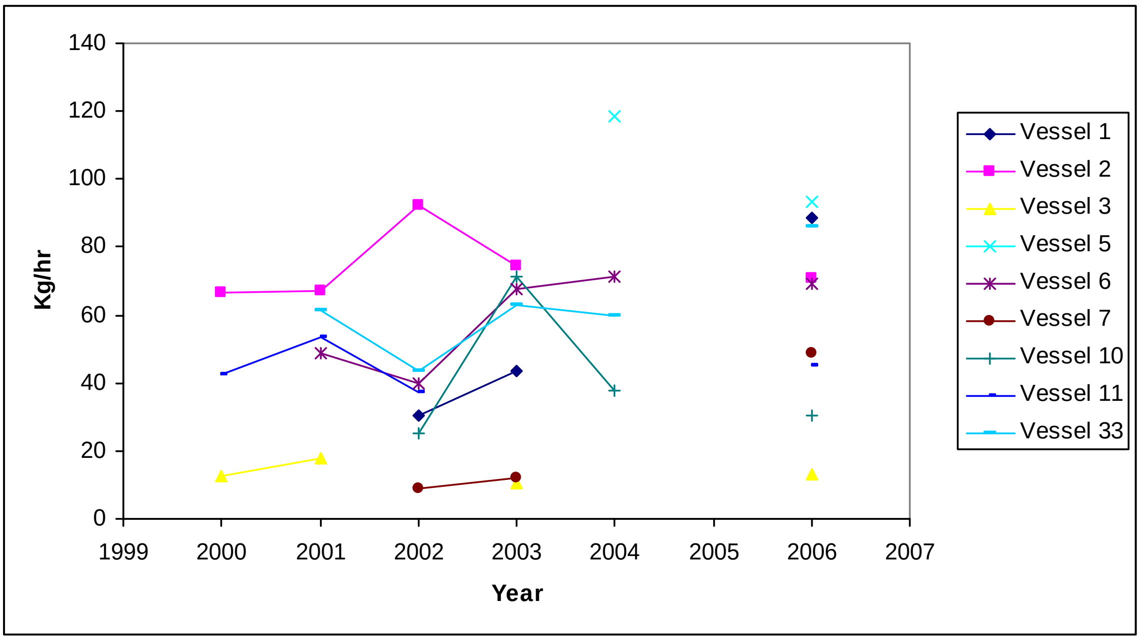


Figure 6.3.3. Anglerfish on the Northern Shelf. Mean first quarter catch rates (Kg/hr) from vessels provided both diary data and participating in the tallybook scheme. Information for 2006 is incomplete and data for 2005 have not been supplied.

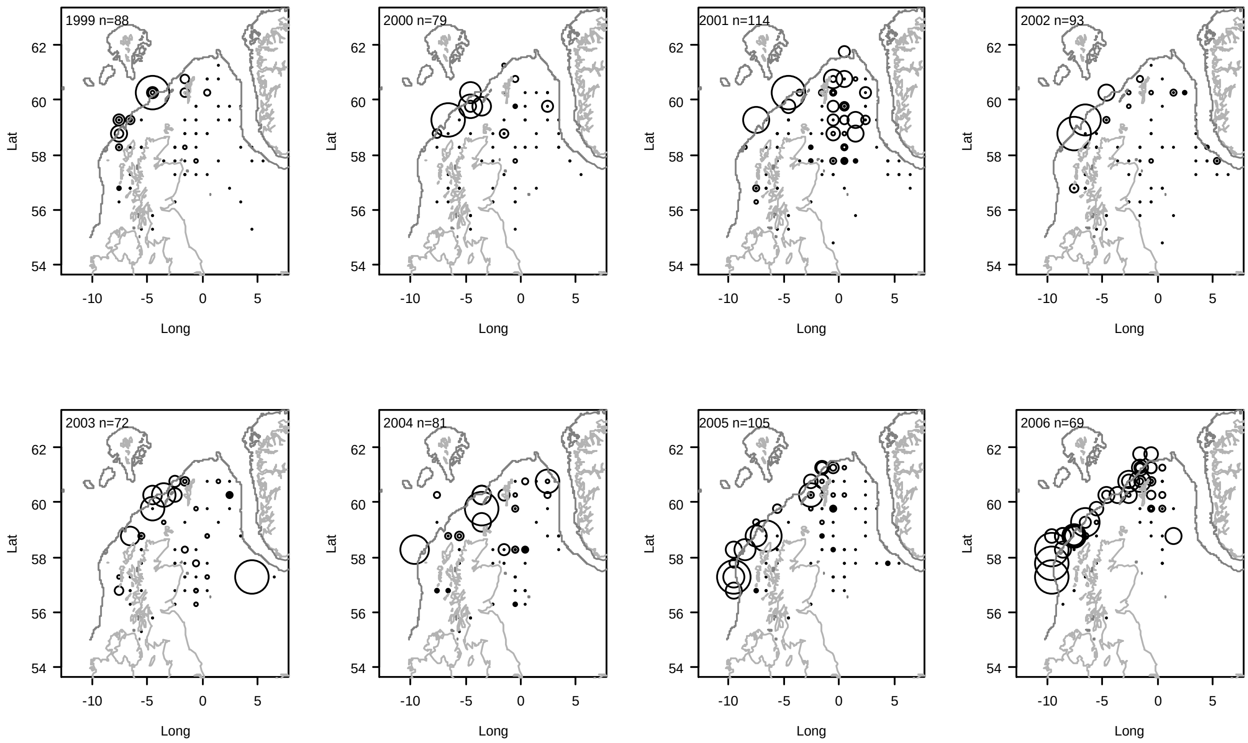


Figure 6.3.4. Anglerfish on the Northern Shelf. Distribution and catch rates of Anglerfish from observer trips conducted in Scotland between 1999 and 2006(Q1 only). The number of statistical rectangles with available data is also shown.

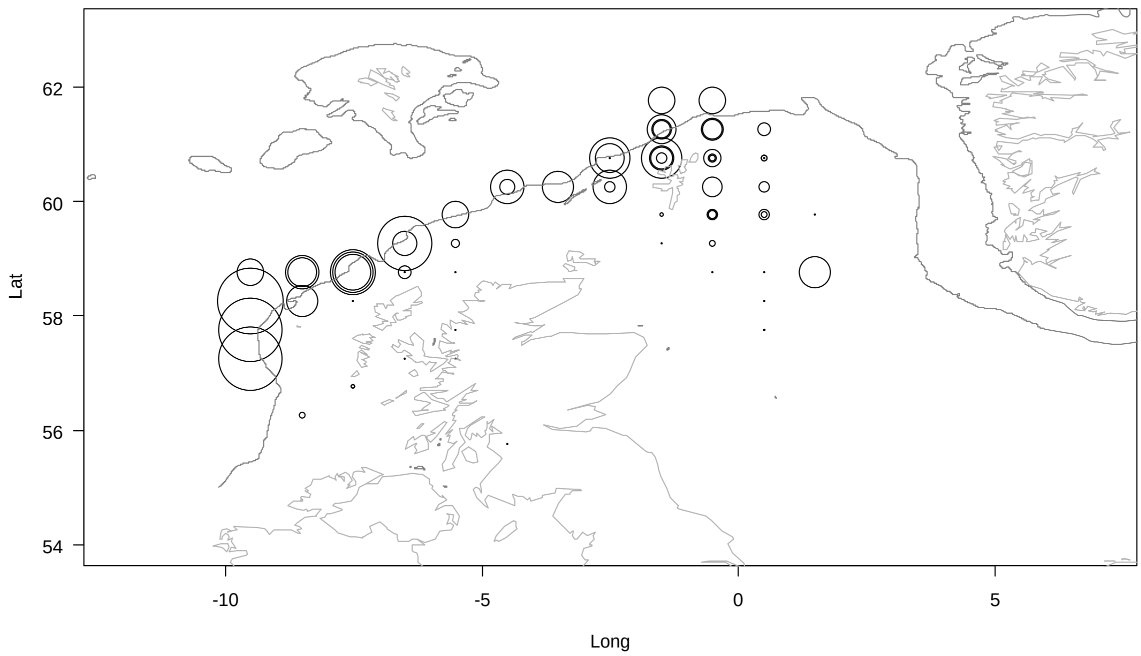


Figure 6.3.5. Anglerfish on the Northern Shelf. Distribution of observed catch rates from the 2006 Scottish Observer programme quarter 1 for all gears showing in more detail the relationship between higher catch rates and the 200m depth contour.

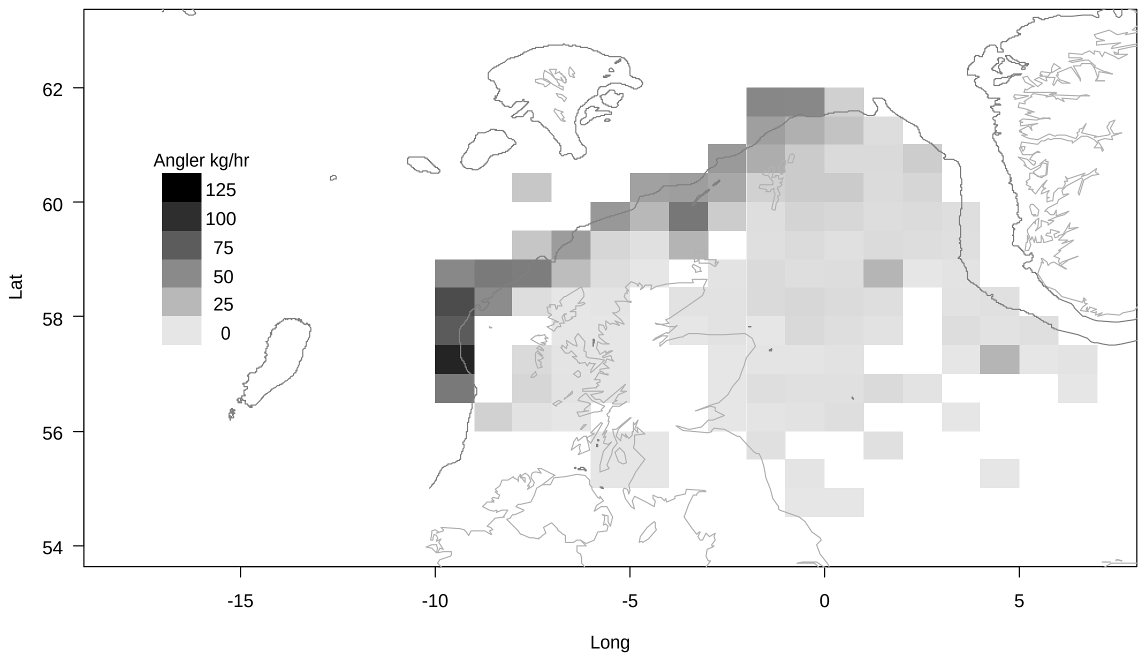


Figure 6.3.6. Anglerfish on the Northern Shelf. Average catch rate per sampled statistical square for all data across all years of the Scottish observer programme. Scale indicates that highest catch rates to the west of Scotland were around 100kg /hour.

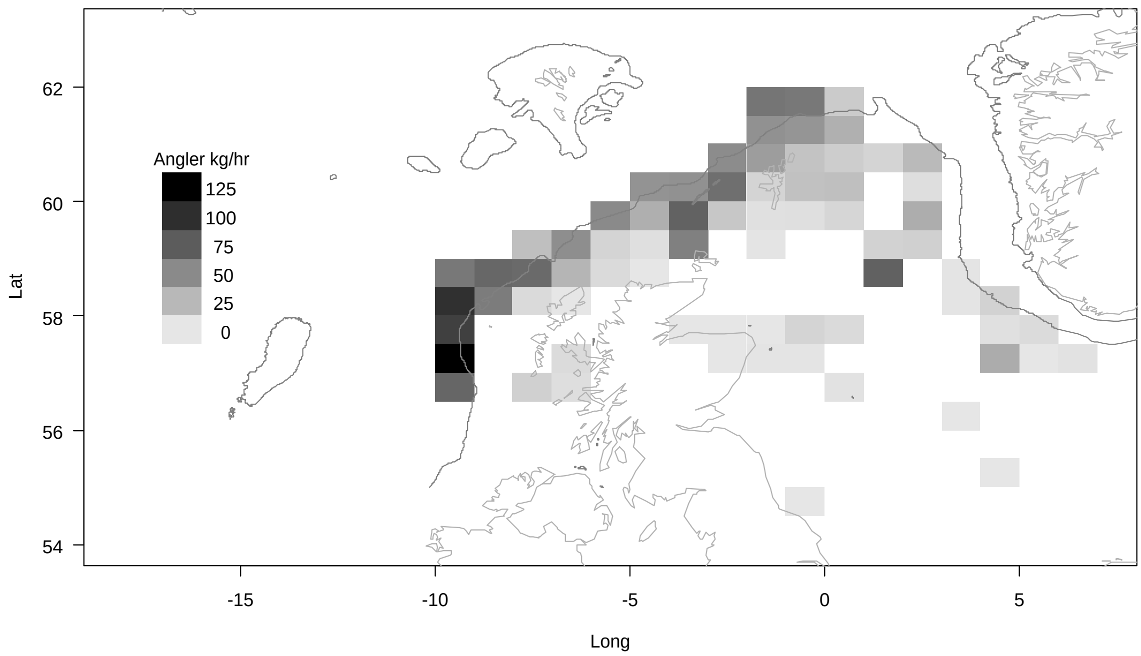


Figure 6.3.7. Anglerfish on the Northern Shelf. Average catch rate per sampled statistical square for light trawl and heavy trawl across all years of the Scottish observer programme.

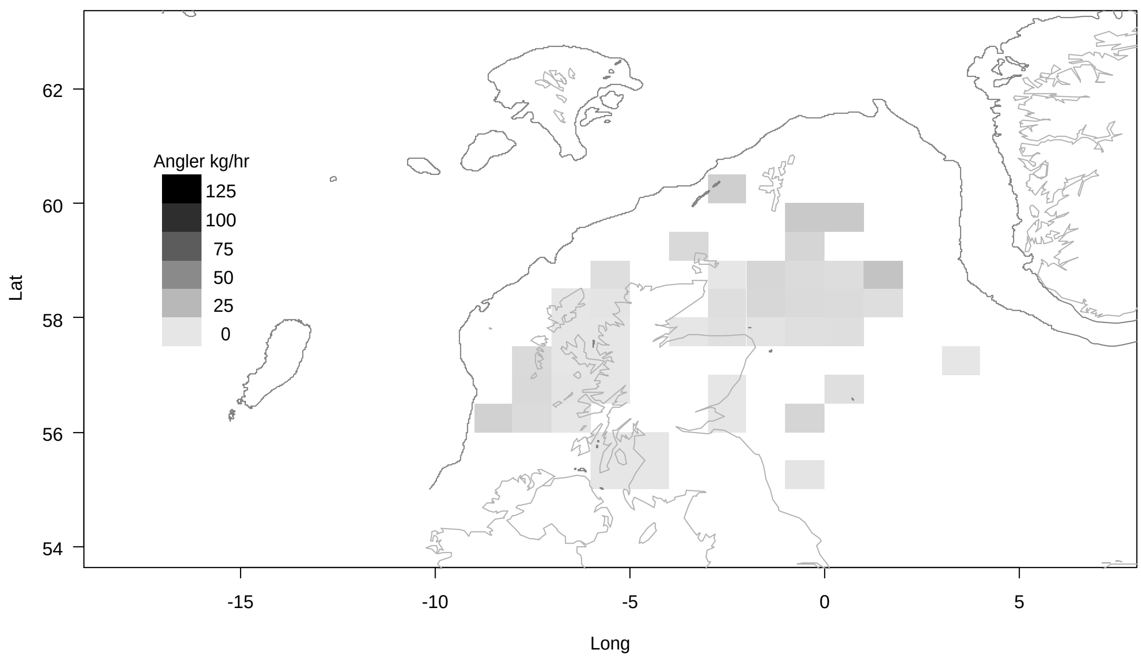


Figure 6.3.8. Anglerfish on the Northern Shelf. Average catch rate per sampled statistical square for light trawl and heavy trawl across all years of the Scottish observer programme.

a) all gears Q1 'anglerfish fishery' area

b) all gears Q1 'nephrops fishery' area

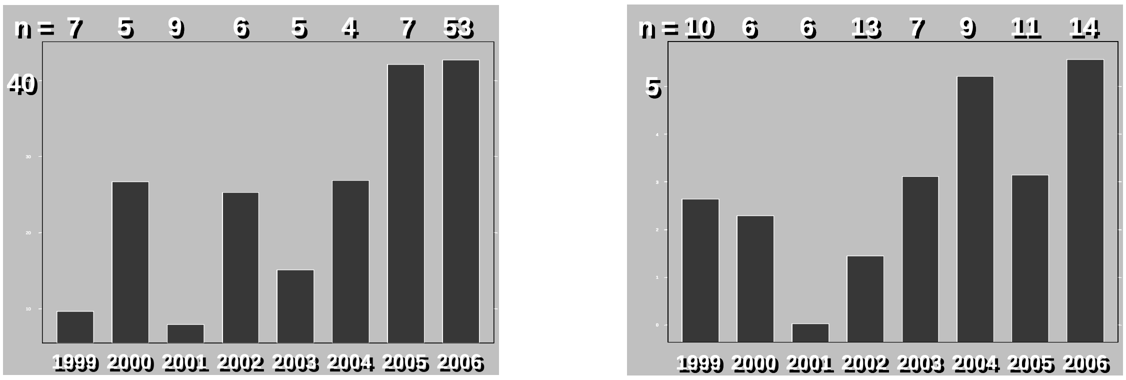


Figure 6.3.9. Anglerfish on the Northern Shelf. Trends in observed catch rate (Scottish Observer programme) between 1999 and 2006 for different subsets of the available data. The number of rectangles sampled is shown for each year and the number on the vertical axis indicates catch rate in Kg/hr.

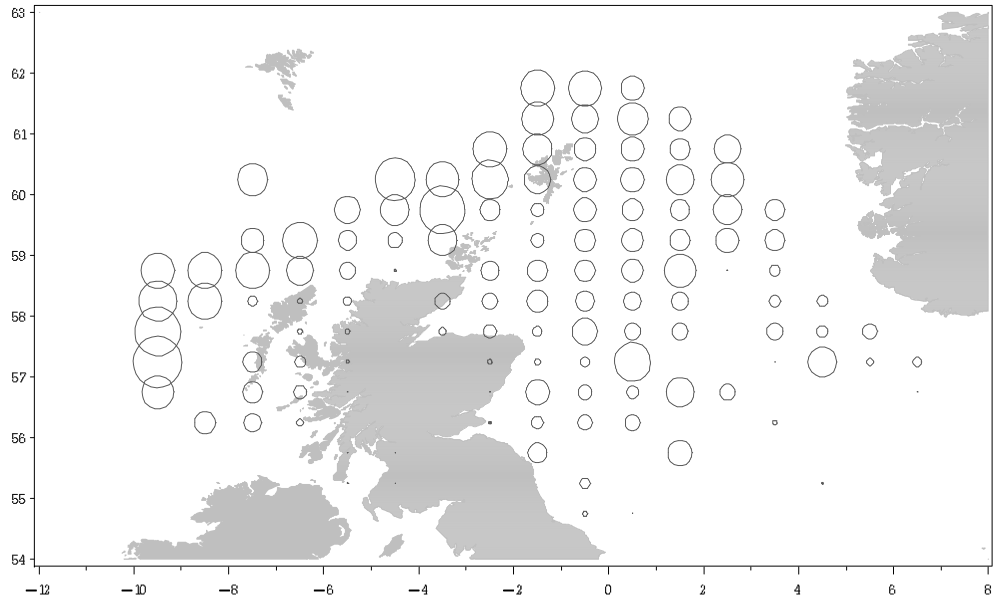


Figure 6.3.10. Anglerfish on the Northern Shelf. Predicted spatial distribution of the landings per unit of effort in the Scottish observer programme, following correction for gear and temporal trends.

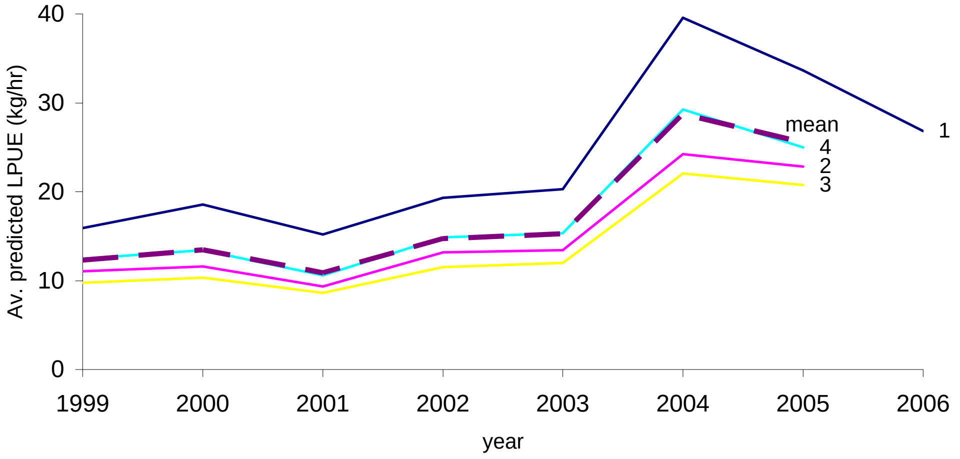


Figure 6.3.11. Anglerfish on the Northern Shelf. Trends in the average predicted landings per unit of effort (kg/hr) by year and quarter as derived from the statistical analysis of the Scottish observer programme.

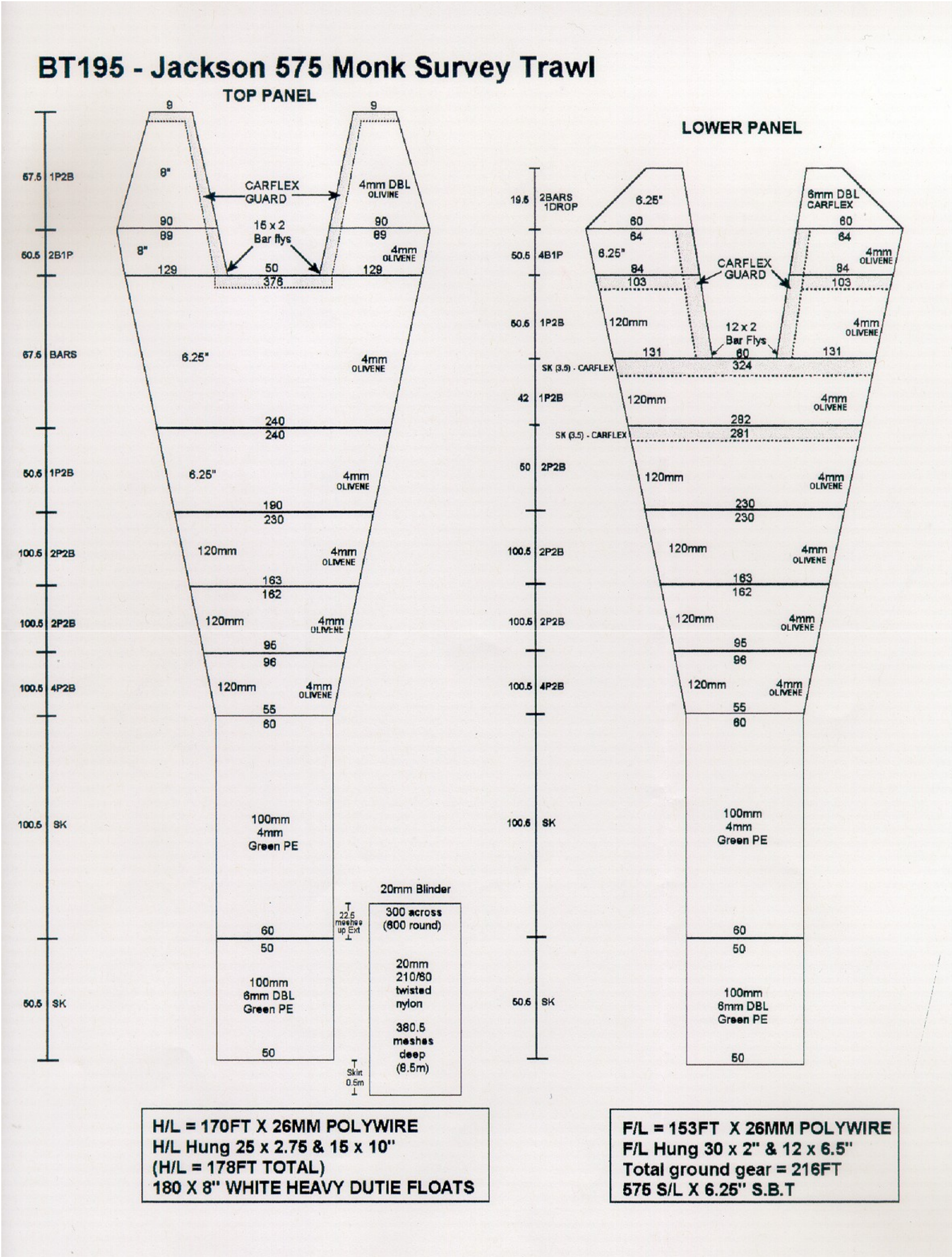


Figure 6.3.12. **Anglerfish on the Northern Shelf. Schematic net diagram of the new joint FRS/industry anglerfish survey trawl.**

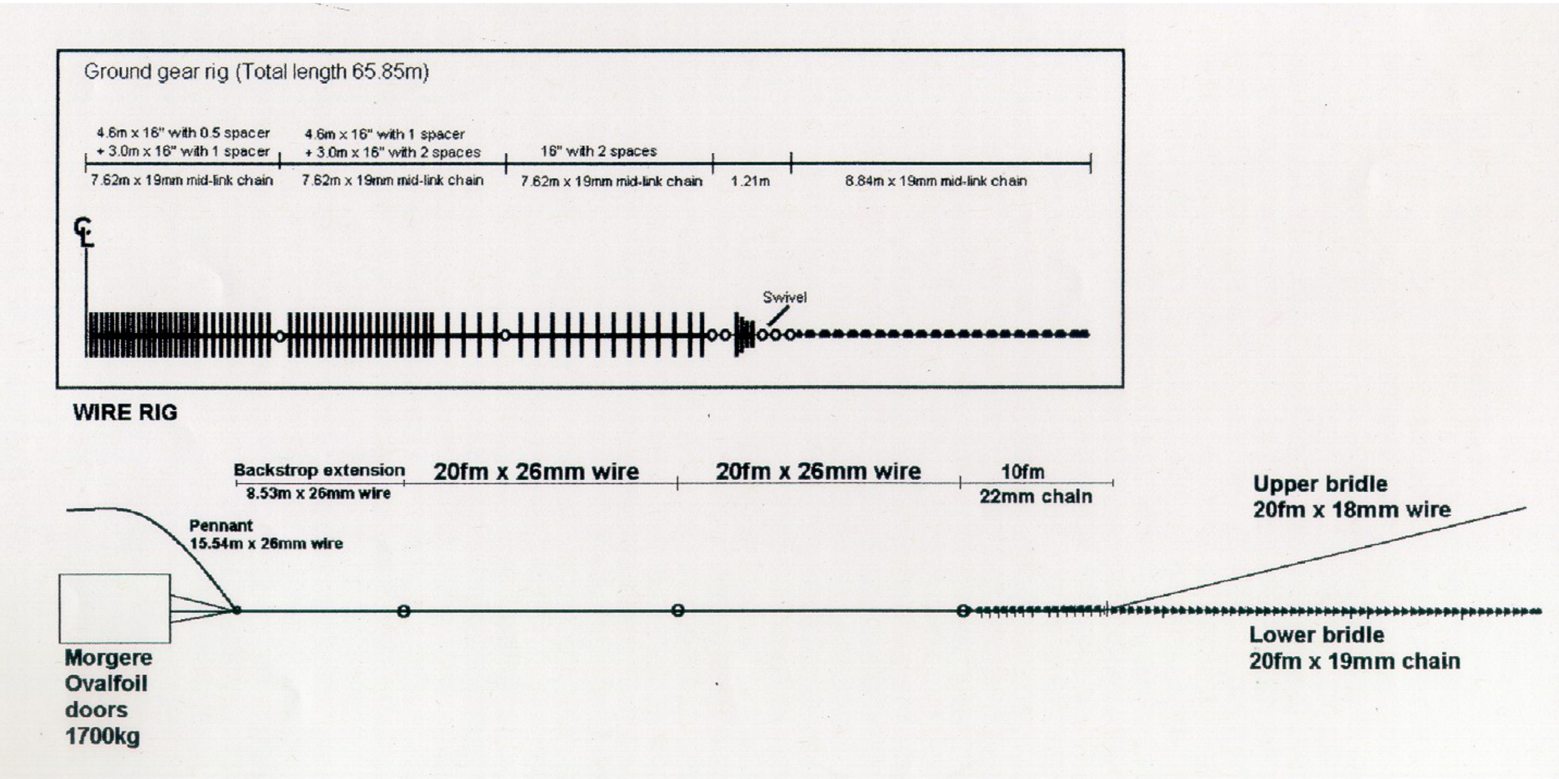


Figure 6.3.13. **Anglerfish on the Northern Shelf. Ground gear and bridle rig for the new joint FRS/industry anglerfish survey trawl.**

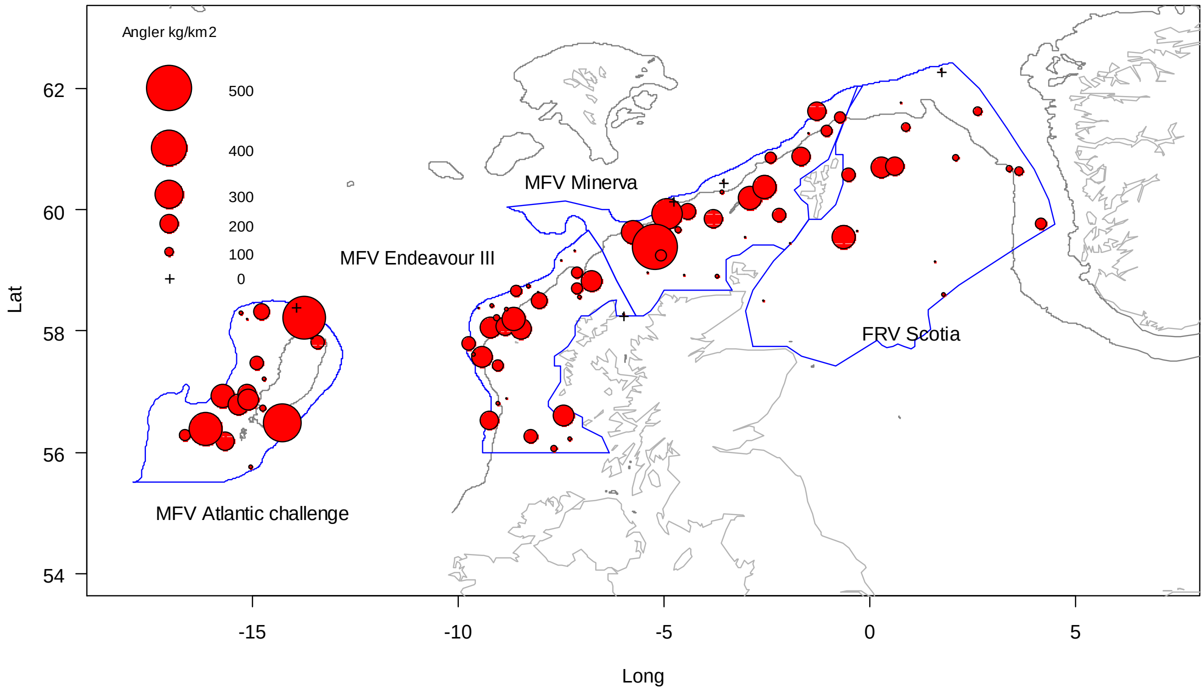


Figure 6.3.14. Anglerfish on the Northern Shelf. Distribution of sample stations and survey abundance in the Scottish Anglerfish survey (joint FRS/ industry). Catch rates expressed as kg/km^2. The blue, irregular polygons signify the four strata used in the survey including Rockall, south west Scotland, north west Scotland and North Sea.

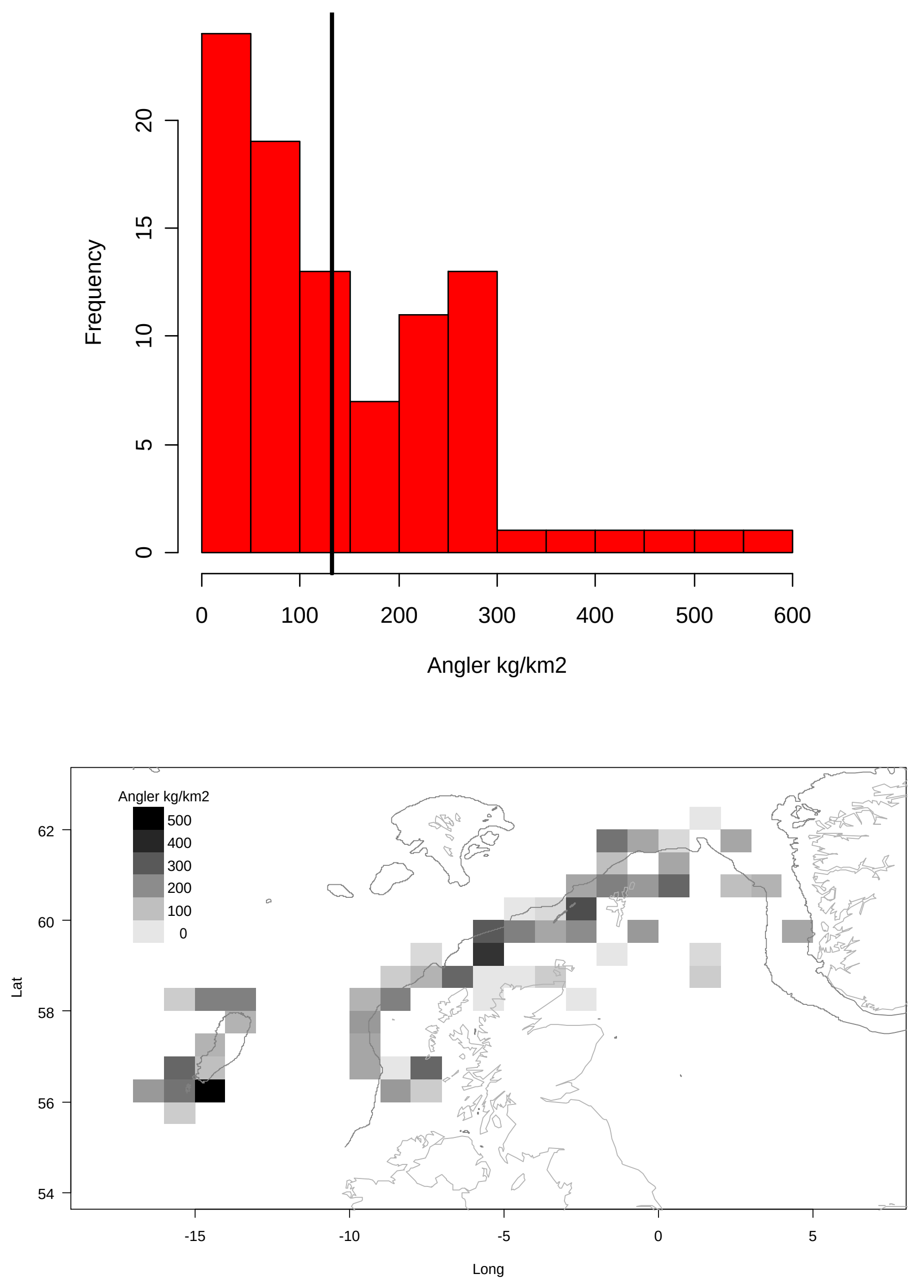


Figure 6.3.15. Anglerfish on the Northern Shelf. Histogram showing distribution of abundances (relatively large number of low abundance stations) from the survey. The vertical line provides an arbitrary median cut-off point and the sampled rectangles corresponding to abundances above this median are shown in the lower panel.

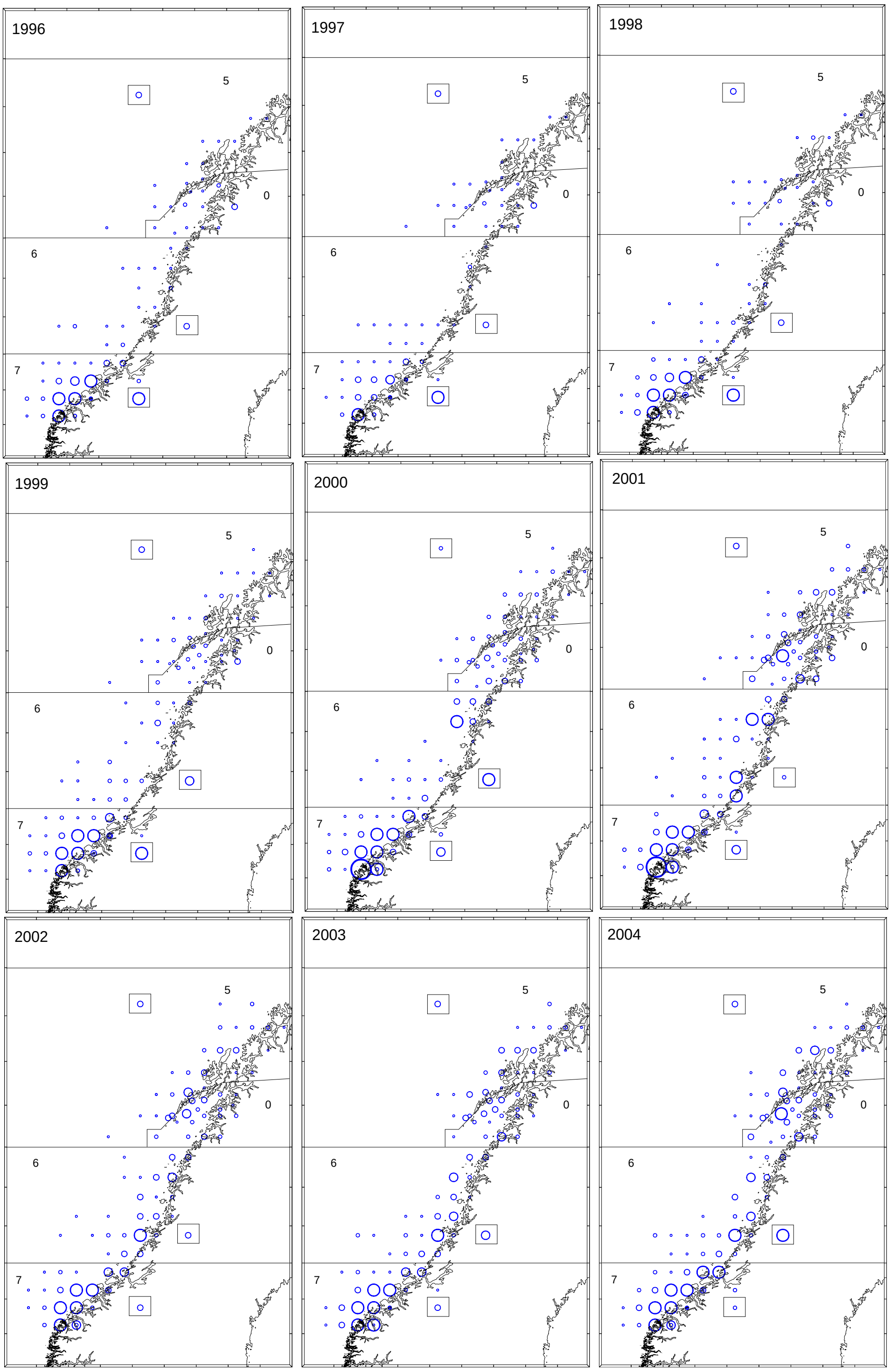


Figure 6.4.1. Anglerfish. Spatial distribution of official Norwegian landings within IIa for the period 1996-2004. Circles in the maps show proportional landings by statistical square in Norwegian statistical areas 5-7 from 1996-2004. Circles enclosed in squares denote landings unallocated to locations within the statistical areas.

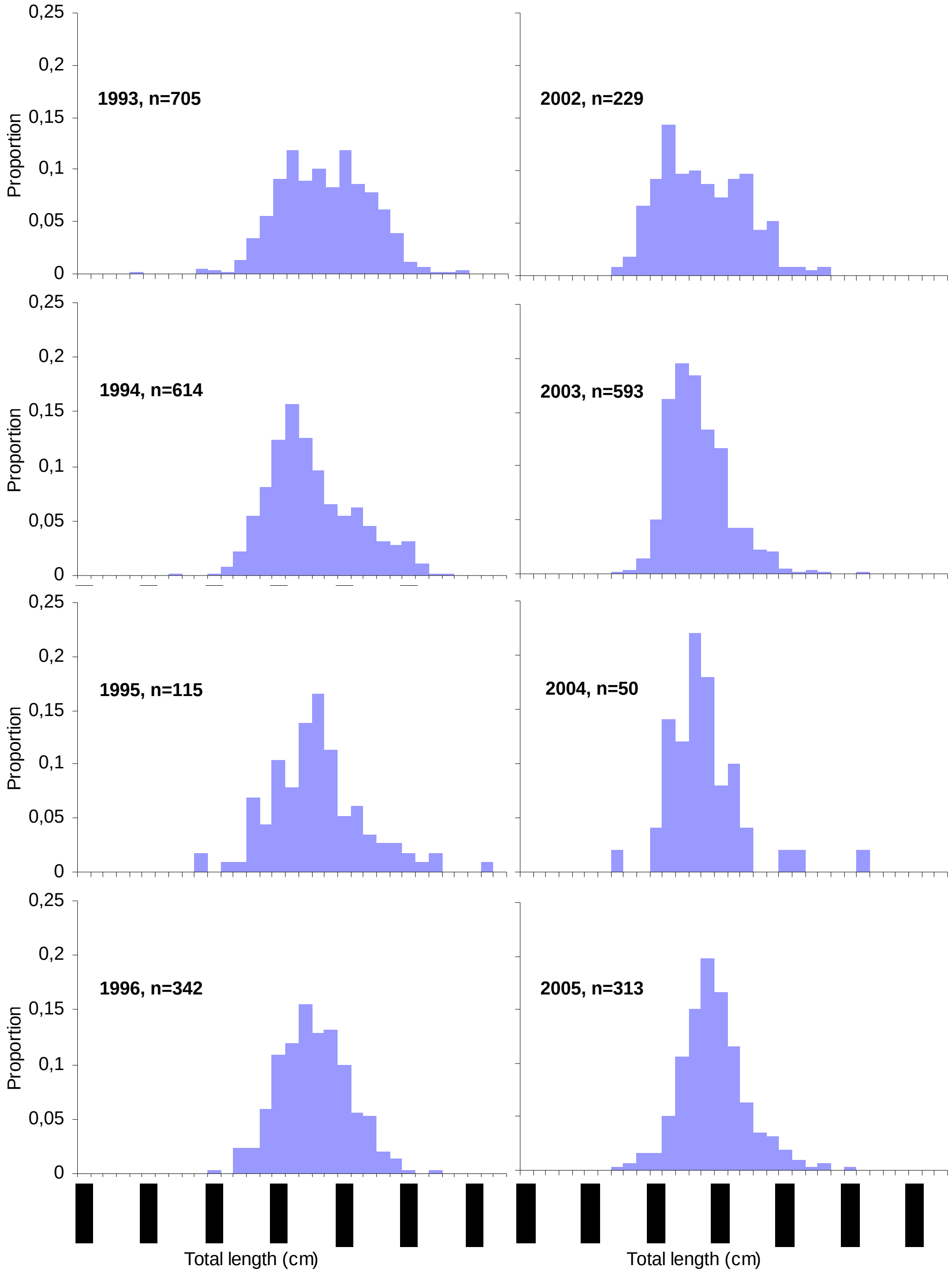


Figure 6.4.2. Anglerfish in IIa. Length distributions for anglerfish caught in the directed coastal gillnetting in Division IIa during 1993-2005. Note that data are lacking for 1997-2001.

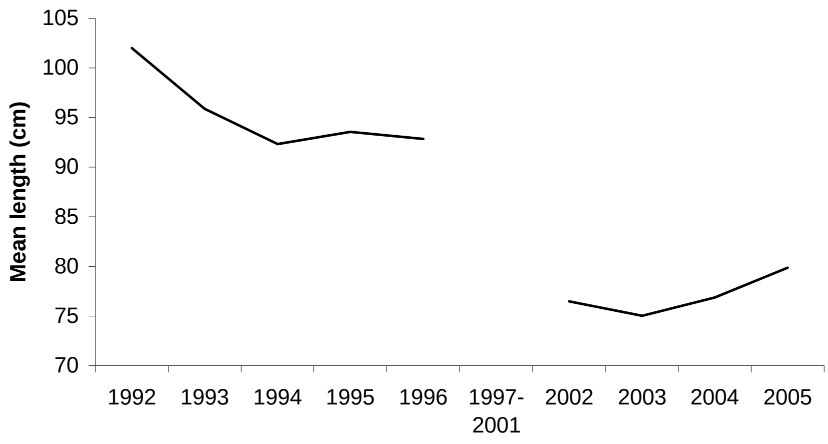


Figure 6.4.3. Anglerfish in IIa. Mean lengths for anglerfish caught in the directed coastal gillnetting in Division IIa during 1992-2005. Note that data are lacking for 1997-2001.

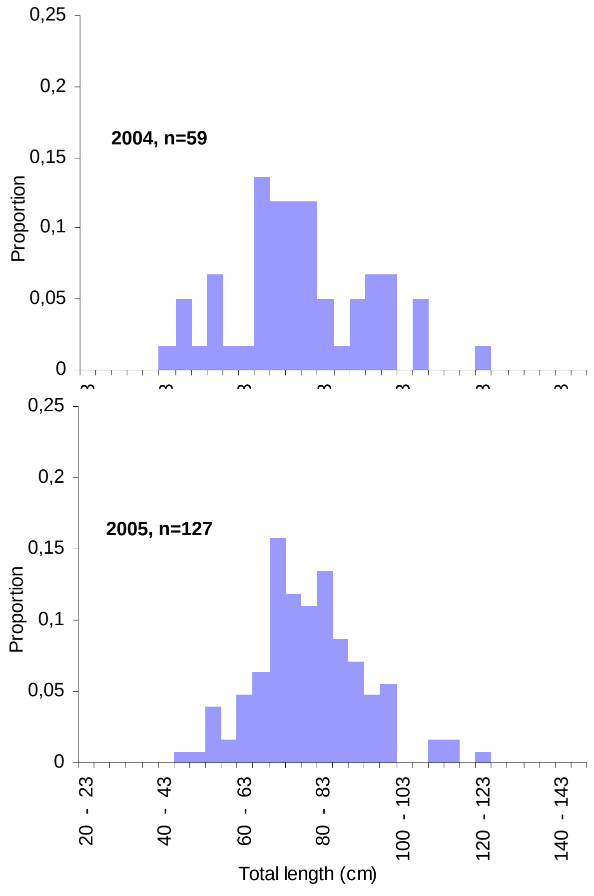


Figure 6.4.4. Anglerfish in IIa. Length distribution for anglerfish caught as bycatch by offshore gillnetting in Division IIa in 2004 and 2005.

7 MEGRIM IN SUB-AREA VI

Megrim in VIa continues to be a monitored stock. The category Monitoring allows for inter-sessional work to be done and signifies that the WGNSDS should continue compiling and presenting, for example, catch and survey data, but that it should not feel obliged to attempt an analytical assessment.

7.1 Megrim in Division VIa

7.1.1 ICES advice applicable from 2005 to 2006

ICES advice for 2005: Catches in 2005 should be no more than the recent (2002-2003) landings in Divisions VIa and VIb and unallocated landings in Subarea IV of about 2,200 t.

ICES advice for 2006: Catches in 2006 should be no more than the recent (2002–2003) landings of about 2300 t. This includes landings in Division VIa and VIb and unallocated landings in Subarea IV.

Advice on fisheries management:

Demersal fisheries in Subarea VI should in 2006 be managed according to the following rules, which should be applied simultaneously:

They should fish:

- **without catch or discards of cod in Subarea VI;**
- **without catch or discards of spurdog;**
- **no directed fishery for haddock in Division VIb;**
- **concerning deep water stocks fished in Subarea VI, Volume 10;**
- **within the biological exploitation limits for all other stocks (see table above).**

Furthermore, unless ways can be found to harvest species caught in mixed fisheries within precautionary limits for <u>all</u> those species individually then fishing should not be permitted (See also Section 1.7).

7.1.2 Management applicable from 2005 to 2006

For a number of years, megrim in Sub-areas VI, XII, XIV and Division Vb (EU zone) have been subjected to a precautionary TAC of 4,360 t. In 2004 this precautionary TAC was reduced to 3,600 t and in 2005 it was reduced further to 2,880 t where it remains for 2006.

Year	ICES Advice	Basis	TAC[1]	% change in F associated with TAC	WG Landings
2002	4,360	Maintain current TAC	4,360	n/a	1,828
2003	4,360	Maintain current TAC	4,360	n/a	1,642
2004[2]	3,600	Reduce TAC to recent landings	3,600	n/a	1,328
2005	2,300	Reduce TAC to recent landings	2,880	n/a	
2006	2,300	Reduce TAC to recent landings	2,880	n/a	

[1]Vb(EC), VI, XII and XIV. [2] Incomplete data. Weights in t.

Effort controls and technical measures enforced for the west of Scotland including those associated with the cod recovery plan are described in Section 1.7.

The minimum landings size of megrim was reduced in January 2000 to 20 cm EC Regulation No 850/98.

7.1.3 The fishery in 2005

The Scottish fleets take around 70% of the Working Group estimates of landings in recent years. There are two main Scottish fleets, the light trawl and heavy trawl, targeting mixed roundfish in VIa. The development of the directed fishery for anglerfish has led to considerable changes in the way this fleet operates. Part of this was a change in the distribution of fishing effort into deeper waters. There have also been changes in the gear used by the heavy trawl fleet with twin rigs and >100 mm meshes being used in deeper water for anglerfish. Vessels using 80 mm mesh to target Nephrops and other species on the shelf also catch megrims. Landings from the Scottish fleet come mainly from the Butt of Lewis, the slope North of the Hebrides and also include some landings from the Stanton Bank. In the past megrim landings have been linked to anglerfish however as the fishing pattern has changed the link may not be as strong in recent years.

Since February 2003, a days at sea effort control regime was implemented in area VI as part of cod recovery measures. This allowed boats to fish a certain number of days per month, depending on the target species and gears used (allocations of either 9, 13, 16 or 21 days per month). This regime appears to have lead to considerable changes in fishing patterns, and may have been an incentive for vessels to switch to targeting anglerfish, megrim or Nephrops to avail of higher effort allocations. The voluntary closure of local grounds also acted to reduce fishing effort in Area VIa. As part of cod recovery measures and a cod tagging programme, the Cape, an inshore fishing ground was closed from mid November 2005 until February 14th 2006 while tagging studies were carried out by the Irish Marine Institute. It was the above measures, coupled with decommissioning of vessels, and good fishing for spring shoaling gadoids in the Celtic Sea which prompted the larger newer boats especially to switch their efforts away from VIa. The shift in fishing effort away from area VIa as part of cod recovery measures obviously reduced the landings of cod from this area, but also caused a reduction in the associated bycatch, especially haddock but also whiting and megrim to a lesser extent.

Between the mid-1970s and the late 1980s the French fleet landed large quantities (1,000-2,000 tonnes/year) of megrim from VIa (based on official landings statistics). During the early 1990s and up until 2003 French landings have declined continuously. This fleet alternated between the shelf and deepwater fisheries and targeted mixed roundfish. No information was available to the working group on the gear, discarding practices or changes to the composition of this fleet in recent years.

Megrim is caught by the Spanish (Basque) fleet targeting them in a mixed fishery for anglerfish, hake and *Nephrops* on the slope west of the Hebrides. In the past these fleets use 80 mm cod-end baka trawls. No information on discarding or recent changes to the composition or gears used by this fleet was available to the Working Group in 2006.

7.1.4 Stock Structure

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.

The migratory behaviour of megrim is poorly understood but commercial data does show clear seasonal patterns in catch rates (highest LPUE's in May each year) this is possibly related to some sort of post spawning migrations (Anon, 2001). The biology of megrim suggests that they are quite mobile when compared with other flatfish species in this area (e.g. plaice and sole). Indeed the WGHMM considers megrim in Divisions VIIb,c,e–k and VIIIa,b,d to be a stock. However, there is no evidence that megrim could migrate across the Rockall trough to such an extent as to consider both populations as continuous. The Rockall trough itself, with depths of in excess of 3000m, must present a significant barrier as it is significantly deeper than the normal bathymetric range of the species (max. depth ~800m).

The stock structure is further complicated since the fishery along the NW coast of Ireland is continuous with the VIIb,c fishery. Megrim larval concentrations have also been found on the VIIb-VIa boundary (Dransfeld *et al.*, 2004) though these concentrations are much lower than observed along the shelf edge in VIIj. On the basis of this information the WG has previously concluded that the megrim population in southern VIa (on slope NW of Ireland) is probably more similar to VIIb than VIb.

Based on reported UK and Irish landings data there appear to be four distinct areas of megrim concentrations in VIa; the Butt of Lewis, the slope North of the Hebrides, Stanton Bank and the slope NW of Ireland (Anon, 2001). Quite how these relate to each other and to VIb requires further investigation. Since the stock structure of megrim on the northern shelf remains rather uncertain the WG has maintained its practice of considering VIb separately.

7.2 Catch Data

7.2.1 Official Catch statistics

Official landings data for each country together with Working Group best estimates of landings from VIa and VIb and are shown in Table 7.2.1. The official data have not been reported in 2005 for most countries. The exception to this is the UK (which reports combined landings rather than those broken down by region) and France. The WG best estimates of landings are those supplied by scientists of the various countries and differ from the official statistics in some years. These were supplied for VIa for some countries in 2005, with Belgian and French landings supplied VIa Scotland.

7.2.2 Revisions to the catch data

Official data became available for France, Ireland, and Spain as well as in disaggregated form for the UK for 2004 and these are given in Table 7.2.1.

7.2.3 Quality of the catch data

Catches of megrim from Sub-area VI 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 and Anon, 2001). It is not clear to the WG whether landings of other countries are accurately partitioned into *Lepidorhombus whiffiagonis* and *L. boscii*

Megrim are caught in association with anglerfish by some fleets and are area misreported along with anglerfish (See Section 6.1.2.2). The official statistics differ substantially from Working Group estimates in recent years. As with anglerfish, the reported Sub-area VI landings have traditionally been adjusted to the Working Groups estimate of catch by including landings declared from Sub-area IV in the ICES statistical rectangles immediately east of the 4 degree W line (see Section 6.1.2.2), however these were not available at the time of this years WG. Area misreporting peaked in 1996 and 1997 when around 50% of the estimated Working Group landings for Division VIa were area misreported.

The above correction does not take into account under reporting of landings. There is some evidence that under reporting occurs in some fleets but the number of vessels examined is small and may not be representative of the entire fishery. The scale of misreporting at the individual vessel level for this species is large enough to make any future analysis based and official landings data highly uncertain.

Discard data provided to the WG by Ireland have indicated that discarding is considerable. The data have now been adjusted according to the raising procedure of Borges, et al (2005) where discards are raised by trip. Discard estimates are not provided by other countries in this fishery.

7.3 Catch-effort data

7.3.1 Commercial

Previously the Working Group investigated the Irish otter trawl commercial fleet as an age structure index for the stock. Due to recent changes in the fleet composition the WG had serious concerns about using this commercial fleet 'uncorrected for fishing power' as a tuning index. In addition this fleet operates mainly in the southern part of VIa and may not be representative index for the whole stock. This effort and LPUE series was updated again this year and is presented in Table 7.3.1.1. Both effort and LPUE are down from 2004 to 2005 by 12% and 34% respectively.

7.3.2 Research vessel surveys

WG investigations in 2004 on Scottish groundfish survey length frequencies concluded that they were of limited use due low and variable catches as well as the fact that the distribution of the stock goes well beyond survey boundaries down the slope into deeper waters. This year no further investigations were made on these survey data and no updates were made to the time series.

The standard IBTS survey gear, the GOV, is not well suited for a flat fish species such as megrim. This is particularly true in its Rockhopper configuration (Groundgear type C) traditionally employed in area VI by the Irish and Scottish groundfish surveys. As well as utilising 200mm meshes in the wings, the Rockhopper configuration results in 21 inch hoppers in the centre section of the trawl and a 30cm gap between footrope and fishing line. A number of study groups have (SGSTG) and are (SGSTS) addressing this and general survey trawl standardisation issues. A revised footrope configuration (Groundgear type D) was implemented for all of the Irish Groundfish Survey (IGFS) stations in VIa from 2004 onwards. Further, given the overlap of survey effort in the Irish Sea agreement was reached to re-allocate Irish Groundfish Survey days from VIIa to extend coverage along the shelf edge from 200m down to 600m in VIa and VIIb,j (Fig. 7.3.2.1). As a new survey stratum in 2005, this area will remain separate from the current survey until a time series is achieved.

A third year of data was provided for the IGFS, which covers the southern part of VIa. Figure 7.3.2.2 maps the IGFS catches by sex to qualitatively illustrate the distribution of this species in the survey and the tendency for relatively more females to be caught in the shallower shelf area. Catch rates are still quite low, but when considering only the strata where megrim catches are highest (VIa Medium-Deep: 75m-200m), numbers of the abundant year classes in recent years range from 30-40/30min tow for each sex (Table 7.3.2.1).

Raised length frequencies by sex and ICES division were also available for the Irish groundfish survey (Figure 7.3.2.3) illustrating the similarity in stock structure between VIa and VIIb (section 7.1.4) indicated from length frequencies, as well as the median differences in length frequency between males and females for these areas.

7.4 Age compositions and mean weights at age

7.4.1 Landings age & length compositions and mean weights at age

Quarterly landings-at-age or length frequency data from VIa were available from Ireland (Fig 7.4.1.1), but unavailable for Scotland and therefore combined international landings-at-age are not updated for 2005 (Table 7.4.1.1).

Earlier investigation of French length-frequency data from 2002 indicated that the size structure of the French megrim landings was similar to that of the Scottish landings. The French vessels are known to mainly fish in deeper waters of VIa like many of the Scottish vessels and a Scottish ALK is therefore normally used to calculate CNAA for the French fleet. Most of the Spanish landings in recent years have been from VIb and no length-frequency data disaggregated by Division have been available to the Working Group, therefore these data cannot be used to calculate landings numbers-at-age for the Spanish fleet.

7.4.2 Discard age compositions and mean weights at age

Estimates of discarding between 1996 and 2005 from the Irish otter trawl fleet were again available to the Working Group (discard length frequencies are also shown in Fig 7.4.1.1). This time series was in need of revision as different raising methods have previously been used. This data has now been updated. Information on discarding practices in other fleets is also needed for this stock.

7.5 Natural mortality, maturity and stock weight at age

(This section will now appear in a stock annex being compiled for this stock).

7.6 Catch-at-age analysis

As previously stated this year did not conduct a catch at age analysis. Only a qualitative exploration of the catch at age data was carried out.

7.6.1 Data Screen Commercial Catch Data

The 2005 Working Group conducted a comparative investigation of the landings numbers-at-age from Scotland and Ireland prior to aggregation. These investigations indicated some differences between the age compositions for these countries with two strong years classes (1992 & 1993) apparent in Scottish data but not so evident in the Irish data. This might be explained by spatio-temporal differences in the catches coming from the fleets rather than mis-specification in the age estimations. However, there was also evidence that when strong year classes occurred in the catch-at-age matrix there were inflated numbers-at-age in surrounding cohorts so inaccurate age estimation may be a problem in this stock. Figure 7.6.1.1 is a plot of the international catch numbers at age first standardised across years then across ages with. This has not been updated due to the paucity of data for 2005, but the plot is presented to indicate the poor tracking of cohorts in the international landings numbers-at-age data. There also appears to be a shift towards landings of older fish in recent years compared with the late 1990s. This may indicate a period of poor recruitment since 2000.

7.6.2 Comparison with last years assessment

As for last year no acceptable assessment could be carried out for this stock.

7.7 Reference points

There is insufficient information to estimate appropriate references points for this stock.

7.8 Quality of the assessment

7.8.1 Landings and LPUE data

The quality of the available landings data, specifically the area misreporting and lack of effort and LPUE data for the main fleet in the fishery, severely hampers the ability of the Working Group to carry out an assessment for this stock at present. It is unlikely that these data will improve in the near future. For stocks like megrim and anglerfish on the northern shelf there is a general need for improved spatio-temporal resolution of commercial catch and effort data since dynamic pool assumptions may be invalidated by size related changes in distribution of the stock in relation to the fishery.

7.8.2 Discards

Discard data should be included in future assessments. Only Irish discard information were available to the Working Group again this year. Irish data suggest that discarding may be substantial in this stock and that the discarding pattern may change over time. These data have now been revised to take account of new raising procedures. Discard data for the Scottish fleet should be worked up for future assessments.

7.8.3 Surveys

There is, currently, there is no survey time series to adequately cover this stock. The Scottish survey catches low numbers of megrim due to incompatible gear and survey coverage. The new Irish GFS survey series is attempting to address some of these issues through the various ICES coordinating and study groups, but as a consequence requires another 3 years at least to produce a viable time series given the change of survey gear used in VIa (see Section 7.3).

As regards coordination and catchability of surveys overlap areas and station positions have been established in VIa between the Scottish and Irish Groundfish surveys, as well as in the eastern Porcupine Bank area of VIIb,c with the Spanish Porcupine Survey. The Spanish survey utilises a modified Baca trawl of 90mm mesh. The baca is a scraper trawl that used commercially for this and other species. Parallel intercalibration tows have been initiated between all these surveys in recent years and should provide data on the relative efficacy of the gears.

7.9 Management considerations

Inaccurate landings and effort data for the main exploiters of the stock make an analytical assessment and the provision of management advice extremely difficult.

Following a period of good recruitment in the mid to late 1990s there are some indications that recruitment in recent years has been weak as the landings at age compositions have been recently dominated by older fish (this perception could also be to changes in fishing pattern). Reported landings have declined continuously since 1996 and the 2004 estimates were around half the long-term average (Fig 7.9.1).

Total landings in recent years are considerably less than the TAC. This is because of poor quota uptake by the French and Spanish fleets. Other national quotas are very restrictive and this has probably led to under-reporting of landings by individual vessels. Area misreporting has also been prevalent (See section 7.2.3) as megrim catches were misreported from Subarea

VI into Subarea IV due to restrictive quotas for anglerfish and megrim (i.e. vessels targeting anglerfish misreported all landings including megrim from Subarea VI into Subarea IV).

In the past, management of the megrim stock has been linked to that for anglerfish on the assumption that landings were correlated in the fishery and it was thought that the anglerfish management would also constrain fishing mortality on megrim. This is probably no longer the case since much of the anglerfish fishery targets that species in deeper waters and with larger meshes. Furthermore the catch controls have not previously constrained fishing mortality.

The minimum landings size of megrim was reduced in January 2000 to 20 cm EC Regulation No 850/98. Despite this extremely small size the catch is routinely high graded and large numbers of fish continue to be discarded above this MLS. The 20cm MLS is also coincident with the separation point between the length frequency modes for male and female megrim from the survey data presented in 7.3.3. indicating again a much higher F impacting on females.

Analysis of the above survey data (WD: 4) has shown not only a strong spatial structuring in the sex ratio with depth, but also in mean length. While a sex ratio of 50:50 was observed between approximately 75-200m, females accounted for only 30% of the catch at 300m plus. As depth decreased females become relatively more abundant although overall catches decline, and females tend to become larger as one moves inshore.

7.10 Megrim in Division VIb

7.10.1 The fishery in 2005

Longer-term international landings from VIb are shown in Figure 7.9.1 (note: historical data based on official figures are incomplete in some years i.e. 1973-76 and 1979). Landings fluctuated around 1,000t between 1986-1999 since then landings have declined.

Megrim are mainly caught by a Scottish heavy otter trawl fleet targeting haddock on the Rockall Bank. This fleet uses >110 mm mesh and twin-trawls have increasingly been used in recent years. Due to larger mesh sizes used in this fishery discarding of megrim by the fleet is not thought to be significant. No information was available to the working group on any recent changes to the composition of this fleet.

The Irish otter trawl fleet in Division VIb take megrim as a by-catch in the haddock fishery on the Rockall Bank. The fleet targeting haddock uses 100 mm mesh and twin rig trawls. Discarding of megrim from the fleet targeting haddock in Division VIb is not thought to be significant (Anon, 2001). Recently the number of vessels participating in the fishery has declined with only 2 vessels reporting significant megrim landings in 2004.

The voluntary closure of the cod box in the cape grounds just north of Greencastle in, coupled with a days at sea regime in VIa and good fishing in near shore grounds on the south coast led to a shift in effort away from ICES area VI in general. Therefore the majority of the VIa otter board fleet shifted its fishing efforts to target spring shoaling gadoids in the Celtic Sea in Quarters 1 and 4 in particular.

Megrim are caught by Spanish fleets in a mixed fishery targeting anglerfish, hake, megrim and witch. Spain also catches four-spotted megrim (*Lepidorhombus boscii*) in VIb. In the past this fleet used 80 mm cod-end baka trawls. No information on current gears or recent changes to the composition this fleet were available to the Working Group.

7.10.2 Official Catch statistics

Official landings data are presented by country in **Table** Table 7.2.1. Note 2005 landings data are incomplete, only the UK and France reported official landings data for this area. No data was available to revise the 2004 WG best estimate.

7.10.3 Quality of the catch data

The catch data for VIb are very problematic. Firstly, estimates of catch were only available from UK and France for VIb in 2005. Secondly, Spain also catches four-spotted megrim (*Lepidorhombus boscii*) in VIb and landings have not been supplied to the WG broken down by species. Finally, there is anecdotal evidence of underreporting and area mis-reporting in this fishery also.

7.10.4 Management applicable to 2005 and 2006

See section 7.1.2.

7.10.5 Commercial catch-effort data and research vessels survey

Catch and effort data were available for the Irish otter trawl fleets from 1995-2005 (Table 7.3.1.1). This fleet takes between 15-20% of the international landings in recent years. The Irish effort for the fleet in VIb increased until 2000. Effort since 2002 has declined substantially due to vessel decommissioning. Irish LPUE in VIb is considerably higher than in VIa but it has fluctuated over the time series. The high LPUEs in some years (1998 and 2002) may simply reflect increased targeting of megrim by the fleet.

7.10.6 Catch age compositions and mean weights at age

Quarterly landings-at-age data for VIb were available to the Working Group for Ireland from 2000 to 2005. However, since this country catches around 20% of the total landings relative to other fleets with more substantial landings the 2005 Working Group did not think it appropriate to use these data in even simple assessments. No further analytical assessment has been done.

7.10.7 Management considerations

Megrim is caught as part of a mixed species fisheries in VIb. Therefore management for haddock and other demersal species in VIb will impact on fleets catching megrim.

Table 7.2.1 MEGRIM in Sub-area VI: Nominal catch (t) of Megrim West of Scotland and 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
Belgium	0	1	0	0	1	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	-
France	398	455	504	517	408	618	462	192	172	0	135	252	79	92	50	36
Ireland	317	260	317	329	304	535	460	438	433	438	417	509	280	344	278	-
Netherlands	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	-
Spain	91	48	25	7	1	24	22	87	111	83	98	92	89	98	45	-
UK - Eng+Wales+N.Irl.	25	167	392	298	327	322	156	123	65	42	20	7	14	13	117	-
UK – Scotland	1093	1223	887	896	866	952	944	954	841	831	754	770	643	558	469	-
UK																442
Offical Total	1924	2154	2125	2047	1907	2451	2044	1795	1622	1394	1424	1630	1105	1105	959	
Unallocated	286	278	424	674	786	1047	2010	1477	1083	1254	823	843	723	537	n/a	n/a
As used by WG	2210	2432	2549	2721	2693	3498	4054	3272	2705	2648	2247	2473	1828	1642	1328	561
Area Mispreported landings	339	338	466	735	871	1126	2062	1556	1156	1066	868	829	731	544	421	n/a

Megrim in Division VIb (Rockall)

Country	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
France	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0.1
Ireland	196	240	139	128	176	117	124	141	218	127	167	176	87	83	43	-
Spain	363	587	683	594	574	520	515	628	549	404	427	370	120	93	71	-
UK - Eng+Wales+N.Irl.	19	14	53	56	38	27	92	76	116	57	57	42	41	74	42	-
UK - England & Wales	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
UK – Scotland	226	204	198	147	258	152	112	164	208	278	309	236	207	382	372	-
UK																266
Offical Total	804	1045	1073	925	1046	816	843	1009	1091	866	964	824	455	632	528	
As used by WG	804	1045	1073	925	1046	816	843	1009	1091	866	964	825	456	632.04	457	n/a

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

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Offical Total	2728	3199	3198	2972	2953	3267	2887	2804	2713	2260	2388	2454	1560	1737	1487	
As used by WG	3014	3477	3622	3646	3739	4314	4897	4281	3796	3514	3211	3298	2284	2274	1785	n/a

n/a = not available due to limited or absent data to allow calculation of the value.

Table 7.3.1.1 MEGRIM in Sub-area VI: Effort and LPUE data for the Irish otter trawl fleet in Division VIa and Division VIb 1995-2005

Year	**Effort (Hrs)**		**LPUE (Kg/Hr)**	
	VIa	**VIb**	**VIa**	**VIb**
1995	57,398	9,142	9.0	15.2
1996	61,676	7,219	7.3	17.0
1997	65,545	7,169	6.4	19.6
1998	58,842	7,461	6.7	27.7
1999	54,129	8,680	6.5	15.5
2000	52,847	9,883	6.8	15.9
2001	48,358	7,244	8.8	22.9
2002	37,231	2,626	6.6	31.8
2003	39,803	4,556	8.1	17.9
2004	35,216	2,234	7.3	20.8
2005	30,941	3,844	4.8	17.16

Table 7.3.2.1. Catch numbers at age for Via South for the Irish Grundfish Survey 2003-2005, disaggregated by sex and only including survey strata where catches are most abundant.

Male Megrim

	Effort(min)	0	1	2	3	4	5	6	7	8	9	10	Total
IGFS03	766	0	5	8	6	4	3	1	1	0	0	0	28
IGFS04	692	0	7	31	16	11	4	0	0	0	0	0	68
IGFS05	540	0	8	20	15	4	5	2	0	0	0	0	53

Female Megrim

	Effort(min)	0	1	2	3	4	5	6	7	8	9	10	Total
IGFS03	766	0	15	24	23	23	16	9	5	4	0	0	120
IGFS04	692	0	16	37	27	13	22	10	3	5	0	0	133
IGFS05	540	0	2	8	23	26	20	12	6	7	2	0	105

Table 7.4.1.1 Megrim in VIa. Landings numbers-at-age ('000s)

Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0
2	0	0	0	0	8	101	30	19	2	97	35	50	7	6	8
3	0	2	8	69	210	569	1,129	186	269	545	380	160	132	165	32
4	121	165	1,053	946	925	1,368	2,739	2,543	709	1,572	1,313	487	755	281	290
5	451	1,046	1,282	1,894	1,611	2,177	2,766	2,897	3,056	1,728	2,227	1,514	1,387	554	358
6	722	812	1,066	773	1,617	1,713	1,439	1,065	2,131	2,220	1,121	2,210	860	693	570
7	795	1,027	948	817	805	1,324	622	642	748	1,205	1,165	1,282	1,006	1,217	585
8	1,112	936	588	680	386	634	295	337	316	397	483	818	299	750	830
9	648	525	445	490	357	410	255	165	137	147	129	191	129	270	609
10	231	376	107	332	269	277	84	117	66	84	55	102	25	136	161
11	175	97	74	178	126	140	101	83	44	29	9	18	10	36	47
12	90	74	21	72	68	68	70	10	12	12	8	3	12	14	18
13	37	1	19	8	45	8	16	5	4	11	0	1	2	11	1
14	3	1	0	1	1	5	8	1	4	10	0	1	1	0	0
15	0	0	0	0	0	0	3	0	0	1	0	1	0	0	0
16	0	0	23	0	1	0	0	0	0	0	0	0	0	0	0

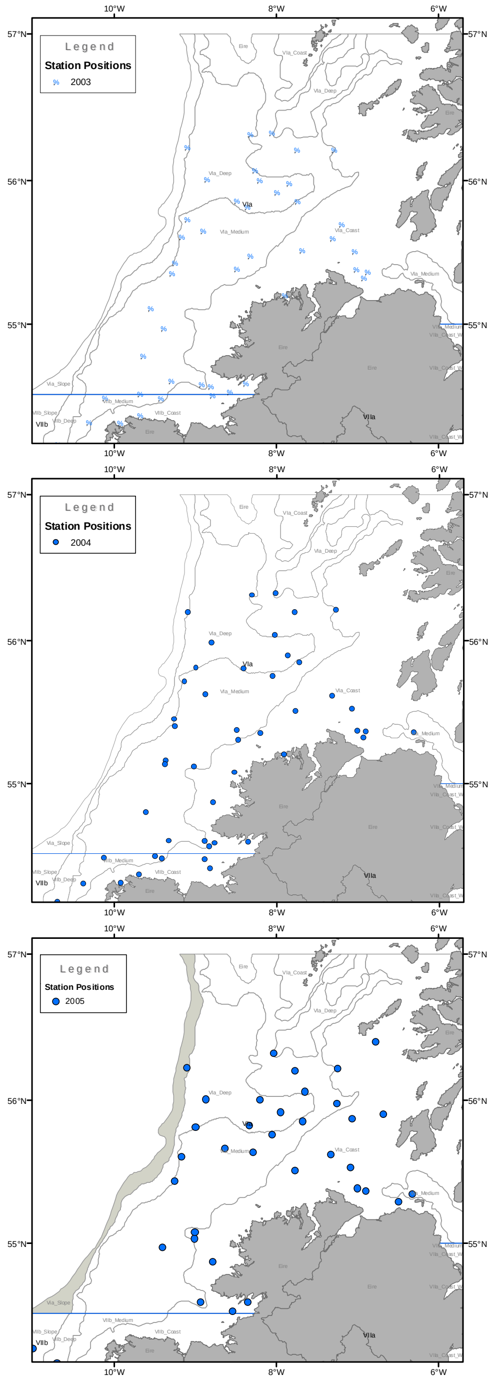


Fig 7.3.2.1 Irish Groundfish Survey Positions from 2003 – 2005, showing the new 200-600m strata off the west coast (shaded in grey in 2005).

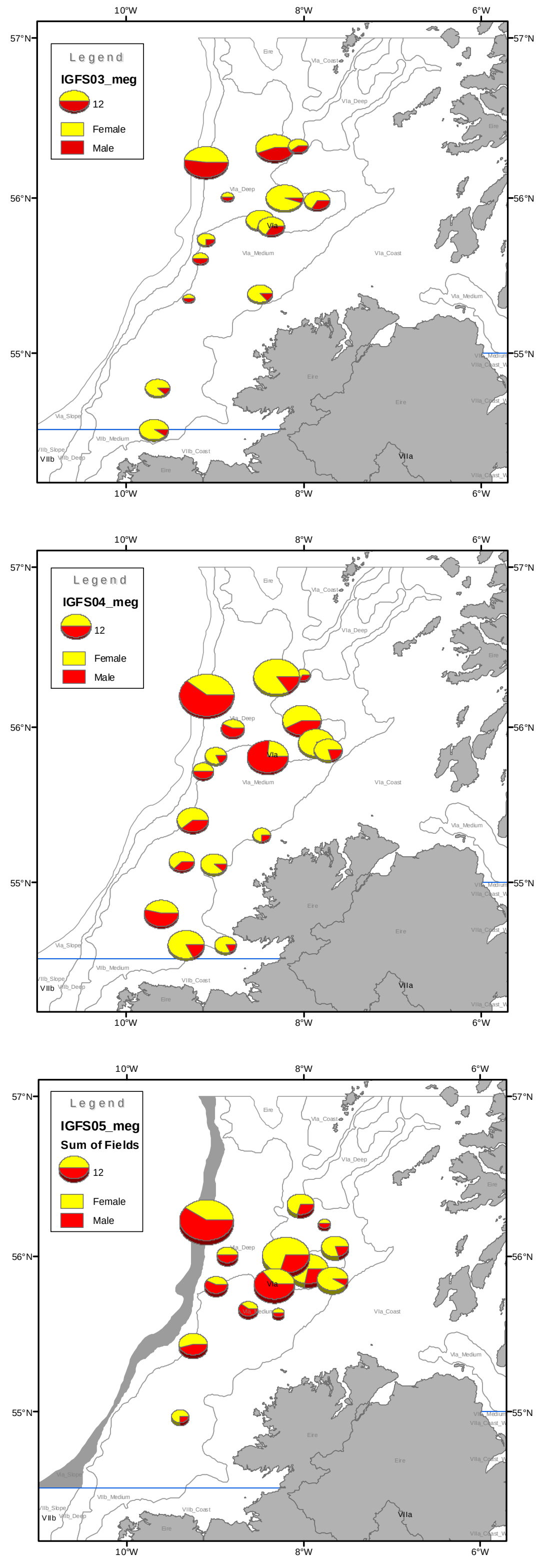


Fig 7.3.2.2 IGFS03 – 05 catches of male and female megrim for VIa in numbers per 30min tow. Footrope toggle chains were shortened after 2003 and survey was extended in 2005 from 200m – 600m depth, to effect more complete coverage of species on the slope such as megrim.

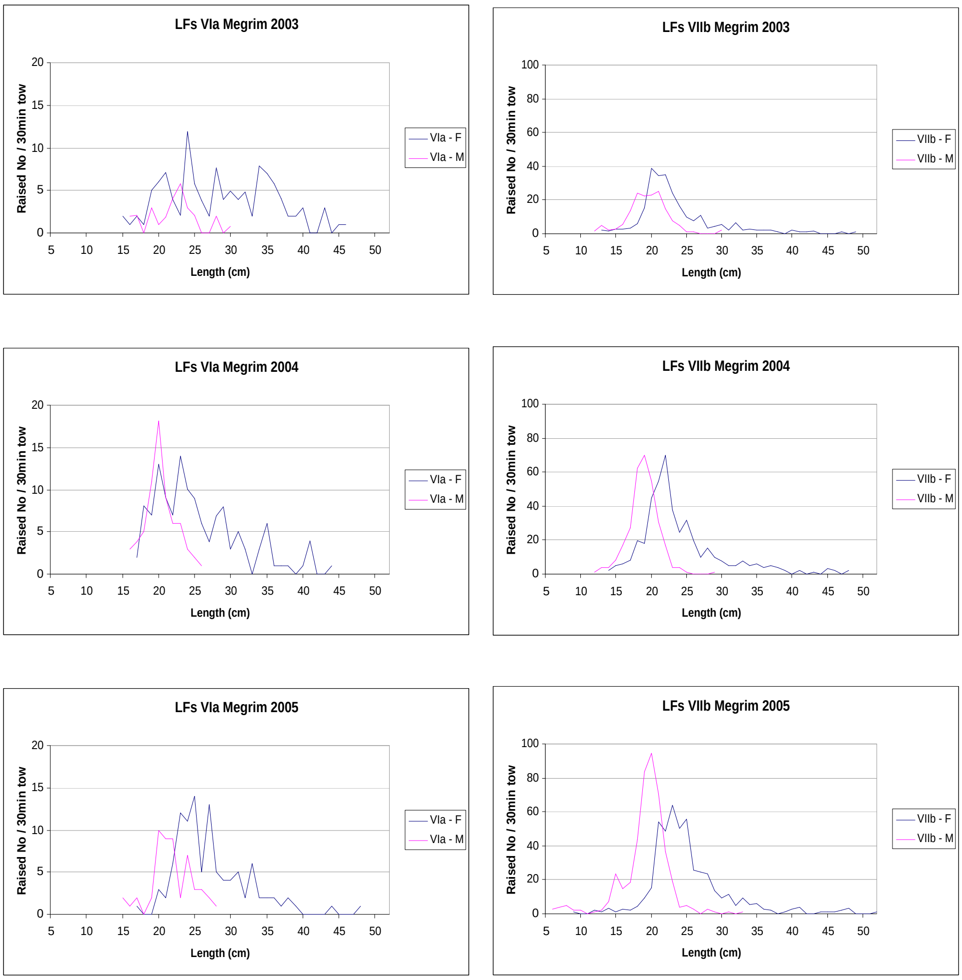


Fig 7.3.2.3. Length frequencies from the Irish Groundfish Survey (IGFS) from 2003-2005 for VIa and VIIb. Note that the increase in catches after 2003 is coincident with the introduction of a new trawl groundgear in VIa and shortening the gap between footrope and fishing line on the standard groundgear. Males are less abundant, and have a smaller average length, for all years in both areas.

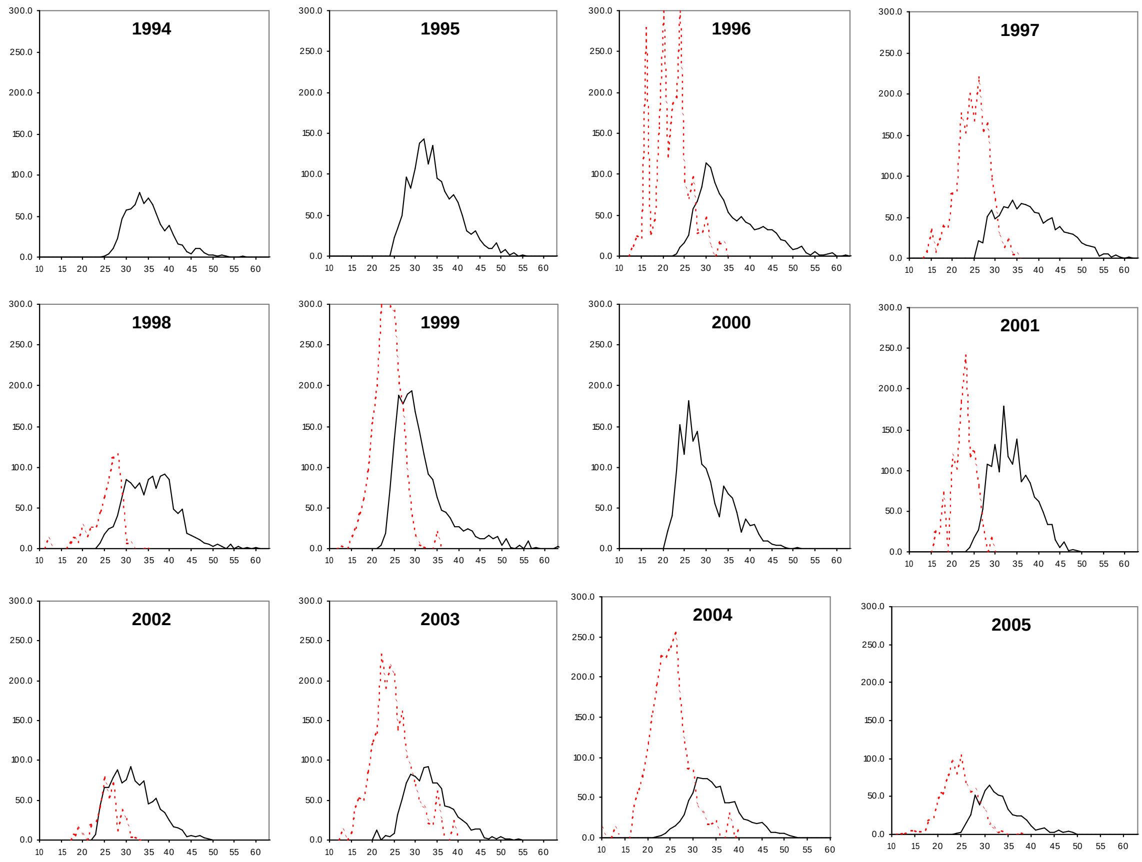


Figure 7.4.1.1 Megrim VIa: Length Frequency distributions of Irish landings and discards 1994-2005 (numbers on y-axis in '000s). Discards length frequency distributions are shown with the red dashed line.

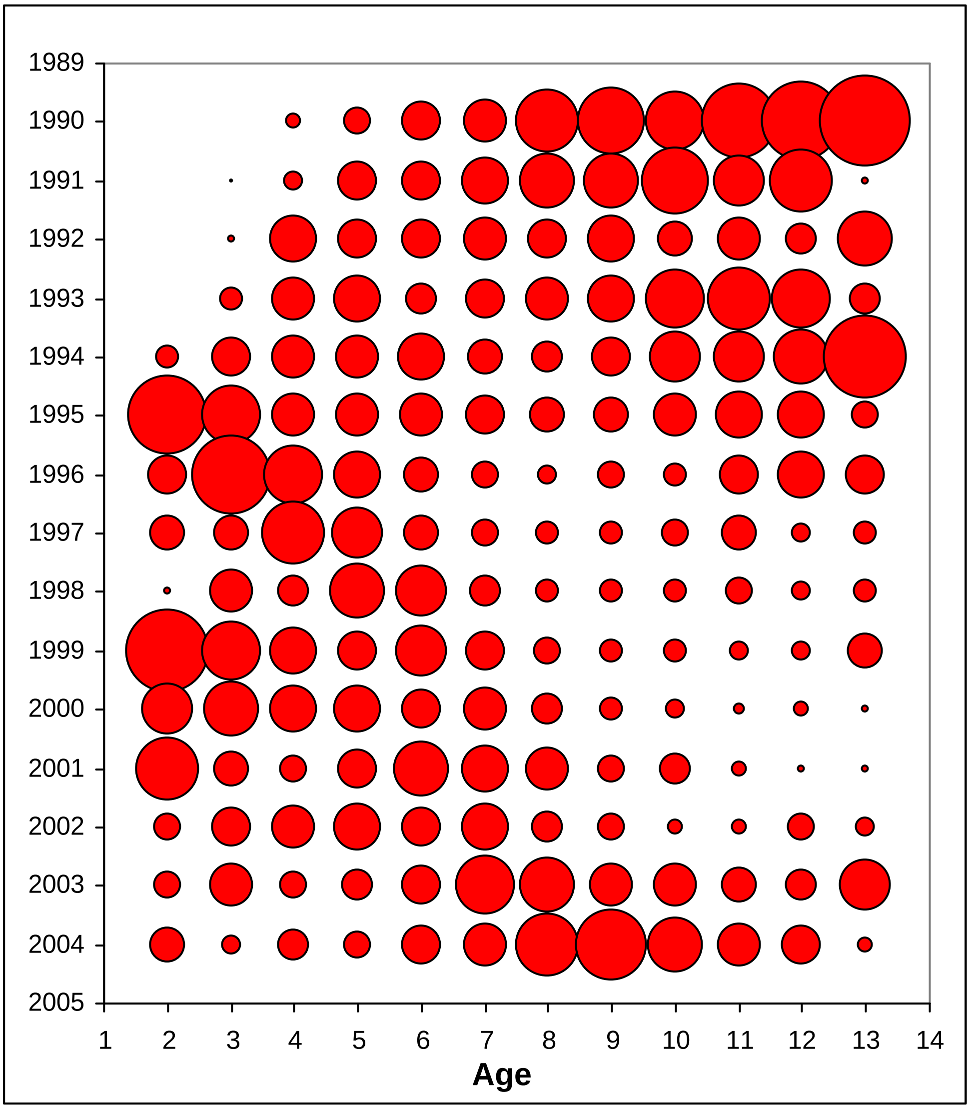


Figure 7.6.1.1 Megrim VIa: A bubble plot of catch numbers-at-age mean standardised across years then ages.

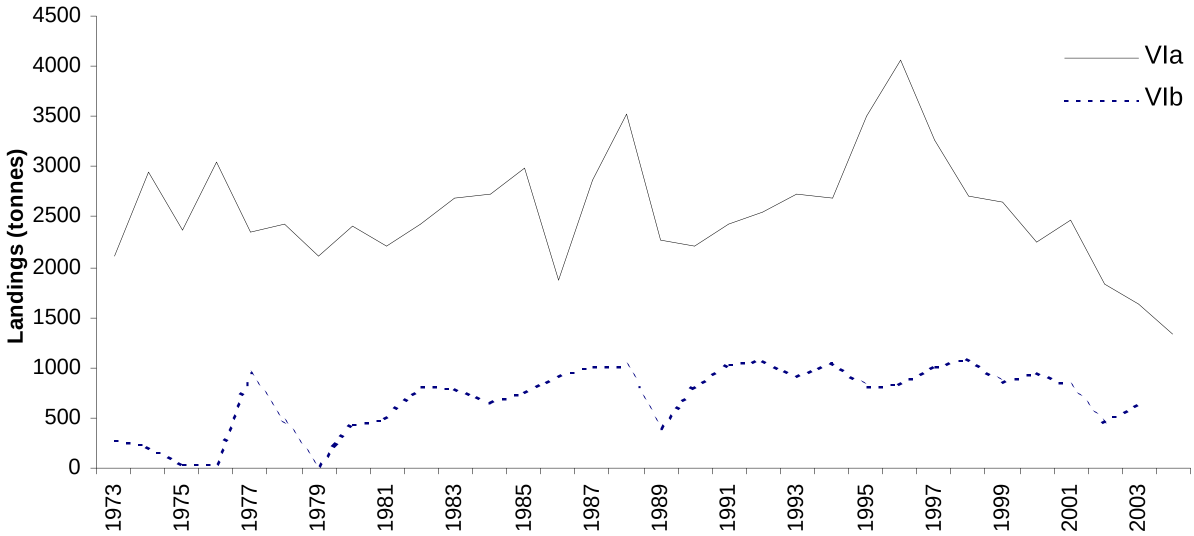


Figure 7.9.1 MEGRIM in Sub-area VI: Long term trends in landings. 1973-1989 data are based on official landings 1990-2004 are WGNSDS best estimates of landings. (2004 data are incomplete for VIb).

8 COD IN DIVISION VIIa

The Irish Sea cod assessment in 2006 is classified as an observation assessment. Prior to 2005, the stock was assessed by WGNSDS using XSA or TSA. The landings into several ports since 1991 were estimated using a sampling scheme rather than official catch statistics, and these estimates contributed ~40-80% of the international landings figures used in the assessments. This sampling scheme confirmed anecdotal information that reported landings figures have become increasingly unreliable since TACs were cut substantially in the 1990s. Owing to a marked deterioration in the sampling coverage in 2003 and 2004, and the absence of similar estimates for other ports since the 1990s, WGNSDS did not carry out a catch-based assessment in 2005. Recent stock trends were investigated using survey data only (SURBA), with additional qualitative information obtained from relative age compositions of landings.

The ACFM sub group reviewing the 2005 WG report (RGNSDS, 2005) considered that the SURBA model was unable to provide useful estimates of mortality for the most recent years, and hence could not form the basis for a forecast. An independent analysis of fishery and survey data was carried out using the B-ADAPT programme developed and simulation-tested by Darby (2004). This procedure was applied in 2005 to North Sea cod (ICES WGNSSK 2006) to carry out an assessment allowing estimation of additional unallocated removals for recent years assuming no persistent trends in survey catchability. For VIIa cod, the B-ADAPT run carried out for RGNSDS in 2005 estimated unallocated removals of 1,300t -3,000t per year since 2000, equivalent to bias factors on reported landings of ~ 2.0 – 3.6, and indicated that F in recent years (including the unallocated mortality) has remained above F_{lim} and SSB below B_{lim}.

The assessment carried out by the 2006 Working Group updates the SURBA and B-ADAPT analyses carried out in 2005.

8.1 The Fishery

The historical development of the fishery for cod in the Irish Sea is described in the Stock Annex. Fig. 8.1.1 shows the breakdown of the official cod landings in 2003-2005 by gear type, mesh band and country. Currently, the main fleets targeting cod include whitefish otter trawlers operating out of ports in UK(NI), UK(E&W) and Ireland, and mid-water trawlers operating out of UK(NI). From 1 January 2000, these vessels have been required to use 100mm cod-ends when targeting cod. Prior to that, many vessels used 80mm cod-ends. By-catches of cod are taken in the *Nephrops* fisheries and in the beam trawl fisheries for flatfish, depending upon season, area fished and fishing practices. In a number of fisheries, the by-catch of cod reduces substantially during summer when adult cod have moved away from the spawning grounds.

Decommissioning at the end of 2003 permanently removed 19 out of 237 UK demersal 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 >=100mm and had more than 5% cod in their reported landings. The previous round of decommissioning in 2001 removed 29 UK(NI) *Nephrops* and whitefish vessels and 4 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 >=100mm and had more than 5% cod in their reported landings.

8.1.1 ICES advice applicable to 2005 and 2006

The advice from ICES for **2005**, under *Single-stock exploitation boundaries*, was as follows:

Exploitation boundaries in relation to existing management plans: Under the assumption that effort regulation and control and enforcement will allow the implementation of an effective TAC, ICES can calculate the maximum TAC for 2005 using the 30% rule on SSB; the value corresponding to this is 2 170 t. This TAC is not predicted to bring SSB above $\mathbf{B}_{lim}$, so according to rule 5 of the Management Plan the TAC should be set lower than this value.

Exploitation boundaries in relation to high long-term yield, low risk of depletion of production potential and considering ecosystem effects: There will be no gain in the long-term yield by having fishing mortalities above $\mathbf{F}_{max}$ (0.31). Fishing at lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits.

Exploitation boundaries in relation to precautionary limits: The recovery plan should include a provision for zero catch until the estimate of SSB is above $\mathbf{B}_{lim}$ or until other strong evidence of rebuilding is observed. In 2005 such a recovery plan would imply zero catch because until now there is no such evidence of a stock recovery.

The advice from ICES for **2006**, in relation to single stock exploitation boundaries, was as follows:

In relation to agreed management plan: zero catch in 2006 provides only 50% probability of rebuilding SSB to B_{lim} in 2007.

In relation to precautionary limits: zero catch

In relation to target reference points: no advice

Advice on fishery management for **2006** was:

Fisheries in the Irish Sea should in 2006 be managed according to the following rules, which should be applied simultaneously. They should fish:

- Without by-catch or discards of cod and spurdog, and with minimal catch of whiting;
- Without jeopardizing the recommended reduction in fishing mortality of haddock;
- Within the biological exploitation limits for all other stocks

Furthermore, unless ways can be found to harvest species caught in mixed fisheries within precautionary limits for all those species individually then fishing should not be permitted.

8.1.2 Management applicable in 2005 and 2006

Management of cod is by TAC and technical measures. The ICES advice, and the agreed TACs and associated implications for cod in Division VIIa since 2002, have been as follows:

Year	**Single stock exploitation boundary (t)**	**Basis for ICES advice**	**TAC (t)**	**Change in F associated with TAC[1]**
2002	-	Establish recovery plan	3200	- 58%
2003	-	Closure of all fisheries for cod	1950	- 64%
2004	0	Zero catch	2150	- 65%
2005	0	Zero catch	2150	-31%
2006	0	Zero catch	1828	(no forecast)

[1] Calculated from F multipliers in status quo forecast.

Technical regulations in force in the Irish Sea, including those associated with the cod recovery plan since 2000, are described in Section 1.7.2.

8.1.3 The fishery in 2005

Technical measures in the Irish Sea fisheries in 2005 remained more or less the same as in 2004, with a western Irish Sea cod closure from mid February to the end of April (with derogations for *Nephrops* trawlers) and minimum mesh size of 100mm for vessels targeting whitefish.

The nominal catches of cod in division VIIa as reported to ICES are given in Table 8.1.3.1. The ICES figure for total international landings in 2005 (909t), based on official catch statistics, was the lowest recorded in the series since 1968, and only 50% of the TAC.

8.2 Commercial catch-effort data and research vessel surveys

8.2.1 Commercial catch-effort data

Information on trends in fishing effort in the Irish Sea is provided in Section 17. This is based on kW days as compiled by the STECF Sub-group SGRST (STECF, 2005). These data have, where possible, been updated and disaggregated into a greater number of gear types to examine trends in specific fisheries. Effort data as kW-days at sea are more complete than hours-fished data which has not been a mandatory field on vessel log sheets. Commercial CPUE data are no longer used in the assessment of Irish Sea cod.

STECF (2005) noted that the total nominal effort of demersal gear types in the Irish Sea has decreased since 2000. During the period 2000-2003, the nominal effort of demersal trawls using $\geq$ 100mm mesh increased. In 2004 there was a substantial drop in the effort reported for this category, amounting to declines of 19% and 38% relative to 2000 and 2002, respectively. The figures on kW-days in 2005 available to WGNSDS indicated a further decline in effort of whitefish trawlers using $\geq$ 100mm mesh (see Section 17).

The ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB, 2006) provided information to WGNSDS concerning changes in fleets and practices in the Irish Sea that could influence the assessments or their interpretation. A recent pattern of vessels switching from $\geq$100mm mesh to the 70-99mm mesh band to avail of greater days-at-sea allowances was particularly noted. During the period of the annual cod closure, some whitefish vessels switch to *Nephrops* fishing to take advantage of the derogation for *Nephrops* trawls in a designated area of the closure.

The changes in fishing practices caused by the conditions of the effort-control regulations, the cod closure and other technical measures, make it difficult to interpret how the reported trends in effort of the different fleet sectors will have impacted cod fishing mortality. Until the linkage between effort and F is quantified, the magnitude of the expected change in F cannot be evaluated. STECF (2005) concluded that, notwithstanding the changes observed in effort, there was no evidence from recent assessments of a reduction in fishing mortality consistent with that required by the cod recovery plan. They however noted the increasing uncertainty over the most recent levels of fishing mortality.

8.2.2 Surveys

Age-structured indices of abundance were available from the following surveys, and are given in Table 8.2.1:

UK(NI) groundfish surveys: March 1992-2006 (NIGFS-Mar) and October 1992 – 2005 (NIGFS-Oct). This survey covers the northern Irish Sea and (in recent years) the St George's Channel using an area-stratified, fixed-station design. A rock-hopper otter trawl is used. Approximately 45 stations in the western and eastern Irish Sea are used for the index. A vessel change took place in 2005, although the previous trawl gear and towing practices were retained and no corrections for vessel power have been estimated.

UK(Scotland) groundfish surveys: March 1996-2006 (9 stations in 1996; 15-17 stations in 1997-2006) and autumn 1997-2005 (11-12 stations) (ScoGFS-Q1 and ScoGFS-Q4). This is an extension of the west-of-Scotland survey using a GOV trawl and a fixed-station design. Age compositions are compiled by ICES rectangle. A change in vessel occurred in 1999, and the catch rates presented are corrected for the change in vessel and gear. The basis of the correction is comparative trawl haul data (Zuur *et al*. 2001).

Irish groundfish survey, autumn 2003 and 2004 (Irish GFS). Survey now terminated and not used in assessment.

UK(NI) MIK net surveys, 1994 – 2005 (NIMIKNET). This survey of pelagic-stage 0-group cod, whiting and haddock deploys a Methot-Isaacs Kidd frame trawl at 25 stations in the western Irish Sea, in May and June each year.

UK(E&W) beam trawl survey, 0-1 gp cod, 1988-2005 (BTS-Sept). A 4-m beam trawl is towed in the eastern and western Irish Sea and St George's Channel. Sampling intensity is highest in the eastern Irish Sea.

A new IBTS-coordinated UK trawl survey started in the Irish Sea in November/December 2004 using RV Endeavour to carry out approx. 30 tows with a GOV trawl in the Irish Sea and St George's Channel, and 50-60 tows in the Celtic Sea and Western Approaches (ICES IBTSWG report ICES CM 2005/D:05). The GOV trawl is rigged with standard or rockhopper ground gear depending on ground type.

UK Fishery Science Partnership Irish Sea groundfish survey, 2004 - 2006 (see Armstrong and Dann, WD 5 and www.cefas.co.uk/fsp). A chartered commercial trawler carries out ~ 38 tows of approx. 6-h duration using a commercial semi-pelagic whitefish trawl in the western Irish

Sea and North Channel. The survey takes place in spring during the cod spawning period. A second chartered trawler carries out ~44 tows of approx. 4-h duration in the eastern Irish Sea at about the same time.

Distribution maps for cod in the NIGFS-Mar and NIGFS-Oct surveys, showing catch rates (kg per 3-mile tow) for cod below and above the minimum landing size of 35 cm, are reproduced in Figures 8.2.1 and 8.2.2 for surveys up to March 2006. The NIGFS-Mar survey shows inter-annual changes in the relative abundance of cod > MLS in the eastern and western Irish Sea (e.g. 1993 and 2003; Figure 8.2.1), and occasional large individual catches (e.g. March 2002 cod > MLS). Note that all primary stations fished throughout each survey series are marked on each map with a dot, whereas some stations may have been missed out in some years. In particular, the March 1992 survey was disrupted by mechanical problems, and most of the stations in the northern half of the Irish coastal zone were not sampled.

The UK Fisheries-Science Partnership surveys in spring 2005-2006 showed high catch rates of cod in the small area of the outer Firth of Clyde closed to commercial fishing in spring, and significant catch-rates of cod in the North Channel (northern part of VIIa, north of 54^o 30'N), close to the Firth of Clyde cod closure (Fig. 8.2.3).

8.3 Landings, age composition and mean weights-at-age

Landings data for Irish Sea cod were provided to the stock coordinator by national fishery scientists. These figures in some cases differ from official statistics if some processing of the data has been required, for example, to allocate landings correctly by ICES Division. From 1991 to 2002, and again in 2005, a routine sampling procedure (see section 2.1.2) was used to estimate landings into three Irish Sea ports rather than rely on official statistics. These estimates comprised ~40-80% of the WG total landings figures. Differences between the sample-based estimates of landings and reported landings in 1991 and 1992 were relatively small, and the WG has assumed that reported landings prior to 1991 are accurate. The TAC for cod prior to 1991 was well above ICES recommendations and was unlikely to be limiting.

The sampling procedure to estimate landings could not be adequately carried out in 2003 and 2004, and last year's WG relied on survey-based assessments only. The landings data used by this year's WG to update the B-ADAPT assessment incorporates the sample-based estimates of landings only for 1991-1999. Although estimates are available for 2000-2002 and 2005, the introduction of the cod recovery measures in 2000, including a large reduction in TAC, raises the possibility for a further deterioration in the accuracy of reported landings of cod during this period.

The methods used in previous years for raising samples to total fleet landings are described in the Stock Annex. Quarterly age compositions of landed catches were provided for 2005 by UK(E&W) and UK(NI) for all sampled gears, and by Ireland for beam trawlers. Sampled countries took 84% of the reported international landings. Due to limited sampling of otter trawlers in some months, Ireland provided age compositions for Q1&Q2 combined and Q3&Q4 combined. Sampling details are given in Tables 2.2 and 2.3.

The time series of numbers at age in the commercial landings, incorporating the sample-based estimates of landings from 1991-1999 in the raising procedure, is given in Table 8.3.1. Time series of weights-at-age in the landings, are given in Table 8.3.2 and Figure 8.3.1. Values have fluctuated by up to +- 20% of the mean for each age group but without any obvious trend over time. Constant mean weights-at-age in the landings were assumed for years up to 1981 but in subsequent years weights-at-age were revised annually. It has still not been possible to revise the pre-1981 data, and SOP values differ from 100% in those years. The estimates of constant weight at age prior to 1981 would appear to be under-estimates and may alter the perception of the stock's dynamics during this period. It is again recommended that inter-sessional work is undertaken to address this issue. The very variable mean weights for age 7+ cod in recent years probably reflect small numbers measured and aged.

The weights-at-age in the landings (Table 8.3.2) were also assumed to represent weights-at-age in the stock. As a result, stock weights for 1-year olds are over-estimated as cod of this age are mostly landed in the second half of the year. This does not influence estimates of spawning stock biomass (SSB) as all 1-year olds are assumed to be immature.

There are no sufficiently complete time-series of discards estimates for inclusion in the VIIa cod assessment. Previous assessments have been based on landings only. The potential magnitude of discarding was investigated using the limited available data from 1996 onwards (Tables 8.3.3 and 8.3.4). These data are discussed in more detail in the report of the 2004 WGNSDS meeting.

Discarding since 1996 took place at age groups 0-2 Although the data are limited there is some indication that fishing mortality on 1-year old cod may be significantly under-estimated by variable amounts by omitting numbers discarded from a catch-at-age stock assessment.

Until a time series of more rigorous estimates of discards are assembled, the WG will be restricted to basing any catch-at-age assessment on landings at age only.

8.4 Natural mortality and maturity at age

Information on these variables is given in the Stock Annex. As in previous assessments, natural mortality was assumed at M=0.2 over all age classes. Proportions of M and F before spawning were set to zero. Proportion mature at age was assumed constant over the full time-series, based on mean values from UK(NI) trawl surveys in March 1992 – 1996 used by previous Working Groups. More recent analysis of the survey data indicates an increase in proportion of 2-year-olds reaching maturity. However, few 2-year-old females become mature, and almost all 3-year-old females have been mature each year since the early 1990s.

Age:	**1**	**2**	**3**	**4+**
Proportion mature:	0	0.38	1.0	1.0

8.5 Stock assessment and prediction

8.5.1 Survey and catch-at-age analyses

8.5.1.1 Commercial catch-at-age data

The commercial fishery landings of VIIa cod show a progressively steeper age profile since the 1960s (Fig. 8.5.1.1a). The contribution of older, mature cod to the catches has fallen substantially below what would be expected if the fishery had operated historically at $\mathbf{F}_{max}$ or $\mathbf{F}_{0.1}$. Since 2000, the numbers of cod older than four years of age in the landing have fallen below 1% of the total. The age composition in the UK Fishery Science Partnership surveys in spring 2004 – 2006, carried out during the cod spawning season using chartered commercial trawlers, confirm the truncated age composition in the stock (Armstrong and Dann: WD5)

(Fig. 8.5.1.1). The surveys used commercial trawls rigged and fished as in normal commercial fishing operations. The highly truncated age compositions in recent years has required a reduction in the plus-group to 5+ in the B-ADAPT assessment, although data are given out to 7+ in Table 8.3.1.

A Separable VPA was carried out on the international catch-at-age data, using settings as adopted by previous Working Groups, to check for anomalous values. No anomalies were apparent, but the residuals for ages 1 / 2 showed persistently lower values since the 1990s, indicating a change in the selectivity characteristics of the international fleet. This has been noted in previous WGNSDS reports

8.5.1.2 Survey data

The raw data indicate that the surveys give similar signals for age groups 0 from 1992 onwards, and for age groups 2 to 4 (Fig. 8.5.1.2.1). Correspondence between survey series was poorer for 1-year-old cod. Last year's WG did not use the index at age 1 from the BTS-Sept at age 1, or the data at all ages from the ScoGFS-Q4 survey, due to poor consistency internally and with other surveys. These data have also been excluded this year. Scatterplots of the indices from one survey against another (Figure 8.5.1.2.2) show positive correlations in all cases. The NIGFS-Mar and ScoGFS-Q1 surveys were strongly correlated at age 2.

The international landings at age show quite similar patterns of year-class variation to the surveys (Figure 8.5.1.2.1). The general trend in the landings at age will differ from that of the surveys due to changes in misreporting and fishing mortality.

Mean-standardised survey indices by year class and by year, and scatter-plots of indices within year classes, show good internal consistency of the NIGFS-Mar survey at ages 1-4 with no marked year-effects (Fig. 8.5.1.2.3 and 8.5.1.2.4). Indices for 5-year-olds are poorly correlated with indices from younger ages (Fig. 8.5.1.2.4), and this age class was excluded from analyses carried out last year. The ScoGFS-Q1 survey showed strongly domed catch-curves and poor consistency at age 1 with other age classes (Figure 8.5.1.2.5 and 8.5.1.2.6). Internal consistency was generally poorer than in the NIGFS-mar survey.

Plots of empirical SSB from the NIGFS-Mar and ScoGFS-Q1 surveys are shown in Figure 8.5.1.2.7. The NIGFS-Mar survey indicates low SSB in 2000 and 2001, an increase in 2002 and 2003, and low values again in 2004 - 2006. The ScoGFS-Q1 survey does not show such a marked increase in SSB in 2003 and 2004. Both series indicate very low SSB in 2006.

8.5.1.3 Exploratory assessment runs

Survey analyses

An extensive analysis of the trawl survey data for Irish Sea cod was carried out by WGNSDS in 2005, using SURBA versions 2.2 and 3.0. The final runs were parameterised using variable catchability at age (derived from ratios of survey indices to TSA population estimates from an earlier assessment), and variable weighting factors for age classes: The weighting factors for the NIGFS-Mar survey were derived from the approximate standard errors of the survey indices (see Table 8.2.1). The SURBA runs this year adopted the model settings in last year's final runs (Table 8.5.1.3.1). Last year's WGNSDS noted that the residuals for the first year of the NIGFS-Mar survey series (1992) were all well above the series means. As this may be a result of reduced survey coverage following a mechanical breakdown, data for this year were down-weighted in SURBA.

Model residuals show some evidence of non-randomness, but do not indicate severe model mis-specification, and no retrospective bias is apparent in biomass and recruitment estimates (Figs. 8.5.1.3.1 & 8.5.1.3.2). Residuals for NIGFS-Mar continue to show a strong year effect in 1992, and given the problems with survey coverage in that year, the 1992 survey data were removed from the B-ADAPT analysis.

The SURBA-derived trends in recruitment from the NIGFS-Mar and ScoGFS-Q1 surveys are very similar, whilst the SSB trends are broadly similar in showing low values around 2000-2001 and again in 2005-06 (Fig. 8.5.1.3.3). Neither survey shows any indication of a reduction in mortality since the introduction of cod recovery measures in 2000. Both surveys indicate very poor recruitment for the 2002 – 2005 year-classes at age-1 in 2003-2006. Surveys of 0-group cod (NIMIKNET, BTS-Sept and NIGFS-Oct) also indicate very weak 2002-2003 year-classes, but consistently show an increased abundance of 0-gp fish in 2004 and 2005 (Fig. 8.5.1.2.1).

Catch-at-age analysis

The B-ADAPT method is described in Section 2.7. Software versions BADAPTv05.exe and B-ADAPT-F.exe were used this year to allow examination of both F-smoothing and catch-smoothing options for the estimation of unallocated removals (for convenience, all unallocated removals are included in a bias factor applied to landings). The objective functions for minimising are given below:

$$SSQvpa = \Sigma_{a,y,f} \{ Ln(u_{(a,y,f)}) - [Ln(q_{(a,f)}) + Ln(N_{(a,y)})]\}^2 \quad \text{(basic SSQ function)}$$

$$SSQf = \lambda \, \Sigma_{a,y} \{Ln(F_{(a,y)}) - Ln(F_{(a+1,y+1)})\}^2 \quad \text{(F-smoothing)}$$

$$SSQcatches = \lambda \, \Sigma \{Ln(B_{(y)} \Sigma_a [C_{(a,y)} CW_{(a,y)}]) - Ln(B_{(y+1)} \Sigma_a [C_{(a,y+1)} CW_{(a,y+1)}])\}^2 \quad \text{(catch smoothing)}$$

Where $u_{(a,y,f)}$ is the survey CPUE for age *a*, year *y*, fleet *f*; C and CW are catch numbers and catch weights at age and λ are the smoothing weights.

Model settings used for exploratory runs are given in Table 8.5.1.3.2.

Three B-ADAPT runs were carried out to examine the separate use of the NIGFS-Mar, ScoGFS-Q1 and a combination of the NIGFS-Oct, BTS-Sept and NIMIKnet surveys for calibration. An F-smoothing weight of 1.0 was set for the bias estimation period (this was the value chosen for the multi-fleet analyses). The catchability residuals from these individual runs showed similar patterns to those from a run using all fleets together, with a slightly reduced tendency for temporal trends. (Figs 8.5.1.3.4 and 8.5.1.3.5).

The two single-fleet runs and the combined autumn survey run give very variable estimates of survivors and bias due to unallocated removals (Table 8.5.1.3.3). The survivors estimates from the multi-fleet run using all five fleets were closest to the NIGFS-Mar single fleet run, whilst the bias estimates were closest to the ScoGFS-Q1 estimates. The S.E.'s of the log estimates of survivors and bias estimates were larger in the 5-fleet run than in the single-fleet runs. This indicates that the external variance is larger than the internal variance. However, the ScoGFS-Q1 survey is expected to perform poorly on its own as there are only four years data prior to the first year for estimating catch bias. Similarly, the autumn surveys are not expected to perform adequately on their own as the age range extends only to age 2, leaving the older ages in the analysis without survey tuning data. The NIGFS-Mar survey covers seven years prior to the bias-estimation period, and has data for all ages requiring tuning. It was concluded that all five surveys could be used in subsequent exploratory runs, with the expectation that the SSB and recruitment estimates from B-ADAPT are likely to be influenced mainly by the NIGFS-Mar survey.

A series of B-ADAPT runs was carried out to examine the influence of the degree of catch or F smoothing on the estimates of population abundance, fishing mortality and bias associated with unallocated removals during 2000-2005. Options included: zero smoothing; F-smoothing and catch-smoothing weights of 0.5, 1.0 and 5.0, and plus-group set to 6+ rather than 5+ (with F-smooth = 1.0). All runs with F-smoothing or catch-smoothing generated similar results; whilst the run with no smoothing yielded the most variable estimates of F and bias (Figure 8.5.1.3.6). Setting the plus-group to 6 had little effect on the values from 2000 onwards, but off-set the historical SSB and F slightly. Estimates of SSB and recruitment were extremely robust to choice of smoothing, and none of the model settings examined changed the perception of the state of the stock.

The use of a 5-plus age group, with annual F(4) set to (F(2)+F(3))/2 in B-ADAPT, means that the F(2-4) estimates are actually F(2-3), representing a change in F-bar range compared with previous WGs. Further, the F's at age 3 from all of the exploratory runs are high for the final year (2005). This results in a sharp upturn in estimated F(2-4) in 2005 that is not reflected in F(2) and F(3), which remain close to the recent average.

A retrospective analysis was carried out on the 5-fleet run with F-smoothing weight of 1.0, by stepping the final year in the analysis back to 2000, without altering the period over which WG landings data were considered relatively unbiased (i.e. up to 1999). No evidence of retrospective bias is apparent (Fig. 8.5.1.3.7). Plots of B-ADAPT population estimates at age against raw survey indices, using the results of the 5-fleet run with F-smoothing weight of 1.0, indicate positive relationships in all cases (Fig. 8.5.1.3.8). Outlying values for some ages/fleets will also be reflected in large residuals in the B-ADAPT model fit and will have influenced the estimates of mean catchability for the pre-2000 period.

8.5.1.4 Final assessment run

The B-ADAPT run using F-smoothing weight of 1.0, and including all five survey series, was adopted as the final assessment run. The data and model settings are given in Table 8.5.1.3.2. The diagnostics from the B-ADAPT run are given in Table 8.5.1.4.1, and the long-term trends in landings, F, SSB and recruitment are given in Fig. 8.5.1.4.1. The 5^{th} and 95^{th} percentiles are shown from 1000 boot-strap runs selecting randomly from the survey catchability residuals.

The landings values in Figure 8.5.1.4.1 show the reported landings, the landings including sample-based estimates from 1991 – 2002 and 2005 (only the 1991-1999 estimates are included in the landings for the B-ADAPT run), and the B-ADAPT estimates of total removals since 2000. The total removals may represent unallocated discards and landings, and losses due to additional natural mortality in excess of M=0.2. The error bars on total removals are ± 2 SE. The B-ADAPT estimates of total removals (including unallocated removals) were very close to the WG landings figures including sample-based estimates for 2000 and 2001, but in excess of the values for 2002 and 2005. The latter fall within the confidence limits of the B-ADAPT estimates.

The recruitment trends from B-ADAPT are very similar to the indices from SURBA for the NIGFS-Mar and ScoGFS surveys (Fig. 8.5.1.4.2). The B-ADAPT recruitment estimates for the 2004 and 2005 year-classes are relatively stronger than indicated by the two surveys. This is likely to have resulted from the influence of the NIMIKNET, NIGFS-Oct and BTSSept data in B-ADAPT, as these surveys indicate relatively larger 2004 and 2005 year classes than indicated by the two quarter-1 surveys (see Fig. 8.5.1.2.1).

Whilst the relative trends in SURBA indices of SSB are similar to those from the B-ADAPT from 1998 onwards, the trends diverge in the pre-1998 data. However, all series indicate very low SSB in 2005 and 2006. The estimates of F from the SURBA runs (Z indices minus M=0.2) are of similar magnitude to the B-ADAPT estimates but show quite different temporal trends. 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.

8.5.1.5 Comparison with last years assessment

The comparison with SURBA runs given in the previous section largely captures the comparison with last year's assessment which was carried out using SURBA only. This year's B-ADAPT estimates of bias (with SE of log estimates in parenthesis), and the estimates of SSB, F(2-4) and recruitment at age 0 in 2003 and 2004, are compared below with the results given by RGNSDS re-assessment of the stock in August 2005.

	Bias 2000	**Bias 2001**	**Bias 2002**	**Bias 2003**	**Bias 2004**	**SSB(04)**	**F(04)**	**R(03)**	**R(04)**
2005 RGNSDS	2.04 (0.33)	2.17 (0.34)	1.99 (0.34)	3.33 (0.38)	3.61 (0.29)	4,340	1.20	1,830	1,560
2006 WG	1.70 (0.21)	1.49 (0.23)	2.14 (0.21)	3.43 (0.22)	3.23 (0.23)	4,200	1.13	2,200	1,380

The addition of another year of data, together with smoothing of the F's, has resulted in some changes to the bias estimates, but the SSB, F and R estimates are not changed substantially, and the perception of the state of the stock remains the same.

8.5.2 Estimating recruiting year class abundance

Working group estimates of year-class strength at age 0 are summarised below. Estimates used in the forecasts are shown in bold. The B-ADAPT estimate for the 2005 year-class is close to the 1992-05 GM and was retained for forecasts as it is estimated from three surveys in 2005 and two in 2006. The log SE of the survivors for this year class from B-ADAPT was 0.32.

Number at age 0		**B-ADAPT**	**GM(92-04)**
Year	**Year class**		
2004	2004	**1,379**	2,568
2005	2005	**2,213**	2,568
2006	2006		**2,568**
2007	2007		**2,568**

8.5.3 Long-term trends in biomass, fishing mortality and recruitment

Long-term estimates from the final B-ADAPT run are given in Fig. 8.5.1.4.1. The decline in SSB to a low value in 2000, following the production of weak year classes in 1997 and 1998, follows the pattern observed in previous WG assessments using analysis of commercial catches at age and survey data. The increase in SSB in 2002 and 2003 reflects improved recruitment. However, below-average recruitment of 0-year-olds since 2002 appears to have caused a further reduction in SSB to close to the value observed in 2000.

All SSB estimates from 1998 onwards are below the $\mathbf{B}_{lim}$ of 6kt, and all estimates of F(2-4) from 1997 onwards are above the $\mathbf{F}_{lim}$ of 1.0.

Stock-recruit estimates, including a fitted Ricker curve, are shown in Fig. 8.5.3.1. The majority of SSB values below Bpa (10,000t) have been recorded from 1990 onwards, and most are associated with below-average recruitment.

8.5.4 Stock predictions

Short-term stock predictions were carried out using MFDP. The inputs, management options table and detailed forecast table are given in Tables 8.5.4.1-8.5.4.3. A 90% reduction in F is required to bring the point value of SSB above B_{lim} by 2008 (Table 8.5.4.2).

A sensitivity analysis of the F_{sq} forecast is shown in Fig. 8.5.4.1. The largest contributor to the variance of the 2007 landings prediction was the survivors estimate of 1-yr-olds in 2006, and the largest contributor to the variance of the SSB prediction for 2008 was the assumed GM recruitment for 2006 and the survivors estimate at age 1 in 2006. Cod in these two year classes are expected to make up 85% of the SSB in 2008 at F_{sq} (Table 8.5.4.3).

Landings figures given in the forecast tables should not be treated as forecasts of total fishery landings, as the status quo fishing mortality estimate is an output from B-ADAPT and includes unallocated mortality associated with the model estimates of bias. As the bias has been of the order of ~3.0 since 2003, this implies that the reported landings associated with F_{sq} would be expected to be approximately 900t in 2006 and 2007 i.e. close to the WG landings figure of 909t for 2005 (based on official statistics). The status quo “landings” predictions for 2006 and 2007 are 2,600t and 2,700t. The extent to which the remaining 1,700 -1,800 t would comprise landings as opposed to discards or additional natural mortality is unknown.

8.5.5 Medium-term predictions

Stochastic projections were run forward using each of 1000 non-parametric bootstrap iterations in B-ADAPT. The scenarios explored were constant status quo fishing mortality and 0.75, 0.5, 0.25, 0.10 and 0.0 multipliers of status quo mortality. Starting populations were taken from each bootstrap iteration. Fishing mortalities were taken as a three-year average scaled to the final year. (Note that the deterministic MFDP prediction in Section 8.5.4 used the 3-year mean F vector without scaling to the final year – this option was not available in the B-ADAPT bootstrap routine. Hence, F_{sq} in the bootstrap predictions is higher than in the MFDP forecasts.) Intermediate-year fishing mortality in 2006 was taken as the status quo mortality rate. Stock and catch weights were the average of the final three years of assessment data. Recruitment was re-sampled from the 1992 – 2005 year-classes, representing the period of reduced recruitment at low SSB. This was considered appropriate as median SSB in most projections tended to remain below B_{pa}.

Figures 8.5.5.1 – 8.5.5.5 present the results of the stochastic projections, in each case fishing mortality, catch, SSB and recruitment (5^{th}, 25^{th}, median 75^{th} and 95^{th} percentiles from the bootstrap distributions are plotted). Percentiles of fishing mortality, SSB and catch in 2006, 2007 and 2008 are tabulated, together with the probability of SSB > B_{lim} in each year and the probability of $\geq$30% SSB growth during the specified year. The 0.5Fsq option returns a median F(2-4) equivalent to the current F_{pa} of 0.72.

In each of the stock projections SSB continues to decline in 2006 to a level close to its historic low by the beginning of 2007. It is only in 2007 that SSB can begin to rebuild according to the fishing mortality from 2007 onwards.

Catch options returning at least a 50% probability of SSB exceeding the B_{lim} of 6,000 t required reductions in F in 2007 of at least 90% from F_{sq} (Figure 8.5.5.5 & 6). The MFDP deterministic forecast gives a similar result (Table 8.5.4.2).

The F_{sq} option provides a 45% probability of 30% SSB growth in 2007, whilst the 0.75*F_{sq} option gives a 70% probability. This is a result of the influence of the 2005 year-class (B-ADAPT estimate) and the 2006 year-class (bootstrap re-sample of 1992-2005) which make up the bulk of the SSB in 2008. These are a major source of variance in the SSB forecast for 2008 (Fig. 8.5.4.1).

8.5.6 Yield and biomass per recruit

The WG did not update the yield-per-recruit and spawning biomass per recruit carried out by the 2004 WGNSDS, as the B-ADAPT assessment uses a reduced plus-group (5+) which will constrain the estimates of landings and SSB at low values of F. The 2004 analysis, conditional on the exploitation pattern obtained by the 2004 WGNSDS from TSA, and long term (1982 – 2003) weights at age, is shown in Table 8.5.6.2 and Figure 8.5.6.1, with inputs listed in Table 8.5.6.1. $\mathbf{F}_{max}$ is estimated to be 0.32 and $\mathbf{F}_{0.1}$ is estimated to be 0.18. These estimates are well below any historical estimates of fishing mortality obtained by previous WGs.

8.5.7 Reference points

Previous assessment Working Groups have explored appropriate reference points for this stock based on stock-recruitment dynamics. The PA reference points proposed by ACFM for Irish Sea cod are:

$\mathbf{F}_{pa}$ = 0.72; $\mathbf{B}_{pa}$ = 10,000 t

$\mathbf{F}_{lim}$ = 1.0; $\mathbf{B}_{lim}$ = 6,000 t

The stochastic bootstrap forecasts presented in Section 8.5.5 (Fig. 8.5.5.6) indicate that the current **F**pa of 0.72 has only an approximately 80% probability of recovering SSB to $\mathbf{B}_{lim}$ in the medium term, if recruitment in the foreseeable future varies around the low average level estimated for the 1992-2005 year classes. A reduction in the value of $\mathbf{F}_{pa}$ may be appropriate if management intends to retain a $\mathbf{B}_{lim}$ reference point at 6,000t, until there is evidence for a sustained recovery of recruitment to pre-1992 values.

There was insufficient time at the WG to re-evaluate the reference points for this stock. It is recommended that the reference points are evaluated in relation to possible continuation of reduced recruitment due to unfavourable environment, and in the context of the design and evaluation of harvest control rules developed for this stock.

8.5.8 Quality of the assessment

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. Limited access to some ports in recent years has also resulted in reduced sampling coverage for estimating length and age compositions.

The Working Group previously attempted to overcome this problem by incorporating sample-based estimates of landings from three major ports in the WG landings figures from 1991 onwards. The sources of this information became more limited in 2003 and 2004. The large TAC reduction for cod from 2000 onwards, with only the spring cod closure as a means of restricting effort until days-at-sea restrictions came into force, may have caused more widespread problems with misreporting or over-quota discarding. Hence the WG considers the international landings figures from 2000 onwards to have potentially large inaccuracies that could lead to retrospective bias and other problems with an analytical assessment.

The use of B-ADAPT was intended to correct for retrospective bias by estimating the quantity of additional “unallocated removals” that would be required to be added or removed from the catch-at-age data in order to remove any persistent trends in survey catchability. The unallocated removals figures given by B-ADAPT could potentially include components due to increased natural mortality and discarding as well as misreported landings. The estimates of bias can also be influenced by any remaining non-randomness of survey catchability or outlying values, particularly where the calibration period is short or the surveys are noisy. For this reason, the absolute values of the estimated unallocated removals should not be over-interpreted.

Fishing effort

The short time-series of kW-days fishing effort available to the Working Group indicates a reduction in effort of vessels using gears designed for targeting demersal species such as cod or that take cod as a significant by-catch in certain localities and months. Given the estimation error in B-ADAPT fishing mortality, and the inability to partition the unallocated mortality between different sources, it has not been possible to examine the relationship between fishing effort and partial-F for the different fleets.

Discarding

Estimates of discards are patchy for Irish Sea cod in previous years, although more comprehensive sampling is now required through the EU Data Collection Regulation. Discarding is mainly at age 1. The absence of raised estimates of discarding for all fleets will result in under-estimation of F at age 1 in any catch-based assessments.

Surveys

The Irish Sea has relatively good survey coverage up to 2006. Reasonably good consistency is observed between surveys at age 0, and at ages 2-4, but poorer consistency is observed at age 1, and at ages 5 and above where catch numbers are small. There are currently conflicting estimates of the 2005 year class between the 0-group and 1-group indices.

The indication that SSB in 2006 has declined close to the very low value of 2000 is supported by SURBA analyses, empirical SSB from the NIGFS-Mar and ScoGFS-spring surveys, the evidence for recent weak year-classes given by other surveys (Figure 8.5.1.3.3, 8.5.1.3.7), and the results of B-ADAPT tuned using these surveys.

Model formulation

The continued steep age-profile in the population, which has resulted in very small catches of cod older than 4 or 5 years of age in the surveys, restricts the number of age classes that can be included in the tuning files. This makes estimation difficult, particularly the estimation of mortality. Estimates of recruitment appear to be quite robust, and the general pattern of recruitment appears well estimated for this stock.

The different groundfish surveys of the Irish Sea appear to have quite different patterns of catchability at age, leading to very different slopes to the catch curves. Individual surveys are therefore not able to provide information on the true level of mortality without ancillary data on true population numbers at age. In this year’s SURBA runs on Irish Sea cod, previous TSA results up to 2002 were used to infer the pattern of catchability at age. However, this is only a partial correction as the assessment excludes discards and does not allow for higher natural mortality at the younger ages.

8.5.9 Management considerations

ICES has classified this stock as having reduced reproductive capacity and as being harvested unsustainably. Based on last year’s assessment, SSB was projected to remain below $\mathbf{B}_{\mathrm{lim}}$ in 2005. The current assessment, based both on B-ADAPT and SURBA analyses, indicates that SSB of Irish Sea cod in 2006 is close to the lowest in the time series due to a combination of high mortality and very poor recruitment since 2002. Recruitment has been below average for the past eighteen years and at least six of the most recent 14 year classes have been extremely weak and well below any of the weakest year classes observed prior to 1990. This is likely due to a combination of low SSB and adverse environmental conditions for early-stage survival (Section 1.4).

Although recent recruitment patterns appear well estimated, 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.

Recent reductions in fishing effort may translate into reductions in fishing mortality of cod, but the current assessment does not provide sufficiently robust estimates of F to allow the relationship between F and effort to be determined. Ireland has introduced a decommissioning scheme aimed at removing around 6,000 GT/18,000 kW from the Irish fleet (information supplied by WGFTFB 2005). This follows from the two Whitefish Renewal Schemes, which introduced around 32 new vessels into the Irish fleet. The decommissioning scheme is targeted at demersal and scallop vessels over 18m. The scheme is split into three rounds, with around 8 vessels already scrapped as part of the first phase and a total of 44 vessels in all due to be scrapped by the end of 2006. Changes in fishing effort resulting from this scheme, and their potential impact on cod, will be documented in future WGNSDS reports.

The VIIa commercial fishery extends into the North Channel, particularly vessels using mid-water trawls. It is not clear if the fish in this region belong to the Irish Sea stock, or to the nearby Clyde stock which exhibits dense aggregations of adult fish during spring in the area covered by the Clyde closure (see Fig. 8.2.3). 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. Spatial patterns in stock structure could cause difficulties in assessing the combined stocks if individual stock components exhibit different patterns of recruitment and mortality. STECF Sub-group SGRST (2005, Appendix 4) concluded that management of the Irish Sea stock on the basis of sub-stock assessment regions would be difficult in practice, particularly the separation of catches when the stock units are mixed. Further tagging and genetics studies are required to investigate stock structure, seasonal movements and mixing in VIIA and neighbouring areas.

The EU Cod Recovery Plan regulation implemented in the Irish Sea from 2004 will continue to impact the management measures for 2007, which will be formulated with reference to the estimates and forecasts of SSB in relation to limit and precautionary reference points. 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:

4. 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,

5. 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.

The present assessment using B-ADAPT indicates that SSB is well below $\mathbf{B}_{lim}$, and that the combination of conditions 1-3 is unlikely to result in SSB recovering above $\mathbf{B}_{lim}$ by the end of 2007.

Table 8.1.3.1 Nominal landings (t) of COD in Division VIIa as officially reported to ICES, and figures used by ICES.

Country	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005[1]
Belgium	169	129	187	142	183	316	150	60	283	318	183	104	115
France	686	208	166	148	268	269	n/a[2]	53	74	116	151[2]	29	29
Ireland	1,328	1,506	1,414	2,476	1,492	1,739	966	455	751	1,111	594	380	n/a
Netherlands	-	-	-	25	29	20	5	1	-	-	-		
Spain	-	-	-	-	-	-	-	-	-	-	14	-	-
UK (England, Wales & NI)	3,244	2,274	2,330	2,359	2,370	2,517	1,665	799	885	1,134	505	646	598[3]
UK (Isle of Man)	57	26	22	27	19	34	9	11	1	7	7	5	n/a
UK (Scotland)	453	326	414	126	80	67	80	38	32	29	23	15	
Total	5,937	4,469	4,533	5,303	4,441	4,962	2,875	1,417	2,026	2,715	1,477	1,179	742
Unallocated	1,618	933	54	-339	1,418	348	1,909	-144	225	-11	-201	-108	167
Total as used by WG	7555[4]	5402[4]	4587[4]	4964[4]	5859[4]	5310[4]	4784[4]	1273[5]	2251[5]	2704[5]	1276[5]	1071[5]	909[5]

[1]Preliminary. [2]Revised. [3]includes Scotland n/a = not available [4] includes sample-based estimates of landings into three ports [5] based on official data only.

Table 8.2.1. Cod in VIIa: survey indices. Approximate CVs 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	**0**	**2**	**5**	**11**	0	2	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)   CV = coefficient of variation

Survey	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+	CV(1gp)	CV(2gp)	CV(3gp)	CV(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

NI-GFS October groundfish survey   Numbers per 3-miles (approx. 1-h tow)   CV = coefficient of variation

Survey	0-gp	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+	CV(0gp)	CV(1gp)	CV(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

Table 8.2.1. Contd.

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)
Feb-March

	0-gp	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+
2004		0	0.35	2.5	0.25	0.25	0.042	0
2005		0	0.92	2.65	1.25	0.09	0.08	0.02
2006		0	0.1	2.7	0.42	0.12	0.021	0.011

UK Fishery Science Partnership eastern Irish Sea otter trawl survey (mean nos. per hour)
Feb-March

	0-gp	1-gp	2-gp	3-gp	4-gp	5-gp	6-gp	7+
2005		0.06	4.02	0.25	0.38	0.004	0.010	0.000
2006		0.83	0.77	0.67	0.007	0.042	0	0.001

UK(EW) BTS beam trawl survey. No. per 100km
September

Survey	0-gp	1-gp
1988	19	8
1989	17	6
1990	190	6
1991	**70**	20
1992	**11**	55
1993	**38**	1
1994	**30**	3
1995	**40**	3
1996	**29**	4
1997	**30**	14
1998	**2**	0
1999	**59**	0
2000	**37**	29
2001	**24**	4
2002	**7**	8
2003	**8**	0
2004	**22**	7
2005	**31**	1

NIMIKNET pelagic 0-gp index
May-June

Survey	0-gp
1992	
1993	
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**

Table 8.3.1. Cod in VIIa: Catch numbers at age (thousands). Note: sample-based estimates of landings from three ports are included in 1991- 1999 data.

Run title : "IRISH SEA COD NSWG 2006 COMBSEX PLUSGROUP"

At 14/05/2006 15:21

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1968	1969	1970	1971	1972	1973	1974	1975
AGE								
0	0	0	0	0	0	0	0	0
1	364	882	1317	2739	789	2263	530	1699
2	1563	1481	1385	2022	3267	1091	3559	642
3	1003	1050	352	904	824	1783	557	1407
4	456	269	204	144	250	430	494	294
5	177	186	163	67	58	173	131	249
6	28	76	52	39	39	60	46	95
+gp	2	37	19	12	20	21	28	22
0 TOTALNUM	3593	3981	3492	5927	5247	5821	5345	4408
TONSLAND	8541	7991	6426	9246	9234	11819	10251	9863
SOPCOF %	87	81	94	97	86	91	86	93

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	1135	816	687	1762	2533	1299	345	814	1577	1218
2	3007	511	1092	1288	2797	3635	2284	932	1195	2105
3	363	1233	310	608	729	1448	1455	751	439	703
4	500	163	311	127	243	244	557	499	240	158
5	61	218	39	164	49	99	102	154	161	84
6	79	31	47	38	51	23	57	27	56	51
+gp	25	40	18	33	4	24	22	19	19	26
0 TOTALNUM	5170	3012	2504	4020	6406	6772	4822	3196	3687	4345
TONSLAND	10247	8054	6271	8371	10776	14907	13381	10015	8383	10483
SOPCOF %	97	99	113	113	102	108	99	98	101	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	974	4323	2792	582	710	1973	1375	223	749	498
2	2248	1793	4734	2163	1075	1408	1243	2907	569	1283
3	699	841	702	1886	545	442	664	403	848	180
4	203	252	263	231	372	127	132	119	68	163
5	64	75	71	86	70	98	42	16	20	7
6	33	19	27	21	23	15	46	6	9	3
+gp	32	24	11	16	7	7	3	7	1	3
0 TOTALNUM	4253	7327	8600	4985	2802	4070	3505	3681	2264	2137
TONSLAND	9852	12894	14168	12751	7379	7095	7735	7555	5402	4587
SOPCOF %	100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
0	0	0	0	0	0	0	6	0	0	0
1	318	523	204	70	288	338	196	45	68	42
2	1113	1149	1926	843	176	840	566	436	101	224
3	700	501	335	871	107	53	406	92	158	62
4	38	213	80	66	50	13	7	35	21	33
5	39	17	28	21	4	9	2	1	6	5
6	4	11	6	6	1	0	2	0	2	1
+gp	2	5	1	0	0	2	1	0	1	0
0 TOTALNUM	2214	2418	2581	1877	626	1255	1186	609	357	367
TONSLAND	4964	5859	5310	4784	1273	2251	2704	1276	1071	909
SOPCOF %	100	100	100	100	100	100	100	99	100	100

Table 8.3.2. Cod in VIIa: mean weights at age in the international landings (also used as stock weights).

Run title : "IRISH SEA COD NSWG 2006 COMBSEX PLUSGROUP"

At 14/05/2006 15:21

Table 2 Catch weights at age (kg)

YEAR	1968	1969	1970	1971	1972	1973	1974	1975
AGE								
0	0	0	0	0	0	0	0	0
1	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
2	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66
3	3.33	3.33	3.33	3.33	3.33	3.33	3.33	3.33
4	5.09	5.09	5.09	5.09	5.09	5.09	5.09	5.09
5	6.19	6.19	6.19	6.19	6.19	6.19	6.19	6.19
6	6.76	6.76	6.76	6.76	6.76	6.76	6.76	6.76
+gp	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
0 SOPCOFAC	0.8734	0.8126	0.9407	0.9683	0.8622	0.9114	0.8575	0.9261

Table 2 Catch weights at age (kg)

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0.61	0.61	0.61	0.61	0.61	0.61	1.01	0.995	0.679	0.783
2	1.66	1.66	1.66	1.66	1.66	1.66	1.524	1.842	1.813	2.023
3	3.33	3.33	3.33	3.33	3.33	3.33	3.488	3.988	3.808	4.244
4	5.09	5.09	5.09	5.09	5.09	5.09	5.573	5.964	5.865	5.825
5	6.19	6.19	6.19	6.19	6.19	6.19	7.592	7.966	7.475	7.5
6	6.76	6.76	6.76	6.76	6.76	6.76	8.697	9.306	9.818	8.81
+gp	8.3	8.3	8.3	8.3	8.3	8.3	10.18	10.925	10.748	9.504
0 SOPCOFAC	0.9706	0.9855	1.1288	1.1267	1.023	1.0757	0.991	0.9835	1.0132	1.0039

Table 2 Catch weights at age (kg)

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0.805	0.713	0.607	0.936	0.842	0.856	0.813	0.847	0.798	0.9
2	1.825	2.161	1.563	1.846	1.938	1.637	1.964	1.706	1.923	1.84
3	3.862	3.91	3.756	3.223	3.572	3.542	3.993	3.666	3.608	4
4	5.855	6.41	5.668	5.408	5.277	5.419	5.975	5.675	6.08	5.791
5	7.391	7.821	8.017	6.571	7.531	6.39	6.923	7.365	7.68	8.452
6	8.116	9.888	9.749	8.256	8.398	8.507	8.509	9.486	8.272	8.712
+gp	9.471	10.658	10.208	11.052	12.699	10.397	11.1	10.761	11.258	9.56
0 SOPCOFAC	1.0034	1.0002	1.0001	0.9977	0.9971	1.0029	1.0026	1.0005	0.9996	1

Table 2 Catch weights at age (kg)

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0.98	0.846	0.925	0.853	0.851	0.99	0.942	1.204	1.112	0.913
2	1.625	1.937	1.647	1.624	1.985	1.823	1.836	1.662	2.202	1.938
3	3.256	3.624	3.729	3.179	3.573	4.149	3.439	3.287	3.633	3.514
4	5.298	5.291	5.371	5.505	5.138	5.606	5.728	5.424	6.505	5.318
5	7.721	6.115	7.033	7.517	7.148	7.332	7.711	10.199	7.638	7.738
6	8.836	8.672	8.833	10.137	8.528	8.471	9.638	10.308	8.937	7.94
+gp	12.256	11.263	12.155	12.618	7.692	9.667	10.761	13.696	7.572	12.237
0 SOPCOFAC	1.0004	1.0002	1.0002	0.9998	1.0005	1.002	0.9994	0.9948	0.9954	0.9961

Table 8.3.3. Cod in VIIa. (a) Proportion of catch by number discarded by sampled UK(NI) fleets, based on limited observer trips. (b) Information from UK(EW) observer trips from 2000-2005.

(a) UK(NI) fleets

			Proportion discarded			
Gear type	No. trips	Period	age 0	age 1	age 2	age 3
Midwater trawl	n/a	Q2-Q4 1997		0.40	0.00	0.00
Midwater trawl	n/a	Q1-Q3 1998		0.26	0.00	0.00
Midwater trawl	5	Q3-Q4 1999	1.00	0.00	0.00	0.00
Midwater trawl	4	Q1 2000		0.90	0.00	0.00
Single Nephrops	4	Q3-Q4 1999		0.00	0.00	
Single Nephrops	6	Q1-Q3 2000		0.75	0.00	0.00
Twin Nep. trawl	n/a	Q2-Q4 1997	1.00	0.94	0.01	0.00
Twin Nep. trawl	n/a	Q1-Q3 1998		0.94	0.08	0.00
Twin Nep. trawl	1	Q4 1999	1.00	0.29	0.00	
Twin Nep. trawl	10	Q1–Q4 2000	1.00	0.78	0.00	0.00

(b) UK (E&W) fleets

			Proportion discarded			
Gear type	No. trips	Period	age 0	age 1	age 2	age 3
Beam trawl	1	Q2 2000		0.99	0.03	0.00
Beam trawl	1	Q1 2002		0.63	0.00	0.00
Beam trawl	2	Q4 2005		0.00	0.00	0.00
Demersal otter trawl	21	Q1&2 2000		0.91	0.05	0.00
Demersal otter trawl	8	Q1,2,4 2001		0.16	0.04	0.00
Demersal otter trawl	4	Q1,3,4 2002		0.32	0.00	0.00
Demersal otter trawl	4	Q1,2,4 2003		0.16	0.01	0.00
Demersal otter trawl	7	Q1-4 2004		0.60	0.02	0.00
Demersal otter trawl	4	Q1,2 2005		0.28	0.02	0.00
Nephrops trawls	8	Q1&2 2001		0.68	0.24	0.00
Nephrops trawls	3	Q3&4 2002		0.38	0.00	0.00
Nephrops trawls	2	Q2 2003		0.00	0.00	0.00
Nephrops trawls	7	Q1-3 2004	1.00	0.69	0.00	0.00
Nephrops trawls	1	Q2 2005		0.00	0.00	0.00
Danish anchor seine	2	Q2 2001		0.00	0.00	0.00

Table 8.3.4 Cod in VIIa. Estimates of numbers discarded in 1996 - 2005. 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. 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)). Tables (e)-(i) all use observer data.

(a) Self sampling scheme: N.Ireland single trawl Nephrops vessels. Estimates are extrapolated to all N.Ireland vessels catching Nephrops (single and twin trawl) (approx 40 trips sampled per year).

Age	1996 Q1-4	1997 Q1-4	1998 Q1-4	1999 Q1-4	2000 Q1-4	2001 Q1-4	2002 Q1-4
0	56	3	0	70	32	4	0
1	82	63	14	83	397	31	22

(b) Observer scheme: N.Ireland vessels catching Nephrops (single trawl only)

	1999 Q3-4	2000 Q1-3	2001 Q1
Age	4 trips	6 trips	1 trip
0	0	0	0
1	0	53	0

(c) Observer scheme: N.Ireland midwater trawl

	1997 Q2-4	1998 Q1-3	1999 Q3-4	2000 Q1	2001 Q1
Age			5 trips	4 trips	2 trips
0	0	0	1.6	0	0
1	17	4	0	0.8	0
2	0.5	2	0	0	0

(d) Observer scheme: N.Ireland twin Nephrops trawl

	1997 Q2-4	1998 Q1-3	1999 Q4	2000 Q1-4	2001 Q1
Age			1 trip	10 trips	2 trips
0	12	0	12	33	0
1	19	38	1	45	0
2	0.2	13	0	0	0

(e) UK(E&W) Beam trawl

	2000 Q2	2002 Q1	2005 Q4
Age	1 trip	1 trip	2 trips
0	0	0	0
1	4.34	0.54	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00

(f) UK(E&W) Demersal otter trawl

	2000 Q1&2	2001 Q1,2,4	2002Q1,3,4	2003 Q1,2,4	2004 Q1-4	2005 Q1,2
Age	21 trips	8 trips	4 trips	4 trips	7 trips	4 trips
0	0	0	0	0	0	0
1	38.91	9.21	3.43	0.60	17.71	1.26
2	0.05	4.46	0.00	0.62	0.81	0.36
3	0.00	0.00	0.00	0.00	0.00	0.00

(g) UK(E&W) Nephrops trawl

	2001Q1,2	2002 Q3,4	2003 Q2	2004 Q1-3	2005 Q2
Age	8 trips	3 trips	2 trips	7 trips	1 trip
0	0.00	0.00	0.00	0.03	0.00
1	3.09	0.03	0.00	0.24	0.00
2	0.70	0.00	0.00	0.00	0.00

(h) UK(E&W) Danish anchor seine

	2001 Q2	2002 Q3	2003	2004 Q3	2005
Age	2 trips	1 trip	0	1 trip	0
0	0	0		0	
1	0.00	0.00		0.00	
2	0.00	0.00		0.00	
3	0.00	0.00		0.00	

Table 8.3.4. contd.

(i) Irish otter trawlers (OTB). (000's fish)

	1996	1997	2000	2004	2005
	8 trips	8 trips	10 trips	11 trips	8 trips
Age	48 hauls	44 hauls	110 hauls	122 hauls	96 hauls
0	15	108	569	536	1816
1	105	120	196	430	139
2	2	31	2	100	0
tonnes	24	33	138	97	25

Table 8.5.1.3.1. Settings for SURBA v3.0 analysis of NIGFS-Mar and ScoGFS-Q1 survey data.

	NIGFS-Mar	**ScoGFS-Q1**
Year range	1992-2006	1996 - 2006
Reference age	2	4
Catchability at age	Age 1: 1.0; Age 2: 0.95; Age 3: 0.73; Age 4: 0.51	Age 1: 0.06; Age 2: 0.16; Age 3: 0.35; Age 4: 0.71; Age 5: 1.0
Age weighting	Age 1: 0.3; Age 2: 1.0; Age 3: 0.6; Age 4: 0.3 All 1992 weightings set to 0.1	Age 1: 0.1; Age 2: 1.0; Age 3: 1.0; Age 4: 1.0; Age 5: 1.0
Lambda	1.0	1.0

Table 8.5.1.3.2. catch-at-age assessment model settings for exploratory and final runs

Year of assessment	**2006 Exploratory runs**	**2006 Final run**
Assessment model	B-ADAPT	B-ADAPT
Fishery data	1968-2005 landings including sample-based estimates for 1991-1999; Catch-at-age and weight-at-age data 1968-2005 (Table 8.3.1&2).	As in exploratory runs
Oldest age	5-plus (6-plus for 1 run).	
Tuning Fleet1	E/W BTS (September) 1991 – 2005; age 0	As in exploratory runs
Tuning Fleet 2	NIGFS -Oct 1992-2005; age 0-2	As in exploratory runs
Tuning Fleet 3	NIGFS-Mar 1993-2006; age 1-4	As in exploratory runs
Tuning Fleet 4	NIMIK net 1994-2005; age 0	As in exploratory runs
Tuning Fleet 5	ScoGFS-Q1 1996-2006, age 1-4	As in exploratory runs
Time series weights	Not applied	Not applied
Power model applied to ages	Not applied	Not applied
Catchability (q) plateau	3	3
F-smoothing weight λ	0, 0.5, 1.0, 5.0	1.0
Catch smoothing weight λ	0, 0.5, 1.0, 5.0	Not applied
Prior weighting of fleets	None	None

Table 8.5.1.3.3. Cod in VIIa. Survivors estimates and bias estimates from B-ADAPT single-fleet runs using NIGFS-Mar and ScoGFS-Q1 and a combination of three autumn surveys, compared with a run using all surveys combined. F-smoothing value of 1.0 applied. CV= SE of log estimates.

	NIGFS Mar		ScoGFS Q1		NIMIK, NIGFS-Oct and BTS-Sept		All surveys combined	
Age	Survivors	CV	Survivors	CV	Survivors	CV	Survivors	CV
0	1481	0.31	447	0.31	3058	0.28	1812	0.32
1	573	0.21	248	0.22	1827	0.23	813	0.26
2	500	0.21	355	0.22	544	0.28	458	0.31
3	32	0.24	39	0.40	48	0.69	26	0.50
Year	Bias	CV	Bias	CV	Bias	CV	Bias	CV
2000	2.50	0.12	2.42	0.12	1.00	0.18	1.70	0.21
2001	2.66	0.14	1.88	0.15	0.92	0.20	1.49	0.23
2002	3.49	0.14	2.08	0.15	1.41	0.18	2.14	0.21
2003	5.65	0.14	3.37	0.15	2.19	0.19	3.43	0.22
2004	4.92	0.14	3.65	0.15	2.07	0.20	3.23	0.22
2005	3.38	0.14	2.45	0.16	2.29	0.21	2.94	0.22

Table 8.5.1.4.1. Cod in VIIa. Selected diagnostics from final B-ADAPT run.

Lowestoft VPA Program

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Adapt Analysis

"IRISH SEA COD NSWG 20(PLUSGROUP"

CPUE data from file Cod7tun Surba.txt

Catch data for 38 years : 1968 to 2005. Ages 0 to 5+

Fleet	First year	Last year	First age	Last age	Alpha	Beta
BTS-Sept	1991	2006	0	0	0.75	0.79
NIGFSOCT(0 2-gp)	1992	2006	0	2	0.83	0.88
NIGFSMAR(1-4gp)	1993	2006	1	4	0.25	0.35
NIMIKNET	1994	2006	0	0	0.38	0.46
ScoGFS-Q1 Survey (No	1996	2006	1	4	0.25	0.35

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Fleet	PowerQ ages<x	QPlateau ages>x
BTS-Sept	0	3
NIGFSOCT(0 2-gp)	0	3
NIGFSMAR(1-4gp)	0	3
NIMIKNET	0	3
ScoGFS-Q1 Survey (N	0	3

Catchability independent of stock size for all ages

Bias estimation :

Bias estimated for the final 6 years.

Oldest age F estimates in 1968 to 2006 calculated as 1.000 * the mean F of ages 2- 3

Total F penalty applied lambda = 1.000

Individual fleet weighting not applied

INITIAL SSQ = 2215.608
PARAMETERS = 10
OBSERVATIONS = 194

SSQ = 85.44956
QSSQ = 83.17694
CSSQ = 2.27262
IFAIL = 0
IFAILCV = 0

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0	0	0	0	0	0	0.012	0	0	0
1	0.147	0.13	0.143	0.128	0.147	0.215	0.141	0.199	0.144	0.128
2	0.891	1.159	0.953	1.43	1.218	0.672	1.184	1.045	0.823	0.825
3	1.099	1.526	1.491	2.013	1.787	1.446	1.617	1.275	1.442	1.963
4	0.995	1.343	1.222	1.721	1.503	1.059	1.4	1.16	1.132	1.394

Table 8.5.1.4.1contd. Cod in VIIa. Selected diagnostics from final B-ADAPT run.

Population numbers (Thousands)

YEAR \ AGE	0	1	2	3	4
1996	5.78E+03	2.56E+03	2.05E+03	1.14E+03	6.60E+01
1997	2.06E+03	4.74E+03	1.81E+03	6.89E+02	3.11E+02
1998	7.79E+02	1.68E+03	3.41E+03	4.66E+02	1.23E+02
1999	4.81E+03	6.37E+02	1.19E+03	1.08E+03	8.59E+01
2000	3.49E+03	3.94E+03	4.59E+02	2.34E+02	1.18E+02
2001	4.29E+03	2.86E+03	2.79E+03	1.11E+02	3.21E+01
2002	1.16E+03	3.52E+03	1.89E+03	1.16E+03	2.14E+01
2003	2.20E+03	9.42E+02	2.50E+03	4.73E+02	1.89E+02
2004	1.38E+03	1.80E+03	6.32E+02	7.20E+02	1.08E+02
2005	2.21E+03	1.13E+03	1.28E+03	2.27E+02	1.39E+02

Estimated population abundance at 1st Jan 2006

0.00E+00 1.81E+03 8.13E+02 4.58E+02 2.61E+01

Taper weighted geometric mean of the VPA populations:

4.94E+03 4.11E+03 2.77E+03 1.02E+03 3.01E+02

Standard error of the weighted Log(VPA populations) :

0.7319 0.7208 0.6614 0.7624 0.9564

Log population residuals (unweighted).

Fleet : BTS-Sept

Log index residuals

Age	1991	1992	1993	1994	1995	1996
0	0.01	-0.21	-0.06	0.02	0.49	-0.45
1	No data for this fleet at this age					
2	No data for this fleet at this age					
3	No data for this fleet at this age					
4	No data for this fleet at this age					

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	0.62	-1.12	0.45	0.33	-0.34	-0.26	-0.77	0.71	0.58	99.99
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									

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	-4.6936
S.E(Log q)	0.5368

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	0.86	0.724	5.14	0.68	15	0.4713	-4.69

Fleet : NIGFSOCT(0 2-gp)
Log index residuals

Age	1991	1992	1993	1994	1995	1996
0	99.99	-1.67	-0.17	1.1	0.34	0.36
1	99.99	-0.31	0.59	0.62	0.61	-0.17
2	99.99	0.02	0.28	0.05	-1.04	-0.15
3	No data for this fleet at this age					
4	No data for this fleet at this age					

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	0.13	-1.33	0.85	0.15	0.09	-0.83	-0.35	0.59	0.73	99.99
1	0.2	-0.01	-0.92	-1.08	-0.18	-0.49	-0.23	0.35	1.01	99.99
2	0.87	0.58	0.41	-1.59	0.15	-0.09	-0.76	0.24	1.04	99.99
3	No data for this fleet at this age									
4	No data for this fleet at this age									

Table 8.5.1.4.1contd. Cod in VIIa. Selected diagnostics from final B-ADAPT run

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
Mean Log q	-1.5504	-1.1952	-2.6321
S.E(Log q)	0.8083	0.6042	0.7185

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	0.56	2.51	4.32	0.73	14	0.38213	-1.55
1	1.03	-0.132	0.97	0.55	14	0.65016	-1.2
2	0.8	0.797	3.59	0.57	14	0.58372	-2.63

Fleet : NIGFSMAR(1-4gp)

Log index residuals

Age	1991	1992	1993	1994	1995	1996
0	No data for this fleet at this age					
1	99.99	99.99	-0.33	0.88	0.52	1.14
2	99.99	99.99	-0.3	-0.5	-0.42	-0.21
3	99.99	99.99	-0.51	-0.39	-0.68	-0.41
4	99.99	99.99	-0.91	-0.62	-1.39	-1.98

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	No data for this fleet at this age									
1	-0.2	-0.32	-0.59	0.14	0.05	0.31	-0.55	-0.14	-0.9	99.99
2	0.23	0.15	0.23	0.2	-0.05	-0.3	0.82	0.3	-0.14	99.99
3	-0.3	-0.08	0.69	0.21	0.19	0.81	0.44	-0.08	0.11	99.99
4	-0.71	-0.38	0.35	0.76	0.18	99.99	0.18	-1.08	0.39	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
Mean Log q	-1.8742	-1.2906	-1.5177	-1.5177
S.E(Log q)	0.591	0.365	0.4628	0.9441

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	0.61	3.127	4.14	0.85	13	0.27329	-1.87
2	1.1	-0.545	0.7	0.74	13	0.41248	-1.29
3	0.98	0.139	1.64	0.74	13	0.47088	-1.52
4	1.3	-0.552	1.11	0.26	12	1.10758	-1.95

Fleet : NIMIKNET

Log index residuals

Age	1991	1992	1993	1994	1995	1996
0	99.99	99.99	99.99	1.57	-0.38	1.27
1	No data for this fleet at this age					
2	No data for this fleet at this age					
3	No data for this fleet at this age					
4	No data for this fleet at this age					

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	-0.15	-3.22	0.53	-0.61	-0.36	-0.09	-0.79	1.76	0.47	99.99
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									

Table 8.5.1.4.1contd. Cod in VIIa. Selected diagnostics from final B-ADAPT run

Fleet : NIMIKNET

Log index residuals

Age	1991	1992	1993	1994	1995	1996
0	99.99	99.99	99.99	1.57	-0.38	1.27
1	No data for this fleet at this age					
2	No data for this fleet at this age					
3	No data for this fleet at this age					
4	No data for this fleet at this age					

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	-0.15	-3.22	0.53	-0.61	-0.36	-0.09	-0.79	1.76	0.47	99.99
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									

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	-5.6566
S.E(Log q)	1.3261

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	0.48	1.795	6.78	0.55	12	0.58424	-5.66

Fleet : ScoGFS-Q1 Survey (No

Log index residuals

Age	1991	1992	1993	1994	1995	1996
0	No data for this fleet at this age					
1	99.99	99.99	99.99	99.99	99.99	-1.33
2	99.99	99.99	99.99	99.99	99.99	-0.22
3	99.99	99.99	99.99	99.99	99.99	-0.1
4	99.99	99.99	99.99	99.99	99.99	0.88

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	No data for this fleet at this age									
1	0.05	-0.4	0.91	1.08	0.82	-0.18	0.67	0	-1.61	99.99
2	-0.08	0.25	0.55	-0.27	0	-0.59	0.43	-0.1	0.02	99.99
3	-0.55	0.42	0.98	0.3	-1.46	-0.14	-0.07	0.57	0.06	99.99
4	0.05	-0.01	1.59	1.28	-0.33	0.18	0.12	99.99	0.5	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
Mean Log q	-5.3186	-3.6475	-2.7613	-2.7613
S.E(Log q)	0.9219	0.3385	0.6665	0.8164

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	0.98	0.041	5.36	0.35	10	0.95856	-5.32
2	0.89	0.716	4.07	0.83	10	0.30827	-3.65
3	0.7	1.706	3.8	0.8	10	0.42236	-2.76
4	0.94	0.226	2.43	0.66	9	0.64492	-2.29

Year	Est.Landin	Landings	Bias
2000	2161	1273	1.699
2001	3341	2251	1.487
2002	5784	2704	2.138
2003	4398	1276	3.428
2004	3471	1071	3.226
2005	2686	909	2.944

Parameters

Age	Survivors	s.e log est
0	1811.734	0.31921
1	813.2406	0.26153
2	458.4783	0.30809
3	26.13952	0.49753

Year	Multiplier	s.e log est
33	1.69851	0.21049
34	1.48724	0.22979
35	2.13789	0.20794
36	3.42846	0.21901
37	3.2256	0.2212
38	2.94388	0.22383

Variance covariance matrix

0.1019	0.00838	0.00646	0.00216	0.00742	0.00816	0.00802	0.00775	0.00773	0.00862
0.00838	0.0684	0.00633	0.00234	0.00734	0.00816	0.00786	0.00661	0.00379	0.01378
0.00646	0.00633	0.09492	-0.02025	0.00733	0.00825	0.0078	0.00513	0.0087	0.00057
0.00216	0.00234	-0.02025	0.24753	0.00719	0.00831	0.00652	0.00438	-0.00736	-0.00381
0.00742	0.00734	0.00733	0.00719	0.04431	0.01271	0.00559	0.00567	0.00677	0.00727
0.00816	0.00816	0.00825	0.00831	0.01271	0.0528	0.01259	0.0041	0.00538	0.0073
0.00802	0.00786	0.0078	0.00652	0.00559	0.01259	0.04324	0.01262	0.00486	0.00523
0.00775	0.00661	0.00513	0.00438	0.00567	0.0041	0.01262	0.04797	0.01176	0.00414
0.00773	0.00379	0.0087	-0.00736	0.00677	0.00538	0.00486	0.01176	0.04893	0.01262
0.00862	0.01378	0.00057	-0.00381	0.00727	0.0073	0.00523	0.00414	0.01262	0.0501

Table 8.5.1.4.2. Cod in VIIa. Estimates of fishing mortality from final B-ADAPT run.

Run title : "IF NSWG 20 PLUSGROUP"

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Table 8 Fishing mortality (F) at age

YEAR	1968	1969	1970	1971	1972	1973	1974	1975
AGE								
0	0	0	0	0	0	0	0	0
1	0.1223	0.1988	0.2251	0.2804	0.2169	0.2451	0.2464	0.2268
2	0.595	1.0139	0.5439	0.6355	0.6327	0.5225	0.7531	0.5302
3	1.0927	1.0844	0.718	0.8518	0.5839	0.882	0.558	0.7814
4	0.8438	1.0492	0.631	0.7436	0.6083	0.7023	0.6556	0.6558
+gp	0.8438	1.0492	0.631	0.7436	0.6083	0.7023	0.6556	0.6558
0 FBAR 2- 4	0.8438	1.0492	0.631	0.7436	0.6083	0.7023	0.6556	0.6558

Table 8 Fishing mortality (F) at age

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0.5463	0.2358	0.1817	0.2168	0.2684	0.2442	0.1429	0.2316	0.3097	0.2295
2	0.7881	0.5107	0.566	0.6033	0.6277	0.7662	0.8864	0.6975	0.6243	0.8829
3	0.6576	0.9149	0.6782	0.7264	0.8446	0.8001	0.8267	0.8513	0.8645	0.9665
4	0.7229	0.7128	0.6221	0.6648	0.7362	0.7832	0.8565	0.7744	0.7444	0.9247
+gp	0.7229	0.7128	0.6221	0.6648	0.7362	0.7832	0.8565	0.7744	0.7444	0.9247
0 FBAR 2- 4	0.7229	0.7128	0.6221	0.6648	0.7362	0.7832	0.8565	0.7744	0.7444	0.9247

Table 8 Fishing mortality (F) at age

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
0	0	0	0	0	0	0	0	0	0	0
1	0.2288	0.3729	0.5519	0.2274	0.2145	0.6236	0.2338	0.1911	0.2164	0.1977
2	0.8569	0.8495	0.9142	1.1713	0.8448	0.8522	1.0826	1.1108	1.0423	0.6964
3	0.8565	0.9637	1.0171	1.2846	1.1561	1.0911	1.4584	1.4639	1.2863	1.2286
4	0.8567	0.9066	0.9657	1.2279	1.0005	0.9716	1.2705	1.2873	1.1643	0.9625
+gp	0.8567	0.9066	0.9657	1.2279	1.0005	0.9716	1.2705	1.2873	1.1643	0.9625
0 FBAR 2- 4	0.8567	0.9066	0.9657	1.2279	1.0005	0.9716	1.2705	1.2873	1.1643	0.9625

Table 8 Fishing mortality (F) at age

YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	FBAR **-**
AGE											
0	0	0	0	0	0	0	0.0122	0	0	0	0
1	0.1466	0.1297	0.1434	0.1281	0.1469	0.2149	0.1406	0.1986	0.1438	0.1284	0.157
2	0.8913	1.1587	0.9528	1.4297	1.2185	0.6721	1.1836	1.0453	0.8231	0.825	0.8978
3	1.0989	1.5264	1.4908	2.0126	1.7873	1.4462	1.617	1.2748	1.4415	1.9626	1.5597
4	0.9951	1.3425	1.2218	1.7212	1.5029	1.0592	1.4003	1.1601	1.1323	1.3938	1.2287
+gp	0.9951	1.3425	1.2218	1.7212	1.5029	1.0592	1.4003	1.1601	1.1323	1.3938	
0 FBAR 2- 4	0.9951	1.3425	1.2218	1.7212	1.5029	1.0592	1.4003	1.1601	1.1323	1.3938	

Table 8.5.1.4.3. Cod in VIIa. Estimates of stock numbers from final B-ADAPT run.

Run title : "IF NSWG 20 PLUSGROUP"

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Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1968	1969	1970	1971	1972	1973	1974	1975
	AGE								
	0	6570	8771	15024	5434	13973	3257	11241	3601
	1	3482	5379	7181	12301	4449	11440	2666	9203
	2	3808	2522	3610	4694	7608	2932	7331	1706
	3	1636	1720	749	1715	2036	3309	1424	2826
	4	871	449	476	299	599	930	1121	667
	+gp	395	499	546	245	280	549	465	831
0	TOTAL	16761	19340	27586	24689	28946	22417	24248	18835

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE										
	0	5215	5557	12139	14437	8046	3484	5285	7938	7975	6393
	1	2948	4270	4549	9939	11820	6588	2852	4327	6499	6529
	2	6006	1398	2762	3106	6551	7399	4225	2024	2810	3904
	3	822	2236	687	1284	1391	2863	2816	1426	825	1232
	4	1059	349	733	285	508	489	1053	1009	498	285
	+gp	350	618	245	528	218	293	342	404	490	290
0	TOTAL	16400	14427	21116	29579	28535	21117	16573	17128	19097	18632

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	AGE										
	0	18601	8791	3841	4938	5672	8852	1722	5168	3729	3132
	1	5234	15230	7197	3145	4043	4643	7248	1410	4231	3053
	2	4249	3409	8588	3394	2051	2671	2038	4697	953	2790
	3	1322	1477	1193	2818	861	721	933	565	1266	275
	4	384	460	461	353	639	222	198	178	107	286
	+gp	244	215	191	188	172	210	137	43	47	23
0	TOTAL	30034	29581	21472	14836	13437	17320	12275	12060	10334	9559

Table 10 Stock number at age (start of year) Numbers*10**-3

	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	GMST 68-**	AMST 68-**
	AGE													
	0	5784	2057	779	4813	3491	4294	1165	2201	1379	2213	0	5229	6482
	1	2564	4736	1684	637	3941	2858	3515	942	1802	1129	1812	4359	5354
	2	2051	1813	3406	1195	459	2786	1888	2501	632	1278	813	2948	3482
	3	1138	689	466	1075	234	111	1165	473	720	227	458	1069	1327
	4	66	311	123	86	118	32	21	189	108	139	26	316	442
	+gp	77	47	55	36	12	28	15	6	44	25	33		
0	TOTAL	11681	9653	6512	7843	8255	10109	7769	6312	4686	5012	3143		
	1													

Table 8.5.1.4.4. Cod in VIIa: Summary table from final B-ADAPT run. SSB value for 2006 is calculated from survivors at age in 2006 and mean weights at age from 2003-2005.

Run title : "IF NSWG 2005 COM PLUSGROUP"

At 15/05/2006 14:52

Table 16 Summary (without SOP correction)

	RECRUITS Age 0	TOTALBIO	TOTSPBIO	LANDINGS	YIELD/SSB	FBAR 2- 4
1968	6570	20808	14765	8541	0.5785	0.8438
1969	8771	18772	12895	7991	0.6197	1.0492
1970	15024	18833	10737	6426	0.5985	0.631
1971	5434	24147	11813	9246	0.7827	0.7436
1972	13973	27063	16519	9234	0.559	0.6083
1973	3257	31164	21167	11819	0.5584	0.7023
1974	11241	27318	18147	10251	0.5649	0.6556
1975	3601	26623	19253	9863	0.5123	0.6558
1976	5215	22268	14289	10247	0.7171	0.7229
1977	5557	18191	14147	8054	0.5693	0.7128
1978	12139	15049	9432	6271	0.6649	0.6221
1979	14437	20420	11161	8371	0.75	0.6648
1980	8046	26730	12778	10776	0.8434	0.7362
1981	3484	30268	18634	14907	0.8	0.7832
1982	5285	27835	20962	13381	0.6383	0.8565
1983	7938	23141	16524	10015	0.6061	0.7744
1984	7975	19636	12064	8383	0.6949	0.7444
1985	6393	22286	12278	10483	0.8538	0.9247
1986	18601	21294	12273	9852	0.8028	0.8567
1987	8791	28823	13398	12894	0.9624	0.9066
1988	3841	26545	13854	14168	1.0226	0.9657
1989	4938	21602	14775	12751	0.863	1.2279
1990	5672	15214	9346	7379	0.7896	1.0005
1991	8852	13549	6864	7095	1.0337	0.9716
1992	1722	15879	7505	7735	1.0306	1.2705
1993	5168	12660	6498	7555	1.1627	1.2873
1994	3729	10806	6293	5402	0.8584	1.1643
1995	3132	10841	4911	4587	0.9341	0.9625
1996	5784	10521	5941	4964	0.8355	0.9951
1997	2057	12025	5841	5859	1.0031	1.3425
1998	779	9976	4940	5310	1.0749	1.2218
1999	4813	6671	4924	4784	0.9715	1.7212
2000	3491	5797	1879	1273	0.6777	1.5029
2001	4294	8766	2788	2251	0.8075	1.0592
2002	1165	11044	5584	2704	0.4842	1.4003
2003	2201	7935	4224	1276	0.3021	1.1601
2004	1379	7063	4195	1071	0.2553	1.1323
2005	2213	5245	2678	909	0.3394	1.3938
2006			**2627**			
Arith. Mean	6236	17969	10691	7739	0.7401	0.973
0 Units	(Thousands)	(Tonnes)	(Tonnes)	(Tonnes)		

Table 8.5.4.1. Cod in VIIa. Deterministic short-term forecast: input data.

Cod in division VIIa : Results of short term forecast with 2006 F mult = 1.0

MFDP version 1a
Run: cod7a2006wg
Time and date: 13:27 17/05/2006
Fbar age range: 2-4

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	2568	0.2	0	0	0	0	0	0
1	1811	0.2	0	0	0	1.076	0.157	1.076
2	813	0.2	0.38	0	0	1.934	0.989	1.934
3	458	0.2	1	0	0	3.478	1.56	3.478
4	26	0.2	1	0	0	5.749	1.229	5.749
5	33	0.2	1	0	0	8.713	1.229	8.713

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	2568	0.2	0	0	0	0	0	0
1	.	0.2	0	0	0	1.076	0.157	1.076
2	.	0.2	0.38	0	0	1.934	0.989	1.934
3	.	0.2	1	0	0	3.478	1.56	3.478
4	.	0.2	1	0	0	5.749	1.229	5.749
5	.	0.2	1	0	0	8.713	1.229	8.713

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
0	2568	0.2	0	0	0	0	0	0
1	.	0.2	0	0	0	1.076	0.157	1.076
2	.	0.2	0.38	0	0	1.934	0.989	1.934
3	.	0.2	1	0	0	3.478	1.56	3.478
4	.	0.2	1	0	0	5.749	1.229	5.749
5	.	0.2	1	0	0	8.713	1.229	8.713

Input units are thousands and kg - output in tonnes

Table 8.5.4.2. Cod in VIIa. Deterministic short-term forecast: management options

Cod in division VIIa : Results of short term forecast with 2006 F mult = 1.0

MFDP version 1a
Run: cod7a2006wg
cod7astpMFDP Index file 11/05/2004
Time and date: 13:27 17/05/2006

2006 Biomass	SSB	FMult	FBar	Landings
5551	2627	1.0000	1.2593	2622

2007 Biomass	SSB	FMult	FBar	Landings	2008 Biomass	SSB
6150	2369	0.0000	0.0000	0	11028	6702
.	2369	0.1000	0.1259	415	10392	6097
.	2369	0.2000	0.2519	788	9821	5558
.	2369	0.3000	0.3778	1124	9309	5077
.	2369	0.4000	0.5037	1426	8848	4648
.	2369	0.5000	0.6297	1699	8434	4263
.	2369	0.6000	0.7556	1946	8060	3919
.	2369	0.7000	0.8815	2170	7722	3611
.	2369	0.8000	1.0075	2373	7417	3334
.	2369	0.9000	1.1334	2557	7140	3086
.	2369	1.0000	1.2593	2725	6889	2862
.	2369	1.1000	1.3853	2879	6660	2661
.	2369	1.2000	1.5112	3019	6452	2480
.	2369	1.3000	1.6371	3147	6262	2317
.	2369	1.4000	1.7631	3265	6088	2169
.	2369	1.5000	1.8890	3374	5929	2035
.	2369	1.6000	2.0149	3474	5782	1914
.	2369	1.7000	2.1409	3566	5647	1805
.	2369	1.8000	2.2668	3652	5523	1705
.	2369	1.9000	2.3927	3731	5408	1614
.	2369	2.0000	2.5187	3805	5302	1532
F = $\mathbf{F}_{pa}$	4616	0.49	0.7203	2750	9451	5095

Input units are thousands and kg - output in tonnes

Table 8.5.4.3. Cod in VIIa. Deterministic short-term forecast: detailed output.

Cod in division VIIa : Results of short term forecast with 2006 F mult = 1.0

MFDP version 1a
Run: cod7a2006wg
Time and date: 13:28 17/05/2006
Fbar age range: 2-4

Year:	2006	F multiplier:	1	Fbar:	1.2593				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
0	0	0	0	2568	0	0	0	0	0
1	0.157	239	257	1811	1949	0	0	0	0
2	0.989	470	910	813	1572	309	597	309	597
3	1.56	336	1169	458	1593	458	1593	458	1593
4	1.229	17	98	26	149	26	149	26	149
5	1.229	22	188	33	288	33	288	33	288
Total		1084	2622	5709	5551	826	2627	826	2627

Year:	2007	F multiplier:	1	Fbar:	1.2593				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
0	0	0	0	2568	0	0	0	0	0
1	0.157	278	299	2103	2262	0	0	0	0
2	0.989	733	1418	1267	2451	482	931	482	931
3	1.56	182	632	248	861	248	861	248	861
4	1.229	52	296	79	453	79	453	79	453
5	1.229	9	81	14	123	14	123	14	123
Total		1253	2725	6278	6150	822	2369	822	2369

Year:	2008	F multiplier:	1	Fbar:	1.2593				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
0	0	0	0	2568	0	0	0	0	0
1	0.157	278	299	2103	2262	0	0	0	0
2	0.989	851	1646	1471	2845	559	1081	559	1081
3	1.56	283	985	386	1342	386	1342	386	1342
4	1.229	28	160	43	245	43	245	43	245
5	1.229	15	127	22	194	22	194	22	194
Total		1454	3217	6593	6889	1010	2862	1010	2862

Input units are thousands and kg - output in tonnes

Table 8.5.6.1. Cod in VIIa. Yield per recruit input data from 2004 WG assessment.

MFYPR version 2a
Run: cod7aypr
"IRISH SEA COD, NSWG 2003, COMBSEX,PLUSGROUP"
Time and date: 21:21 11/05/2004 input F are mean F_{01-03} unscaled
Fbar age range: 2-4 Catch and stock weights are $mean_{82-02}$

Age	M	Mat	PF	PM	SWt	Sel	CWt
1	0.2	0	0	0	0.874	0.192	0.874
2	0.2	0.38	0	0	1.811	0.792	1.811
3	0.2	1	0	0	3.662	1.326	3.662
4	0.2	1	0	0	5.629	0.965	5.629
5	0.2	1	0	0	7.490	0.939	7.490
6	0.2	1	0	0	8.981	0.921	8.981
7	0.2	1	0	0	10.817	0.973	10.817

Weights in kilograms

Table 8.5.6.2. Cod in VIIa. Results of yield per recruit analysis carried out by 2004 WG.

MFYPR version 2a
Run: cod7aypr
Time and date: 21:21 11/05/2004
Yield per results

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	5.5167	32.5432	4.0090	30.7501	4.0090	30.7501
0.1000	0.1028	0.2822	1.5797	4.1125	19.1807	2.6145	17.4051	2.6145	17.4051
0.2000	0.2055	0.4247	2.0229	3.4070	13.0133	1.9185	11.2548	1.9185	11.2548
0.3000	0.3083	0.5104	2.1156	2.9848	9.6369	1.5055	7.8952	1.5055	7.8952
0.4000	0.4111	0.5677	2.0872	2.7047	7.5890	1.2345	5.8637	1.2345	5.8637
0.5000	0.5138	0.6088	2.0181	2.5054	6.2555	1.0442	4.5464	1.0442	4.5464
0.6000	0.6166	0.6397	1.9388	2.3564	5.3395	0.9039	3.6463	0.9039	3.6463
0.7000	0.7194	0.6640	1.8612	2.2404	4.6826	0.7965	3.0050	0.7965	3.0050
0.8000	0.8221	0.6836	1.7894	2.1473	4.1945	0.7118	2.5321	0.7118	2.5321
0.9000	0.9249	0.6999	1.7247	2.0706	3.8206	0.6434	2.1732	0.6434	2.1732
1.0000	1.0277	0.7136	1.6669	2.0061	3.5265	0.5870	1.8938	0.5870	1.8938
1.1000	1.1304	0.7255	1.6153	1.9508	3.2898	0.5397	1.6715	0.5397	1.6715
1.2000	1.2332	0.7359	1.5692	1.9027	3.0955	0.4994	1.4913	0.4994	1.4913
1.3000	1.3360	0.7451	1.5280	1.8604	2.9331	0.4647	1.3427	0.4647	1.3427
1.4000	1.4387	0.7533	1.4909	1.8227	2.7952	0.4345	1.2185	0.4345	1.2185
1.5000	1.5415	0.7608	1.4575	1.7887	2.6765	0.4080	1.1131	0.4080	1.1131
1.6000	1.6443	0.7675	1.4271	1.7580	2.5732	0.3844	1.0229	0.3844	1.0229
1.7000	1.7470	0.7737	1.3995	1.7298	2.4822	0.3634	0.9448	0.3634	0.9448
1.8000	1.8498	0.7795	1.3743	1.7040	2.4014	0.3445	0.8766	0.3445	0.8766
1.9000	1.9526	0.7848	1.3512	1.6801	2.3290	0.3274	0.8166	0.3274	0.8166
2.0000	2.0553	0.7897	1.3299	1.6579	2.2637	0.3119	0.7634	0.3119	0.7634

Reference point	F multiplier	Absolute F
Fbar(2-4)	1.0000	1.0277
FMax	0.3112	0.3198
F0.1	0.1786	0.1835
F35%SPR	0.2116	0.2175

Weights in kilograms

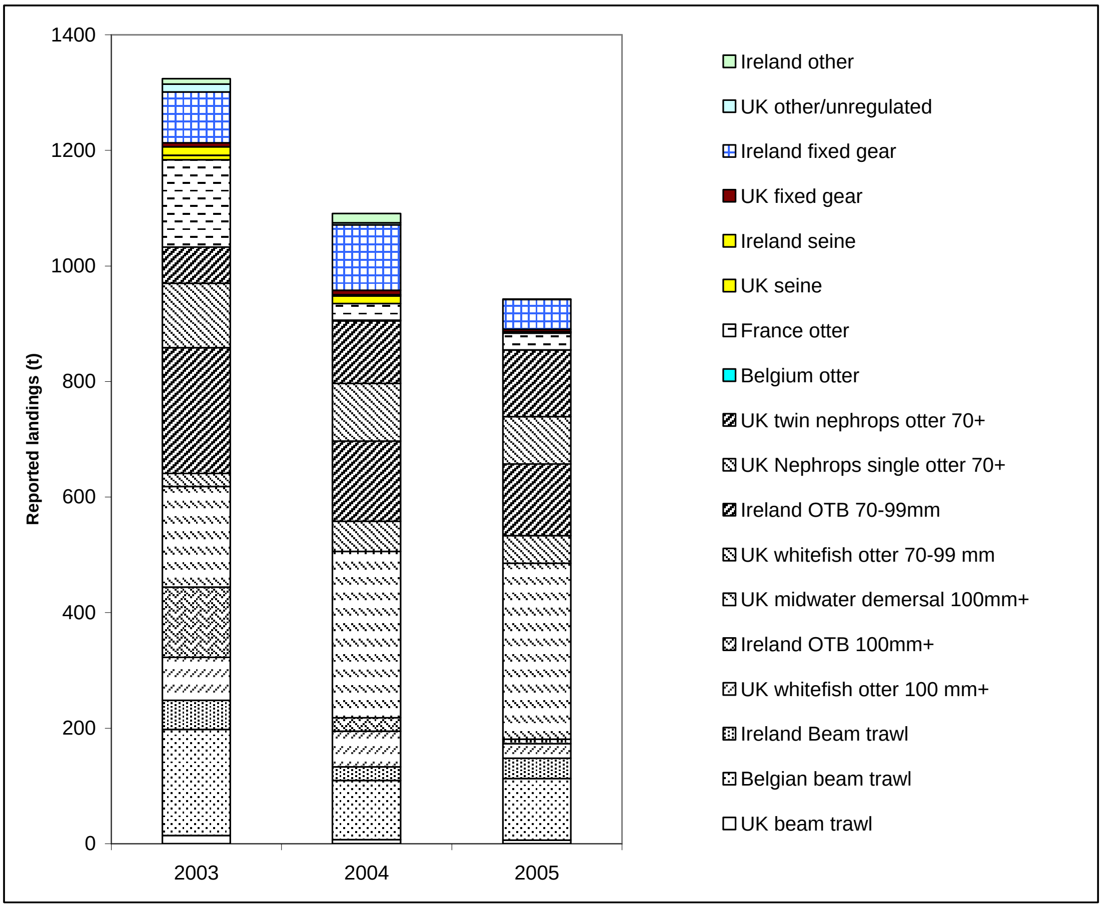


Fig. 8.1.1. Cod in VIIa. Official landings by fleet and mesh band, 2003-2005.

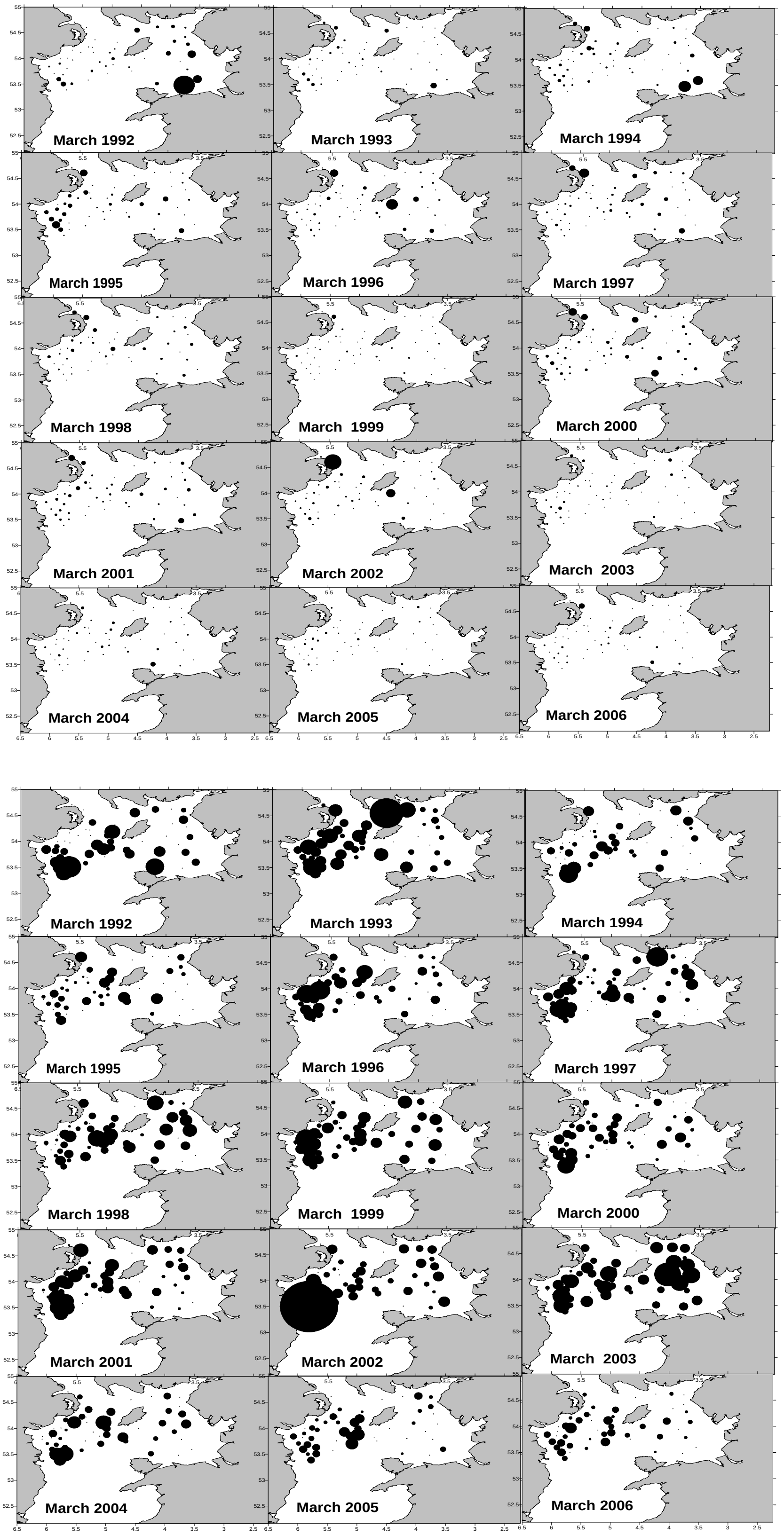


Figure 8.2.1. Cod in VIIa: NIGFS (March) survey distribution of cod. Areas of circles proportional to catch rate in kg per 3 mile tow. Top: cod < 35cm. Bottom: cod 35cm and over. Note: scale on top plot expanded by factor of 2.5.

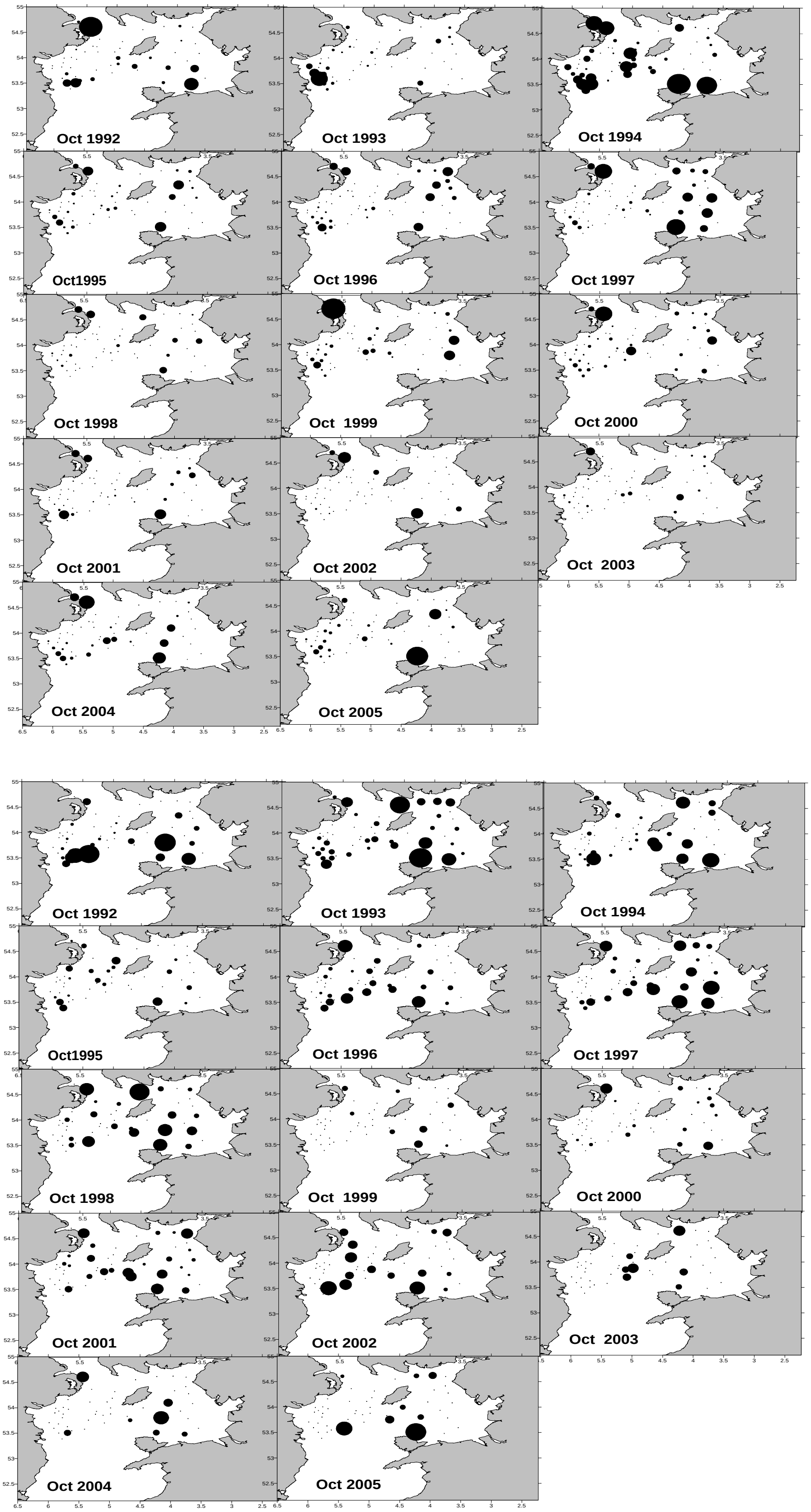


Figure 8.2.2. Cod in VIIa: NIGFS (Oct) survey distribution of cod. Areas of circles proportional to catch rate in kg per 3 mile tow. Top: cod < 35cm. Bottom: cod 35cm and over. Catch-rate scales same as for March survey in previous figure.

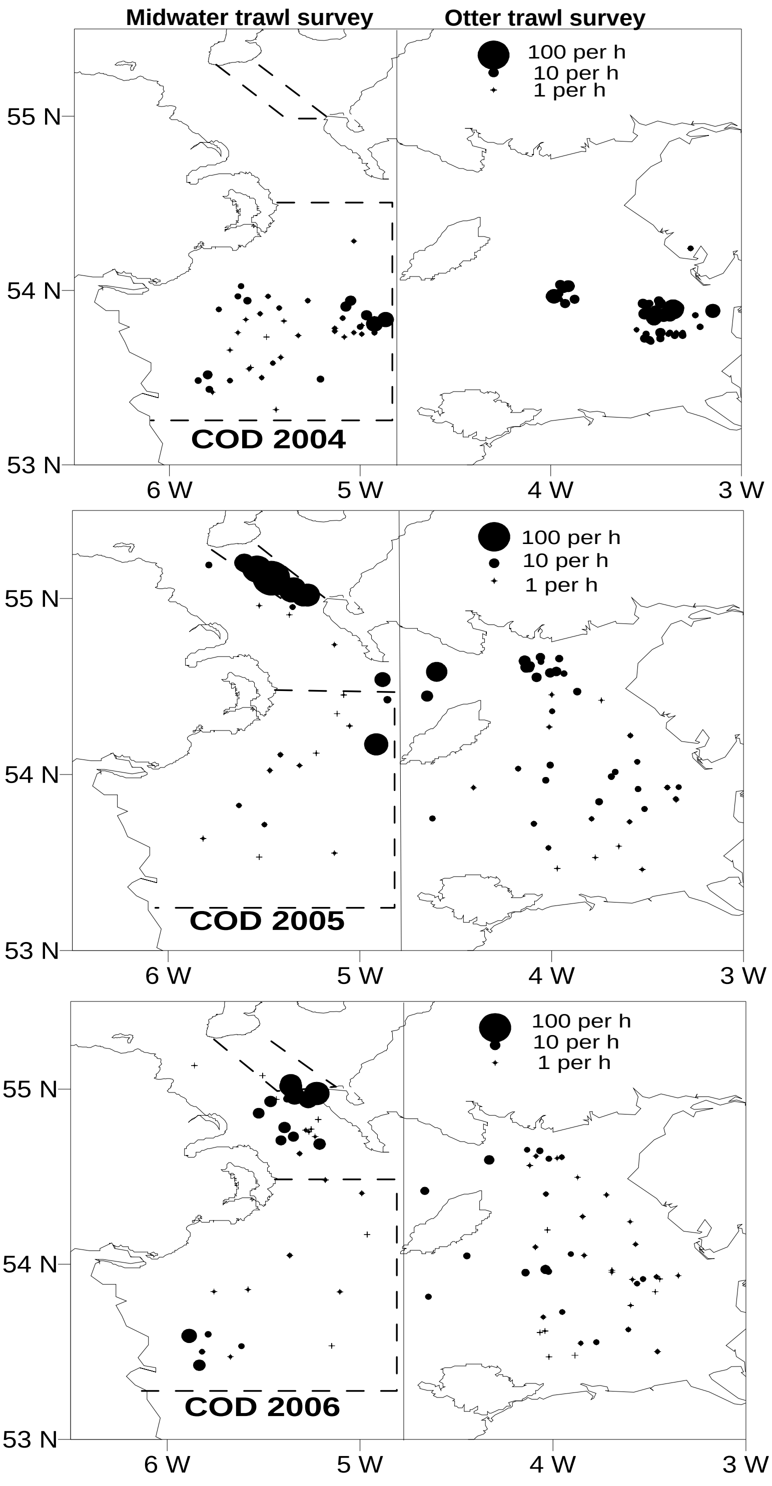


Figure 8.2.3. Cod in VIIa: UK Fisheries Science Partnership surveys in spring 2004-2006. Tows to west of vertical line were carried out by a mid-water trawler; tows to the east by an otter trawler. Areas of spots are proportional to catch rate in numbers of fish per hour towed. Spring closures in western Irish Sea and Firth of Clyde are indicated by dashed lines.

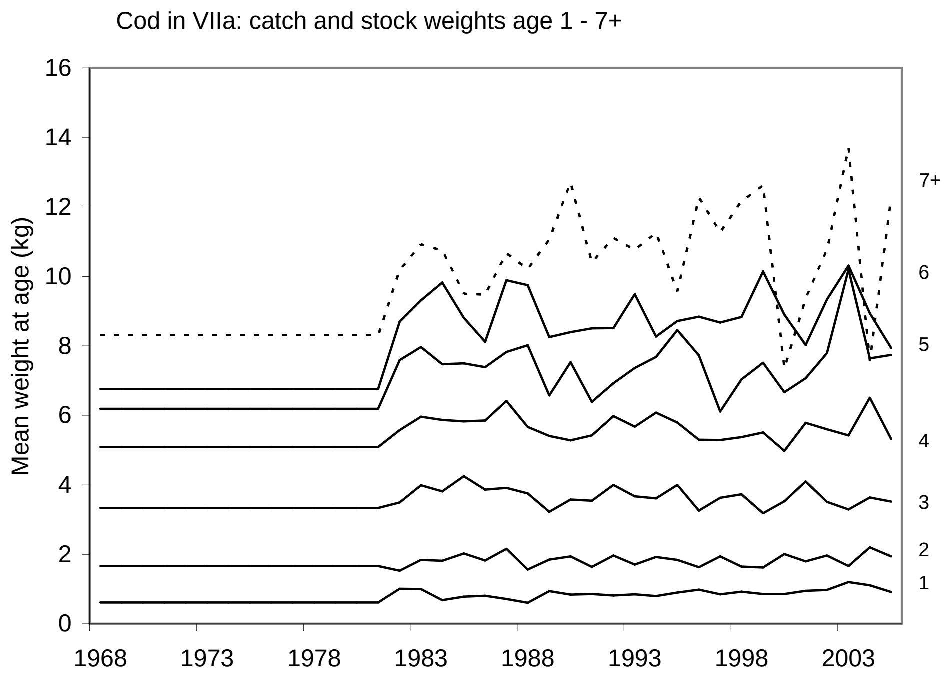
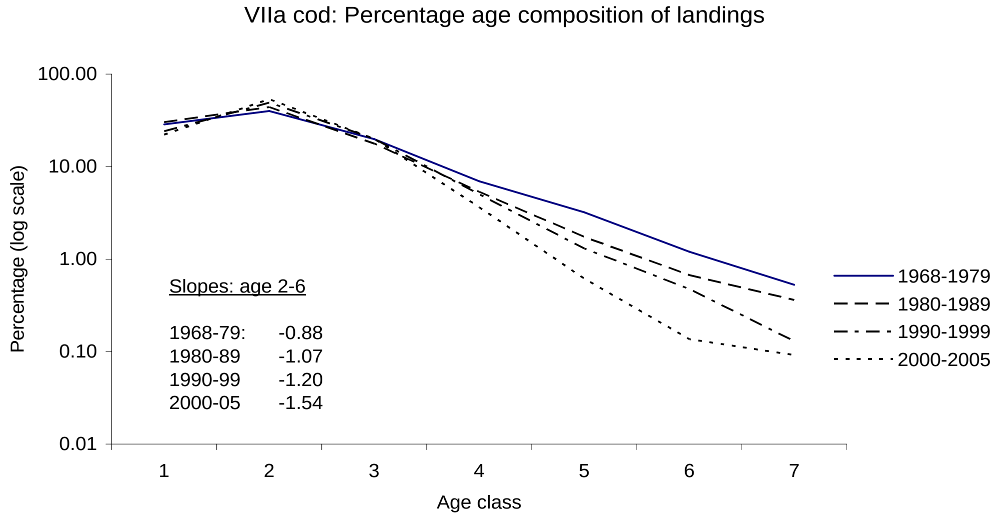


Figure 8.3.1. Cod in VIIa. Mean weight at age in the catch and stock.

(a) Historical commercial fishery



(b) Fishery Science Partnership survey age compositions

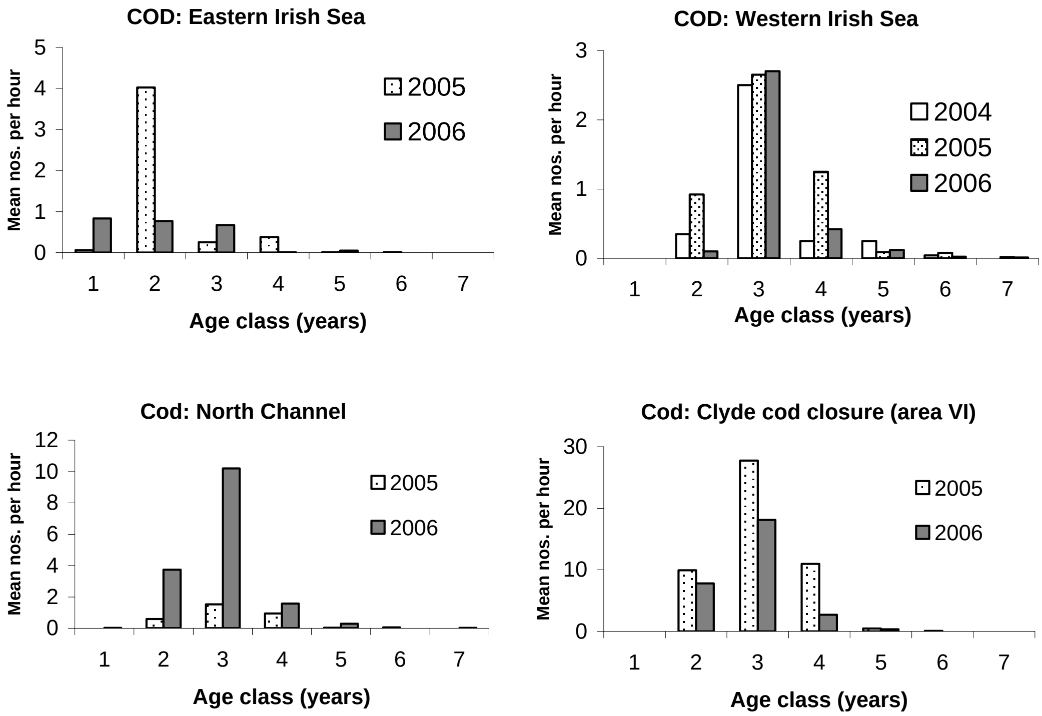


Fig. 8.5.1.1. Cod in VIIa: (a) Mean landings at age in the commercial fishery, for different time periods (log scale; slopes of log catch nos vs age for ages 2-6 are given); (b) Mean age compositions (numbers per hour towed) for cod caught during the UK Fisheries Science Partnership surveys of the Irish Sea during spring 2004-2006 (from Armstrong and Dann: WD5). Data for the Firth of Clyde cod closure (ICES Division VIa) are also shown (see Fig. 8.2.3).

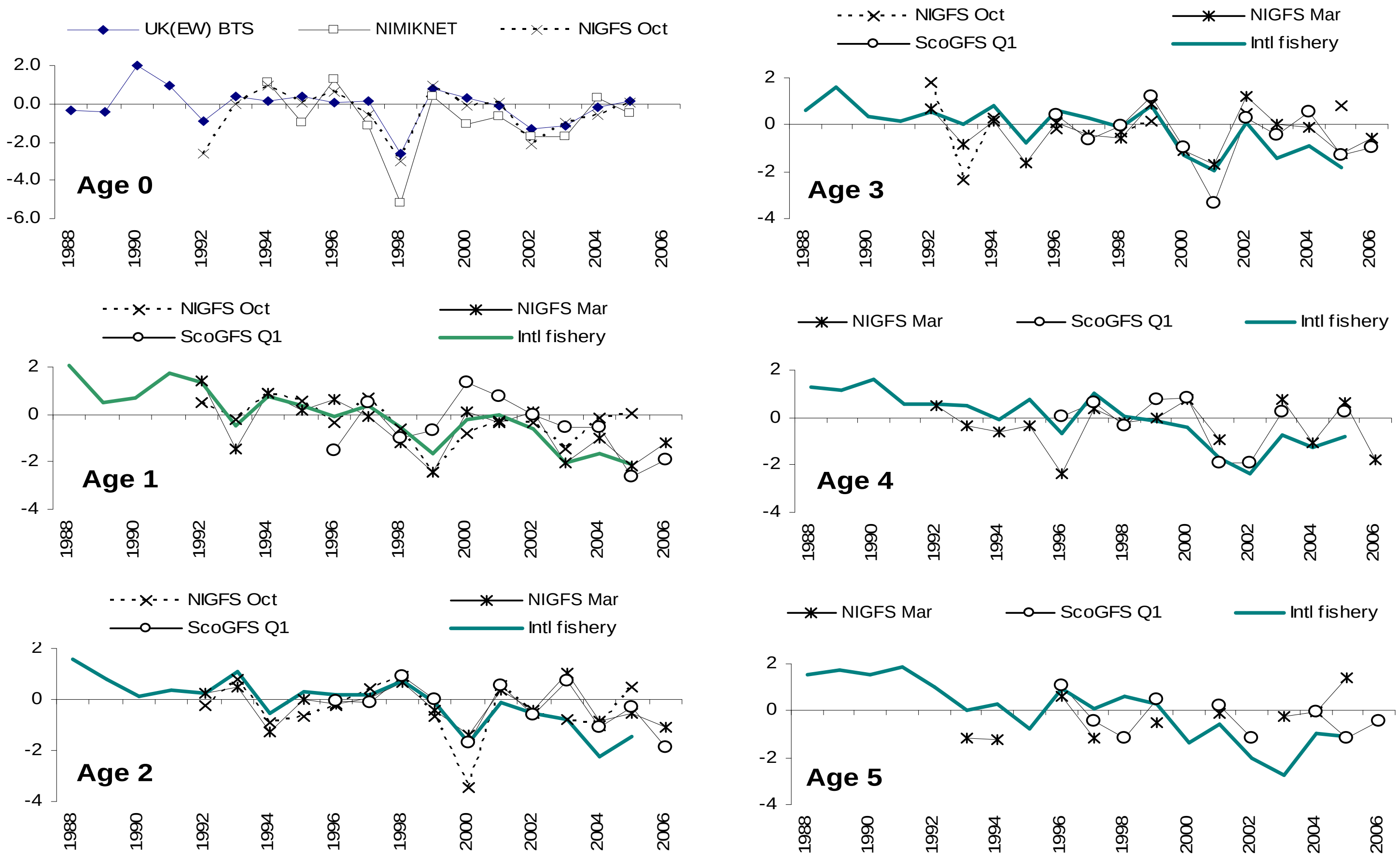


Figure 8.5.1.2.1. Cod in VIIa. Plots of log survey indices at age vs year of survey (standardised by dividing by the series mean for years from 1992). The international landings at age (Table 8.3.1) are also shown for comparison of year-class signals.

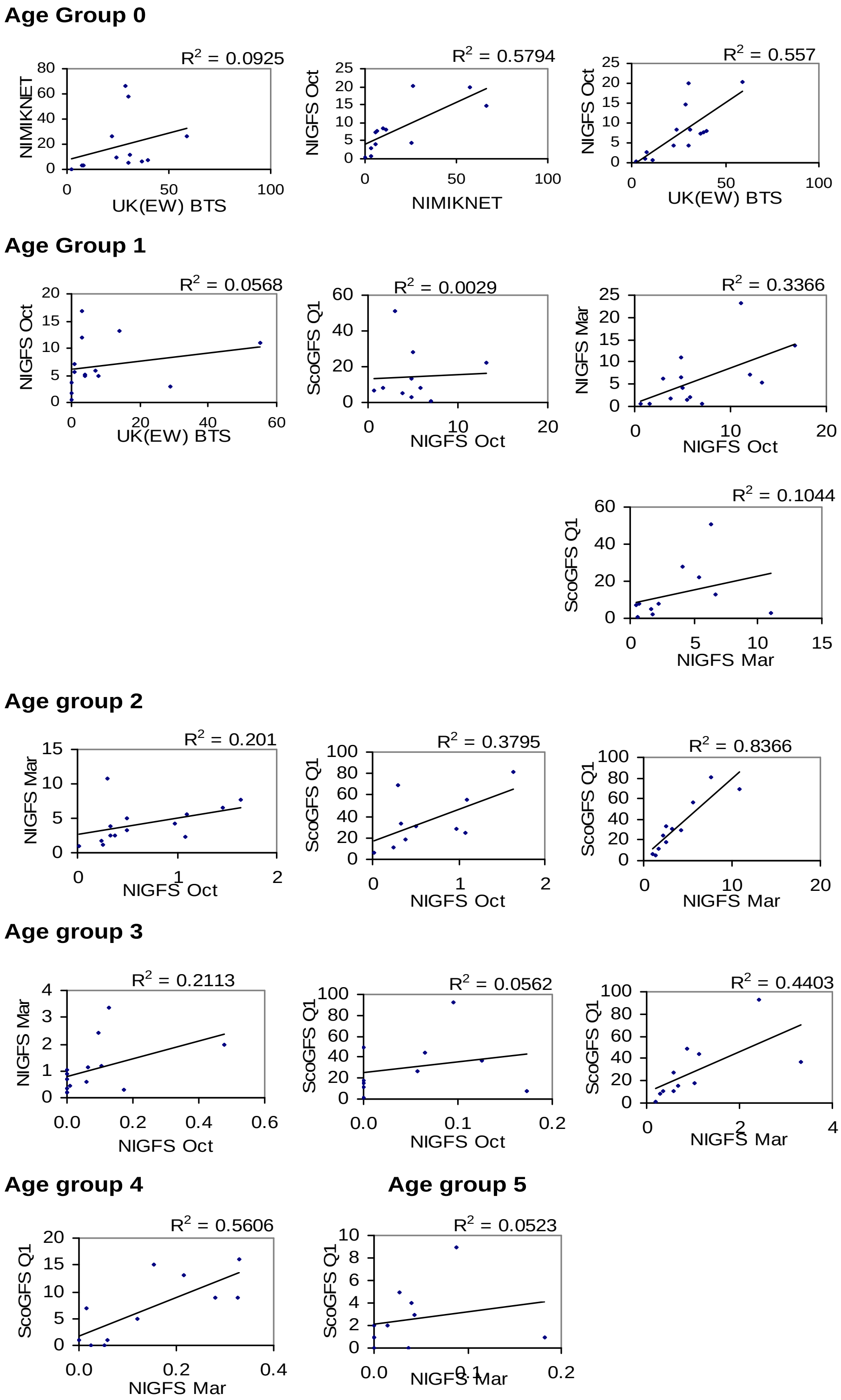


Figure 8.5.1.2.2. Cod in VIIa. Correlation between survey series, by age class.

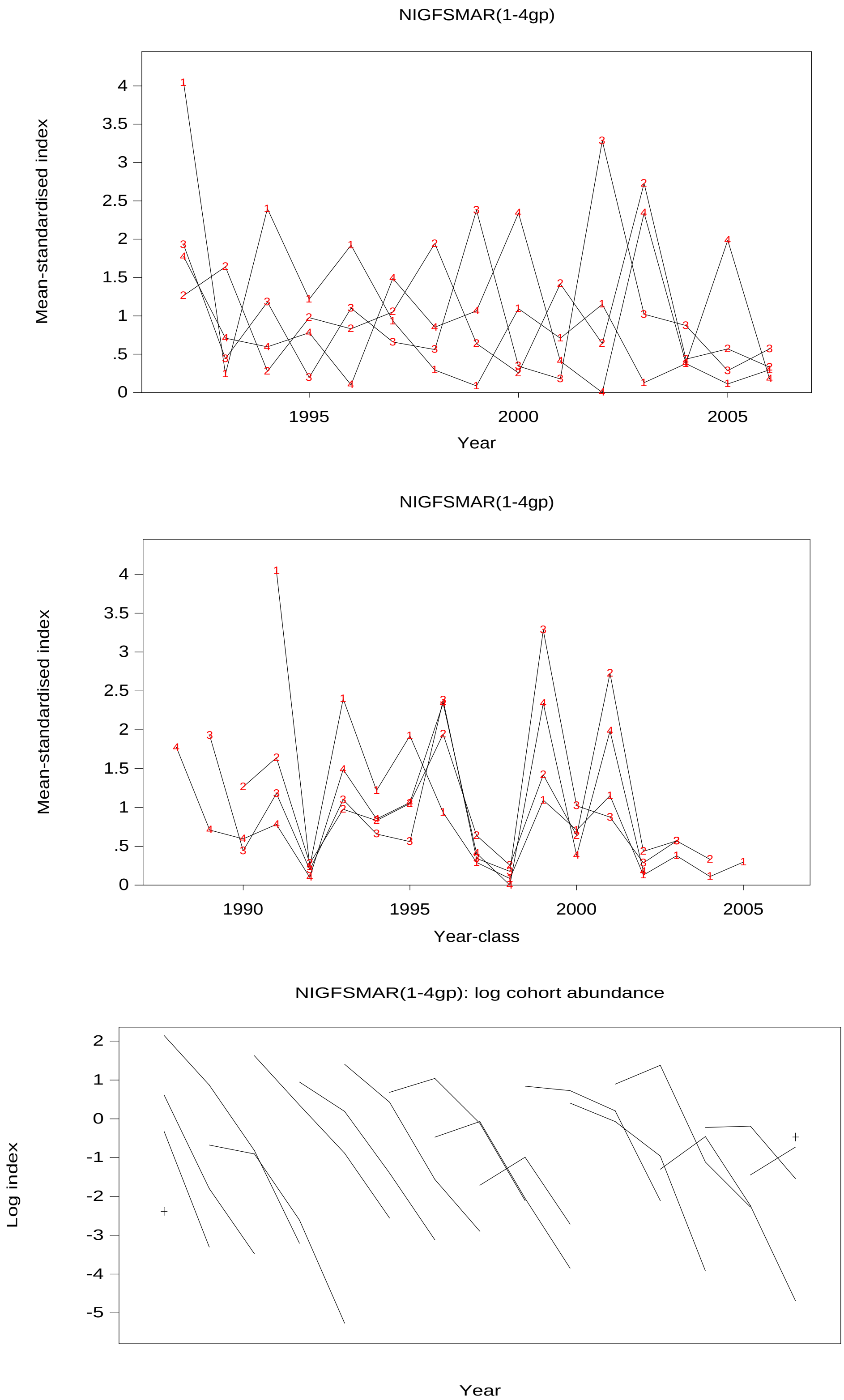


Figure 8.5.1.2.3. Cod in VIIa. SURBA v3.0 plots for NIGFS-Mar trawl survey, age groups 1-4. Top two plots are mean-standardised indices by year and age class. Bottom plot shows log catch curves .

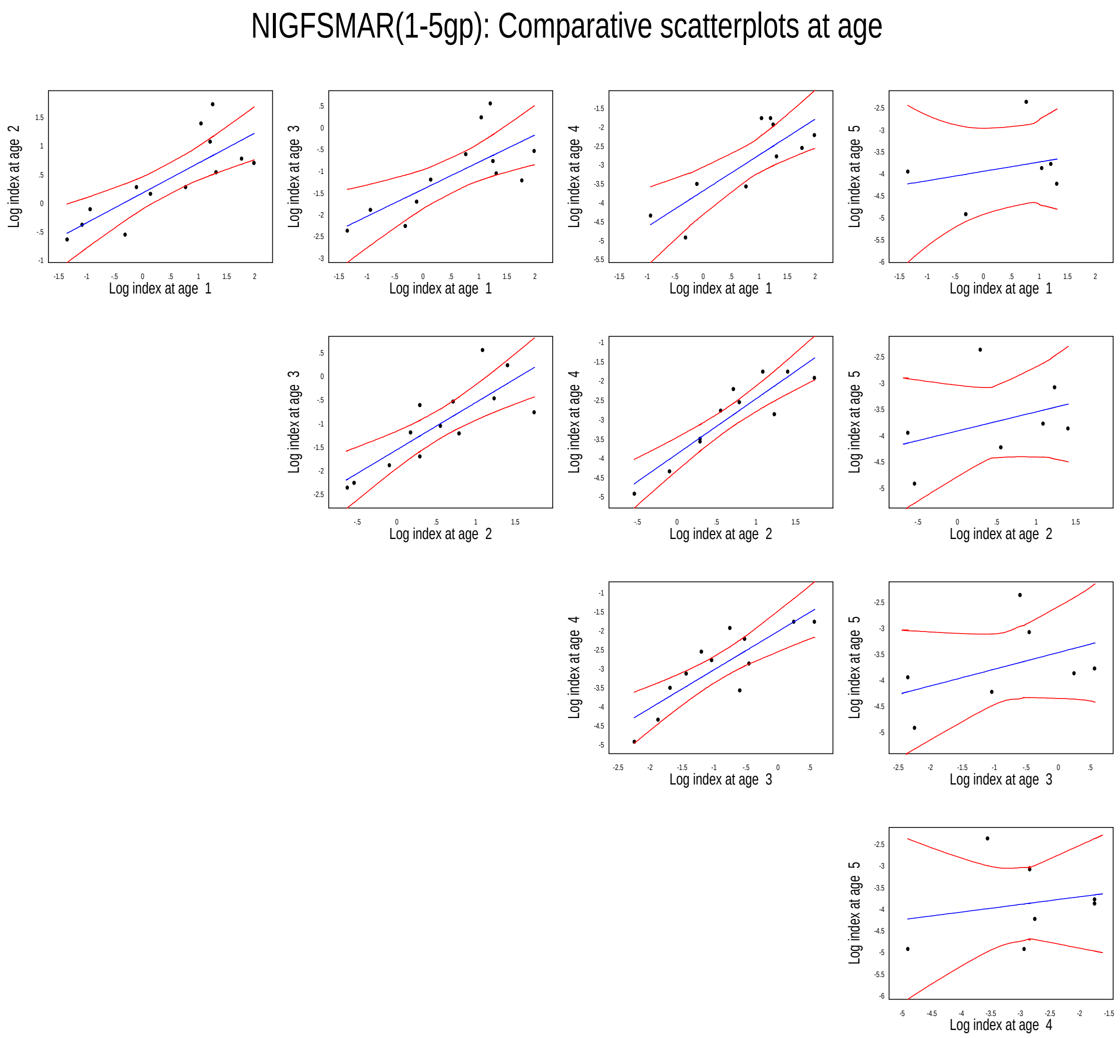


Figure 8.5.1.2.4. Cod in VIIa. SURBA v3.0 scatter plots for NIGFS-Mar trawl survey, age groups 1-5.

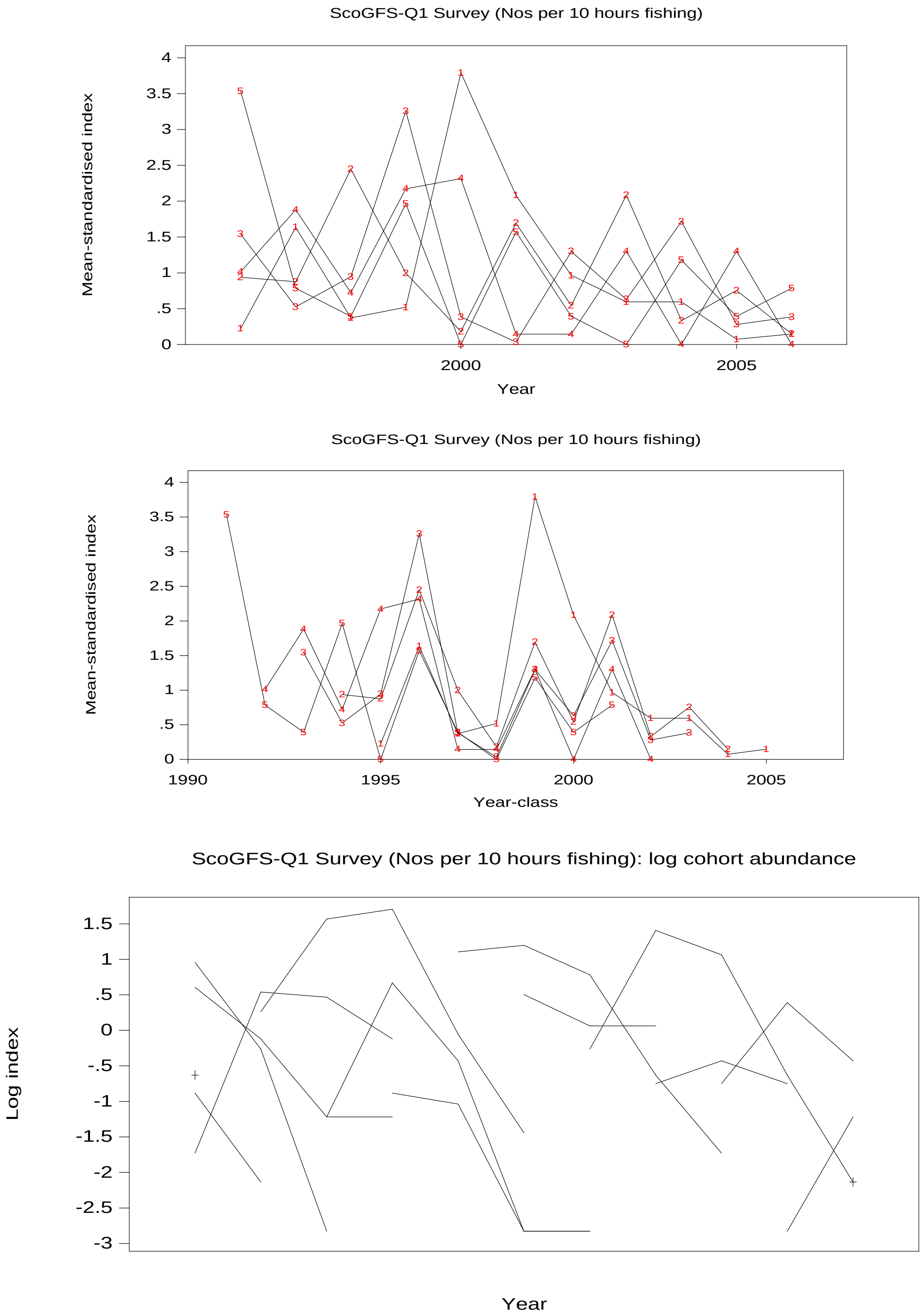


Figure 8.5.1.2.5. Cod in VIIa. Surba v3.0 plots for ScoGFS-Q1trawl survey, age groups 1-5. Mean-standardised indices by year and age class and catch curves.

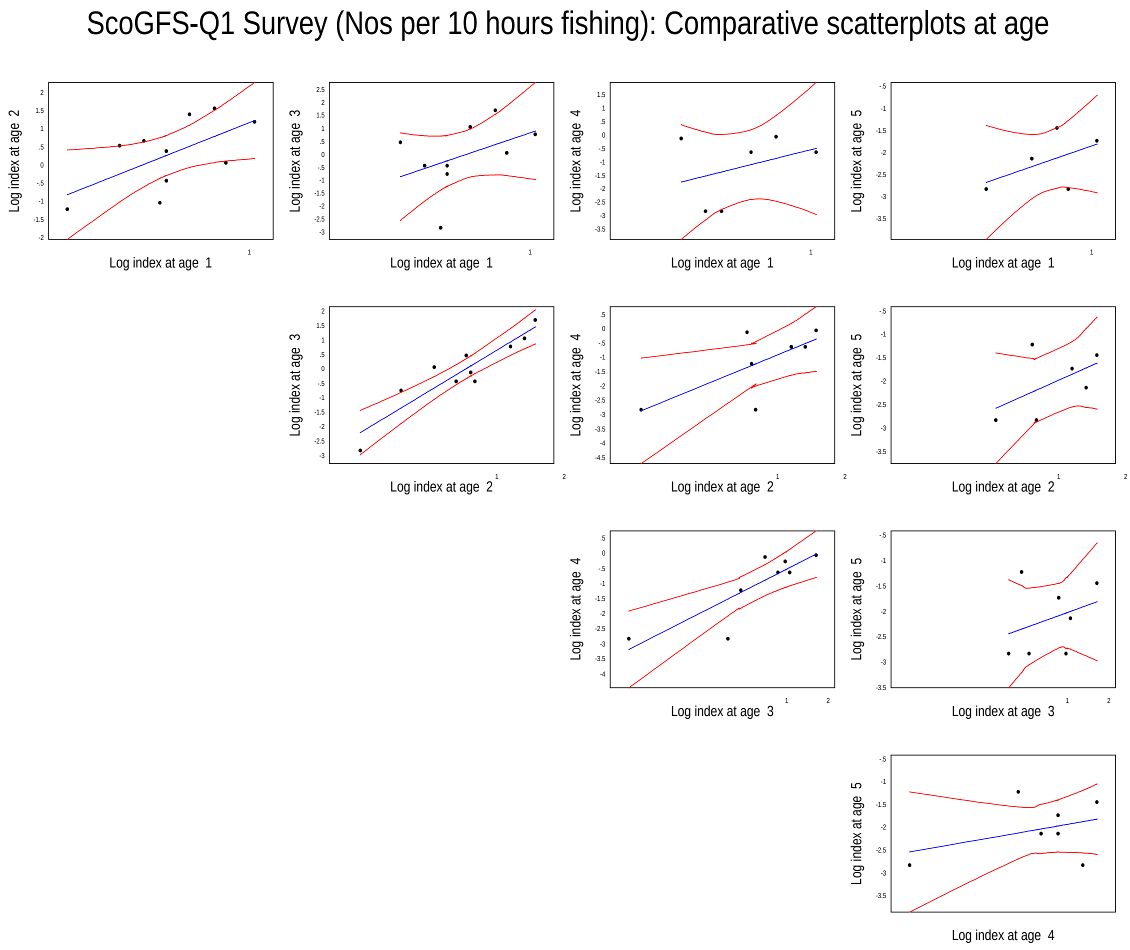


Figure 8.5.1.2.6. Cod in VIIa. Surba v3.0 scatter plots for ScoGFS-Q1trawl survey, age groups 1-5.

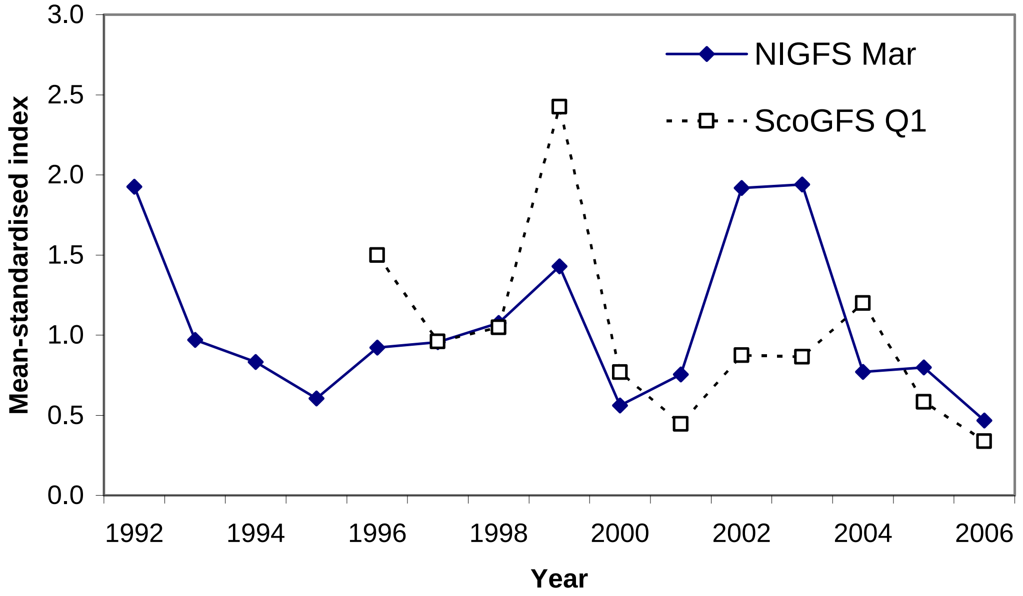


Figure 8.5.1.2.7. Cod in VIIa. Mean-standardised empirical SSB indices for NIGFS-Mar and ScoGFS-spring surveys, based on raw survey indices up to age 7, and stock weights as given in Table 8.3.2.

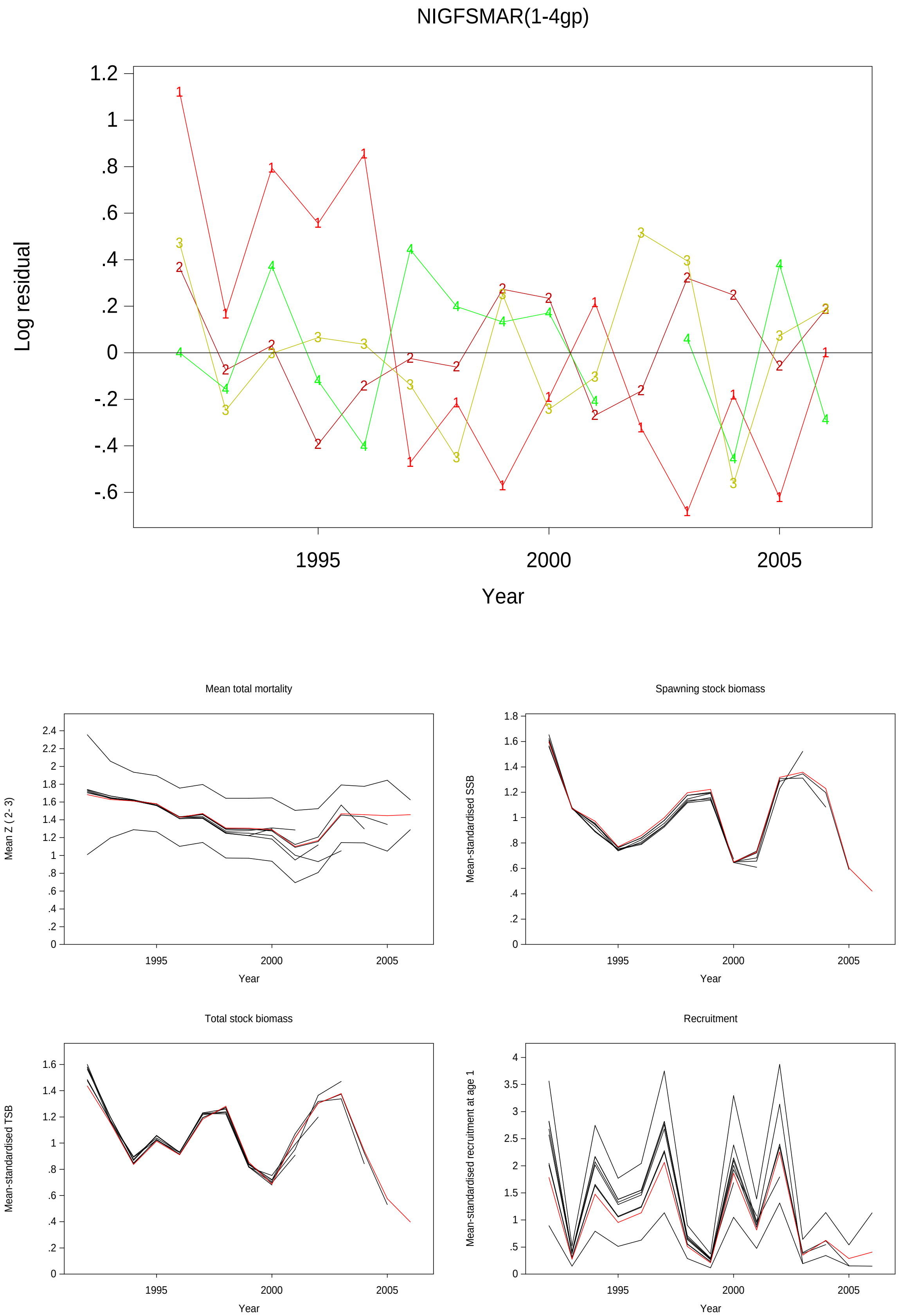


Figure 8.5.1.3.1. Cod in VIIa. Surba v3.0 plots for NIGFS-Mar trawl survey, age groups 1-4. Top: residual plots. Bottom: retrospective plots

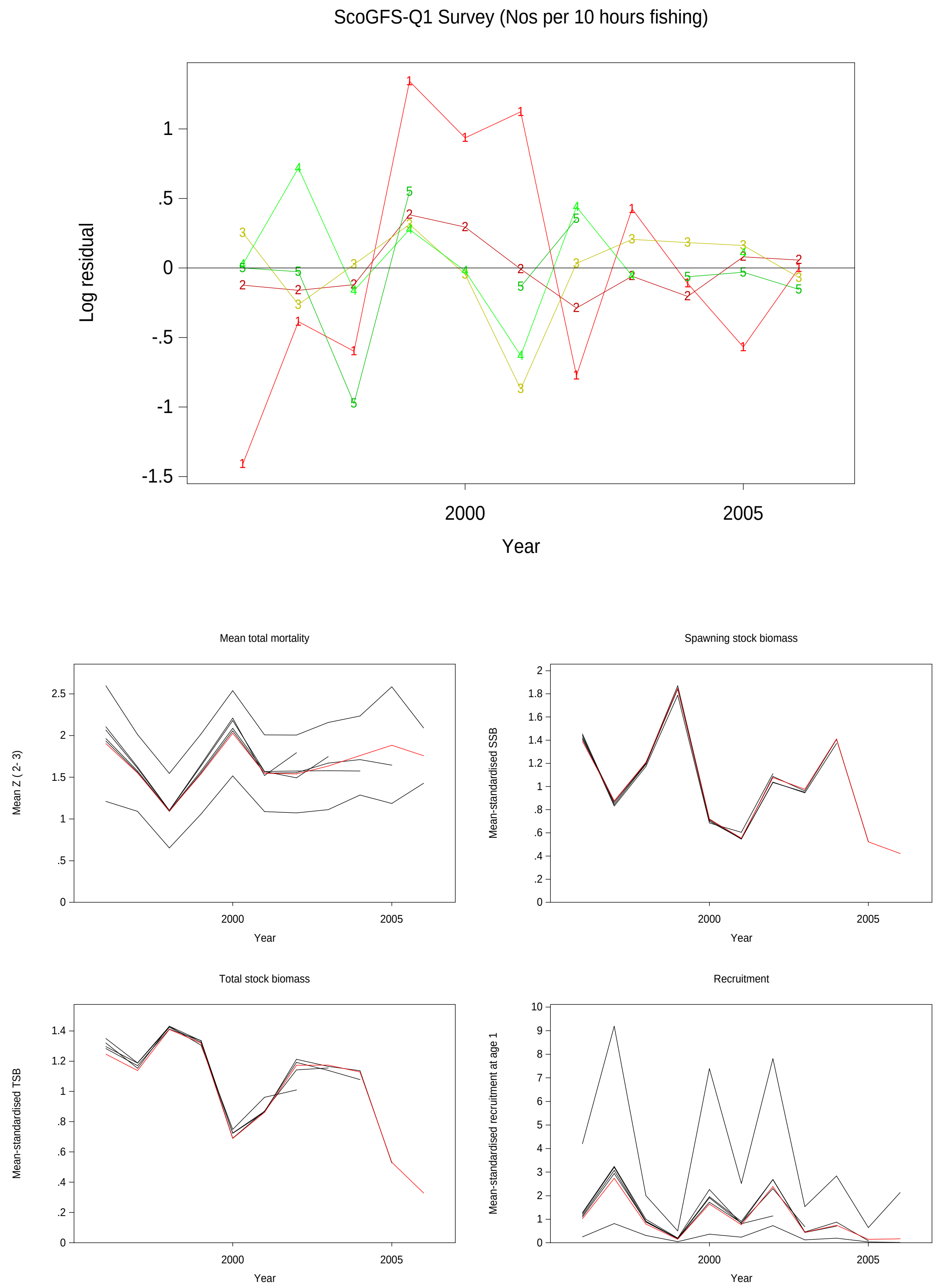


Figure 8.5.1.3.2. Cod in VIIa. Surba v3.0 plots for ScoGFS-Q1trawl survey, age groups 1-5. Residuals and retrospective plots.

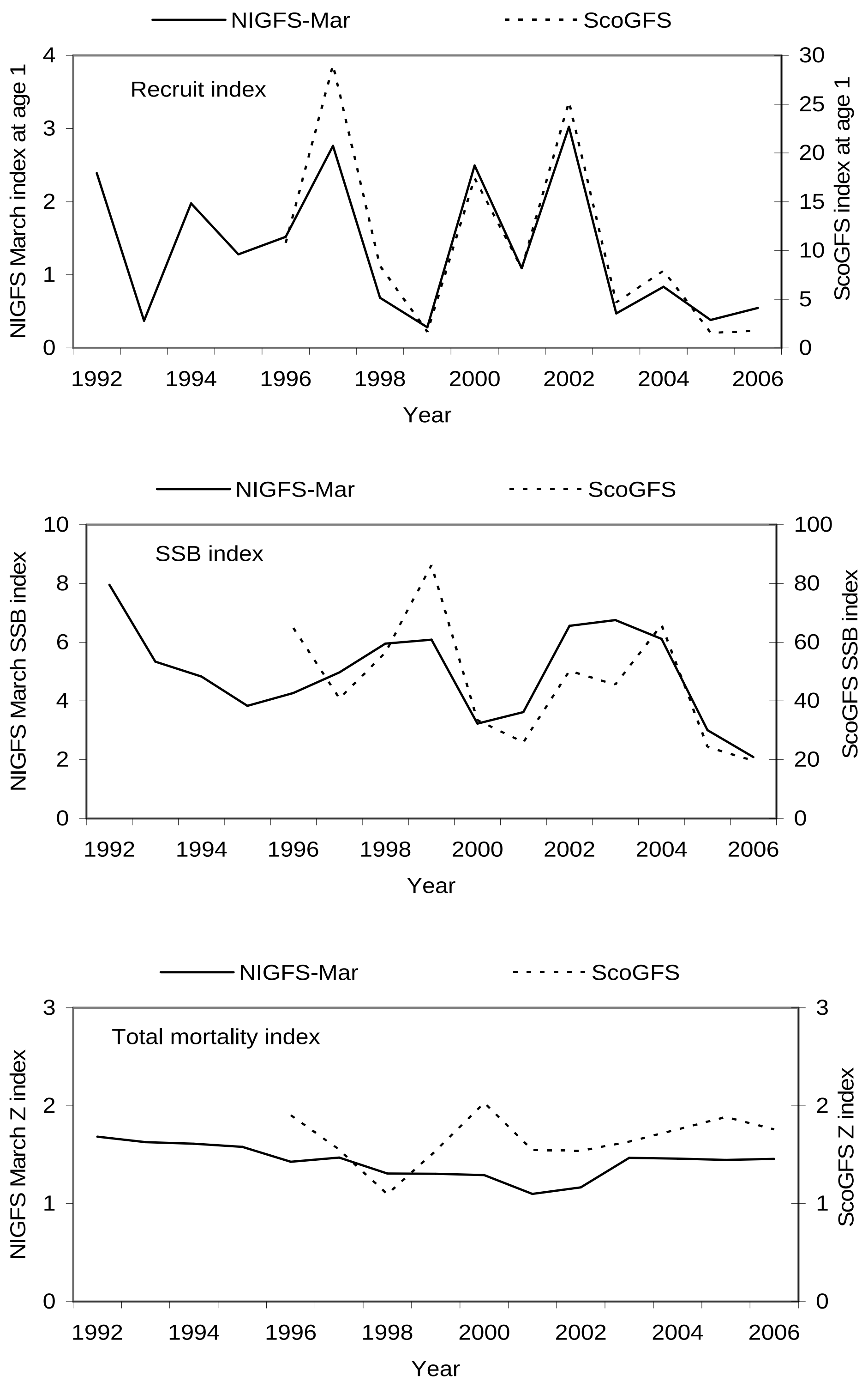
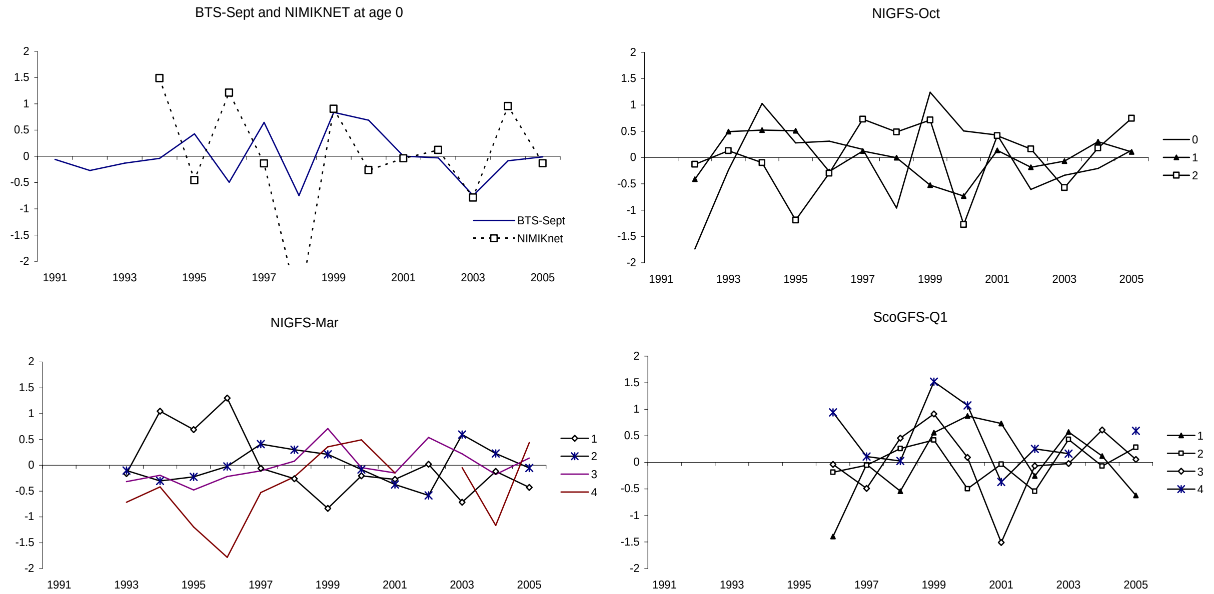
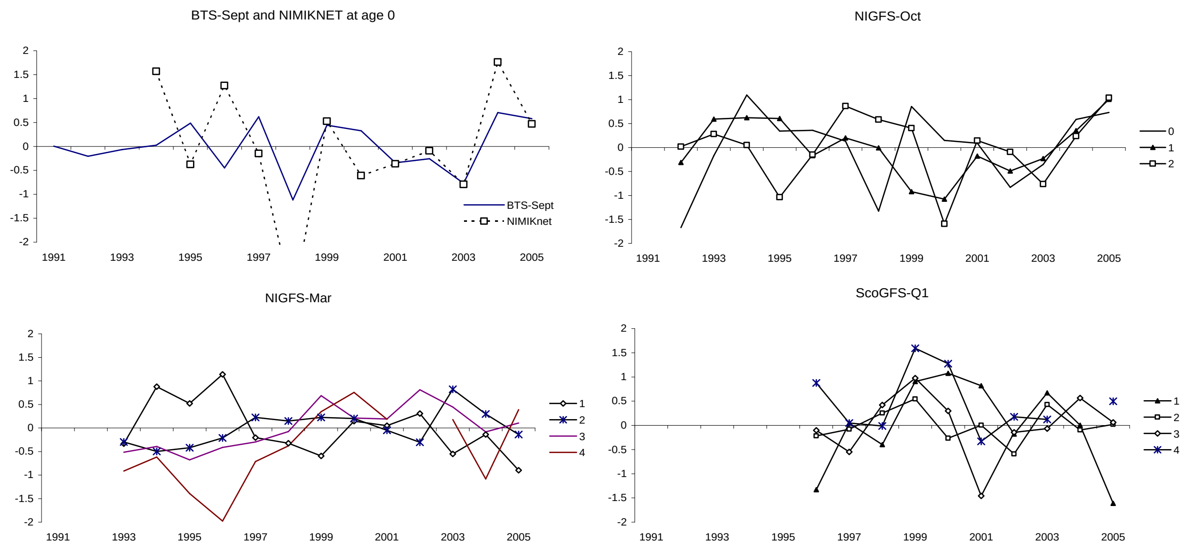


Figure 8.5.1.3.3. Cod in VIIa. Comparison of SURBA v3.0 time series of recruitment at age 1, SSB and Z, for the ScoGFS-Q1and NIGFS-March trawl surveys.



Figs 8.5.1.3.4. Cod in VIIa: Catchability residuals from single-fleet exploratory B-ADAPT runs using NIGFS-Mar and ScoGFS-Q1 surveys and a combination of the NIGFS-Oct, NIMIKNET and BTS-Sept surveys.



Figs 8.5.1.3.5. Cod in VIIa: Catchability residuals from a multiple-fleet B-ADAPT run using all five surveys.

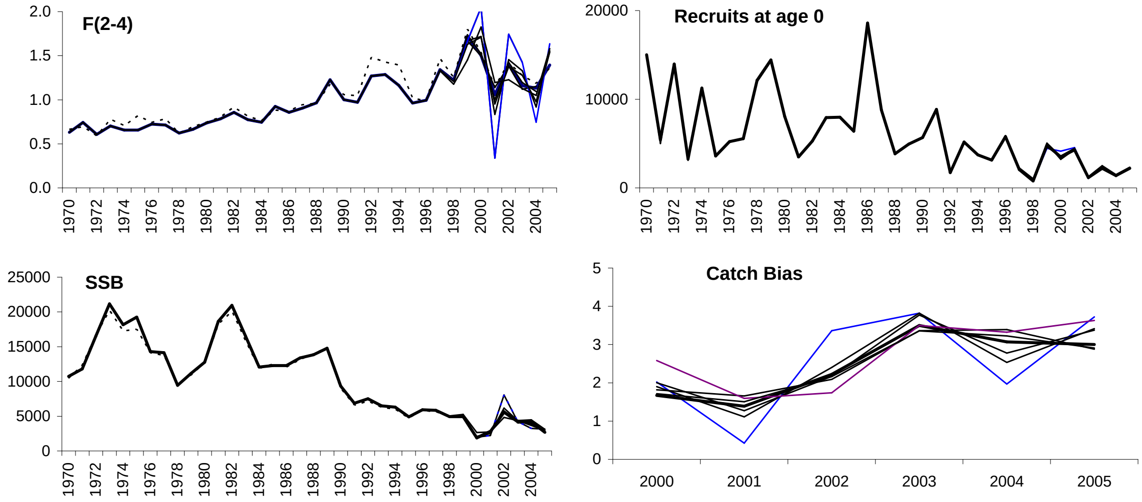


Fig 8.5.1.3.6. Cod in VIIa: trends in F, recuits, SSB and bias for a range of B-ADAPT model settings as listed in Table 8.5.1.3.2. The extreme values of F in 2000-2005, and the most variable bias estimates, are from the run without F- or catch-smoothing. Dotted line is for the run with 6-plus group.

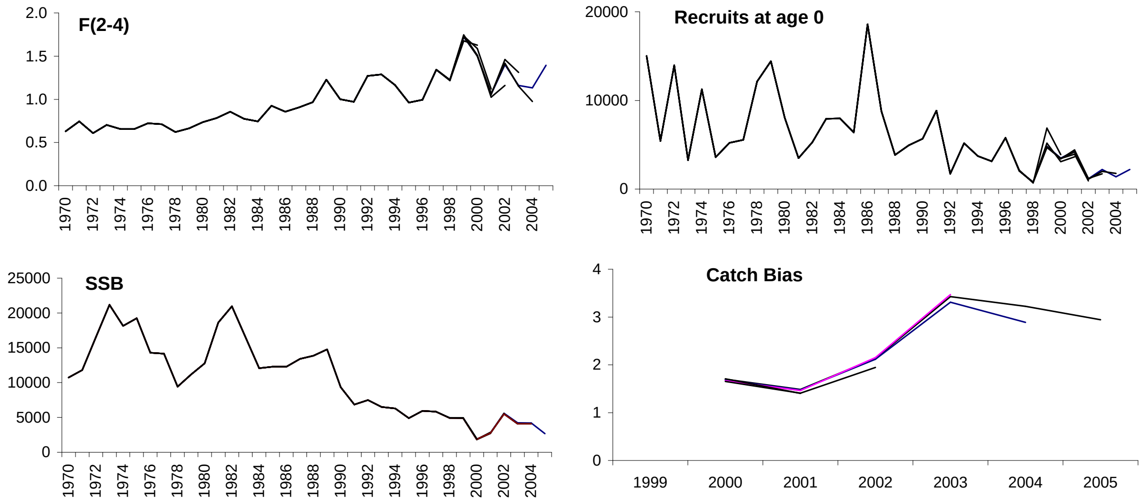


Fig 8.5.1.3.7. Cod in VIIa: Retrospective estimates of stock trends and catch bias from final B-ADAPT assessment.

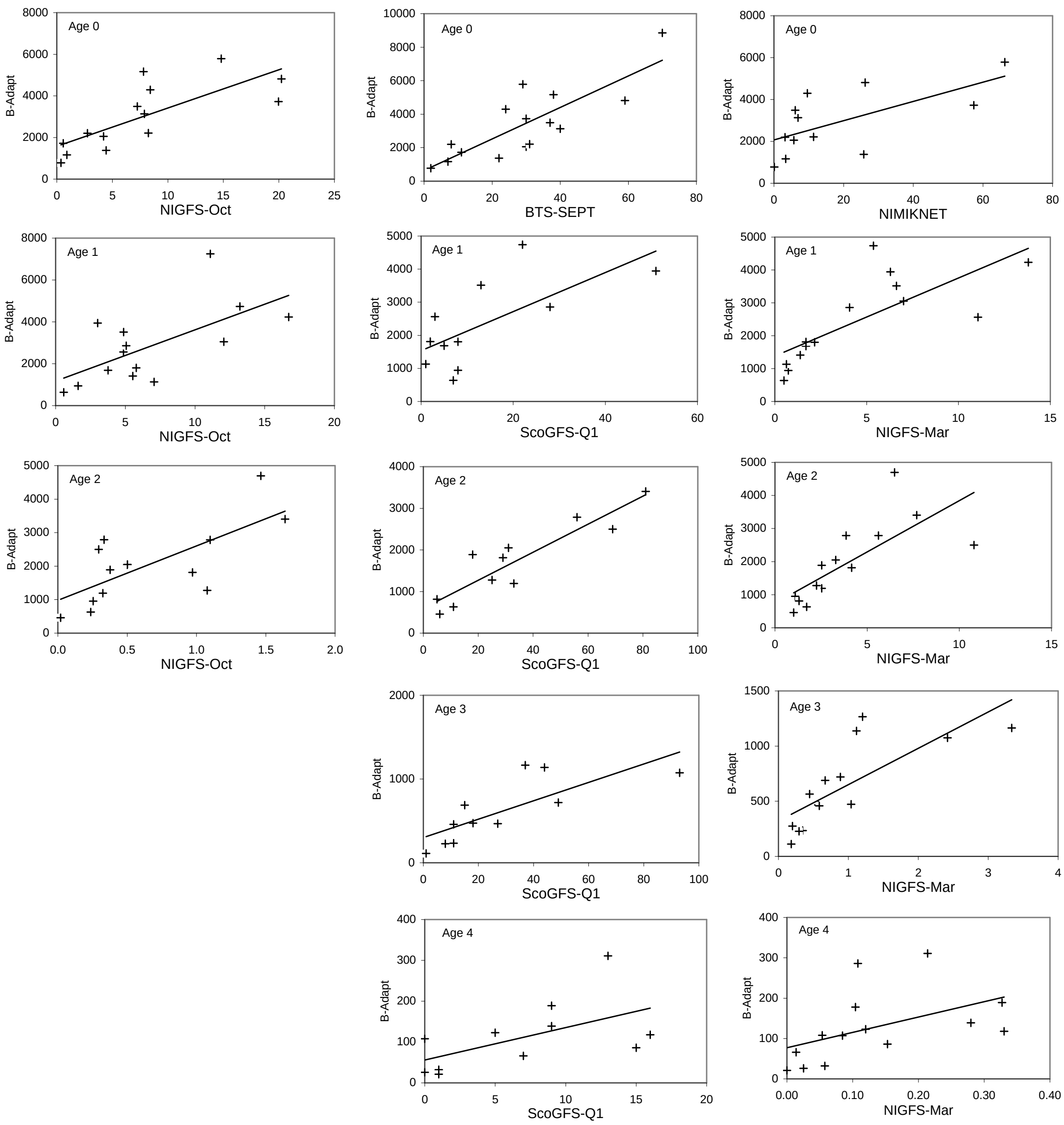


Fig. 8.5.1.3.8. Scatterplots of B-ADAPT estimates of population numbers at age and raw survey indices for surveys used in the assessment (see X-axis labels for survey name).

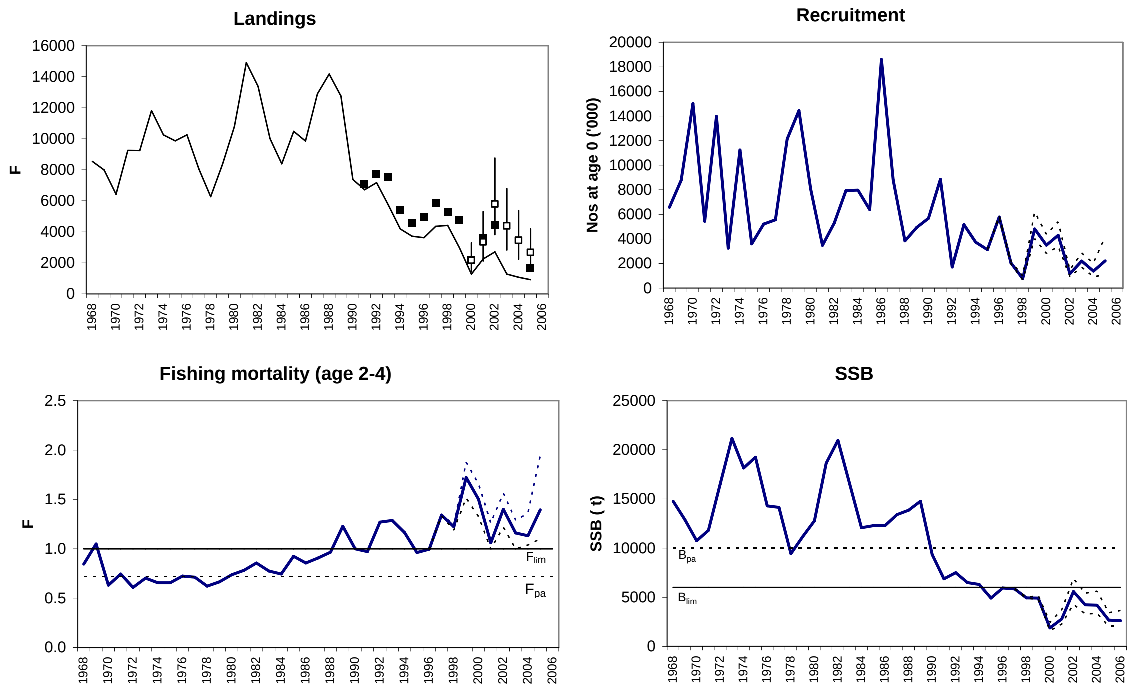


Fig 8.5.1.4.1. Cod in VIIa: landings and stock trends from final B-ADAPT run. Continuous line on landings plot is the reported landings; filled squares are landings in 1991-2002 and 2005 including sample-based estimates at three ports; open squares (± 2SE) are total removals estimates from B-ADAPT and may include unallocated discards and landings and any additional natural mortality in excess of the value for M assumed in the assessment. Dotted lines on plots are 5th and 95th bootstrap percentiles.

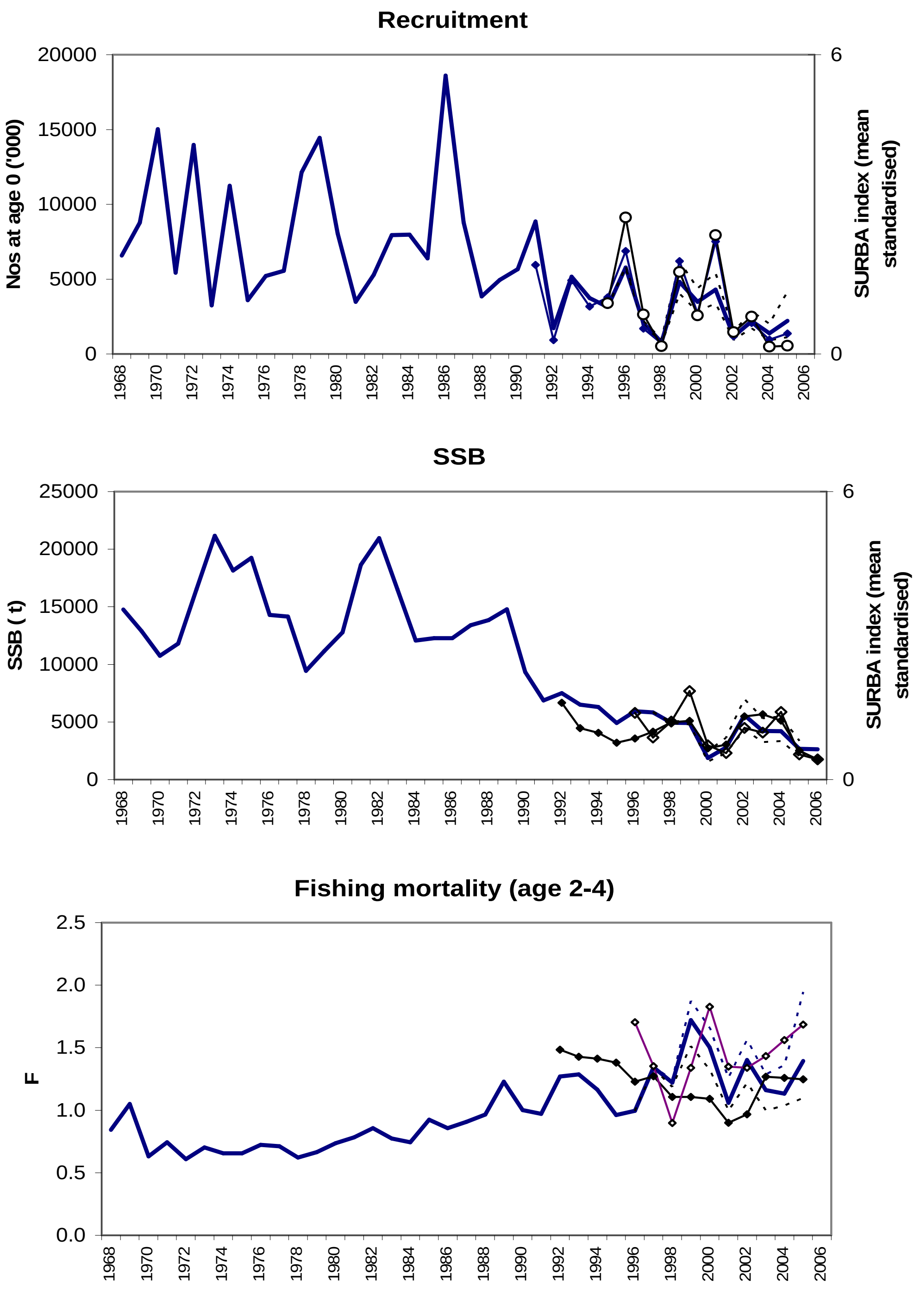


Fig 8.5.1.4.2. Cod in VIIa: comparison of final B-ADAPT stock trends with indices of recruitment, SSB and fishing mortality from SURBA runs with NIGFS-Mar (filled diamonds) and ScoGFS-Q1 (open diamonds). The SURBA indices of Z have been reduced by M=0.2 to give F indices comparable with the ADAPT estimates. Dotted lines are 5th and 25th percentiles of B-ADAPT estimates.

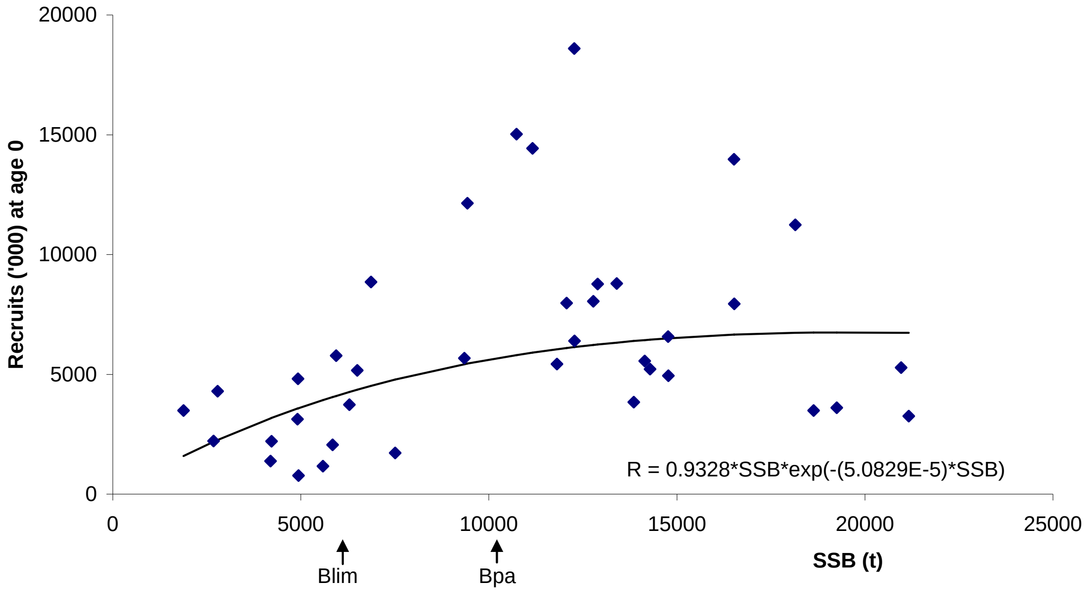


Fig. 8.5.3.1. **Cod in VIIa. Stock and recruit data from final B-ADAPT model run.**

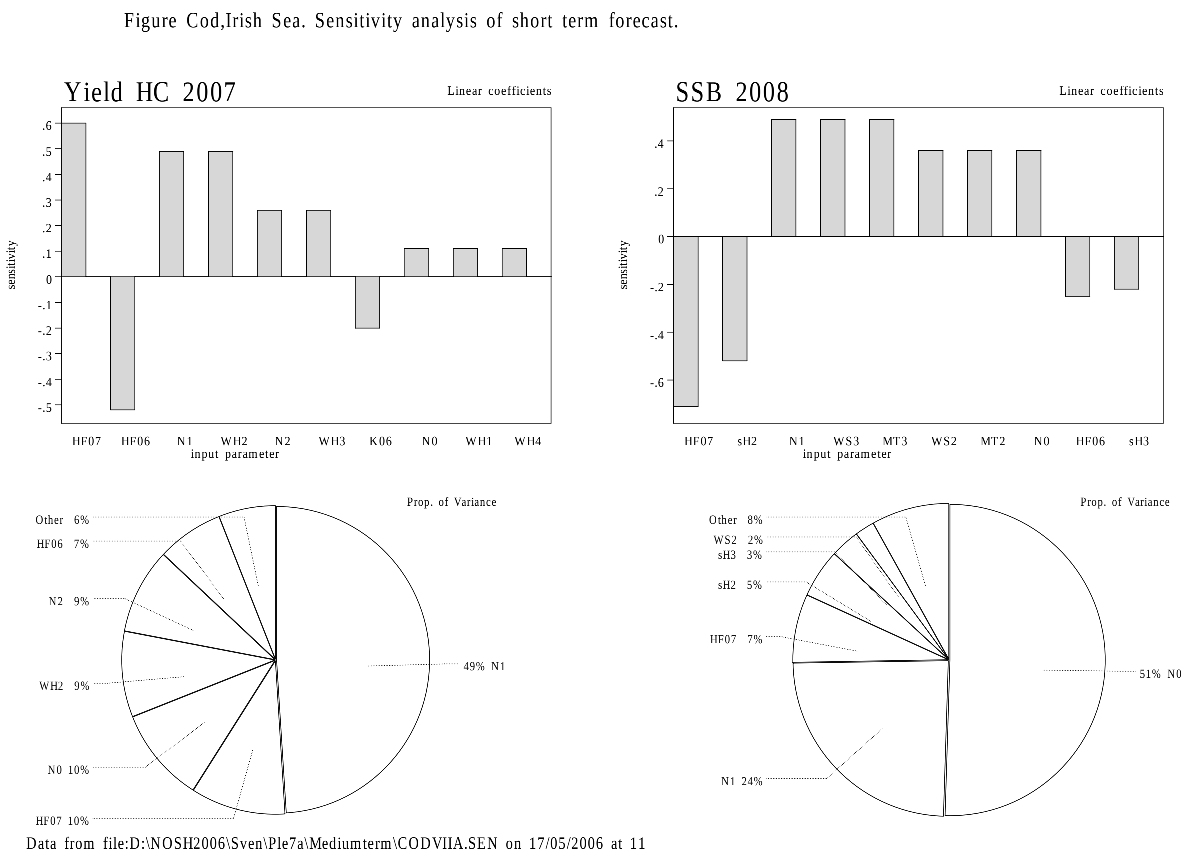


Figure 8.5.4.1. **Cod in VIIa. Sensitivity analysis of short-term status-quo forecast.**

Fbar(2-4)	Year		
Percentile	2006	2007	2008
0.05	1.06	1.06	1.06
0.25	1.27	1.27	1.27
0.5	1.43	1.43	1.43
0.75	1.64	1.64	1.64
0.95	1.93	1.93	1.93

SSB	Year		
Percentile	2006	2007	2008
0.05	1996	1484	1483
0.25	2351	1904	2241
0.5	2700	2255	2868
0.75	3074	2651	3647
0.95	3665	3323	4650

Catch	Year		
Percentile	2006	2007	2008
0.05	2138	1892	1982
0.25	2543	2396	2705
0.5	2845	2842	3531
0.75	3200	3322	4525
0.95	3808	4254	5577

P(SSBYear > Blim)			
2007	2008	2009	2010
0.00	0.00	0.04	0.05

Prob 30% SSB incr	
2006	2007
0.02	0.45

F status quo projection
Recruitment 1992 - 2005

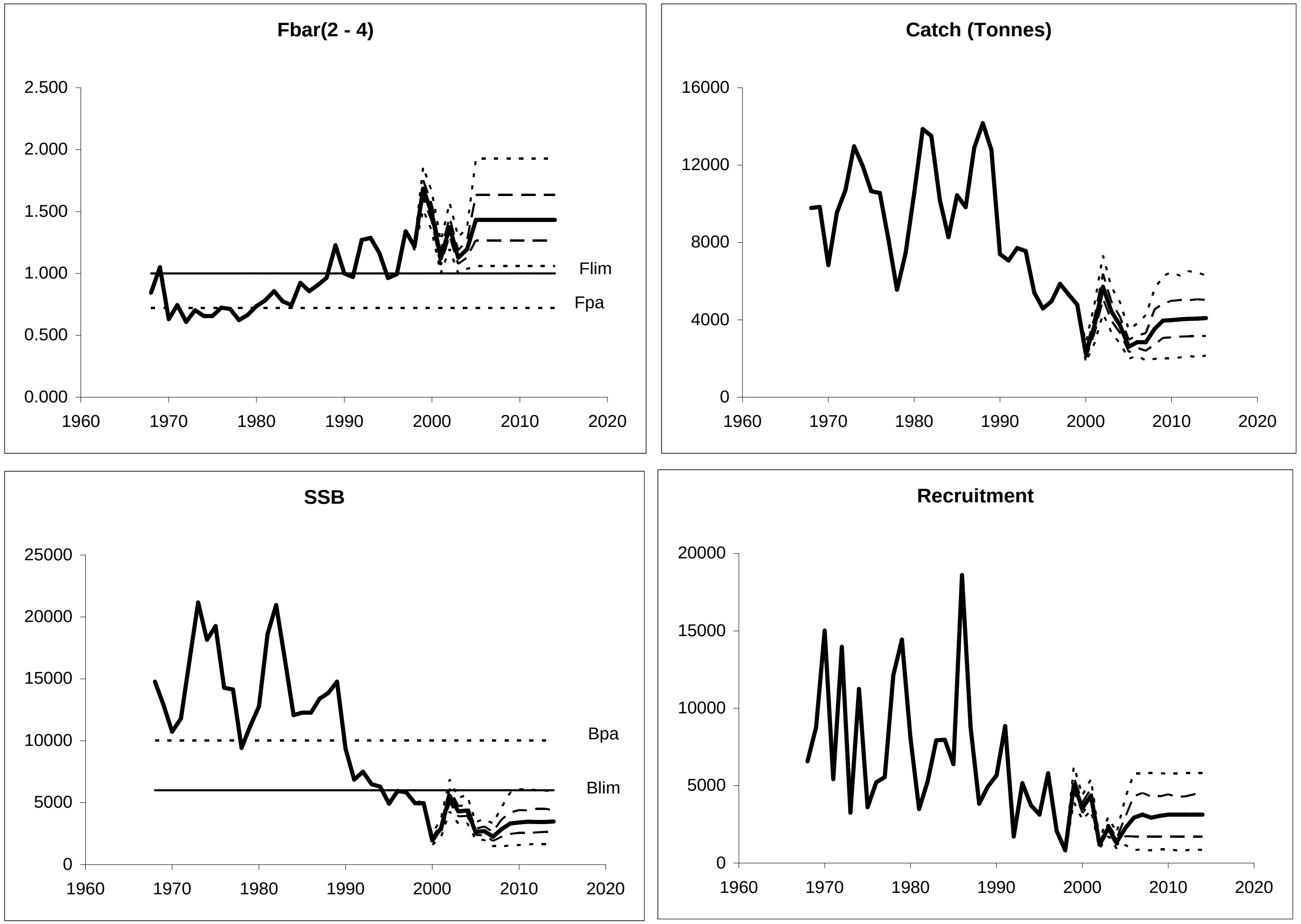


Figure 8.5.5.1. Cod in VIIa. Bootstrap B-ADAPT medium-term forecast for status-quo F, with recruitment from 2006 onwards re-sampled from 1992-2005 values in each projection. Note that F(2-4) includes unallocated mortality associated with the estimation of unallocated removals over the 2000-2005 period, and hence the catch in the forecast period also includes an expected unallocated removal.

Fbar(2-4)	Year		
Percentile	2006	2007	2008
0.05	1.06	0.80	0.80
0.25	1.27	0.95	0.95
0.5	1.43	1.07	1.07
0.75	1.64	1.23	1.23
0.95	1.93	1.44	1.44

SSB	Year		
Percentile	2006	2007	2008
0.05	1996	1484	1855
0.25	2351	1904	2768
0.5	2700	2255	3472
0.75	3074	2651	4342
0.95	3665	3323	5526

Catch	Year		
Percentile	2006	2007	2008
0.05	2138	1606	1944
0.25	2543	2009	2654
0.5	2845	2374	3439
0.75	3200	2789	4285
0.95	3808	3560	5285

P(SSBYear > Blim)			
2007	2008	2009	2010
0.00	0.00	0.02	0.18

Prob 30% SSB incr	
2006	2007
0.02	0.71

0.75 F status quo projection
Recruitment 1992 - 2005

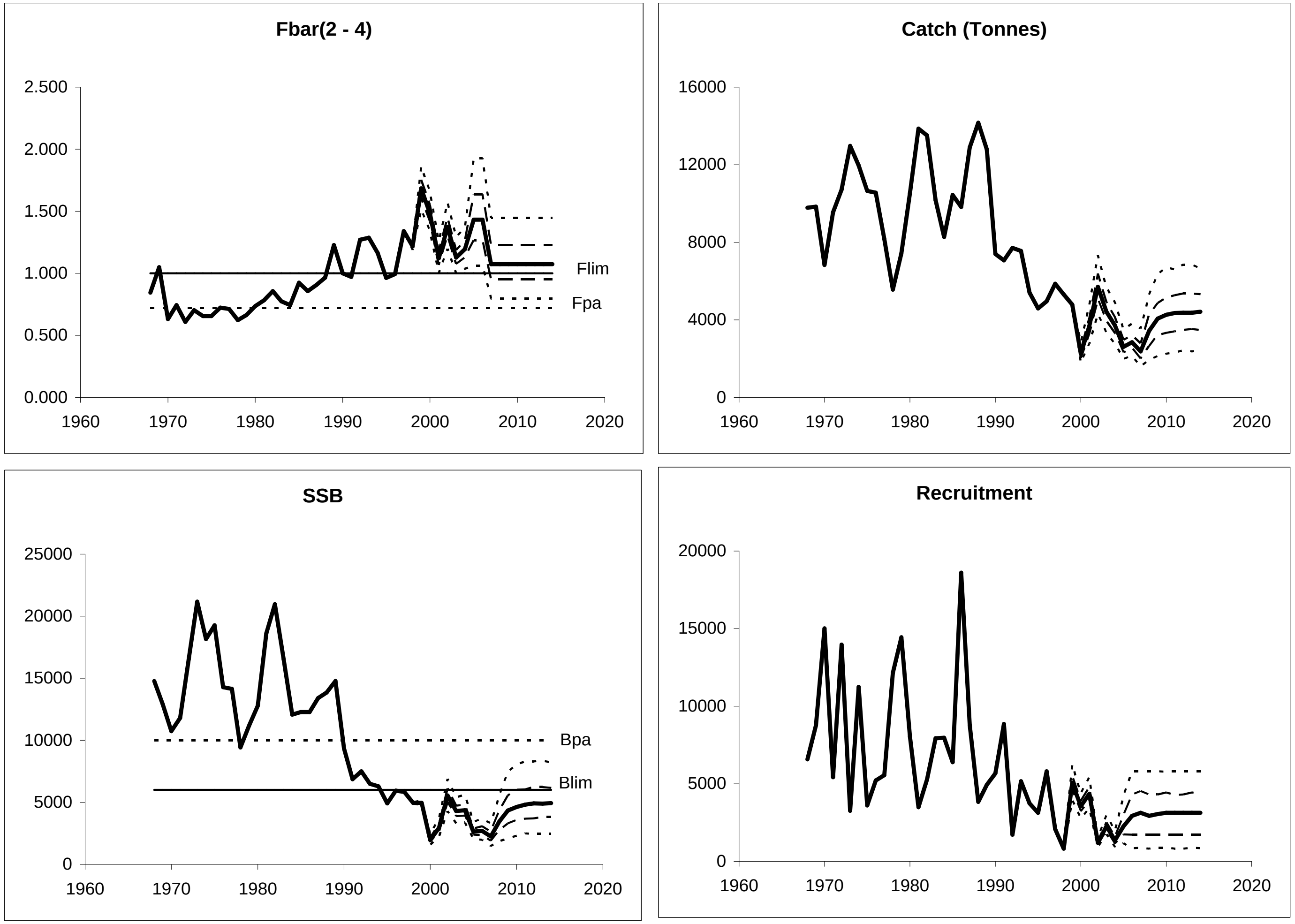


Figure 8.5.5.2. Cod in VIIa. Bootstrap B-ADAPT medium-term forecast for 0.75* status-quo F, with recruitment from 2006 onwards re-sampled from 1992-2005 values in each projection. Note that F(2-4) includes unallocated mortality associated with the estimation of unallocated removals over the 2000-2005 period, and hence the catch in the forecast period also includes an expected unallocated removal

Fbar(2-4)	Year		
Percentile	2006	2007	2008
0.05	1.06	0.53	0.53
0.25	1.27	0.63	0.63
0.5	1.43	0.72	0.72
0.75	1.64	0.82	0.82
0.95	1.93	0.96	0.96

SSB	Year		
Percentile	2006	2007	2008
0.05	1996	1484	2406
0.25	2351	1904	3467
0.5	2700	2255	4291
0.75	3074	2651	5237
0.95	3665	3323	6651

Catch	Year		
Percentile	2006	2007	2008
0.05	2138	1229	1759
0.25	2543	1523	2416
0.5	2845	1791	3054
0.75	3200	2093	3745
0.95	3808	2704	4725

P(SSBYear > Blim)			
2007	2008	2009	2010
0.00	0.12	0.50	0.67

Prob 30% SSB incr	
2006	2007
0.02	0.99

0.5 F status quo projection
Recruitment 1992 - 2005

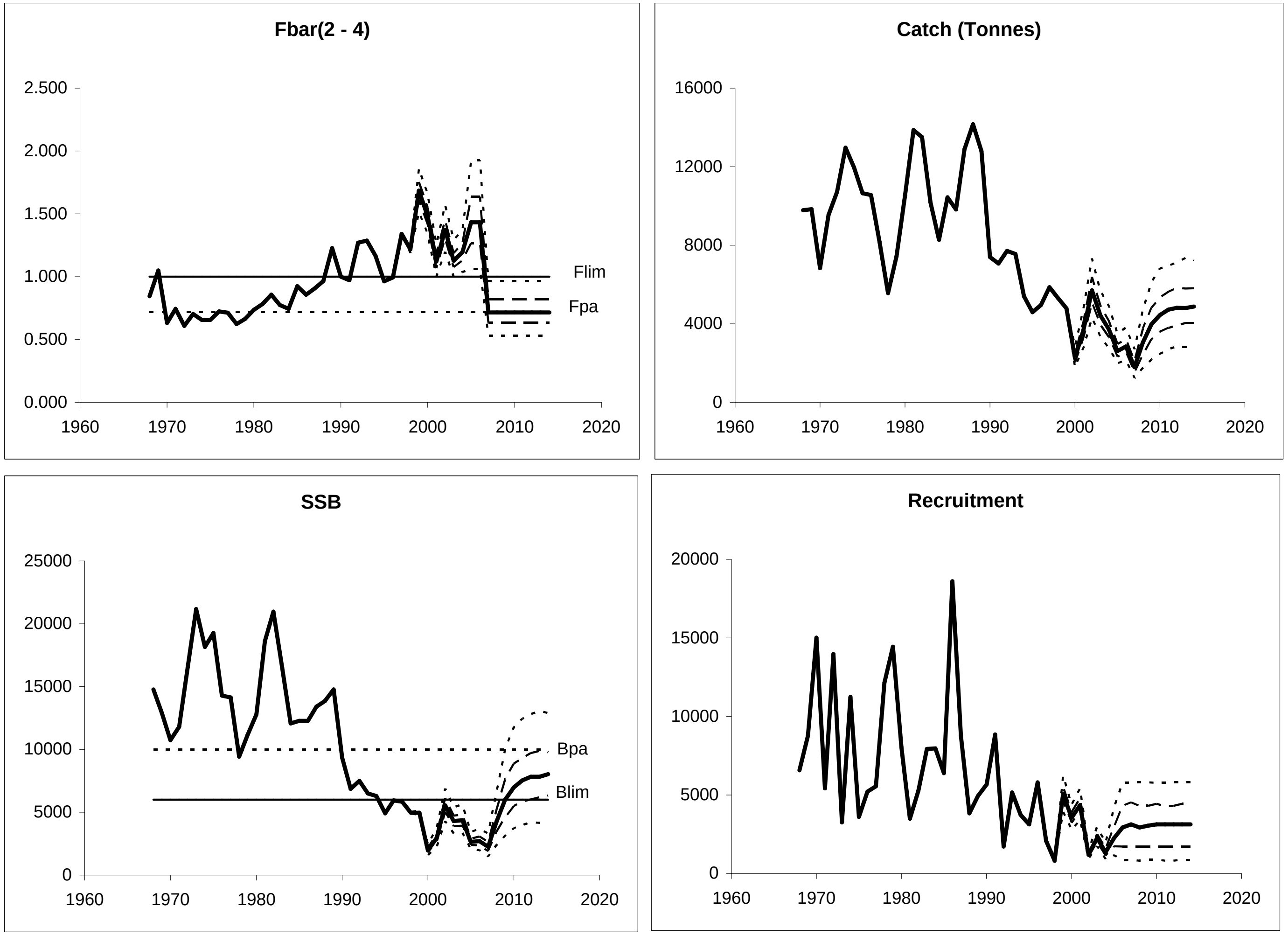


Figure 8.5.5.3. Cod in VIIa. Bootstrap B-ADAPT medium-term forecast for 0.50* status-quo F, with recruitment from 2006 onwards re-sampled from 1992-2005 values in each projection. <u>Median F from 2007 onwards is equivalent to Fpa</u>. Note that F(2-4) includes unallocated mortality associated with the estimation of unallocated removals over the 2000-2005 period, and hence the catch in the forecast period also includes an expected unallocated removal

Fbar(2-4)	Year		
Percentile	2006	2007	2008
0.05	1.06	0.27	0.27
0.25	1.27	0.32	0.32
0.5	1.43	0.36	0.36
0.75	1.64	0.41	0.41
0.95	1.93	0.48	0.48

SSB	Year		
Percentile	2006	2007	2008
0.05	1996	1484	3149
0.25	2351	1904	4415
0.5	2700	2255	5415
0.75	3074	2651	6482
0.95	3665	3323	8195

Catch	Year		
Percentile	2006	2007	2008
0.05	2138	696	1249
0.25	2543	869	1710
0.5	2845	1017	2142
0.75	3200	1196	2582
0.95	3808	1535	3333

P(SSBYear > Blim)			
2007	2008	2009	2010
0.00	0.34	0.86	0.98

Prob 30% SSB incr	
2006	2007
0.02	1.00

0.25* F status quo projection
Recruitment 1992 - 2005

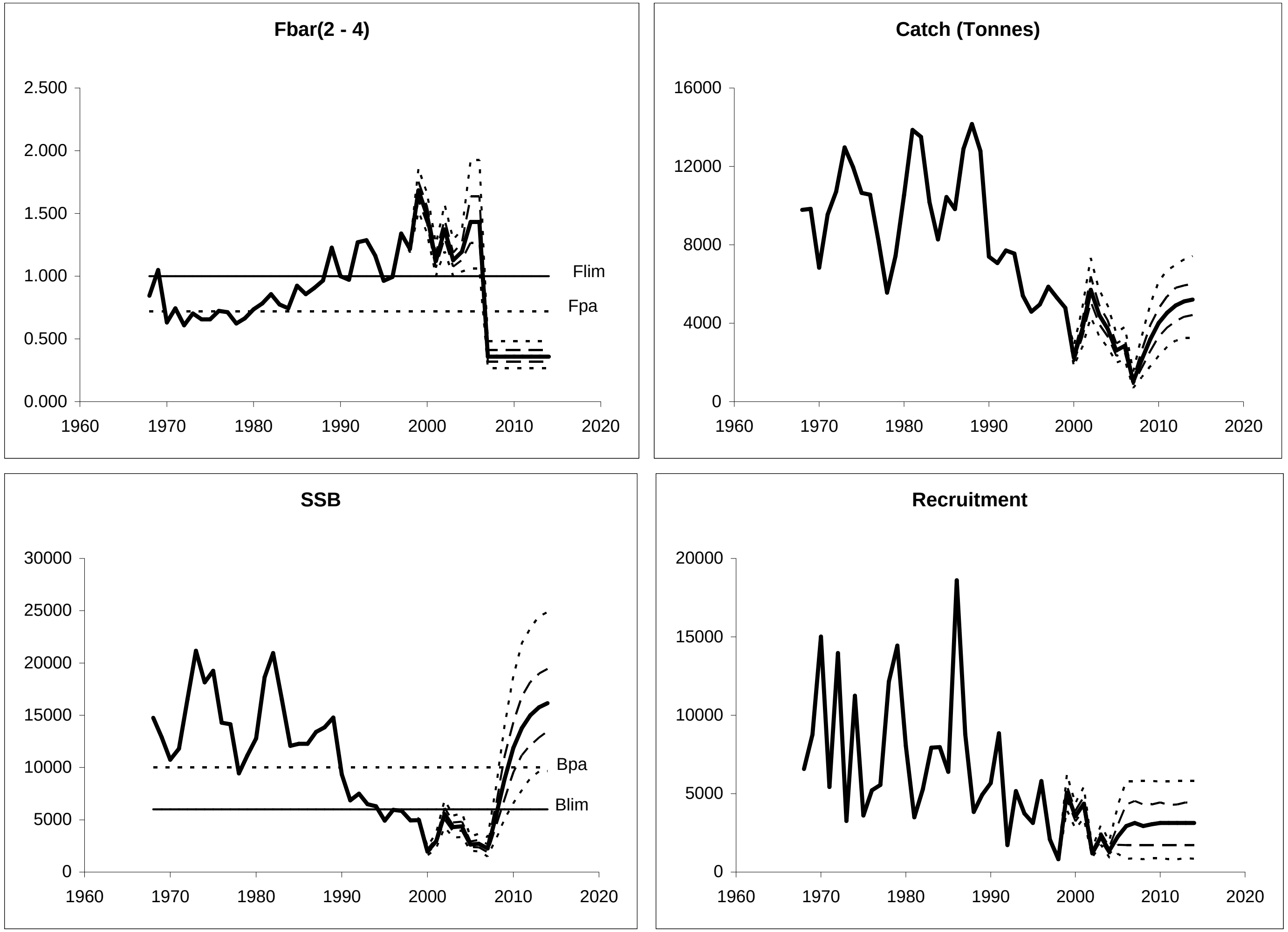


Figure 8.5.5.4. Cod in VIIa. Bootstrap B-ADAPT medium-term forecast for 0.25* status-quo F, with recruitment from 2006 onwards re-sampled from 1992-2005 values in each projection. Note that F(2-4) includes unallocated mortality associated with the estimation of unallocated removals over the 2000-2005 period, and hence the catch in the forecast period also includes an expected unallocated removal

Fbar(2-4)	Year		
Percentile	2006	2007	2008
0.05	1.06	0.11	0.11
0.25	1.27	0.13	0.13
0.5	1.43	0.14	0.14
0.75	1.64	0.16	0.16
0.95	1.93	0.19	0.19

SSB	Year		
Percentile	2006	2007	2008
0.05	1996	1484	3722
0.25	2351	1904	5143
0.5	2700	2255	6221
0.75	3074	2651	7420
0.95	3665	3323	9350

Catch	Year		
Percentile	2006	2007	2008
0.05	2138	303	634
0.25	2543	380	847
0.5	2845	443	1073
0.75	3200	522	1284
0.95	3808	672	1680

P(SSBYear > Blim)			
2007	2008	2009	2010
0.00	0.55	0.98	1.00

Prob 30% SSB incr	
2006	2007
0.02	1.00

0.1 F status quo projection
Recruitment 1992 - 2005

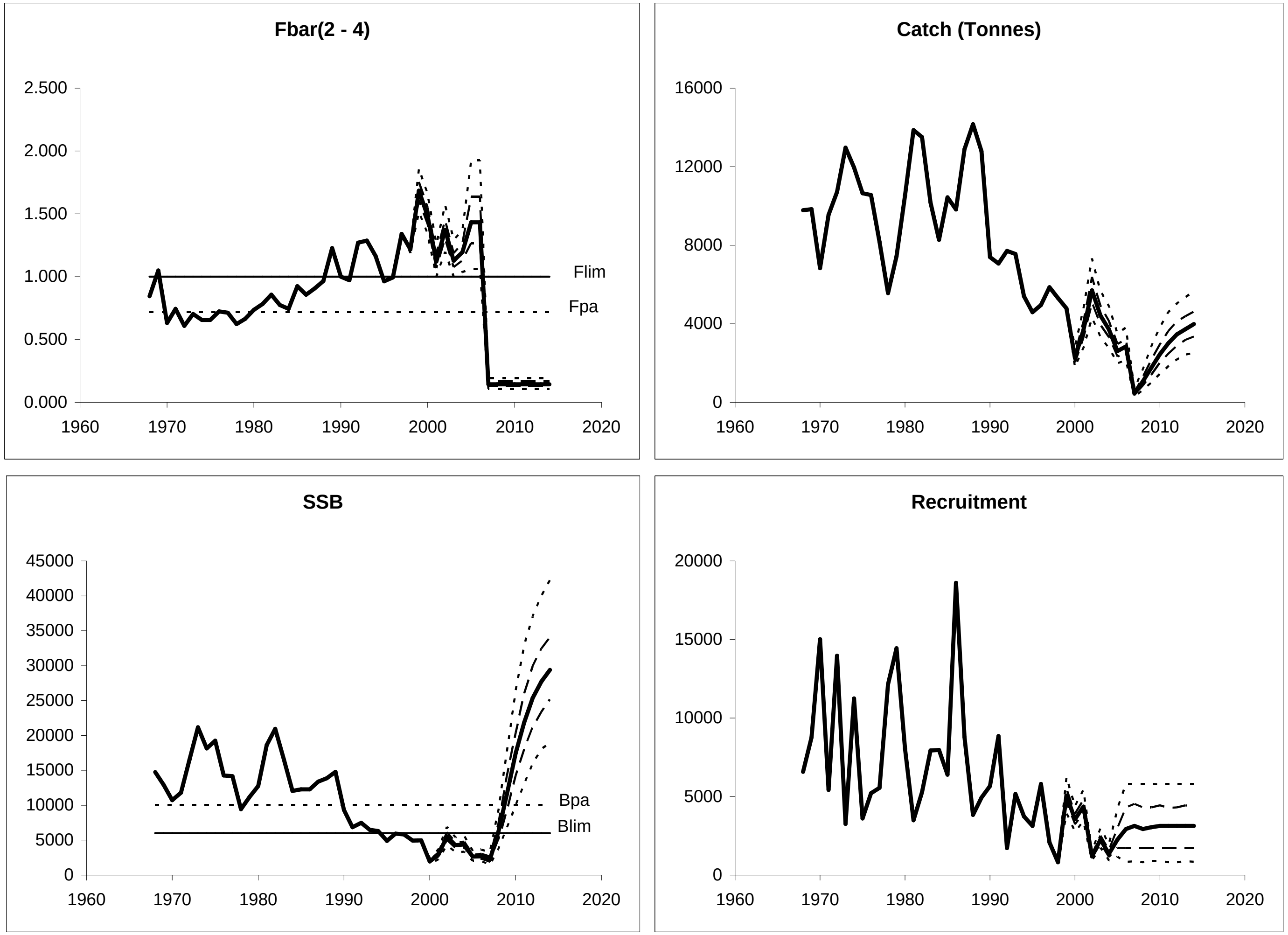
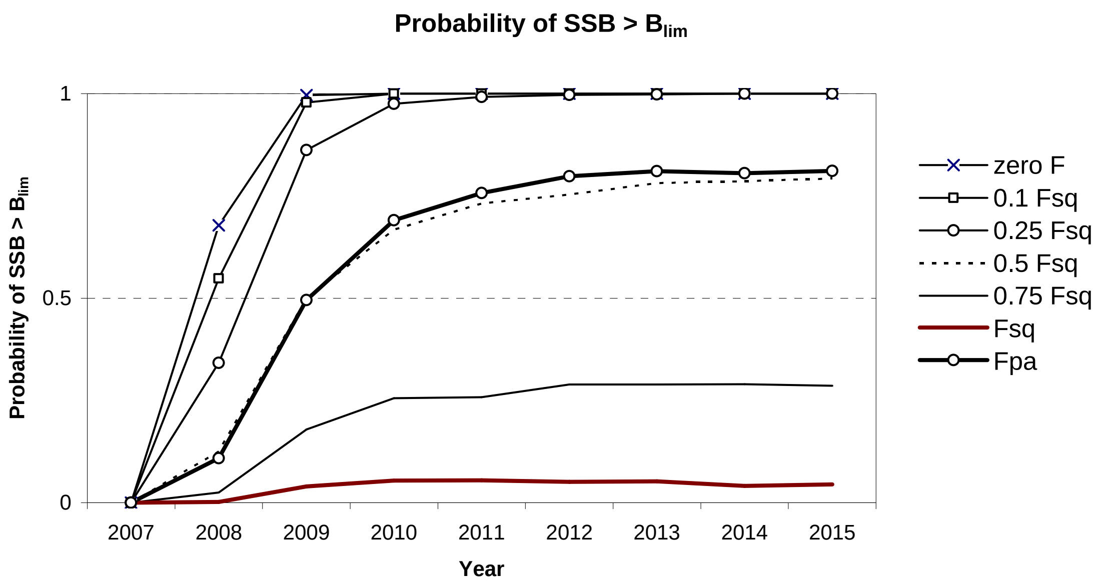


Figure 8.5.5.5. Cod in VIIa. Bootstrap B-ADAPT medium-term forecast for 0.10* status-quo F, with recruitment from 2006 onwards re-sampled from 1992-2005 values in each projection. Note that F(2-4) includes unallocated mortality associated with the estimation of unallocated removals over the 2000-2005 period, and hence the catch in the forecast period also includes an expected unallocated removal.



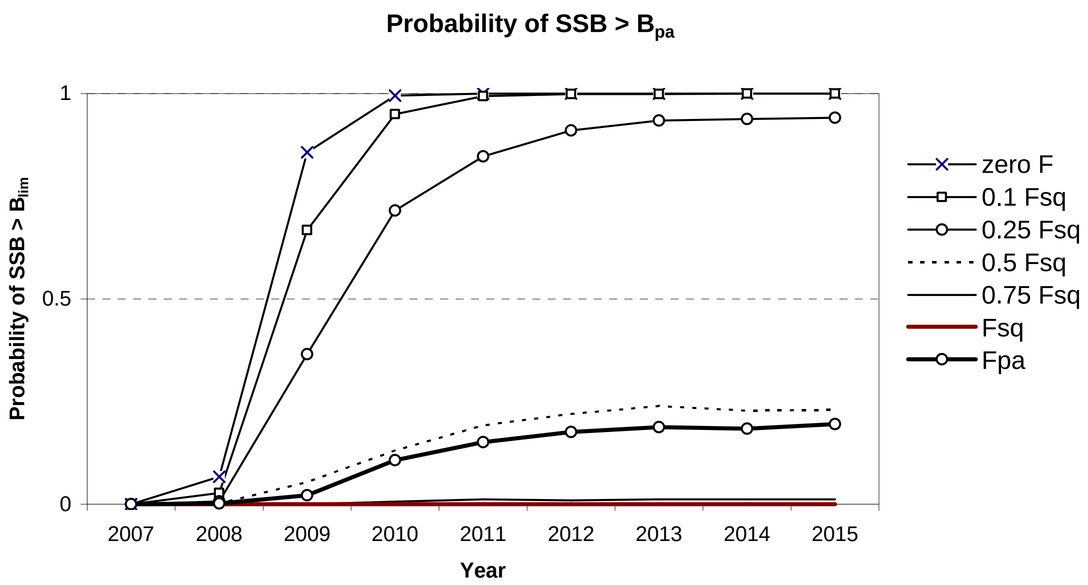
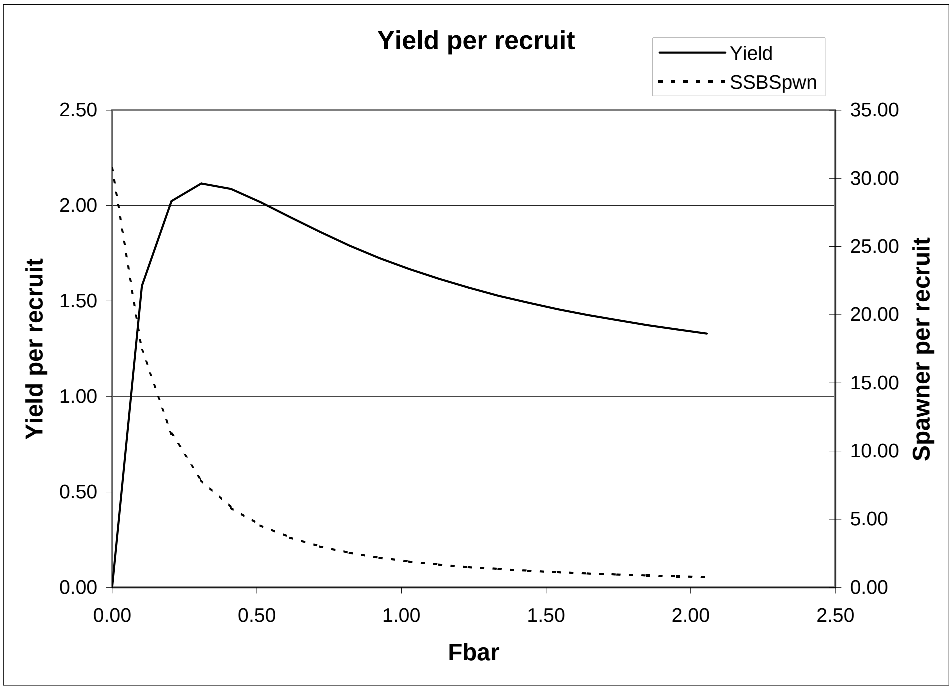


Figure 8.5.5.6. Cod in VIIa. Bootstrap B-ADAPT medium-term forecast values of probability of SSB > B_{lim} and B_{pa}. For different F-multipliers from 2007 onwards, and for constant F=F_{pa}.



MFYPR version 2a
Run: cod7aypr
Time and date: 21:21 11/05/2004

Reference point	F multiplier	Absolute F
Fbar(2-4)	1.0000	1.0277
FMax	0.3112	0.3198
F0.1	0.1786	0.1835
F35%SPR	0.2116	0.2175

Weights in kilograms

Figure 8.5.6.1. Cod in VIIa. Results of yield per recruit analysis. (From 2004 WG assessment).

9 Haddock in Division VIIa

The Working Group attempted a benchmark assessment for this stock in 2006. The VIIa haddock stock has been assessed prior to the 2004 WG using XSA. Due to unreliable landings estimates and no catch numbers-at-age for 2003, the 2004 assessment focused on a Survey Based Assessment (SURBA) and Time Series Analysis (TSA) which allows the 2003 commercial catch data to be treated as missing. In the absence of reliable landing data and catch at age data based on official logbook data only, the 2005 WG performed a benchmark assessment of recent stock trends based on survey data only. Although the Review Group considered SURBA as a useful tool for situations where commercial catch data are considered unreliable, they felt that it was in need of a thorough simulation testing to evaluate its performance. The survey based assessment was, nevertheless, accepted as indicative of trends in SSB and recruitment. The issue of how to provide advice was left unresolved, although the advice is driven to a large extent by linkages to cod in Division VIIa.

The Review group suggested that the use of a separable model; e.g. ICA, to estimate age distributions for missing years should be explored, followed by the use of an ADAPT approach modified to overcome problems of incomplete/missing catch. The 2006 Working Group updates the survey-based assessment carried out in 2005.

9.1 The fishery

The characteristics of the fishery are described in the Stock Annex.

9.1.1 ICES advice applicable in 2005 and 2006

ICES advice for 2005, under *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: The current estimated fishing mortality is 1.19. There will be no gain to the long-term yield by having fishing mortalities above F_{max} (0.35). Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits.

Exploitation boundaries in relation to precautionary limits: In order to harvest the stock within precautionary limits, fishing mortality should be kept below F_{pa} (0.5). This corresponds to catches of less than 1 370 t in 2005.

No limit reference points have been set for this stock due to the short time series of assessment data. ICES has adopted a precautionary F_{pa} of 0.5 as this is the value for the neighbouring stock in VIa.

The advice from ICES for 2006, under *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: Recent estimates of fishing mortality have been in excess of 1.0 and there will be no gain to the long-term yield by having fishing mortalities above F_{max} (0.35). Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits.

Exploitation boundaries in relation to precautionary limits: The fishing mortality should be reduced in order to make the fishery less sensitive to variable recruitment. Recent estimates of fishing mortality have been in excess of 1.0, compared to an Fpa of 0.5. Effort and catches should bereduced considerably to approach Fpa. Given the poor information on the actual catches it is not possible to quantify this reduction.

Advice on fisheries management for 2006 was as follows:

Fisheries in the Irish Sea should in 2006 be managed according to the following rules, which should be applied simultaneously. They should fish:

- without bycatch or discards of cod and spurdog, and with minimal catch of whiting;
- without jeopardizing the recommended reduction in fishing mortality of haddock;
- within the biological exploitation limits for all other stocks.

Furthermore, unless ways can be found to harvest species caught in mixed fisheries within precautionary limits for all those species individually then fishing should not be permitted.

9.1.2 Management applicable in 2005 and 2006

Management advice and WG landings in 2005 and 2006 are summarised below:

YEAR	SINGLE SPECIES EXPLOITATION BOUNDARY[1]	BASIS	TAC	F MULTIPLIER ASSOCIATED WITH TAC[2]	WG LANDINGS
2002	<1200	Reduce F below Fpa	1300	0.38	1972
2003	0	Linked to cod	585	<0.1	n/a
2004	<1500	Reduce F below Fpa	<1500	0.53	1278
2005	<1370	Reduce F below Fpa	<1370	0.50	699
2006	-	Substantial reduction in F	-	-	

[1] VIIa allocation for VII, VIII, IX, X. [2] From short term forecast.

Due to the by-catch of cod in the haddock fishery, the regulations affecting Irish Sea haddock remain linked to those implemented under the Irish Sea cod recovery plan. Technical measures and effort regulations are described in Section 1.7.

Limited sampling schemes since the 1990s have shown high rates of discarding of haddock less than 3 years old, and variable discarding of 3-year-olds in fisheries using 70-80 mm mesh nets. Data for whitefish vessels since the introduction of 100+ mm mesh and other recent technical measures are too few to form a basis for evaluation. However, any measures to reduce discards in the fishery will result in increased future yield.

The minimum landing size for haddock in the Irish Sea is 30cm.

9.1.3 The fishery in 2005

The fishery in 2005 was prosecuted by the same fleets and gears as in recent years, with directed fishing prevented inside the cod closure in spring. The shift of whitefish vessels to the Clyde was less marked since 2001 because of the Clyde closure.

9.2 Catch data

9.2.1 Official catch statistics

Table 9.1 gives nominal landings of haddock from the Irish Sea (Division VIIa) as reported by each country to ICES since 1984.

9.2.2 Revision of Catch data

Table 9.2 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. The 2005 WG estimates include unofficial estimates of landings into Ireland, France, Belgium and the UK, supplied to the WG. Similar to 2004, the reported uptake of the TAC has been poor in 2005, with the estimated percentage uptake of UK, Irish and French vessels being 50% (estimated 361 t of 718 t quota), 36% (139 t of 649 t) and 19% (21 t of 109 t), respectively. For these figures, quota swaps have, however, not been taken into account. The Belgium fleet in contrary had 93% uptake of the TAC (21 t of 24 t).

9.2.3 Quality of Catch data

Official logbook landings were partially corrected for by the WG for this stock from 1993-2002, based on a routine sampling procedure used to estimate landings in at ports in one country only. Sample-based estimates of landings were not available for 2003 and of poor quality in 2004. Estimates have been variable and have a substantial influence on the SSB and recruitment estimates for the stock. Landings and catch at age data based on official logbook reported landings are considered unreliable for an analytical catch-based assessment.

9.3 Commercial catch-effort and research vessel surveys

9.3.1 Commericial catch-effort data

Recent trends in effort (kW.days) of various fleets are described in Section 17. Longer term trends in hours fished are given in the VIIa whiting section.

The ICES-FAO Working Group on Fishing Technology and Fish Behaviour (WGFTFB, 2006) provided information to WGNSDS concerning changes in fleets and practices in the Irish Sea that could influence the assessments or their interpretation. A recent pattern of vessels switching from ≥100mm mesh to the 70-99mm mesh band to avail of greater days-at-sea allowances was particularly noted. During the period of the annual cod closure, some whitefish vessels switch to *Nephrops* fishing to take advantage of the derogation for *Nephrops* trawls in a designated area of the closure.

9.3.2 Surveys

Survey series for haddock available to the Working Group are described in the stock Annex for 7a haddock (Section B.3).

Age-structured abundance indices are available from the following sources:

- UK(NI) groundfish survey (NIGFS) in March (age classes 1 to 4, years 1992 - 2006)
- UK(NI) groundfish survey (NIGFS) in October (age classes 0 to 3; years 1991 to 2005)
- Republic of Ireland Irish Sea – Celtic Sea groundfish survey (IR-ISCSGFS) in November (ages 0 to 5; years 1997 – 2002)
- Republic of Ireland groundfish survey (IR-GFS) in autumn (age classes 0 to 6, years 2003-2004)
- UK(NI) Methot-Isaacs Kidd (MIK) net survey in June (age 0; years 1994 – 2005)
- UK(Scotland) groundfish survey (SCOGFS) in spring (age classes 1 to 4, years 1996 – 2006)
- UK(Scotland) groundfish survey (SCOGFS) in autumn (age classes 0 to 3, years 1996 – 2005).
- UK Fishery Science Partnership Irish Sea roundfish survey, 2004-2006 (see Armstrong and Dann, WD 5 and www.cefas.co.uk/fsp)

Results from the UK Fishery Science Partnership Irish Sea roundfish survey have been presented to the Working Group. A chartered commercial trawler carries out ~ 38 tows of approx. 6-h duration using a commercial semi-pelagic whitefish trawl in the western Irish Sea and North Channel. The survey takes place in spring during the cod spawning period. A second chartered trawler carries out ~44 tows of approx. 4-h duration in the eastern Irish Sea at about the same time.

A new IBTS-coordinated UK trawl survey started in the Irish Sea in November/December 2004 using RV Endeavour to carry out approx. 30 tows with a GOV trawl in the Irish Sea and St George's Channel, and 50-60 tows in the Celtic Sea and Western Approaches (ICES IBTSWG report ICES CM 2005/D:05). The GOV trawl is rigged with standard or rockhopper ground gear depending on ground type. Tuning data from this survey have not yet been provided to the Working Group.

The vessel used for the UK(NI) groundfish surveys has changed in 2005. No intercalibration trawls were carried out. No changes were made to the fishing gear, but the vessel effect is unknown. The two Irish groundfish surveys (IR-GFS and IR-ISCS GFS) in autumn were not considered because of the short series. Coverage of the Irish Sea in the IR-GFS survey (2003-2004) has been terminated. The IR-ISCS GFS is also excluded on the basis of changes in survey design and the method of calculating the indices not allowing for the changes in spatial coverage. The ScoGFS-Autumn survey was also excluded due to the small number of stations in the western Irish Sea where haddock are most abundant, and the poor internal consistency and consistency with other fleets. The first year of the ScoGFS-Spring survey (1996) was also excluded, as there was only one station per ICES rectangle resulting in only a few stations covering the western Irish Sea. The survey input files for the SURBA runs are given in Table 9.3.

The distribution of haddock from the NIGFS March and October surveys, showing catch rates in kg per 3 mile above and below the minimum landing size (30 cm), is shown in Figure 9.1 and Figure 9.2. Distribution of haddock is patchy and concentrated in the western Irish Sea. The highest abundance of haddock above and below MLS during the NIGFS-Mar and NIGFS-Oct surveys is to the west and southwest of the Isle of Man and closer inshore off the east coast of Ireland (north and south of Dundalk Bay). Larger haddock are more dispersed during the NIGFS-Oct survey, but the highest concentrations are still found in the main areas mentioned in most years.

Distribution of haddock during the 2004-2006 UK Fisheries-Science Partnership surveys confirms the distribution pattern and patchiness observed in the research surveys. The 2005-2006 survey also showed relatively high catch rates of haddock in the North Channel (northern part of VIIa, north of 54o 30'N), close to the Firth of Clyde cod closure (Figure 9.3).

9.4 Age composition and mean weights at age

9.4.1 Catch age composition and mean weights at age in the catch

The methods for estimating quantities and composition of haddock landings from VIIa, used in previous years, are described in the Stock Annex (Section B1.1). Data on quarterly age compositions of landings and associated mean weights at age were provided by UK (NI) and Ireland in 2005. Sampling covered the main fleets landing haddock in 2005. Following a poor period of sampling levels and coverage of landings in 2003-2004, sampling levels and coverage of landings for 2005 were satisfactory with scientists having access to all major Irish Sea landings ports. The landings of the fleets sampled by quarter comprise 81% of the international total in 2005 (85% in 2002). Numbers measured and aged are given in Table 2.2. The series of numbers at age in the international commercial landings is given in Table 9.4, and includes sampled-based estimates of unallocated landings in all years. 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 9.5. Since the large expansion of the haddock stock in the mid 1990s the mean weight at age has been variable (±40% of the mean for each age group). The general trend since 1996 indicate a slight decrease in mean weight at age for ages 2-4. The 2005 values are relatively low compared to 2004, but are similar to the 2002 values.

9.4.2 Discard age composition

Methods for estimating quantities and composition of discards from UK(NI) and Irish *Nephrops* trawlers are described in the Stock Annex (Section B1.2). Previous analytical assessments have been based on landings only. The revised series of the Irish discard data, raised to the number of trips instead of landings, provided to the WG in 2005 was updated. Sampling levels has increased in recent years, but the highly variable and very large estimates of discarding for this fleet observed by previous WG are, however, still evident and raise concerns over their reliability.

Due to the poor levels of discard sampling from UK(NI) in 2003 and no sampling in 2004-2005, an estimate could not be provided for this fleet. Historically, discarding took place mainly at ages 0 to 2 in the otter trawl fisheries and at ages 1 to 2 in the mid-water trawl fishery (Table 9.6). The absence of 0-group discards in the mid-water trawl fishery reflects the mesh-size and deep-water distribution of fishing in this fishery. Discard rates could not be calculated from the *Nephrops* fishery self-sampling scheme as concomitant landings were not recorded or samples taken. Discarding in the mid-water trawl and twin trawl fishery was strongly influenced by the minimum landing size of 30cm. Proportions discarded at age are given in Table 9.7. These results indicate that discarding may account for a significant and potentially variable fishing mortality on age classes 1 and 2 in particular.

A time series of discard estimates for VIIa haddock was constructed by the 2003 WG for exploratory use only to determine if estimates of F(2-4) and SSB are sensitive to inclusion of discards data, and to investigate the magnitude of fishing mortality caused by discarding. The discard data in its present form are considered to have poor precision due to a low number of sampling trips. This time series was updated with the revised discard data series for the Irish *Nephrops* fleet. Table 9.8 gives the total catch at age for 1993-2004 including the estimates of discards.

9.5 Natural mortality, maturity and stock weights at age

The derivation of these parameters and variables is described in the Stock Annex (Section B.2). The proportion of F and M before spawning were set to zero to reflect a SSB calculation date of 1 January. 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 for a decline in mean length of adult haddock over time (Figure 9.4), 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 B.2. The procedure was updated this year using NIGFS-Mar data for 2006 and commercial mean length at age data for 2005 Q1. The time series of length weight parameters indicate a reduction in expected weight at length since 1996:

	Length-weight parameters		Expected weight at length	
Year	*a*	*b*	30cm	40cm
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

This decline coincides with the large growth in biomass of haddock in the Irish Sea.

The following parameter estimates were obtained (last year's estimates in parentheses):

Mean LI_{yc} = 75.0 cm (72.8); K = 0.232 (0.253); t_0 = -0.278 (-0.226)

Year class effects giving estimates of asymptotic length relative to the mean were as follows (2004 and 2005 data were combined as there is only one observation for the 2005 year-class):

Year class	Effect	Year class	Effect
1990	1.212	1998	0.969
1991	1.130	1999	0.927
1992	1.064	2000	0.945
1993	1.082	2001	0.943
1994	1.097	2002	0.930
1995	1.067	2003	0.856
1996	0.983	2004/2005	0.837
1997	0.958		

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 close fit of the model to observed length-at-age data is shown by year class in Figure 9.4. The resultant stock weights at age are given in Table 9.9.

9.6 Survey and Catch-at-age analysis

9.6.1 Data screening and exploratory runs

9.6.1.1 Commercial catch data

The commercial catch data have only been partially corrected for unallocated estimates of landings and should be considered unreliable, especially in 2003-2004. The series of international landings at age and mean weight at age are given in Table 9.4 and Table 9.5. A Separable VPA run (S=1.0; F=1.0, 1.2, 1.4; reference age = 3) showed no anomalies in the landings at age data for ages 2 and over. Residuals at age 1-2 were more variable, probably due to the absence of discards data (results on ICES system).

9.6.1.2 Survey data

The survey data for this stock are given in Table 9.3. The relative cpue data are plotted against time in Figure 9.5. Surveys give similar signals for all ages (0-4). Strong 1994, 1996, 1999, 2001, 2003 and 2004 year-classes are indicated by the 0-group indices from the NIGFS-Oct and MIK surveys. These strong year classes were also evident for the older age groups in all surveys, indicating that the different surveys were capturing the prominent year-class signals in this stock (Figure 9.6). Correlation between survey indices by age (Figure 9.7) is positive for all surveys and show high consistency within each fleet, but patchy consistency between the fleets. However, it should be noted that the time series are short. The NIGFS-Mar and ScoGFS-Spring survey series showed good correspondence in the past, but a deviation between the two surveys can be observed for indicating the strength of the 2004 year-class. High catch rates of 2-year-old haddock in the western Irish Sea were observed in the 2006 UK Fishery Science Partnership survey, reflecting the a strong 2004 year-class indicated by the 0-group and NIGFS survey indices. The international landings at age (excl. 2003) show similar patterns of year-class variation to the surveys (Figure 9.5), giving confidence in the combined ability of the surveys to track year classes through time. Relative values for the landings at age in the last 2 years are well below the survey estimates.

Three tuning fleets, NIGFS-Mar, NIGFS-Oct and ScoGFS-Spring, were screened using SURBA (ver. 3.0) to examine for year, age and cohort effects. Survey catchability and weighting factors by age were all entered manually as 1.0. The indices of the single fleet runs showed no obvious year-effects (Figure 9.8 to Figure 9.10) and were generally capturing the prominent year-class signals in this stock very well. Despite the vessel change in the NIGFS-Mar survey, there is no evidence of a year-effect in 2005. The age scatter plots indicates good internal consistency in the NIGFS surveys, but poorer internal consistency for the ScoGFS-Spring survey. The survey data nevertheless show similar year-class patterns between fleets. Indices for age 5 in the NIGFS-Mar survey were previously excluded from further analysis due to small and variable catches evident from the raw data, but numbers in recent years have increased (Table 9.3) and have been retained this year. Indices from age 5 in the ScoGFS-Spring show poor correlation with other age classes. The catch curves from the two NIGFS surveys show similar steep profiles. The ScoGFS-Spring survey shows shallower catch curves.

The ScoGFS-Spring survey was used in last year’s assessment. Possible reasons for the observed inconsistency in trends between this fleet and the other survey indices observed for the past two years were investigated. The distribution of haddock at age by ICES rectangles for the ScoGFS-Spring survey 2005-2006 (Figure 9.11a) shows that catches are predominantly age 1 and 2, with small and variable catches of older fish (see also Table 9.3). The distribution of haddock, as shown by the NIGFS and UK Fishery Science Partnership surveys, has been noted to be patchy and concentrated in a few areas in the western Irish Sea (Section 9.3.2). The number of stations in the ScoGFS-Spring survey for 2005 and 2006 were 16 and 15, respectively, with 8 and 7 stations in the western Irish Sea. Comparing the station positions to the main areas of haddock abundance from the NIGFS-Mar surveys (Figure 9.11b) indicates poor coverage. The only station that covers the area off the Irish coast, with a high abundance of lower age fish, was not sampled during 2006. The decreased catchability at age 1 later in the ScoGFS survey series (Figure 9.10) is also likely to contribute to the deterioration in correspondence with other surveys. Based on the poor correspondence with the NIGFS surveys in 2005-2006 for ages 1-2 the ScoGFS-Spring survey has been excluded from further analysis.

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 increasing trend (Figure 9.12). In recent years the NIGFS-Mar survey shows an decreased SSB in 2004, a slight increase in 2005 and a high SSB in 2006. The ScoGFS survey shows a similar increase in 2003 and decrease in 2004, but show a further decreasing trend in SSB in 2005-2006.

9.6.1.3 Exploratory assessment runs

WGNSDS 2005 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. No solution was found for the NIGFS-Oct survey with a reference age other than 1. Changing the reference age had very little effect on the results and similar trends in Z, SSB and recruitment were found for the NIGFS-Mar and ScoGFS-Spring surveys.

SURBA model residuals (log population indices) for the NIGFS-Mar and NIGFS-Oct surveys show noisy residuals (Figure 9.13 to Figure 9.14). Residuals from the NIGFS-Mar survey show some evidence of year effects in older ages in some years. The age 2 residual pattern from the NIGFS-Mar survey (Figure 9.13) continue to show a better patterns than the other ages. The RGNSDS 2005 commented that this seems to indicate that the fit was only derived from age 2 indices. Although this is still evident, it is less evident in this year's run. The NIGFS-Mar survey model show quite large retrospective patterns in SSB, but less so for recruitment estimates. The retrospective analysis for the NIGFS-Oct survey failed due to convergence problems. This was difficult to explain and reinforced the need for simulation testing of SURBA and more detailed diagnostic output.

A comparison of the results of SURBA runs is given in Figure 9.15 and 9.16. A general tendency for the temporal trend in Z to increase up to 1999 is evident in the total mortality estimates for the NIGFS series. The NIGFS-Mar survey shows a slight increase in Z in 2003-2004, after a decreasing trend since 1999. Both the NIGFS surveys show a slight decrease in Z in 2005. The Z and SSB estimates from the NIGFS-Oct survey are more variable than the NIGFS-Mar surveys. The surveys give generally similar trends in SSB, with the exception of the NIGFS-Oct 1998 and 2003 estimate. These differences are related to the NIGFS-Oct having fewer age groups than the spring survey, which is reflected in the noisier Z trend and less ages being represented in the SSB. The historical trend in recruitment at age 0 is also similar, with a slightly lower recruitment in the terminal year. The surveys show different estimates of numbers at age 2 since 2003 (Figure 9.16), but show similar trends at age 1 and 3.

Figure 9.17 compares the trends in SSB, Z and recruitment from the 2005 final assessment with the SURBA run including an additional year of data. The comparison indicates that the 2005 estimates of Z and SSB in 2004-2005 and the recruitment at age 1 in 2005 differ slightly.

The WG decided not to pursue multiple-fleet runs pending further investigation of the performance of SURBA 3.0 in this mode.

RGNSDS 2005 suggested that the Working Group should explore the use of a separable model; e.g. ICA, to estimate age distributions for missing years. This should then be followed by the use of an ADAPT approach modified to overcome problems of incomplete/missing catch (similar to the cod in Division VIIa assessment). The Working Group attempted this approach.

A number of ICA assessments were run to explore the sensitivity of settings regarding iterative survey weighting, catchability model fits and survey data inclusions on the diagnostic outputs (results on ICES network). Catch information for 2003 were omitted and unallocated landings estimates were removed from the catch numbers and weight at age for 2000-2005. The diagnostic of the results using the model settings below is given in Table 9.10.

TUNING FLEETS	YEARS OF SEPERABLE PERIOD	TERMINAL S	REF AGE	CATCHABILITY MODEL	CATCH NUMBER AT AGE RANGE
NIGFS-Mar (ages 1-5) NIGFS-Oct (ages 0-3) MIK net (age 0)	6	1	2	Linear	1-5+

Selectivity curves appeared to be realistically constrained. The diagnostic output is graphically displayed in Figure 9.18. The model did not converge and was unable to find a minimum value, resulting in very low estimates for F for 2004-2005. Input data were restrictive due to the short data series and narrow age range. Comparing the predicted catch from the model to officially reported landings indicated an unrealistically large catch in 2003. The age distribution output, however, compared well with the observed catch at age numbers giving some confidence in the age distribution. The age distribution was scaled to officially reported landings using an average of catch weight at age observed in 2002 and 2004.

In order to provide catch at data for the subsequent B-ADAPT analysis the age distribution output from the ICA run was used for 2003. A series of exploratory B-ADAPT runs was then carried out to examine the influence of the degree of catch or F smoothing on the estimates of population abundance, fishing mortality and bias associated with unallocated removals of landings during 2000-2005. The runs used official reported landings 2000-2005, the landings including sample-based estimates from 1993-1999 and survey data from the NIGFS-Mar, NIGFS-Oct and MIK net surveys. The model did not converge when no smoother was applied. F-smoothing or catch-smoothing generated similar results (Figure 9.19 illustrate an example where F and catch smoothers of 1.0 were applied). The degree of smoothing had very little influence on the results. The model, however, produced unsatisfactory results indicating unrealistically high estimates of bias in the 2000-2005 and very low Fs (Table 9.11 gives example output for model with F smoother of 1.0 applied, results from other runs are on the ICES network). Removal estimates for the 2004-2005 period were particularly high. The results reflect the relatively low catches compared to the survey indices (Figure 9.5) in recent years. This could not be explained by the Working Group.

The Working Group spent considerable amount of time exploring the dynamics and characteristics of various assessment methods to resolve the issue of missing and incomplete catch at age information in recent years. Model results were, however, unsatisfactory. Similar to the 2005 assessment, WG performed a final assessment of recent stock trends based on survey data only.

9.6.1.4 Final assessment

The stock is characterised by highly variable recruitment, however, the NIGFS-Oct survey showed good internal consistency and gives similar trends to the other surveys, but showed variable trends in Z and SBB estimates. SURBA outputs for this survey were, however, questionable and no convergence was found for the retrospective analysis. The SURBA run using NIGFS-Mar survey data was chosen as the final assessment model. The data for age 5 from the survey have improved for recent years and this was included in this year's assessment. The model setting are given below:

	WGNSDS 2005	**WGNSDS 2006**
Year range:	1992-2005	1992-2006
Age range:	1-4	1-5
Catchability:	1.0 at all ages	1.0 at all ages
Age weighting	1.0 at all ages	1.0 at all ages
Smoothing (Lambda):	1.0	1.0
Cohort weighting:	not applied	not applied

The trends in Z, SSB and recruitment from this run, and the model residuals are given in Figure 9.20 and Figure 9.21. The SURBA fitted numbers at age and total mortality at age given in Table 9.12. The SURBA index of Z follows the much noisier empirical estimates. Both the empirical and SURBA estimates of SSB give a similar increase in 2006. The recruitment estimates at age 1 indicate a decrease in recruitment in 2006, indicating a weaker 2005 year-class compared to recent years, which was also indicated by the 0-group indices. In general, the SURBA results capture similar year-class dynamics than observed from the raw survey indices (Figure 9.5). The retrospectives for the NIGFS-Mar survey data are given in Figure 9.13.

9.6.1.5 Comparison with 2005 WG assessment

Error! Reference source not found. compares the relative trends between the SURBA fitted estimates using the NIGFS-Mar survey data in 2005 and 2006. The SSB estimates from the 2005 assessment were relatively higher in 2003 and lower in 2000-2001 compared to this year's estimates, but the two series show similar trends. The recruitment estimates show similar signals of year class strength, but the relative strength of the 2001 and 2004 year-classes differ between the two sets of estimates. The trend in Z from the 2005 SURBA model is also higher in recent years in last year's assessment compared to this year. Despite the different patterns in Z over the entire time series for the two models, it has relatively little effect on the SSB trends.

9.6.2 Estimating recruiting year class abundance

The SURBA run give model estimates of relative abundance at age up to the 2005 year-class from NIGFS-Mar at age 1. Although only based on one observation, it agrees with the indication of strength of the 2005 year-class of average and weaker than the 2004 year-class given by the NIGFS-Oct and the UK (NI) MIK net surveys at age 0.

9.6.3 Long term trends of biomass, recruitment and fishing mortality

Detailed knowledge of the development of this stock is restricted to the recent period for which survey data are available. Figure 9.20 and Table 9.12 summarise the estimates of recruitment, spawning stock biomass, and total mortality Z(2-3) from the SURBA indices for the period 1993 to 2006. The spawning stock biomass increased substantially following entry of the strong 1994 and 1996 year-classes. High fishing mortality combined with weaker year classes in 1997 and 1998 resulted in a decline in abundance from 1999 to 2000. Stronger recruitment in 1999, 2001 and 2003-2004 resulted in an increase in biomass since 2001. The 2003 and 2004 year classes have been above average and reflect into a SSB estimate similar to the 1998 level.

9.6.4 Short-term stock predictions

No short term forecast has been performed in 2006 for this stock.

9.6.5 Medium term predictions

Medium-term predictions were not carried out for this stock. The stock of haddock in the Irish Sea has historically exhibited short-lived periods of population growth, and the recruitment patterns over the time-series are may not represent the potential variability in the forthcoming decade.

9.6.6 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 9.13, and the summary output is given in Table 9.14. The YPR and SPR curves are plotted in Figure 9.23.

9.6.7 Reference points

The ACFM view on this stock 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, October 2002). ACFM (2006) proposed 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.

9.6.8 Quality of the assessment

Sampling of landings for length and age appears adequate for years up to 2002 but was inadequate in 2003 to allow compilation of catch at age data. Sampling was improved in 2004, but still low due to limited access to some landing ports. Sampling levels and coverage was adequate in 2005. The absence of reliable discard estimates is also a potentially serious deficiency that must be addressed if management is to be based on catch-at-age analysis. Landings data for this stock are uncertain because of evidence of a persistent difference between estimates of landings from a routine sampling procedure and official reported landings. Restrictive quotas for some countries caused extensive misreporting during the 1990s prior to the introduction of a separate TAC allocation for the Irish Sea. Whilst unallocated landings estimates appear to have declined since 2000, the recent attempts to reduce fishing mortality substantially through low TACs whilst the stock has continued to grow has coincided with anecdotal information for increased unreported landings. The reported landings and catch at age data based are still considered too inaccurate to form the basis for a traditional analytical assessment based on catch-at-age data.

Survey indices in recent years indicate relatively high abundance of haddock compared to the commercial landings. Although the general trend in landings at age is expected to differ from that of surveys due to changes in misreporting and fishing mortality, the reason for the increased discrepancy in recent years is uncertain.

The narrow age range in the haddock stock and the resulting low 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. Despite the vessel change in the NIGFS-Mar survey, there is no evidence of a year-effect in 2005. 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 that will affect any forecast and lead to overoptimistic forecast estimates. Despite the declining trend in the weight at age and length at age, there is no evidence of a change in catchability.

No forecast was possible using results from the SURBA-based assessment. The problem is that these use (Z-M) as a proxy for F, when the survey Z is really only a measure of loss and not necessarily a measure of total mortality. These

The perception of the stock from this year’s assessment does not differ qualitatively from that obtained last year.

9.6.9 Management considerations

This stock grew substantially in the 1990s following unusual pulses of recruitment, and has gone from a minor by-catch species to one of the most economically valuable target species in the Irish Sea. 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 are highly uncertain. The WG landings for 2001 and 2002 were 20% and 16% below the status quo forecast. The TACs in those years were expected to reduce fishing mortality by 20% and 62% respectively, and by 52% in 2004. The current assessment has insufficient accuracy to determine if F has reduced by these amounts in 2001, 2002 and 2004. The prevention of directed fishing for haddock during the cod closures in 2000-2004, other than during limited fishing experiments, should to have curtailed the directed fisheries on mature haddock that occur in spring.

Haddock in the Irish Sea are taken as both a by-catch in *Nephrops* and cod fisheries, and in a directed fishery using mid-water trawls and otter trawls. The latter fishery also takes a by-catch of cod, which has been a matter of some concern in drawing up the Irish Sea cod recovery programme. The distribution of the haddock stock is largely encompassed by the cod closure, and the closure has impacted directed haddock fishing at a time of year when fishermen claim that haddock are most available. Experimental haddock fishing took place during the 2000 and 2001 cod closure periods to determine the ability of mid-water trawl fishermen to target haddock shoals using echosounders and hence to minimise the by-catch of cod. The results from 2000 were inconclusive in terms of the impact on cod, and the results from 2001 indicated a by-catch of cod of just over 15%. Hence the possibility of managing haddock fishing mortality in isolation from measures imposed for cod is not yet proven.

Whilst management of fishing mortality on this stock may not prevent it from declining again to low abundance due to natural causes, achieving a fishing mortality close to F_{max} would result in improved YPR and SPR and result in more persistent benefits from strong year classes. However, fishing patterns in the 1990s have shown that restrictive quotas for fleets fishing haddock in the Irish Sea have had little effect on actual landings, and have resulted in very uncertain data on quantities of fish caught by the fleet.

The EU Cod Recovery Plan regulation implemented in the Irish Sea from 2004 will impact the management measures for haddock in 2007 and the setting of a TAC for this stock.

Table 9.1 Nominal landings (t) of HADDOCK in Division VIIa, 1984–2005, as officially reported to ICES. (Working Group figures are given in Table 9.2)

Country	1984	1985	1986	1987	1988	1989	1990	1991	1992
Belgium	3	4	5	10	12	4	4	1	8
France	38	31	39	50	47	n/a	n/a	n/a	73
Ireland	199	341	275	797	363	215	80	254	251
Netherlands	-	-	-	-	-	-	-	-	-
UK (England & Wales)[1]	29	28	22	41	74	252	177	204	244
UK (Isle of Man)	2	5	4	3	3	3	5	14	13
UK (N. Ireland)	38	215	358	230	196	…	…	…	…
UK (Scotland)	78	104	23	156	52	86	316	143	114
Total	387	728	726	1,287	747	560	582	616	703

Country	1993	1994	1995	1996	1997	1998	1999	2000	2001
Belgium	18	22	32	34	55	104	53	22	68
France	41	22	58	105	74	86	n/a	49	184
Ireland	252	246	320	798	1,005	1,699	759	1,238	652
Netherlands	-	-	-	1	14	10	5	2	-
UK (England & Wales)[1]	260	301	294	463	717	1,023	1,479	1,061	1,238
UK (Isle of Man)	19	24	27	38	9	13	7	19	1
UK (N. Ireland)	…	…	…	…	…	…	…	…	…
UK (Scotland)	140	66	110	14	51	80	67	56	86
Total	730	681	841	1,453	1,925	3,015	2,370	2,447	2,229

Country	2002	2003	2004	2005
Belgium	44	20	15	22
France	72	146	20	19
Ireland	401	229	296	
Netherlands	-	-	-	
UK (England & Wales)[1]	551	248	421	
UK (Isle of Man)	-	-	-	
UK (N. Ireland)	…	…	…	…
UK (Scotland)	47	31	9	
United Kingdom				351*
Total	1,115	674	761	392*

[*]Preliminary.

[1]1989–2004 Northern Ireland included with England and Wales.

n/a = not available.

Table 9.2 Haddock in VIIa. Total international landings of haddock from the Irish Sea, 1972 – 2005, 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. 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	2228	2498
2002	1115	1972
2003	674	n/a
2004	761	1278
2005	n/a	699

Table 9.3 Haddock in VIIa: Available tuning data (file name: h7ani.tun). Ages used in assessment are in bold type.

IRISH SEA haddock,2006 WG,ANON,COMBSEX,TUNING DATA(effort, nos at age)
107
NIGFS March [Northern Ireland March Groundfish Survey – Effort: numbers caught/3 nm]
1992 2006
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

NIGFS Oct [Northern Ireland October Groundfish Survey – Effort: numbers caught/3 nm]
1991 2005
1 1 0.83 0.88
0 3

1	**15780**	**70**	**0**	**0**	0	0
1	**124**	**784**	**151**	**0**	0	0
1	**4462**	**101**	**375**	**3**	0	0
1	**56683**	**1137**	**12**	**79**	0	0
1	**1661**	**10153**	**74**	**0**	5	0
1	**143300**	**1167**	**1480**	**13**	0	0
1	**16400**	**39680**	**174**	**98**	1	0
1	**41820**	**1243**	**3778**	**22**	3	4
1	**80674**	**2835**	**71**	**145**	0	1
1	**6545**	**8598**	**763**	**31**	39	0
1	**75017**	**2003**	**2742**	**311**	0	20
1	**15116**	**10501**	**86**	**365**	0	0
1	**53922**	**7125**	**3008**	**59**	79	0
1	**70337**	**14413**	**1261**	**649**	0	0
1	**49795**	**11243**	**506**	**258**	0	0

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

Table 9.3 contd.

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MIK net May/June [Northern Ireland Methot-Isaacs Kidd net survey in May/June –
Effort: numbers/km2]
1994 2005
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
```

Fleets below not included in assessment

```
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
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
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
```

Table 9.4 Haddock in VIIa: catch numbers at age (include partial estimates of misreporting).

	CATCH NUMBERS AT AGE				NUMBERS*10**-3								
YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE													
0	0	0	0	0	0	0	0	0	0	0	n/a	0	0
1	94	30	1341	109	1285	100	91	459	597	120	n/a	54	37
2	1250	123	1322	4619	700	6427	519	915	2263	632	n/a	203	522
3	18	861	107	735	2411	292	4462	238	1116	1853	n/a	751	134
4	1	3	222	16	203	539	49	374	80	196	n/a	76	222
+gp	1	2	5	30	16	35	72	28	127	28	n/a	97	43
TOTALNUM	1364	1019	2997	5509	4615	7393	5193	2014	4183	2829	n/a	1181	983
TONSLAND	813	1043	1753	3023	3391	4902	4129	1380	2498	1971	n/a	1278	699
SOPCOF %	100	100	100	100	95	100	100	97	100	100	n/a	100	100

Table 9.5 Haddock in VIIa: catch weights at age

	CATCH WEIGHTS AT AGE (KG)												
YEAR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE													
0	0	0	0	0	0	0	0	0	0	0	n/a	0	0
1	0.351	0.346	0.361	0.346	0.348	0.19	0.325	0.329	0.3	0.279	n/a	0.401	0.273
2	0.596	0.56	0.545	0.474	0.592	0.53	0.416	0.474	0.452	0.357	n/a	0.519	0.417
3	1.688	1.103	0.898	0.917	1.002	1.13	0.802	0.786	0.859	0.749	n/a	1.007	0.697
4	2.52	2.73	1.983	2.034	1.349	2	2.064	1.573	1.243	1.361	n/a	1.940	1.256
+gp	2.52	2.522	2.178	2.682	1.955	2.55	2.854	2.365	1.869	2.107	n/a	2.544	2.268
SOPCOFAC	0.9995	1.0008	1.0007	1.0029	0.9465	0.9958	0.9996	0.9675	1.0002	0.9991			

Table 9.6 Haddock in VIIa: Estimates of Irish Sea haddock discards 1995-2005. 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) (approx 40 trips sampled per year).

	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**
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
1	229	1209	318	342	2384	140	1073	62	n/a	n/a
2	179	88	210	69	253	199	37	28	n/a	n/a
3	0	0	0	0	0	0	11	0	n/a	n/a

(b) Observer scheme: N.Ireland vessels catching *Nephrops* (single trawl only)

	1999 Q3-4	**2000 Q1-3**	**2001 Q1**
Age	4 trips	6 trips	1 trip
0	2185	210	0
1	22	280	1677
2	0	57	1593

(c) Observer scheme: N.Ireland midwater trawl

	1997 Q2-4	**1998 Q1-3**	**1999 Q3-4**	**2000 Q1**	**2001 Q1**
Age	n/a	n/a	5 trips	4 trips	2 trips
0	0	0	68	0	0
1	178	316	96	20	0.4
2	19	1342	35	83	19
3	4	0	2	5	0

(d) Observer scheme: N.Ireland twin trawl

	1997 Q2-4	**1998 Q1-3**	**1999 Q4**	**2000 Q1-4**	**2001 Q1**
Age	n/a	n/a	1 trips	10 trips	2 trips
0	34	4	26	10	0
1	284	205	3	13	3
2	6	382	0	10	19
3	0.5	0	0	0	0

(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**
Age	8 trips	8 trips	7 trips	4 trips	10 trips	2 trips	1 trip	9 trips	11 trips	8 trips
0	3808	165	565	87	182	5349	47	1169	5663	776
1	713	11396	1973	58	2193	7354	31	1747	6566	2350
2	297	303	3564	59	580	140	0	1178	2301	996
3	0	0	0	0	0	15	0	10	225	120
4	0	0	0	0	0	0	0	0	0	0

(f) 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**
Age	51 trips	n/a	n/a	48 trips	58 trips	47 trips	36 trips	17 trips	n/a	n/a
0	8293	265	2117	1429	292	47	36	17	n/a	n/a
1	942	12783	2607	496	4597	6432	898	1169	n/a	n/a
2	476	410	5116	163	916	7494	1104	1809	n/a	n/a
3	0	4	0	2	5	358	37	1206	n/a	n/a
4	0	0	0	0	0	15	11	10	n/a	n/a

Table 9.7 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	
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	
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	

Table 9.8 Haddock in VIIa: total catch numbers at age.

	CATCH NUMBERS AT AGE				NUMBERS*10**-3								
YEAR	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
AGE													
0	0	0	0	0	0	0	0	0	0	0	n/a	0	0
1	959	306	13676	1051	13890	2391	491	5036	8091	1224	n/a	8197	2951
2	1645	162	1740	5095	1091	10201	647	1748	2602	669	n/a	2986	1727
3	18	861	861	735	2411	292	4462	238	1131	1864	n/a	1147	345
4	1	3	3	16	203	539	49	374	80	196	n/a	76	222
+gp	1	2	2	30	16	35	72	28	127	28	n/a	97	43
TOTALNUM	2624	1334	16282	6927	17611	13458	5721	7424	12031	3981		12502	5288
TONSLAND	813	1043	1753	3023	3391	4902	4129	1380	2498	1971		1278	699
SOPCOF %	60	90	26	85	41	67	96	41	51	86		20	33

Table 9.9 Haddock in VIIa: stock weights at age

	STOCK WEIGHTS AT AGE (KG)												
YEAR	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
AGE													
0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0.090	0.079	0.081	0.079	0.067	0.056	0.054	0.046	0.049	0.048	0.047	0.036	0.033
2	0.433	0.349	0.363	0.378	0.370	0.265	0.234	0.237	0.210	0.225	0.219	0.204	0.159
3	1.153	0.999	0.810	0.822	0.905	0.769	0.586	0.527	0.565	0.493	0.505	0.485	0.470
4	1.893	2.168	1.712	1.321	1.454	1.412	1.301	0.979	0.935	0.984	0.810	0.826	0.835
+gp	2.665	3.160	3.292	2.572	2.213	2.042	2.159	1.991	1.685	1.517	1.425	1.223	1.274

Table 9.10 Haddock in VIIa: Selected diagnostics and model output from the exploratory ICA run.

Catch in Number

AGE	1993	1994	1995	1996	1997	1998	1999	2000
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1	94.0	30.0	1341.0	109.0	1285.0	100.0	91.0	443.0
2	1250.0	123.0	1322.0	4619.0	700.0	6427.0	519.0	947.0
3	18.0	861.0	107.0	735.0	2411.0	292.0	4462.0	270.0
4	1.0	3.0	222.0	16.0	203.0	539.0	49.0	428.0
5	1.0	2.0	5.0	30.0	16.0	35.0	72.0	30.0

x 10 ^ 3

Catch in Number

AGE	2001	2002	2003	2004	2005
0	0.0	0.0	*******	0.0	0.0
1	520.0	88.0	*******	36.0	30.0
2	1988.0	400.0	*******	114.0	412.0
3	1004.0	1046.0	*******	424.0	110.0
4	70.0	116.0	*******	44.0	165.0
5	115.0	16.0	*******	60.0	32.0

x 10 ^ 3

Predicted Catch in Number

AGE	2000	2001	2002	2003	2004	2005
0	0.0	0.0	0.0	0.0	0.0	0.0
1	406.0	135.8	165.3	83.5	40.4	56.7
2	1213.8	3327.0	296.4	2424.2	105.8	249.6
3	220.5	1233.6	927.7	624.7	437.7	106.0
4	432.0	84.7	113.7	767.6	38.6	164.4

x 10 ^ 3

Fitted Selection Pattern

AGE	1993	1994	1995	1996	1997	1998	1999	2000
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.3994	0.0169	0.1781	0.1016	0.0877	0.1153	0.0301	0.1035
2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.7062	1.9681	2.0023	1.3293	1.2118	1.7669	2.0342	1.6292
4	1.9684	0.7903	1.3163	0.9324	0.8637	1.0659	0.8465	1.0000
5	1.9684	0.7903	1.3163	0.9324	0.8637	1.0659	0.8465	1.0000

Fitted Selection Pattern

AGE	2001	2002	2003	2004	2005
0	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.1035	0.1035	0.1035	0.1035	0.1035
2	1.0000	1.0000	1.0000	1.0000	1.0000
3	1.6292	1.6292	1.6292	1.6292	1.6292
4	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0000

No of years for separable analysis : 6

Age range in the analysis : 0 . . . 5

Table 9.10 contd.

```
Year range in the analysis : 1993  . . . 2005
Number of indices of SSB : 0
Number of age-structured indices : 3

Parameters to estimate : 29
Number of observations : 146

Conventional single selection vector model to be fitted.
```

Table 9.10 contd. Haddock in VIIa: Selected diagnostics and model output from the exploratory ICA run.

PARAMETER ESTIMATES

Parm. No.			Maximum Likelh. Estimate	CV (%)	Lower 95% CL	Upper 95% CL	-s.e.	+s.e.	Mean of Param. Distrib.
Separable model : F by year									
1	2000		0.3672	31	0.1966	0.6859	0.2670	0.5051	0.3864
2	2001		0.4861	31	0.2638	0.8958	0.3558	0.6640	0.5103
3	2002		0.1478	34	0.0755	0.2893	0.1050	0.2082	0.1568
4	2003		0.3214	97	0.0480	2.1541	0.1218	0.8484	0.5148
5	2004		0.0538	34	0.0271	0.1068	0.0379	0.0763	0.0572
6	2005		0.0430	31	0.0231	0.0799	0.0313	0.0590	0.0452
Separable Model: Selection (S) by age									
7	0		0.0000	0	0.0000	0.0000	0.0000	0.0000	0.0000
8	1		0.1035	30	0.0566	0.1894	0.0761	0.1409	0.1086
	2		1.0000		Fixed : Reference Age				
9	3		1.6292	24	1.0089	2.6306	1.2758	2.0803	1.6786
	4		1.0000		Fixed : Last true age				
Separable model: Populations in year 2005									
10	0		9497	40	4278	21083	6322	14266	10316
11	1		14090	32	7523	26389	10229	19406	14830
12	2		6540	26	3863	11072	4999	8555	6780
13	3		1726	26	1034	2883	1329	2243	1786
14	4		4308	29	2407	7712	3201	5799	4503
Separable model: Populations at age									
15	2000		1540	48	597	3971	950	2497	1731
16	2001		239	36	117	491	166	345	256
17	2002		909	37	433	1908	623	1327	977
18	2003		3063	34	1549	6058	2163	4338	3255
19	2004		812	43	343	1920	523	1259	894
Age-structured index catchabilities									
NIGFS March									
Linear model fitted. Slopes at age :									
20	1	Q	1.247	28	.9473	2.913	1.247	2.212	1.731
21	2	Q	.5565	28	.4232	1.294	.5565	.9844	.7708
22	3	Q	.2868	29	.2152	.6958	.2868	.5220	.4047
23	4	Q	.1037	32	.7578E-01	.2732	.1037	.1996	.1518
24	5	Q	.2290E-01	36	.1619E-01	.6670E-01	.2290E-01	.4715E-01	.3507E-01
NIGFS Oct									
Linear model fitted. Slopes at age :									
25	0	Q	4.326	26	3.346	9.548	4.326	7.385	5.858
26	1	Q	.9629	26	.7458	2.117	.9629	1.640	1.302
27	2	Q	.2041	26	.1581	.4487	.2041	.3475	.2759
28	3	Q	.1143	28	.8679E-01	.2675	.1143	.2030	.1588
MIK net May/June									
Linear model fitted. Slopes at age :									
29	0	Q	1.116	15	.9595	1.777	1.116	1.528	1.322

Table 9.10 contd.

```
 PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)
 ----------------------------------------------------

 Separable model fitted from 2000  to 2005
 Variance                             3.4550
Skewness test stat.                   2.4294
Kurtosis test statistic               2.9607
Partial chi-square                    0.6833
Significance in fit                   0.5916
Degrees of freedom                         1
```

Table 9.10 contd. Haddock in VIIa: Selected diagnostics and model output from the exploratory ICA run.

PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES

DISTRIBUTION STATISTICS FOR NIGFS March

Linear catchability relationship assumed

Age	1	2	3	4	5
Variance	0.1358	0.0982	0.1047	0.0266	0.1141
Skewness test stat.	-1.8960	-0.3771	0.0049	-0.3357	0.3233
Kurtosis test statisti	0.3992	-0.7739	0.3096	-0.4582	-0.6848
Partial chi-square	0.2246	0.1789	0.3744	0.0741	0.7280
Significance in fit	0.0000	0.0000	0.0000	0.0000	0.0002
Number of observations	14	14	13	12	10
Degrees of freedom	13	13	12	11	9
Weight in the analysis	0.2000	0.2000	0.2000	0.2000	0.2000

DISTRIBUTION STATISTICS FOR NIGFS Oct

Linear catchability relationship assumed

Age	0	1	2	3
Variance	0.1368	0.1163	0.2217	0.1138
Skewness test stat.	-1.6917	0.0706	-0.5268	-0.9309
Kurtosis test statisti	-0.0138	-0.3037	-0.9767	0.0872
Partial chi-square	0.1735	0.1863	0.4688	0.8635
Significance in fit	0.0000	0.0000	0.0000	0.0000
Number of observations	13	13	13	12
Degrees of freedom	12	12	12	11
Weight in the analysis	0.2500	0.2500	0.2500	0.2500

DISTRIBUTION STATISTICS FOR MIK net May/June

Linear catchability relationship assumed

Age	0
Variance	0.8315
Skewness test stat.	1.0061
Kurtosis test statisti	-0.1073
Partial chi-square	1.1023
Significance in fit	0.0001
Number of observations	12
Degrees of freedom	11
Weight in the analysis	1.0000

ANALYSIS OF VARIANCE

Unweighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	68.4803	146	29	117	0.5853
Catches at age	3.4550	20	19	1	3.4550
Aged Indices					
NIGFS March	28.0841	63	5	58	0.4842
NIGFS Oct	27.7950	51	4	47	0.5914
MIK net May/June	9.1462	12	1	11	0.8315

Weighted Statistics

Variance

	SSQ	Data	Parameters	d.f.	Variance
Total for model	15.4617	146	29	117	0.1322
Catches at age	3.4550	20	19	1	3.4550

Table 9.10 contd.

Aged Indices					
NIGFS March	1.1234	63	5	58	0.0194
NIGFS Oct	1.7372	51	4	47	0.0370
MIK net May/June	9.1462	12	1	11	0.8315

Table 9.11 Haddock in VIIa. Selected diagnostics and model output from the exploratory B-ADAPT run using the NIGFS and MIK net surveys with an applied F-smoothing value of 1.0.

Lowestoft VPA Program

16/05/2006 9:11

Adapt Analysis

IRISH SE/ 2006 WG 01-May ANON COMBSEX PLUSGROUP

CPUE data from file h7anitun.dat

Catch data for 13 years : 1993 to 2005. Ages 0 to 5+

Fleet	First year	Last year	First age	Last age	Alpha	Beta
NIGFS Ma	1993	2006	1	4	0.21	0.25
NIGFS Oc	1993	2006	0	3	0.83	0.88
MIK net M	1994	2006	0	0	0.38	0.47

Time series weights :

Tapered time weighting not applied

Catchability analysis :

Fleet	PowerQ ages<x	QPlateau ages>x
NIGFS	0	3
NIGFS	0	3
MIK ne	0	3

Catchability independent of stock size for all ages

Bias estimation :

Bias estimated for the final 6 years.

Oldest age F estimates in 1993 to 2006 calculated as 1.000 * the mean F of ages 2- 3

Total F pe lambda = 1.000

Individual fleet weighting not applied

INITIAL S	1675.156
PARAMET	10
OBSERVA	144

SSQ =	74.37006
QSSQ	65.62507
CSSQ	8.74499
IFAIL =	3

IFAILCV = 0

Regression weights

1	1	1	1	1	1	1	1	1	1

Fishing mortalities

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
0	0	0	0	0	0	0	0	0	0	0
1	0.074	0.075	0.061	0.019	0.053	0.12	0.021	0.026	0.02	0.012
2	0.743	0.906	0.634	0.508	0.447	0.228	0.471	0.299	0.287	0.41
3	1.074	1.197	1.371	1.356	0.986	0.697	0.716	0.528	0.54	0.616
4	0.909	1.052	1.002	0.932	0.717	0.462	0.593	0.414	0.413	0.513

Table 9.11 contd. Haddock in VIIa. Selected diagnostics and model output from the exploratory B-ADAPT run using the NIGFS and MIK net surveys with an applied F-smoothing value of 1.0.

Population numbers (Thousands)

	AGE				
YEAR	0	1	2	3	4
1996	2.40E+04	1.68E+03	9.60E+03	1.21E+03	2.91E+01
1997	2.26E+03	1.97E+04	1.28E+03	3.74E+03	3.38E+02
1998	6.56E+03	1.85E+03	1.49E+04	4.22E+02	9.24E+02
1999	1.75E+04	5.37E+03	1.43E+03	6.49E+03	8.78E+01
2000	6.39E+03	1.43E+04	4.32E+03	7.02E+02	1.37E+03
2001	1.84E+04	5.23E+03	1.11E+04	2.26E+03	2.14E+02
2002	5.05E+03	1.50E+04	3.80E+03	7.25E+03	9.21E+02
2003	1.59E+04	4.14E+03	1.20E+04	1.94E+03	2.90E+03
2004	2.63E+04	1.30E+04	3.30E+03	7.31E+03	9.37E+02
2005	1.41E+04	2.15E+04	1.04E+04	2.03E+03	3.49E+03

Estimated population abundance at 1st Jan 2006

0.00E+00	1.16E+04	1.74E+04	5.66E+03	8.97E+02

Taper weighted geometric mean of the VPA populations:

9.15E+03	5.88E+03	3.94E+03	1.27E+03	2.38E+02

Standard error of the weighted Log(VPA populations) :

0.8699	1.1378	1.1054	1.6265	2.3403

Log population residuals (unweighted).

Fleet : NIGFS March

Log index residuals

Age	1993	1994	1995	1996
0	No data for this fleet at this age			
1	-1.19	-1.7	0.68	-0.42
2	-0.74	-0.78	-0.94	0.03
3	1.79	-0.44	99.99	-1.32
4	99.99	99.99	-0.57	-0.74

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	No data for this fleet at this age									
1	0.28	0.78	0.14	0.01	-0.42	0.67	0.55	0.45	0.15	99.99
2	0.02	0.4	0.18	0.06	0.39	-0.6	1.03	0.54	0.42	99.99
3	0.66	-0.15	0.5	-0.84	0.41	-0.43	-0.29	0.25	-0.14	99.99
4	-0.47	-0.62	-0.16	-0.74	-0.25	-1	-0.68	-1.61	-1.26	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
Mean Log	0.0257	-0.7545	-1.2816	-1.2816
S.E(Log q)	0.7535	0.5972	0.8018	0.8807

Regression statistics :
Ages with q independent of year class strength and constant w.r.t. time.

Age	Slope	t-value	Intercept	RSquare	No Pts	Reg s.e	Mean Q
1	0.74	2.014	2.2	0.85	13	0.50064	0.03
2	0.76	2.432	2.58	0.9	13	0.38122	-0.75
3	1.23	-1.223	-0.09	0.74	12	0.96259	-1.28
4	1.17	-1.761	1.28	0.92	11	0.45249	-2.02

Table 9.11 contd. Haddock in VIIa. Selected diagnostics and model output from the exploratory B-ADAPT run using the NIGFS and MIK net surveys with an applied F-smoothing value of 1.0.

Fleet : NIGFS Oct

Log index residuals

Age	1993	1994	1995	1996
0	-1.08	0.16	-1.3	0.69
1	-1.01	-0.77	0.21	0.07
2	0.24	-0.98	-1.26	0.6
3	1.14	0.28	99.99	-1.43
4	No data for this fleet at this age			

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	0.89	0.76	0.44	-1.07	0.32	0	0.13	-0.11	0.17	99.99
1	1.14	0.02	-0.25	-0.1	-0.49	0.03	0.94	0.49	-0.27	99.99
2	0.61	1	-0.73	0.48	0.63	-1.55	0.7	1.12	-0.84	99.99
3	-0.44	0.4	-0.46	-0.1	0.79	-0.19	-0.86	0.22	0.65	99.99
4	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
Mean Log	1.2636	-0.1988	-1.6606	-2.011
S.E(Log q)	0.7202	0.6102	0.929	0.7306

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	0.76	1.399	1.26	0.75	13	0.52442	1.26
1	0.79	1.847	1.95	0.88	13	0.44162	-0.2
2	0.74	1.549	3.4	0.76	13	0.64849	-1.66
3	1.26	-1.53	0.65	0.78	12	0.86623	-2.01

Fleet : MIK net May/June

Log index residuals

Age	1993	1994	1995	1996
0	99.99	1.27	0.01	0.88
1	No data for this fleet at this age			
2	No data for this fleet at this age			
3	No data for this fleet at this age			
4	No data for this fleet at this age			

Age	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	2.06	-0.77	0.07	-1.13	0.13	-1.24	-1.12	0.18	-0.34	99.99
1	No data for this fleet at this age									
2	No data for this fleet at this age									
3	No data for this fleet at this age									
4	No data for this fleet at this age									

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	-0.112
S.E(Log q)	1.0196

Table 9.11 contd. Haddock in VIIa. Selected diagnostics and model output from the exploratory B-ADAPT run using the NIGFS and MIK net surveys with an applied F-smoothing value of 1.0.

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	1.04	-0.113	-0.28	0.41	12	1.11504	-0.11

Year	Est.Landir	Landings	Bias
1993	813	813	
1994	1042	1043	
1995	1752	1753	
1996	3014	3023	
1997	3583	3391	
1998	4923	4902	
1999	4131	4129	
2000	2356	1569	1.502
2001	2306	2226	1.036
2002	3952	1215	3.253
2003	4064	674	6.021
2004	5001	760	6.58
2005	4134	533	7.757

Fishing Mortality

YEAR	AGE				
	0	1	2	3	4
1993	0	0.23529	0.59282	1.32486	0.95884
1994	0	0.00924	0.54781	1.1238	0.83581
1995	0	0.11861	0.68096	1.44499	1.06297
1996	0	0.07419	0.74321	1.07437	0.90879
1997	0	0.07472	0.90617	1.19729	1.05173
1998	0	0.06139	0.63407	1.37059	1.00233
1999	0	0.01886	0.50812	1.35572	0.93192
2000	0	0.05256	0.44743	0.98599	0.71671
2001	0	0.12039	0.2275	0.69725	0.46238
2002	0	0.02123	0.47057	0.71642	0.59349
2003	0	0.02602	0.299	0.52849	0.41374
2004	0	0.02033	0.28715	0.53973	0.41344
2005	0	0.012	0.40984	0.61554	0.51269
2006	0	0.012	0.40984	0.61554	0.51269

Parameters

Age	Survivors	s.e log est
0	11565.19	0.45269
1	17415.17	0.33789
2	5660.054	0.33025
3	896.9203	0.39776

Year	Multiplier	s.e log est
8	1.50154	0.25933
9	1.03587	0.29269
10	3.25333	0.27948
11	6.02107	0.2991
12	6.57982	0.31243
13	7.7567	0.34602

Variance covariance matrix

0.20493	0.01773	0.01261	0.00792	0.01197	0.01518	0.01593	0.01555	0.01592	0.01726
0.01773	0.11417	0.01861	0.00415	0.01137	0.01387	0.01367	0.01096	0.00955	0.03092
0.01261	0.01861	0.10907	0.02657	0.01113	0.0126	0.01059	0.00006	0.00156	-0.00883
0.00792	0.00415	0.02657	0.15821	0.0106	0.01079	0.00448	-0.0035	-0.02751	-0.04219
0.01197	0.01137	0.01113	0.0106	0.06725	0.0294	0.01441	0.00844	0.00777	0.00866
0.01518	0.01387	0.0126	0.01079	0.0294	0.08567	0.03624	0.01486	0.00804	0.0082
0.01593	0.01367	0.01059	0.00448	0.01441	0.03624	0.07811	0.03408	0.01658	0.01119
0.01555	0.01096	0.00006	-0.0035	0.00844	0.01486	0.03408	0.08946	0.0429	0.02411
0.01592	0.00955	0.00156	-0.02751	0.00777	0.00804	0.01658	0.0429	0.09761	0.05577
0.01726	0.03092	-0.00883	-0.04219	0.00866	0.0082	0.01119	0.02411	0.05577	0.11973

Table 9.12 Haddock in VIIa: SURBA 3.0 fitted numbers-at-age, total mortality at age, SSB and Z using the NIGFS-Mar survey data.

	NIGFS-March									
Numbers at age						Total mortality at age				
	Age					Age				
Year	1	2	3	4	5	1	2	3	4	5
1992	0.406	0.015	0	0	0	0.714	0.716	0.971	1.455	1.455
1993	0.061	0.199	0.007	0	0	0.922	0.925	1.254	1.881	1.881
1994	0.475	0.024	0.079	0.002	0	1.072	1.075	1.458	2.187	2.187
1995	6.789	0.162	0.008	0.018	0	1.428	1.432	1.943	2.913	2.913
1996	0.532	1.627	0.039	0.001	0.001	1.039	1.042	1.413	2.119	2.119
1997	10.321	0.188	0.574	0.009	0	1.299	1.302	1.766	2.649	2.649
1998	0.877	2.817	0.051	0.098	0.001	1.368	1.371	1.86	2.789	2.789
1999	3.256	0.223	0.715	0.008	0.006	1.267	1.271	1.724	2.585	2.585
2000	6.678	0.917	0.063	0.128	0.001	1.17	1.174	1.592	2.387	2.387
2001	1.419	2.072	0.284	0.013	0.012	1.326	1.33	1.803	2.704	2.704
2002	7.76	0.377	0.548	0.047	0.001	0.877	0.88	1.193	1.789	1.789
2003	2.323	3.228	0.156	0.166	0.008	1.089	1.092	1.481	2.22	2.22
2004	8.633	0.782	1.083	0.036	0.018	1.149	1.152	1.563	2.343	2.343
2005	12.763	2.736	0.247	0.227	0.003	1.192	1.195	1.621	2.431	2.431
2006	5.322	3.875	0.828	0.049	0.02	1.143	1.146	1.555	2.332	2.332

Stock summary

Year	Recruits (age 1)	log SE (rec)	SSB	TSB	Z(2-3)	SE (Z)
1992	0.406	0.379	0.007	0.043	0.843	0.341
1993	0.061	0.314	0.094	0.1	1.089	0.243
1994	0.475	0.285	0.092	0.129	1.267	0.2
1995	6.788	0.311	0.098	0.648	1.688	0.169
1996	0.532	0.268	0.651	0.693	1.228	0.195
1997	10.321	0.28	0.603	1.295	1.534	0.161
1998	0.877	0.286	0.926	0.975	1.616	0.156
1999	3.256	0.278	0.495	0.67	1.497	0.153
2000	6.678	0.27	0.376	0.684	1.383	0.158
2001	1.419	0.293	0.627	0.696	1.567	0.16
2002	7.76	0.254	0.402	0.775	1.036	0.163
2003	2.323	0.277	0.932	1.041	1.286	0.165
2004	8.633	0.296	0.736	1.047	1.357	0.16
2005	12.763	0.338	0.745	1.166	1.408	0.167
2006	5.322	0.417	0.943	1.151	1.351	0.078

Table 9.13 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 9.14 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

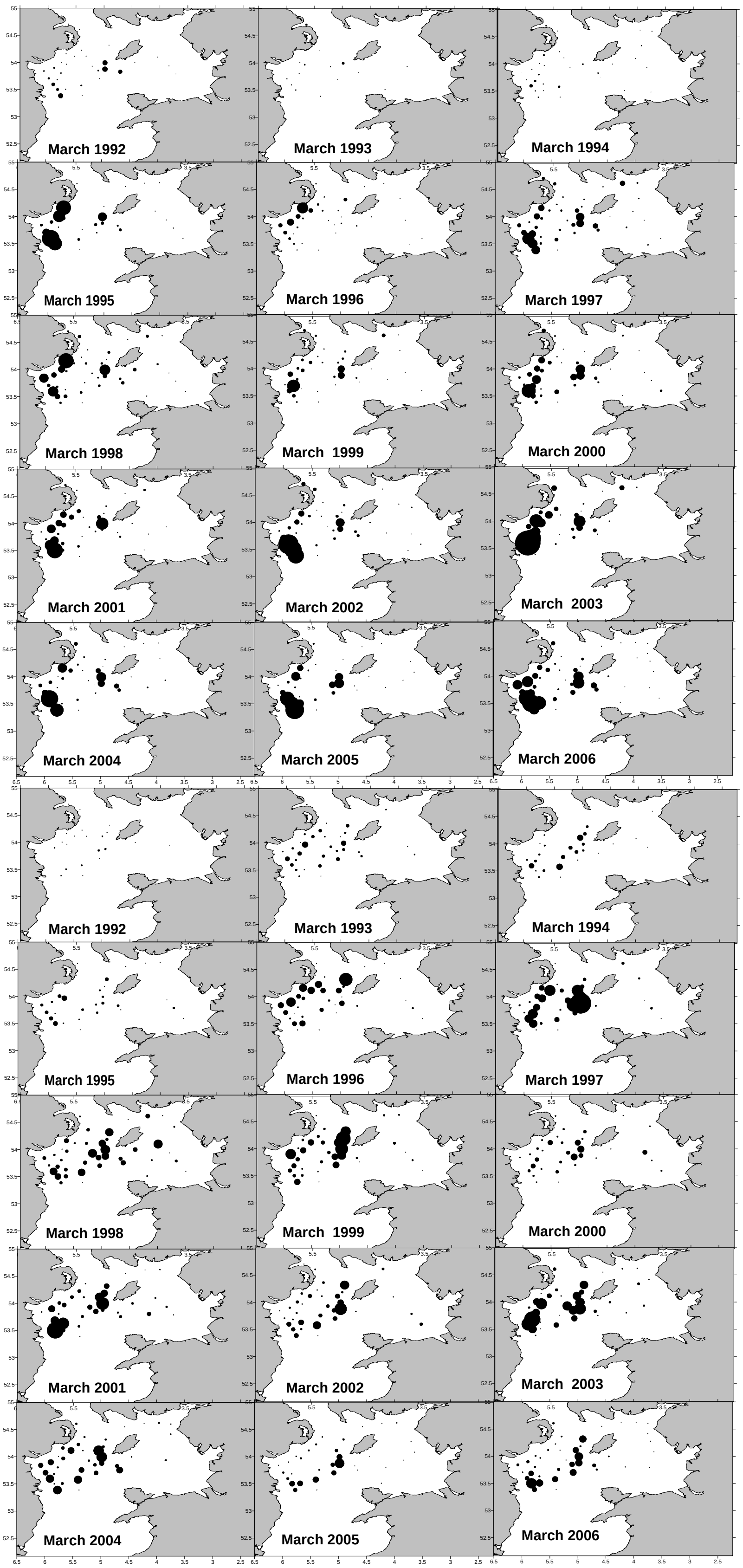


Figure 9.1 Haddock in VIIa: Distribution of haddock less than MLS (30 cm) (top plot) and above MLS (bottom plot) in spring, based on NIGFS March surveys. Areas of circles are proportional to catch rate in kg per 3 miles, with the largest circle relating to a catch rate of 665 (top) and 450 kg per 3 miles (bottom).

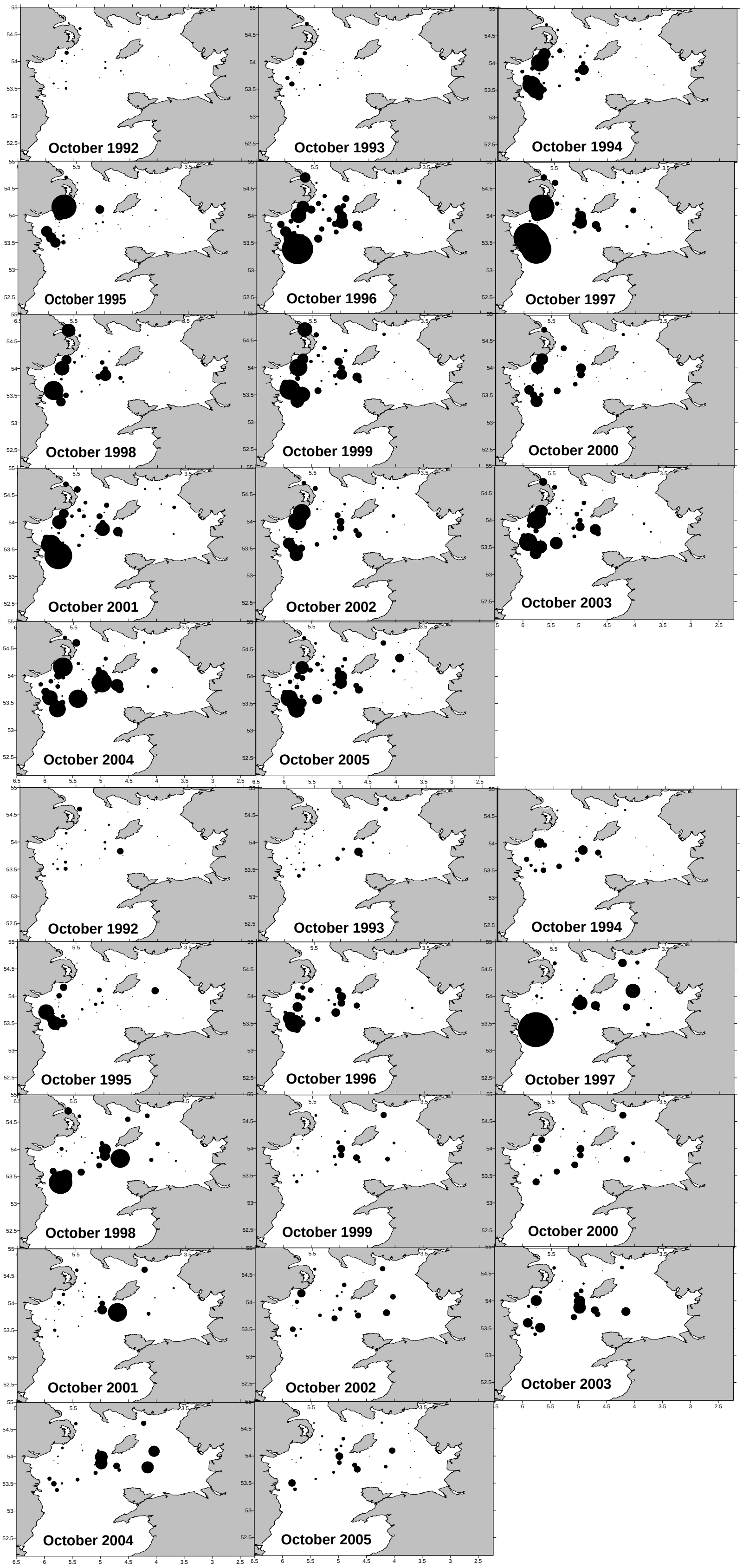


Figure 9.2 Haddock in VIIa: Distribution of haddock less than MLS (30 cm) (top plot) and above MLS (bottom plot) in autumn, based on NIGFS October surveys. Areas of circles are proportional to catch rate in kg per 3 miles, with the largest circle relating to a catch rate of 1030 (top) and 880 kg per 3 miles (bottom).

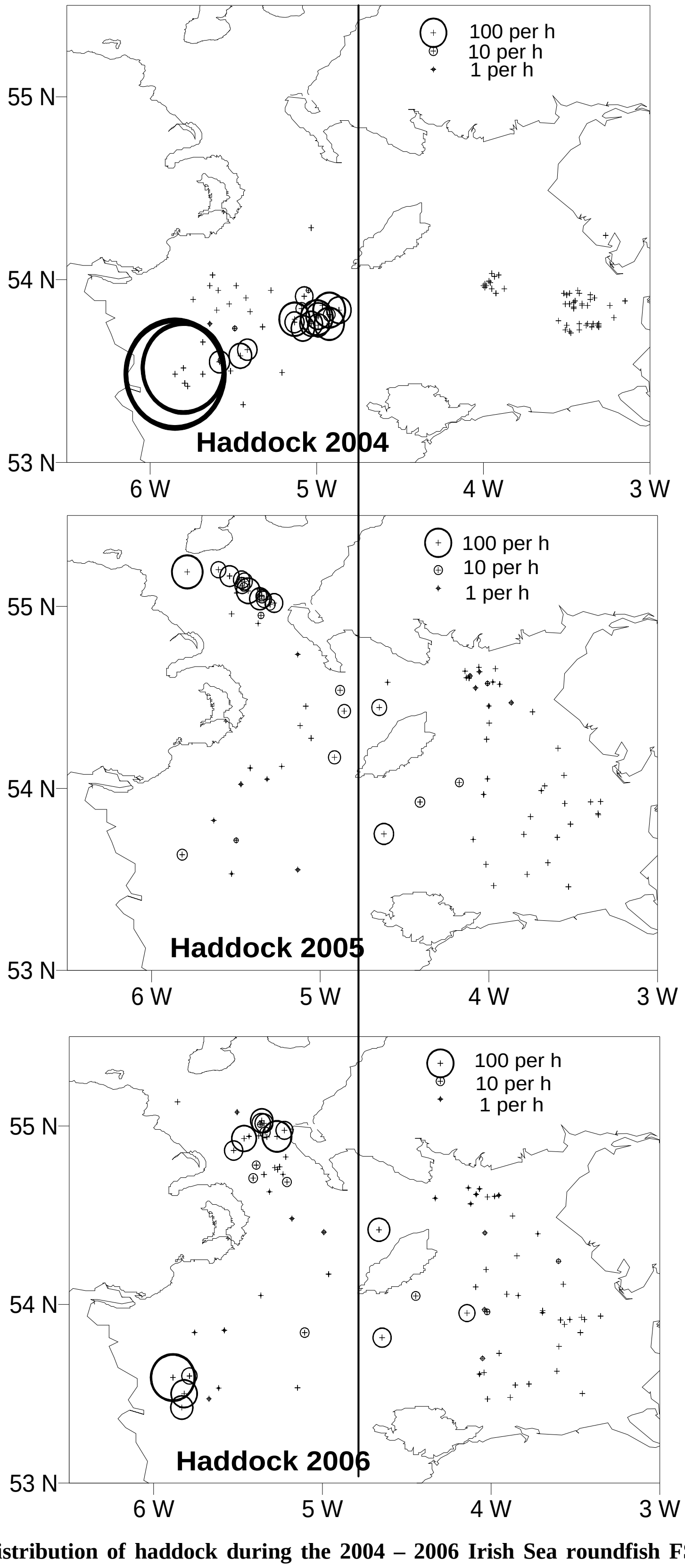


Figure 9.3 Distribution of haddock during the 2004 – 2006 Irish Sea roundfish FSP. The areas of the circles are proportional to numbers caught per hour (same scale for all plots).

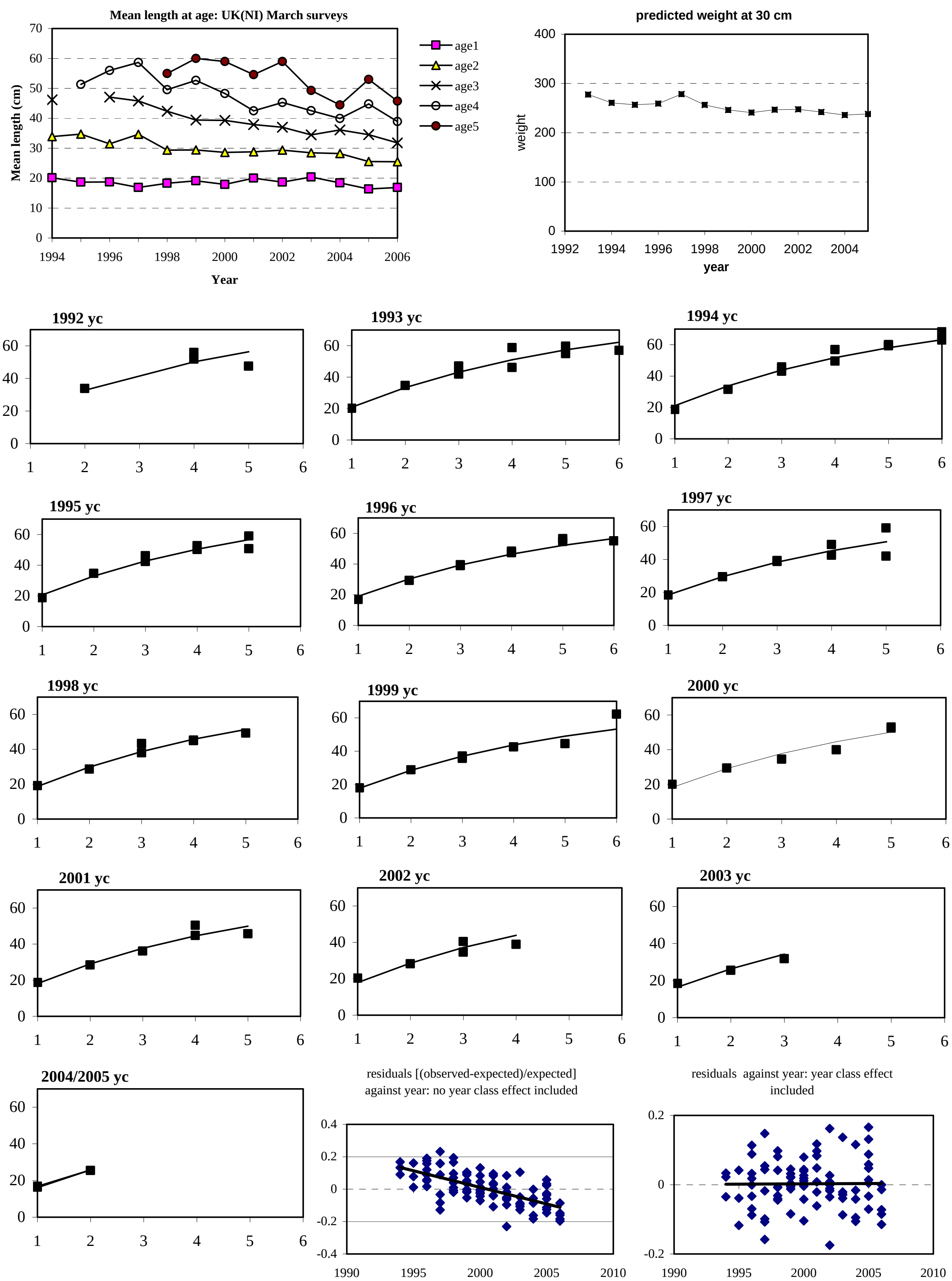


Figure 9.4 Growth of haddock in the Irish Sea. Top two panels: mean length at age in N.Ireland groundfish surveys in March, by year and age, and expected mean weight at length based on length-weight parameters from each survey. Lower panels: mean length at age from March surveys, and from Quarter 1 commercial 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.

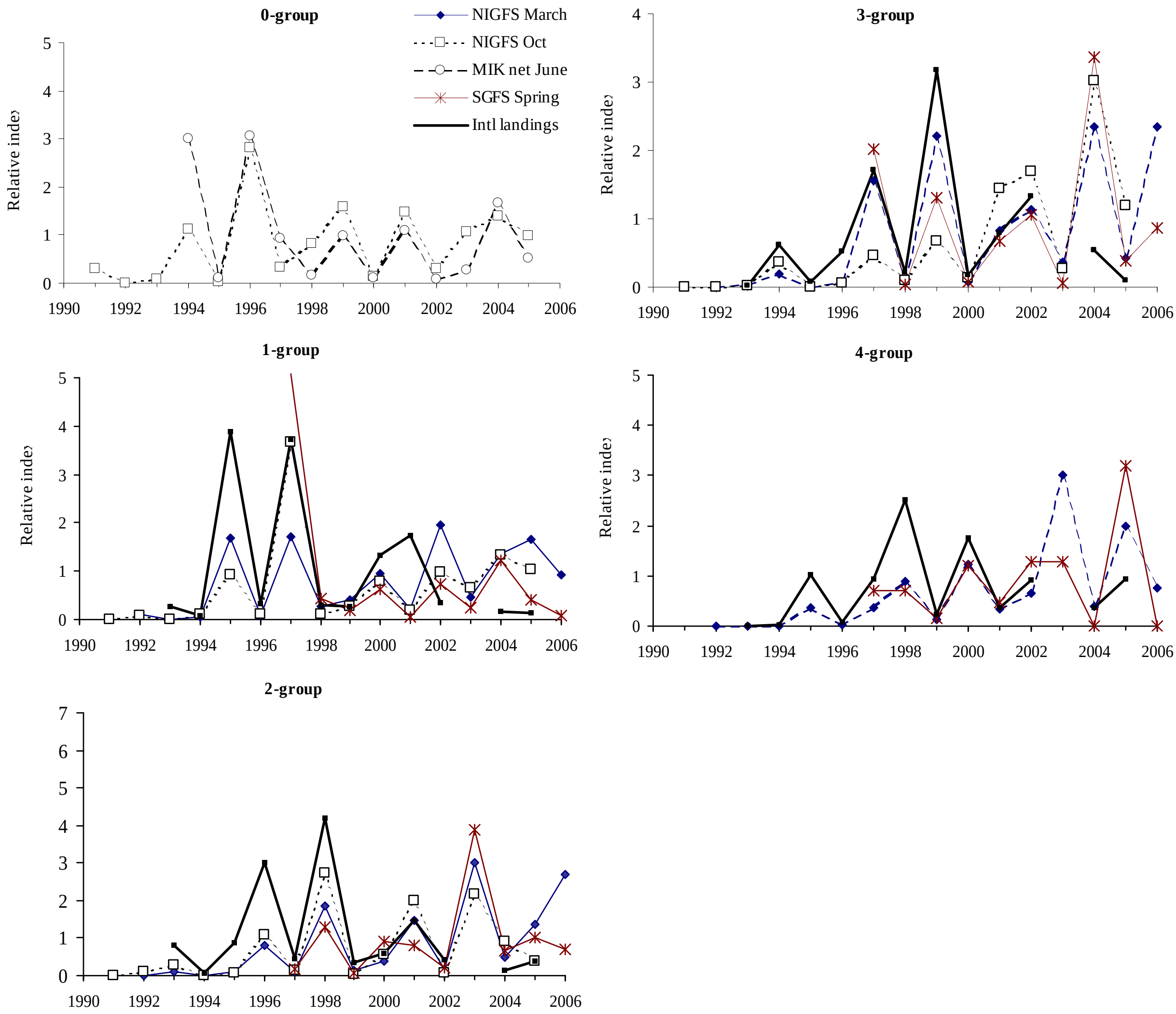


Figure 9.5 Haddock in VIIa: Trends in raw survey indices compared with international landings, by age class and year. All values are standardised to the mean for years common to all series in each plot.

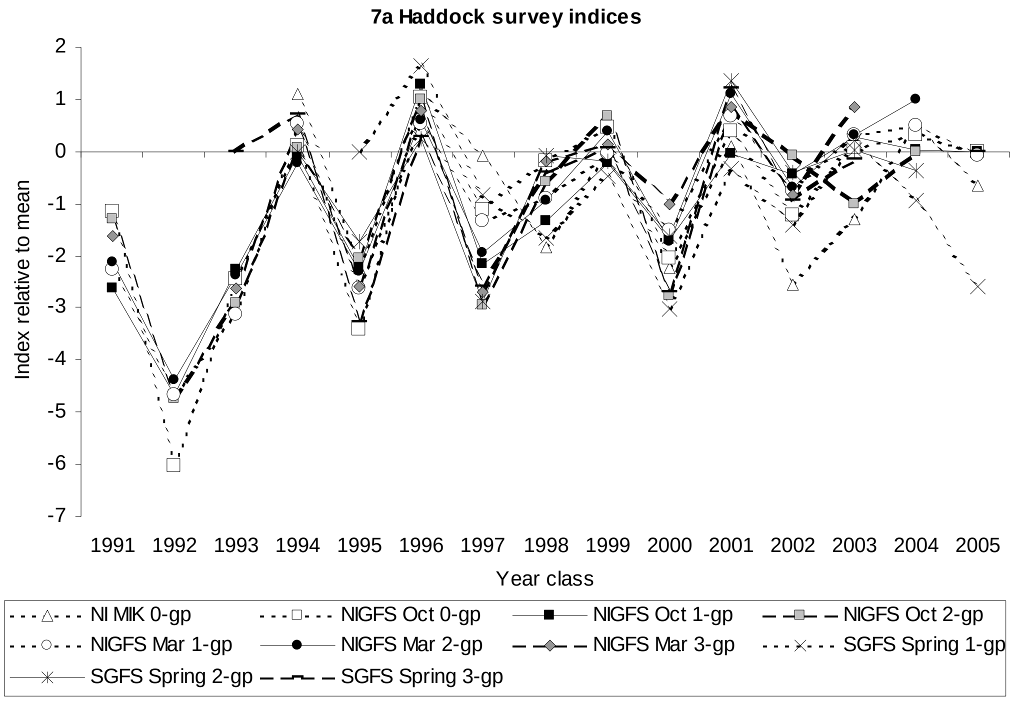


Figure 9.6 Haddock in VIIa: Time series plots of the logarithms of survey indices at age by year class, after standardising by dividing by the series mean for years from 1991. Data have only been illustrated for the most abundant ages for comparison of year-class signals.

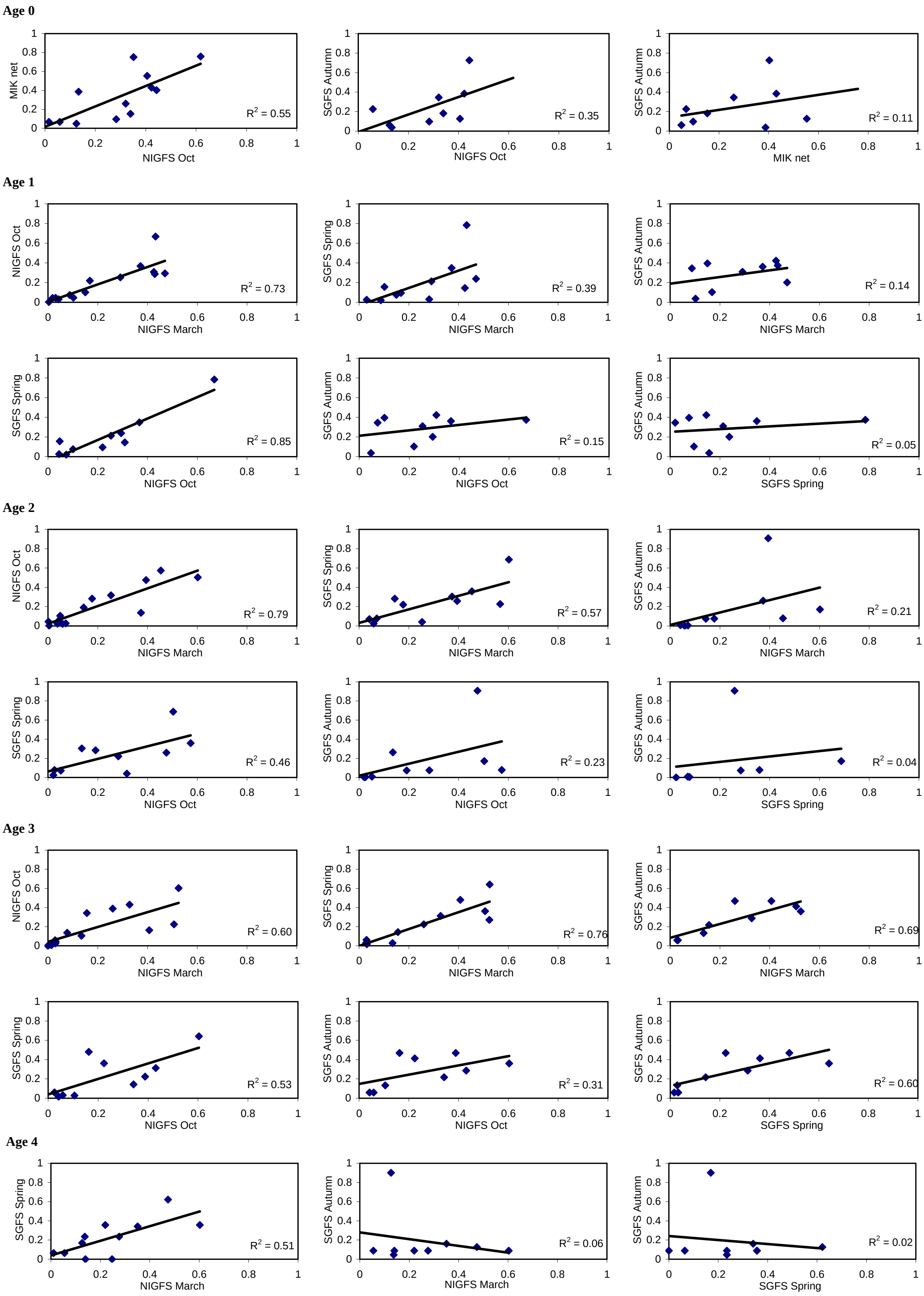


Figure 9.7 **Haddock in VIIa: Correlation between survey series by age class.**

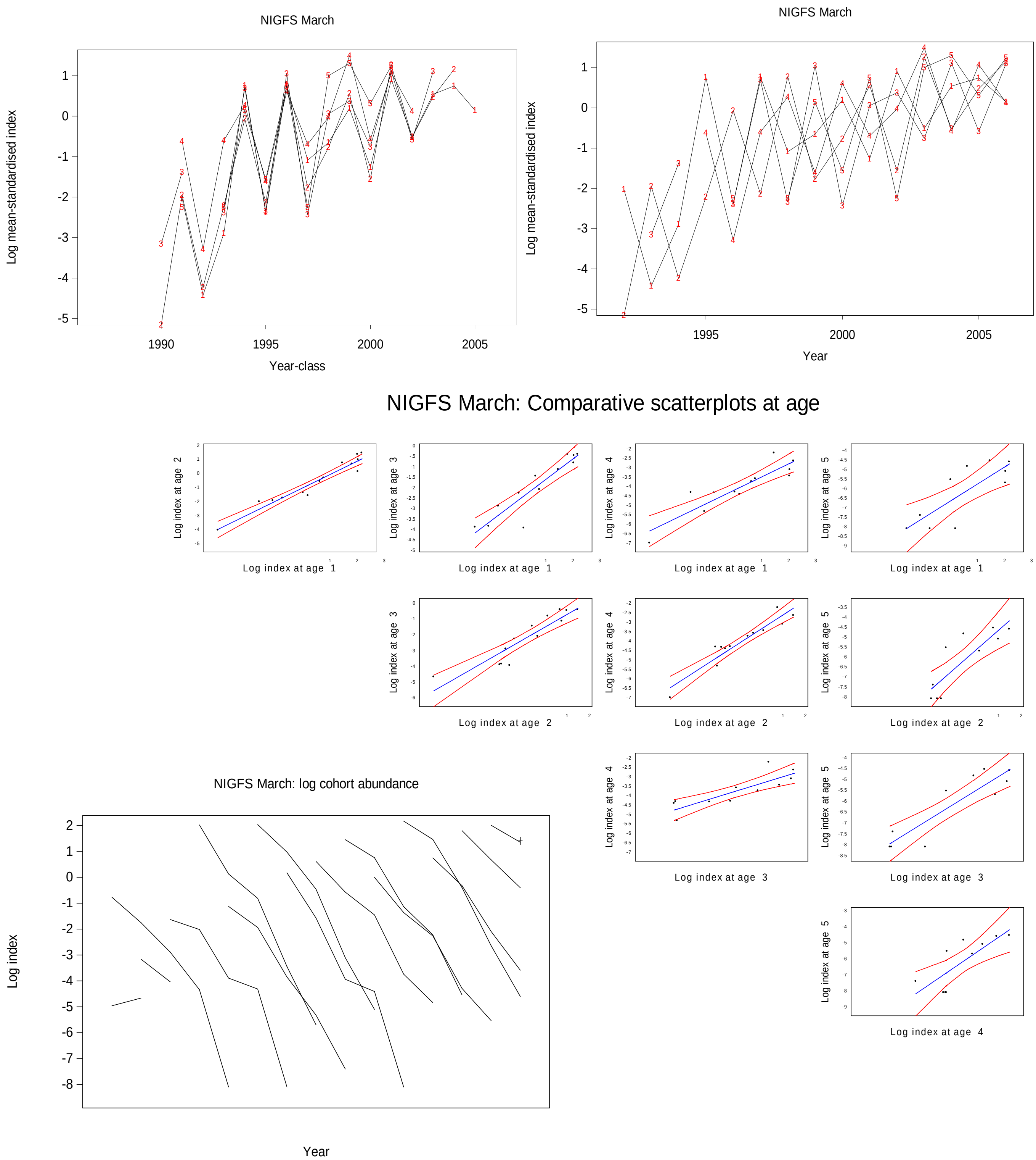


Figure 9.8 Haddock in VIIa: Output from SURBA (ver. 3.0) plots for NIGFS March survey (ages 1-5), showing log mean-standardised indices by year and age class, scatter plots and catch curves.

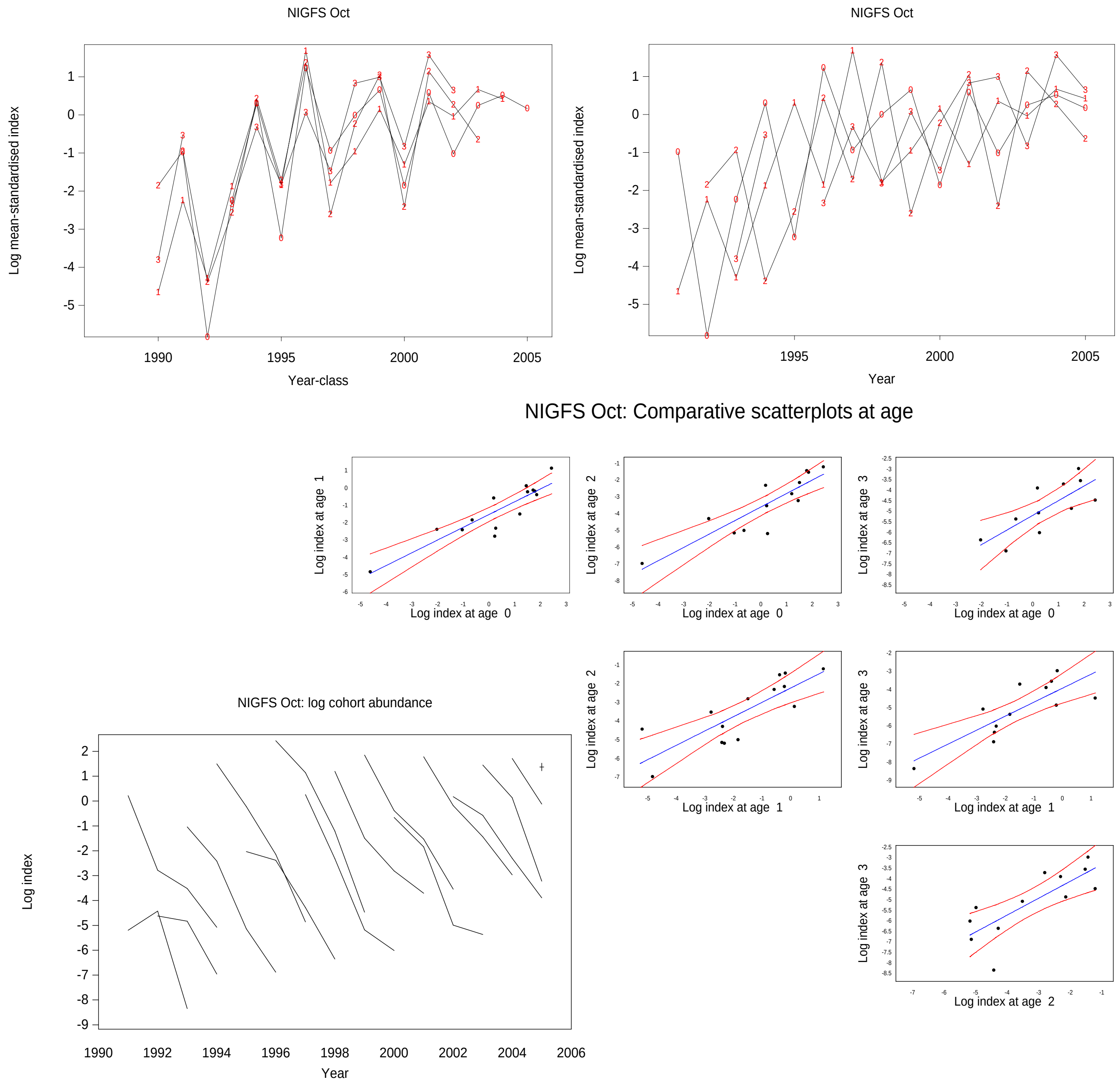


Figure 9.9 **Haddock in VIIa: Output from SURBA (ver. 3.0) plots for NIGFS October survey (ages 0-3), showing log mean-standardised indices by year and age class, scatter plots and catch curves.**

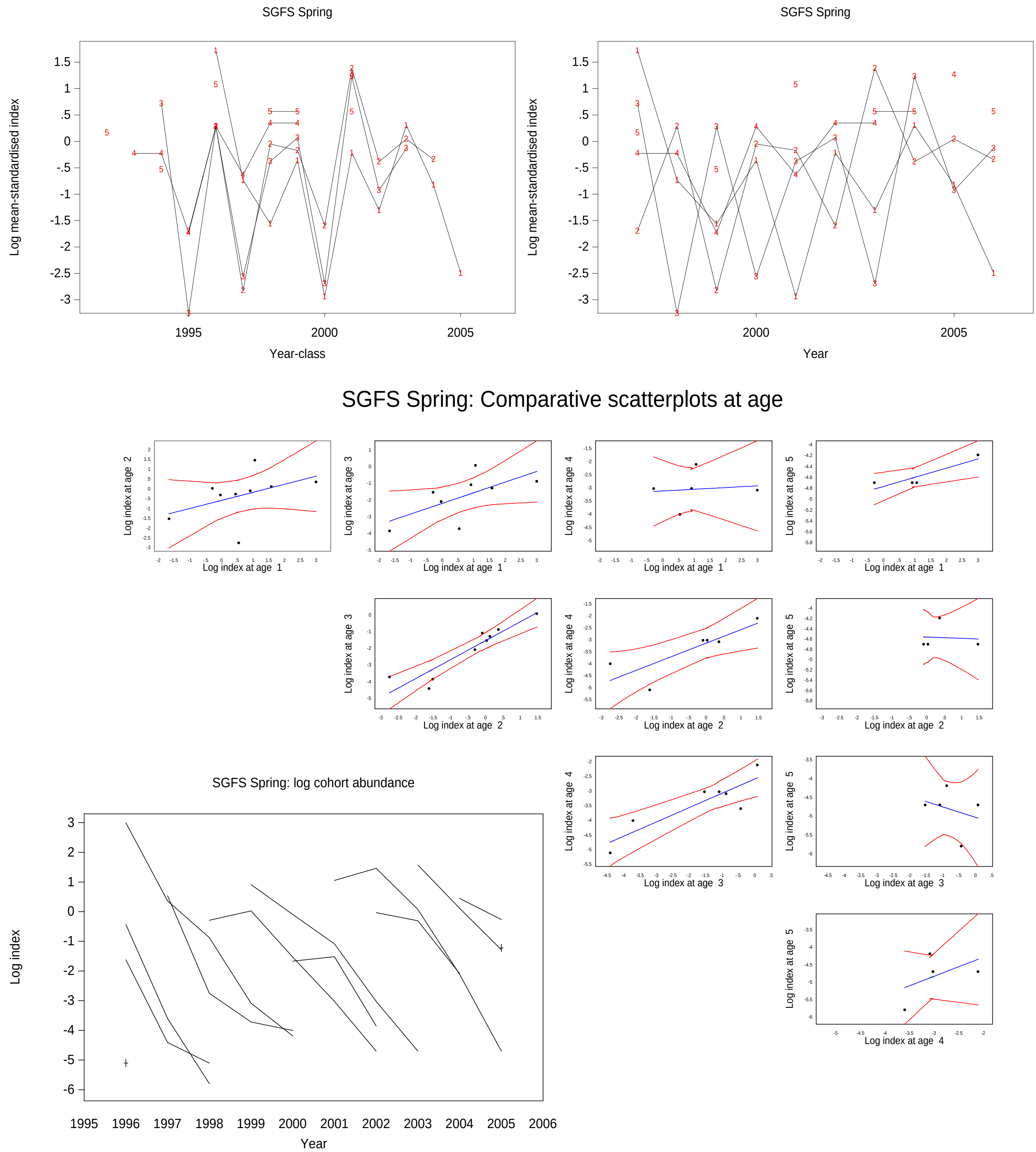


Figure 9.10 Haddock in VIIa: Output from SURBA (ver. 3.0) plots for ScoGFS Spring survey (ages 1-5), showing log mean-standardised indices by year and age class, scatter plots and catch curves.

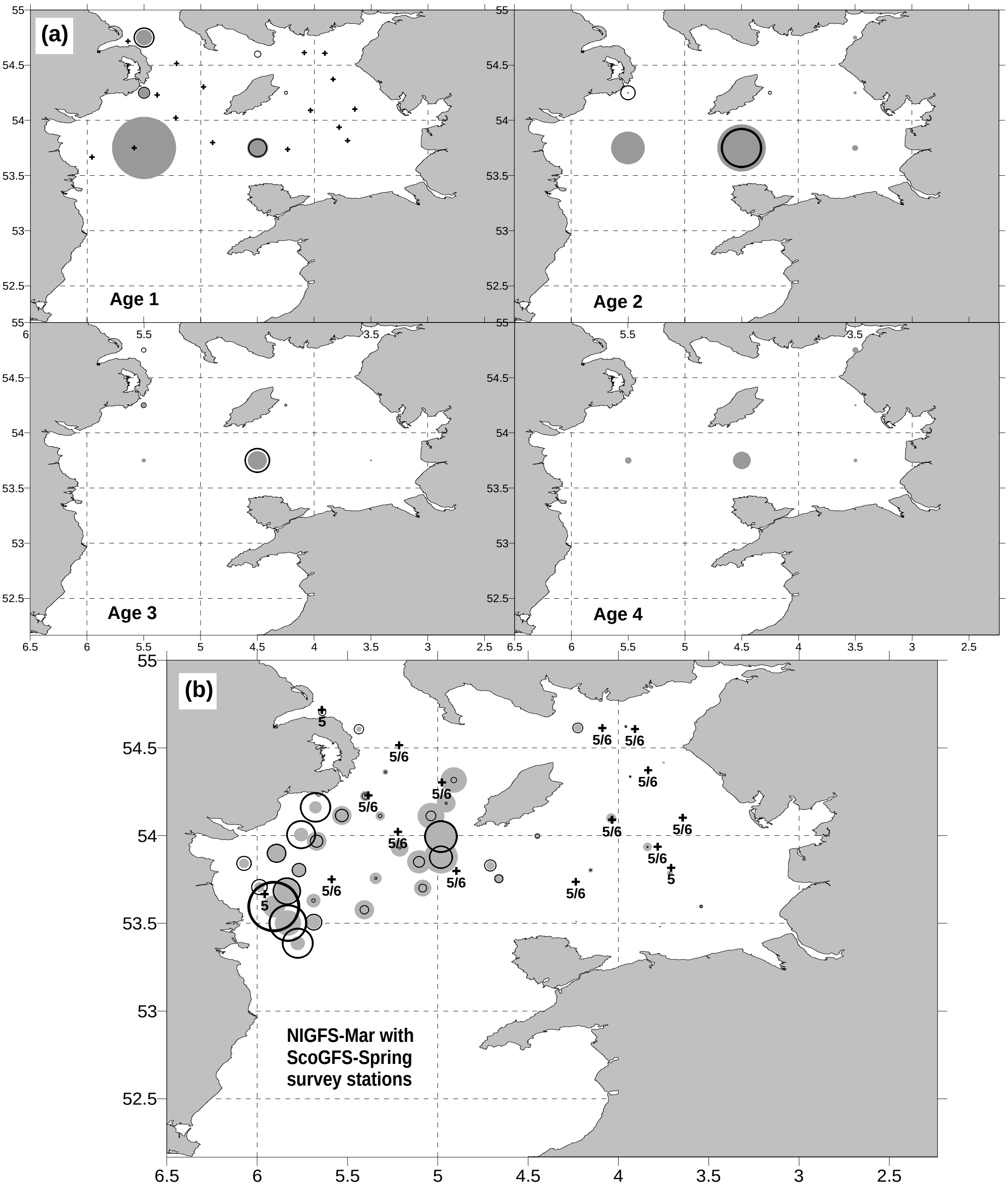


Figure 9.11 Haddock VIIa: Distribution of haddock and station positions in spring 2005-2006, based on ScoGFS-Spring surveys. (a) Distribution of haddock at age by ICES statistical rectangle (2005 – grey shaded circles, 2006 – black open circles). Areas of circles are proportional to catch rate in number per hour, with the largest circle relating to a catch rate of 345 fish per hour. (b) Distribution of haddock based on the average catch rates 1992-2006 from the NIGFS-Mar surveys (>MLS – grey shaded circles, <MLS – black open circles). Areas of circles are proportional to catch rate in kg per 3 miles, with the largest circle relating to a catch rate of 185 kg per 3 miles. Station positions from the Sco-Spring surveys are indicated by + symbols and labelled by sampling year in (b).

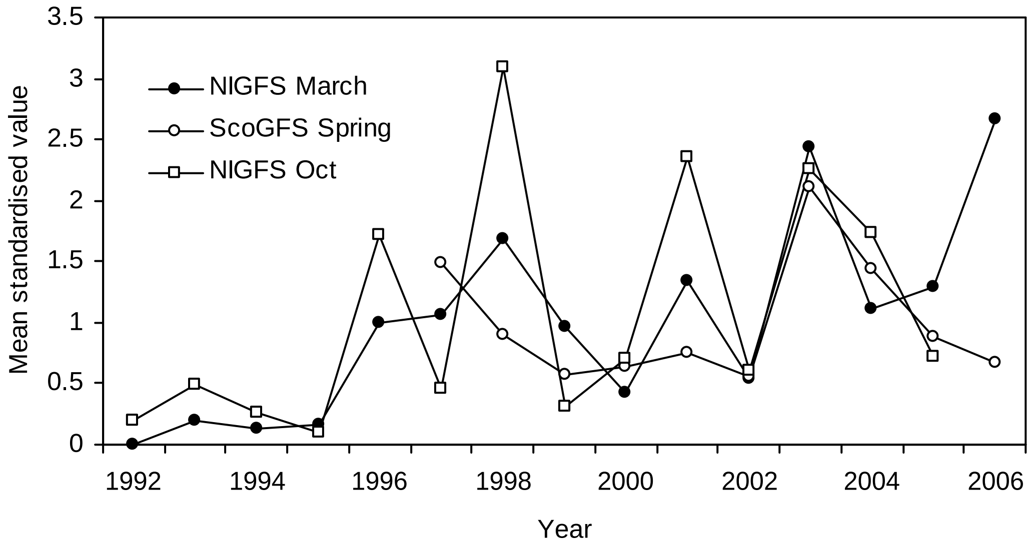


Figure 9.12 **Haddock in VIIa: Mean Standardised empirical SSB indices from the NIGFS-Mar, NIGFS-Oct and ScoGFS-Spring surveys, based on raw indices up to age 6.**

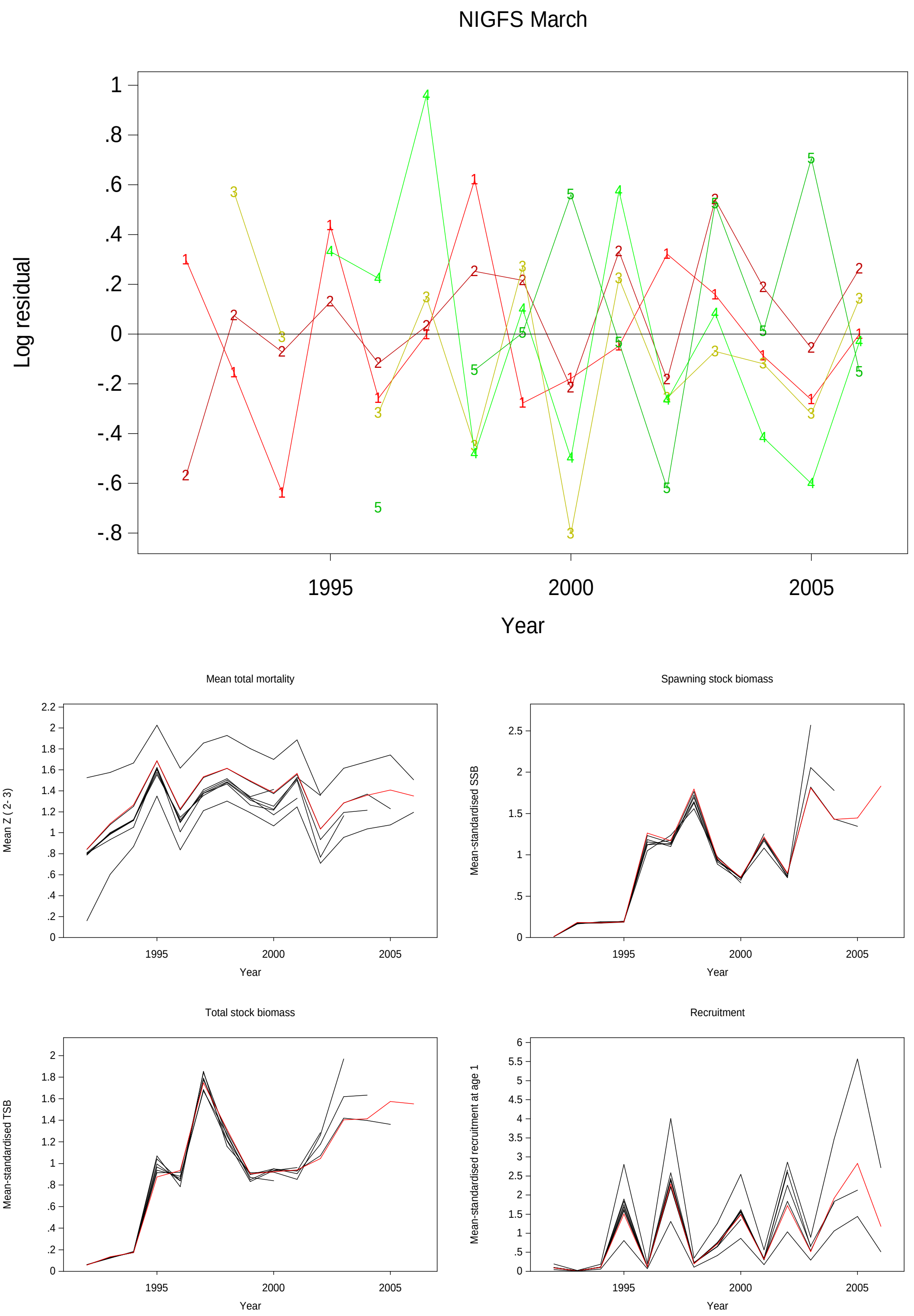


Figure 9.13 **Haddock VIIa:SURBA 3.0 Residuals at age (top panel) and residual plots (bottom panel) for the NIGFS-Mar survey.**

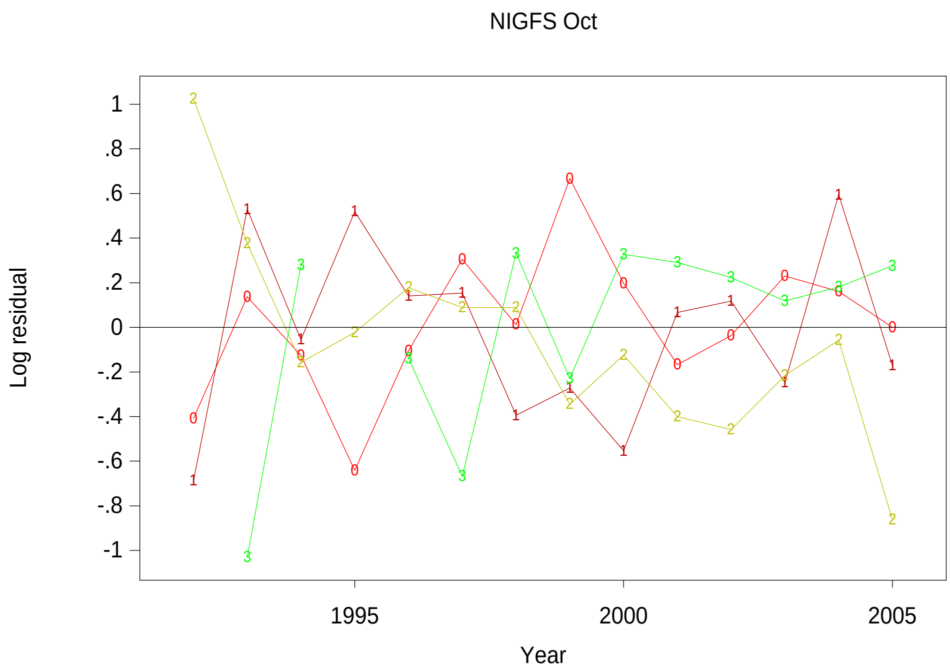


Figure 9.14 **Haddock VIIa: SURBA 3.0 Residuals at age for the NIGFS-Oct survey.**

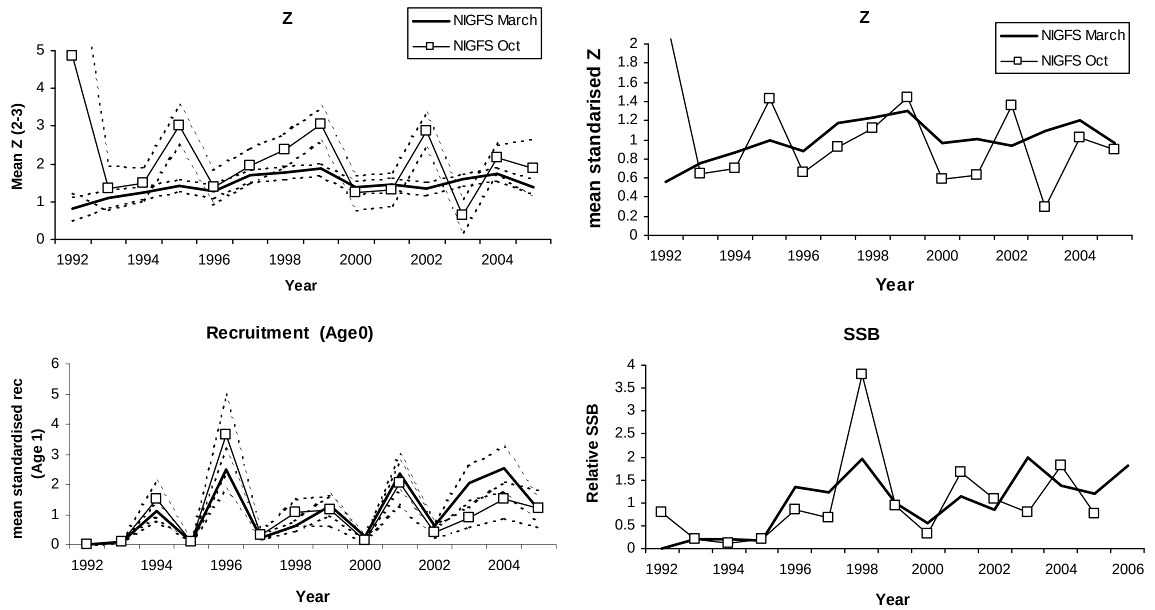


Figure 9.15 **Haddock in VIIa: Comparison of SURBA runs using NIGFS-Mar and NIGFS-Oct survey data. Dotted lines are +/- 1SE. Z estimates given as absolute and relative.**

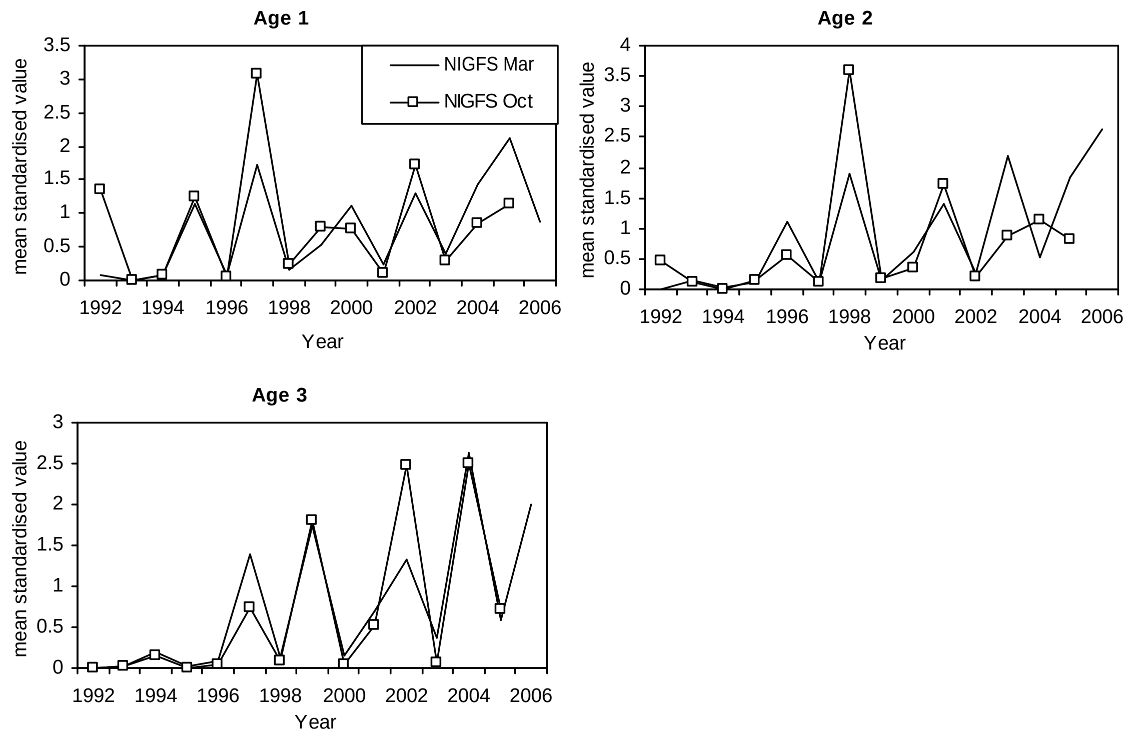


Figure 9.16 Haddock in VIIa: Comparison of SURBA estimates of numbers at age (mean standardised) using NIGFS-Mar and NIGFS-Oct survey data.

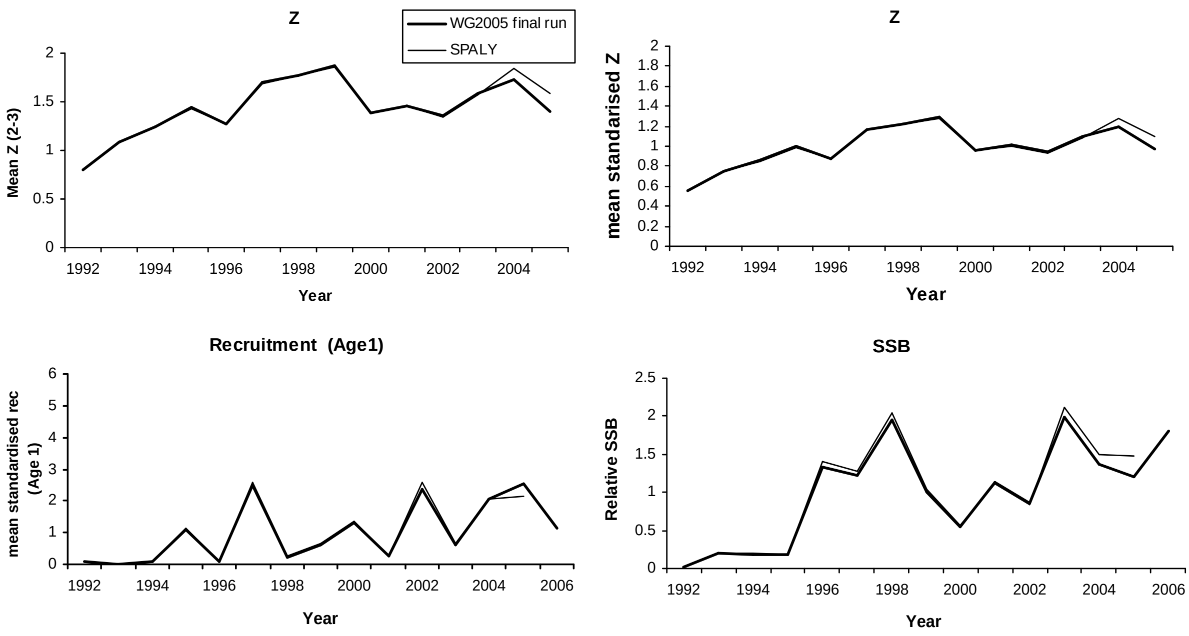


Figure 9.17 Haddock VIIa: Results of SPALY SURBA run using NIGFS-Mar survey data (ages 1-4).

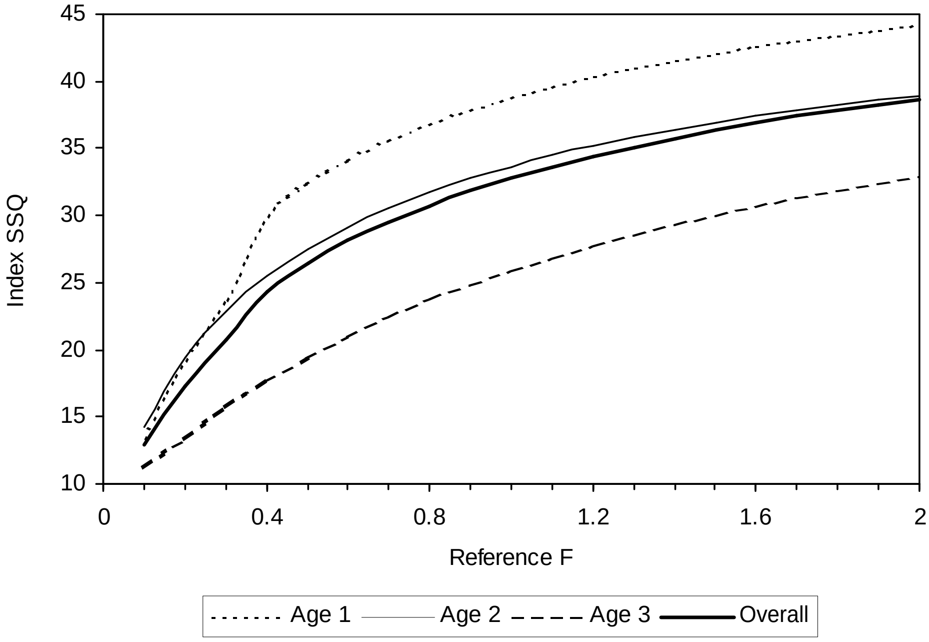


Figure 9.18 Haddock VIIa: SSQ surface plot from ICA run excluding unallocated landings estimates, using tuning data from the NIGFS-Mar, NIGFS-Oct and MIK-net surveys.

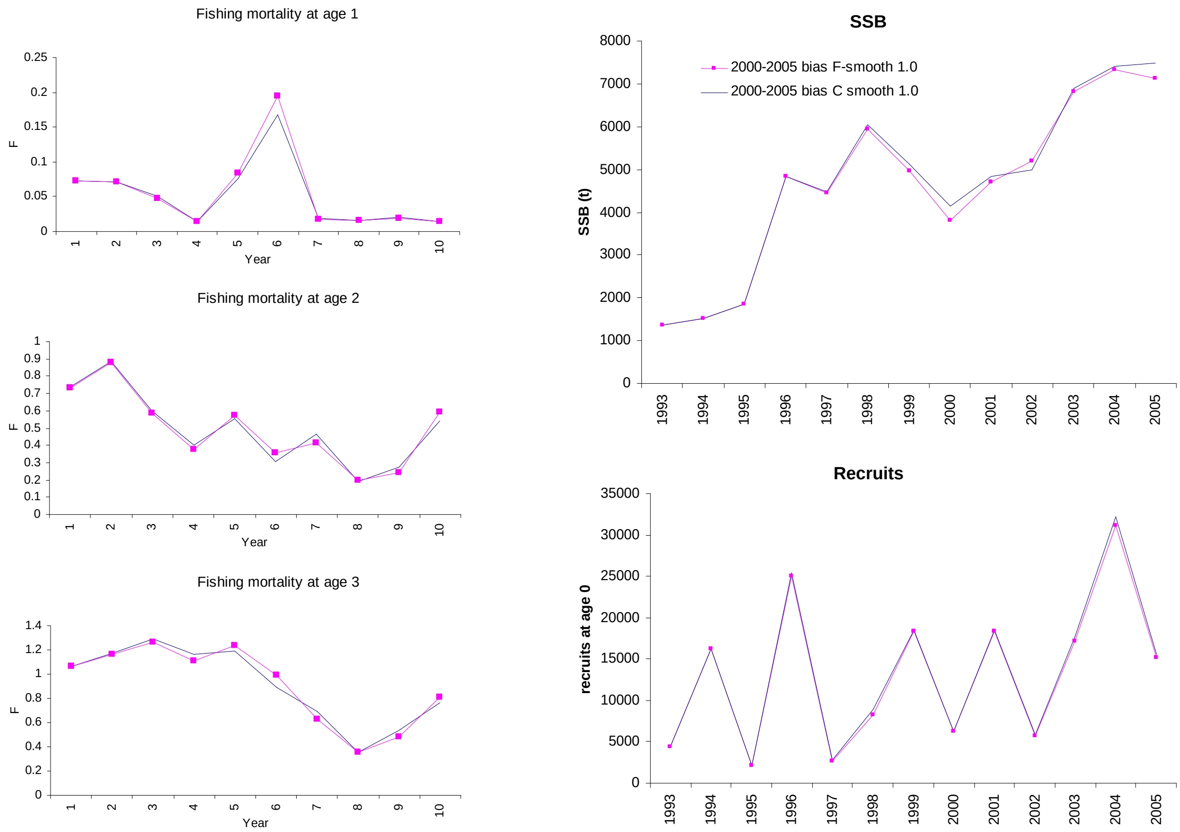


Figure 9.19 Haddock VIIa: Results from exploratory B-ADAPT run comparing results applying a F and catch smoother of 1.0, using tuning data from the NIGFS-Mar, NIGFS-Oct and MIK-net surveys.

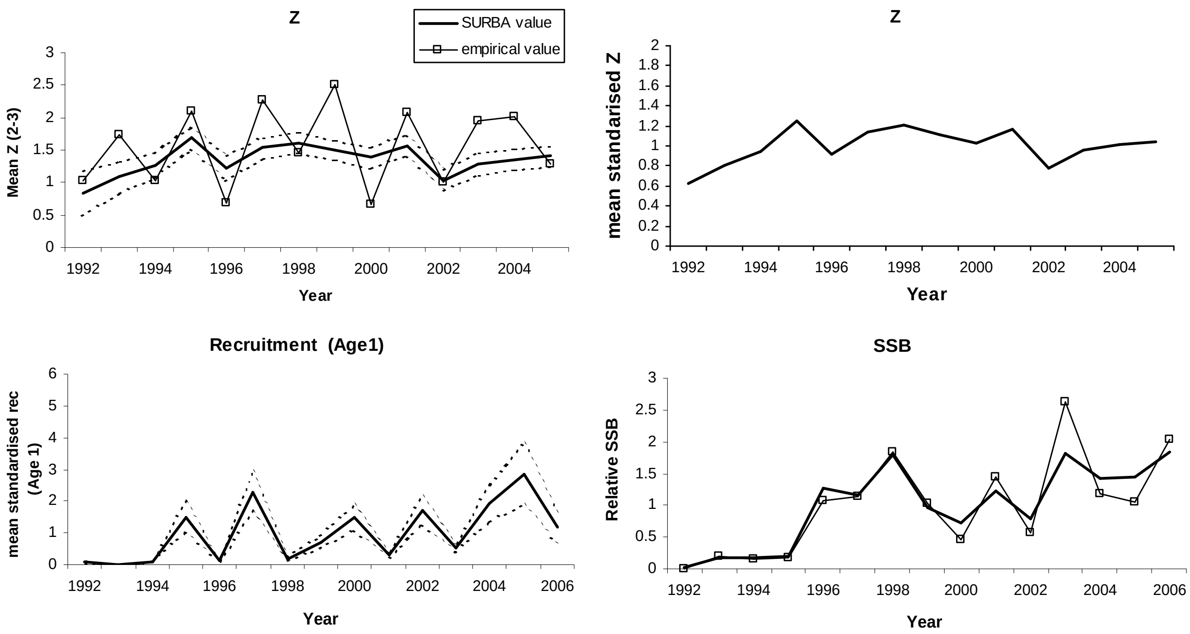


Figure 9.20 Haddock VIIa: Results of final SURBA 3.0 run using NIGFS-Mar survey data. Dotted lines are +/- 1SE. Z estimates given as absolute and relative. Empirical estimates of SSB and Z given by SURBA from the raw survey data are also shown.

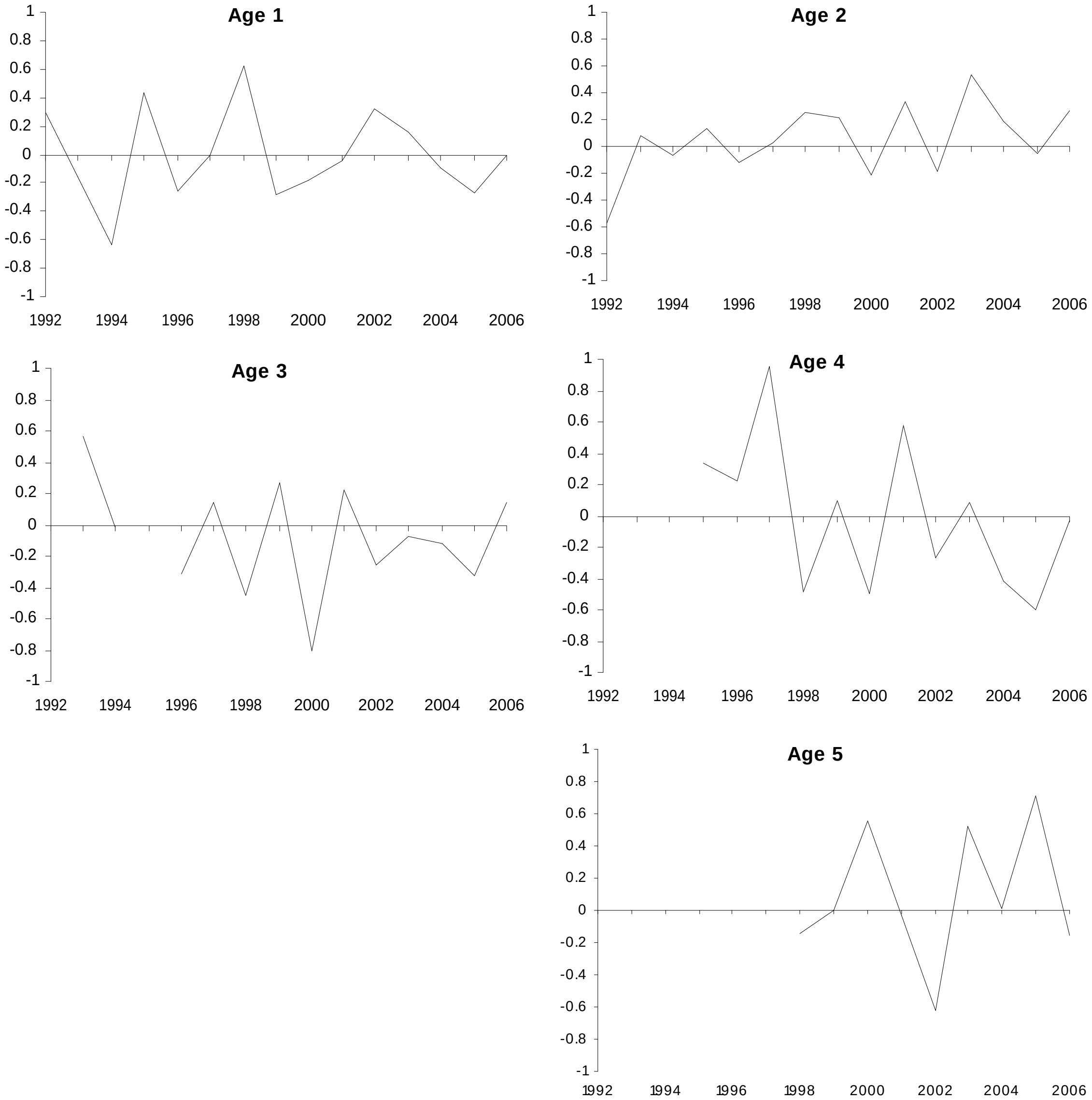


Figure 9.21 **Haddock VIIa: SURBA 3.0 Residuals at age for final run using the NIGFS-Mar survey data.**

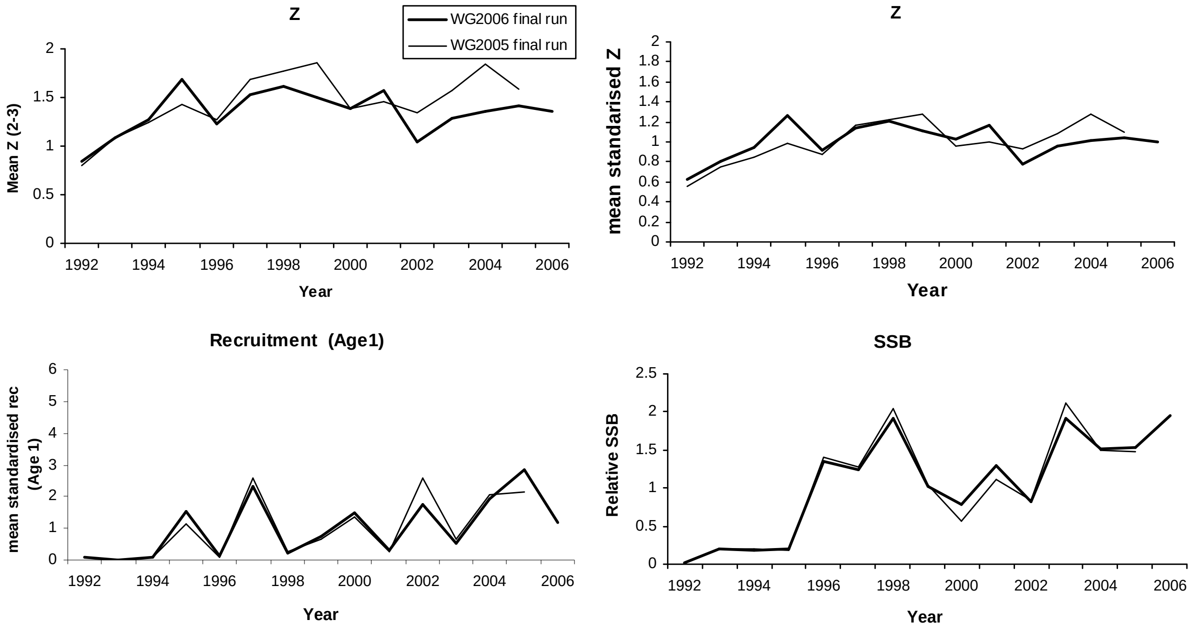
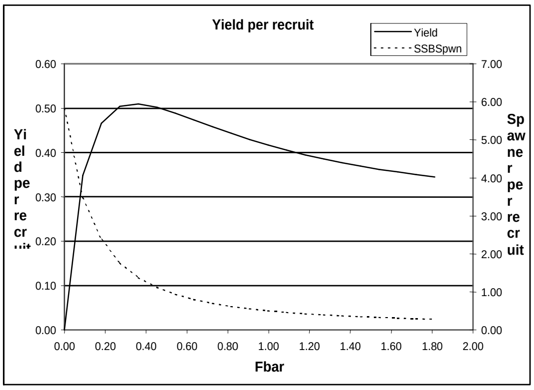


Figure 9.22 Haddock VIIa: Trends in SSB, recruitment and Z(2-3) from the 2005 and 2006 SURBA. SSB and recruitment are standardised to the mean for years common to all series (1993-2005) in each plot.



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 9.23 Haddock VIIa: Yield per recruit based on analysis carried out in 2004.

10 WHITING IN DIVISION VIIa

No analytical assessment was carried out for this stock in 2005. The review group recommended that this stock be monitored in 2006. The category *Monitoring* allows for inter-sessional work to be done and signifies that the WGNSDS should continue compiling and presenting, for example, catch and survey data, but that it should not feel obliged to attempt an analytical assessment.

10.1 The Fishery

The characteristics of the fishery are described in the Stock Annex.

10.1.1 ICES advice applicable to 2006

Overall advice for this stock is given in Section 1.8

The Single Stock Exploitation Boundary advised by ICES for 2005 was as follows:

- *Exploitation boundaries in relation to precautionary limits*

On the basis of the stock status ICES advises that catches of whiting in 2006 should be the lowest possible.

Advice on fisheries management in the Irish sea was as follows:

Fisheries in the Irish Sea should in 2006 be managed according to the following rules, which should be applied simultaneously:

They should fish:

- without bycatch or discards of cod and spurdog, and with minimal catch of whiting;
- without jeopardizing the recommended reduction in fishing mortality of haddock;
- within the biological exploitation limits for all other stocks

10.1.2 Management applicable in 2005 and 2006

Recent management advice is summarised below:

Year	**ACFM advice**	**Basis**	**TAC**
2002	0	Lowest possible F	1,000
2003	0	Lowest possible F	500
2004	0	Zero catch	514
2005	0	Lowest catch	514
2006	0	Lowest catch	437

Since the mid 90's square mesh panel legislation has been mandatory for UK and Irish vessels in 1994 specifically to reduce the fishing mortality on juvenile whiting in the *Nephrops* fishery. There are no specific recovery plans for whiting in VIIa, however, the technical measures for cod described in Section 1.7 will also impact of vessels catching whiting. The minimum landing size (MLS) for whiting is 27 cm. Section 1.7 summarises the technical measures in place in the Irish Sea. Technical measures remain unchanged for 2005 and 2006.

10.1.3 The Fishery in 2005

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 2005 but is unlikely to have affected whiting catches which are mainly by-caught in the derogated *Nephrops* fishery. As in previous years, the Irish and UK NI *Nephrops* fishery shows a peak in activity in the summer which is outside the time of the closed period for cod. Effort for Irish trawl vessels and the UK (E+W) otter trawl declined slightly in 2005. There was an increase in effort for the UK (E+W) beam trawl. (Table 10.3.1.1).

10.2 Catch Data

10.2.1 Official Catch Statistics

Table 10.1.3.1 gives the nominal landings of VIIa whiting as reported by each country to ICES. The officially reported landings have declined since 1996. Although official statistics have not been supplied by all countries to ICES, figures supplied to the working group indicate landings of around 158 t in 2005. This is the lowest recoded in the time series. No estimates from the Nephrops fishery discards previously used by the WG were available in 2005. It was not possible to reliably estimate 2005 discard volumes (see Section 10.4(10.4)). Working groups estimates of catch available since 1980 are illustrated in Figure 10.2.1.1 and indicate the declining trend since the start of the time series.

10.2.2 Revisions to Catch Data

Small revisions to the 2004 French landings were made.

10.2.3 Quality of the Catch data

There is evidence that officially reported landings of whiting are inaccurate due to misreporting. Landings data has 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.

10.3 Commercial catch-effort and research vessel surveys

10.3.1 Commercial catch and effort data

Commercial catch and effort series available to the Working Group are described in the stock Annex for 7a whiting (Section B:4). Effort, presented as kw days at sea from different fleet sectors are reported in Section 17. Although this data may be more complete than hours fished data the longer time series of hours is also presented in Table 10.3.1.1 and Figure 10.3.1.1 (a) and (b). Figure 10.3.1.1 (a) shows a marked decline for otter trawlers 70-99 mm mesh and midwater demersal trawls 70-99mm mesh. There is an increase in effort for twin rig *Nephrops* mainly 70-99 mesh. Figure 10.3.1.1 (b) shows a stable trend in effort for the seine nets apart from a peak in 1993 with a decline in recent years. Seine nets 100mm+ also has steady effort trend with two large peaks in 2003 and 2004 but a subsequent decline in 2005.

The most important fleets for the whiting fishery are UK (NI) fleets and the IR-OTB *Nephrops* directed fleets. Table 10.3.1.2 shows landings, effort and LPUE data for beam trawl (IR-TBB) and Scottish seine (IR-SSC) for 1995-2005 and IR-OTB fleets. Irish effort has declined significantly since 1999 but has remained stable in 2005. Effort for Irish beam trawlers shows an overall increasing trend since 1996, for Irish Scottish seines effort has declined in the last three years but generally has remained stable since 1995.

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. 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 >=100mm. The previous round of decommissioning in 2001 removed 29 UK(NI) *Nephrops* and whitefish vessels and 4 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 >=100mm.

10.3.2 Research vessel surveys

The following research surveys were available to the Working group:

- UK (NI) groundfish survey: March 1992-2006
- UK (NI) groundfish survey October 1992 – 2005.
- 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 – 2005
- UK (E&W) beam trawl survey, 0-1 gp cod, 1988-2005

Table 10.3.2.1 describes the survey data available. In 2004 a UK(E&W) groundfish survey commenced in the Irish Sea using a GOV trawl and it is envisaged that this data will contribute to the future survey indices for this stock.

The Northern Ireland groundfish survey series commenced in 1992. It comprises of 45 3-mile tows at fixed station positions in the northern Irish Sea, with an additional 12 1-mile tows at fixed station positions in the St George's channel carried out since October 2001 (the latter are not included in the tuning data). The survey is stratified by depth and sea-bed type and is carried out using a rock-hopper otter trawl. Figure 10.3.2.1 shows the survey distribution of the NIGFS in March and October. Seasonal changes in the distribution of whiting are evident in the trawl surveys. The distribution of whiting below MLS of 27cm remains fairly consistent between spring and autumn, although there is a tendency for the fish in the eastern Irish Sea to be more aggregated off Cumbria in autumn and to be more dispersed in spring (Figure 10.3.2.1 (b) and (d). This may be indicative of movement of the mature fish in this size range towards spawning grounds. Whiting above MLS, which are mostly mature individuals, tend to be more abundant in the eastern Irish Sea than in the western Irish Sea ((Figure 10.3.2.1 (a) and (c)). Catch-rates are quite patchy, with no obvious distinction between distributions in spring and autumn other than a tendency for higher catch-rates off North Wales in spring compared to autumn. This may reflect the movement of fish into spawning areas. Figure 10.3.2.2 shows the decline in mean catch rate of whiting in both the eastern and western Irish sea since 2003.

Further information on whiting distribution is detailed in the results of Fisheries Science Partnership surveys of Irish Sea roundfish stocks (WD5). These surveys corroborate the findings of the UK (NI) trawl surveys showing much higher catch rates of adult whiting in the eastern Irish Sea than in the western Irish Sea. Whiting were found to be more abundant in the eastern Irish Sea in 2006 than in 2005.

The Scottish groundfish survey uses a GOV trawl and is an extension of the Scottish West Coast groundfish survey for Area VI. The design consists of two fixed-position stations per ICES rectangle from 1997 onwards (17 stations) and one station per rectangle in 1996 (9 stations). The survey extends from the Northern limit of the Irish Sea to around 53^{o} 30'.

Survey series for whiting provided to the Working Group are further described in the stock Annex for 7a whiting (SectionB.3).

10.4 Age compositions and mean weights at age

10.4.1 Landings age composition and mean weights at age

Sampling and raising methods previously used are described in the stock Annex for 7a whiting. Methods for estimating quantities and composition of whiting landings from VIIa are described in the Stock Annex (Section B1.1). Both Irish and Northern Irish sampling for whiting in VIIa was poor in 2005, mainly due to low landings and restricted access to some ports. Length frequencies were provided by UK (NI) for Quarters 2 and 3. The majority of Irish sampling was from the Scottish Seine fleet (Quarter 3 and 4). Quarter 3 sampling data was also available from the OTB- fleet. Irish catch numbers-at-age were produced by combining catch at age data from these two fleets. Length frequency data were available from UK E&W sampling from the eastern Irish Sea however this fleet only accounted for only 3% total landings supplied to the working group. No representative international landings-numbers-at age could be provided for 2005.

10.4.2 Discards age composition

Methods for estimating quantities and composition of discards from UK (NI) and Irish *Nephrops* trawlers are described in the Stock Annex section B1.2. In 2005 no discard estimates were available for UK NI. A recent study on discarding in the demersal fishery in the waters around Ireland has been carried out by Borges *et al* (2005). Results indicate that there was high discarding (in number) for whiting in all Irish otter trawl fleets in 2000-2002 and that there was substantial discarding of smaller fish by the *Nephrops* fleets operating in VIIa. Revised Irish discard estimates (1996-2005) raised according to the methods described in Borges *et al* (2005) were available to the Working Group (Table 10.4.10). 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 some intersessional work on the discard data is needed before international estimates of discard numbers at age can be made.

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 10.4.1 to 10.4.6. The proportion of the total catch comprising discards from the *Nephrops* fleets increased over time at ages 1 and over (Table 10.4.7) although this will also reflect trends in catch of vessels not sampled for discards. While the proportion has increased it is largely due to the decline in abundance of marketable sized whiting and the total volume over time has declined as in Table 10.4.8.

The length frequency of landings and discards of sampled fleets in 2005 is given in Table 10.4.9. Irish Discard sampling in 2005 was based on 8 trips (96 hauls). The UK (E&W) supplied data on the raised length compositions of landed and discarded whiting from 7 trips and 75 hauls sampled in 2005, but not raised to the fleet. The total length frequency and discard ogive for the sampled UK (E&W) trips is also given in Table 10.4.9. Length at 50% retention for this fleet was around 27 cm equivalent to the MLS of 27cm.

10.5 Natural mortality, maturity and stock weight at age

The derivation of these parameters and variables is described in the Stock Annex B.2. Natural mortality was assumed as 0.2 for all ages and years, and proportion mature knife-edged at age 2 for all years. Recent investigations into the biological parameters (maturity, sex and growth parameters) of whiting in VIIa are described in the Stock Annex.

The stock weights used in WGNSDS 2002 are shown in Table 10.5.1. These are calculated from commercial catch weights and smoothed using a three-year rolling average as described in the Stock Annex. There has been a marked downward trend in stock weights in all ages over the period 1988 to 2002. Weights at age for ages 5 and 6+ are poorly estimated in recent years as these ages now represent less than 1% of the catch in number.

Information on biological parameters for Irish Sea whiting carried out during a Marine Institute funded biological survey in 2004 are presented in WD 1. The results indicate that all whiting aged three and older were mature, as well as most two-year-olds and one-year-old males. Some one-year-old females were also mature. The catches of three-year-olds were dominated by females. A significant difference was found between the sexes, with males maturing at smaller sizes, both sexes were fully mature by the age of 3. A modest, but significant increase with length in the proportion female existed, indicating faster growth in females.

Gerritsen *et al* 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 whilst most females were mature, almost all 3 year olds of both sexes were mature. Length at 50 maturity average around 19cm in males and 22cm in females.

10.6 Catch-at-age analysis

Section 2.7 outlines the general approach adopted at this year's Working Group. Catch at age data was not updated for 2005.

10.6.1 Data Screening and Exploratory Runs

10.6.1.1 Commercial Catch data

Commercial catch data was not explored for 2005.

10.6.1.2 Survey Data

Trends in log mean standardized survey indices are presented for the NIGFS, ScoGFS, UKNI-MIKnet and UK (E+W) beam trawl surveys in Figure 10.6.1.2.1. There is no obvious coherence between surveys or tracking of year classes with the possible exception of 1995 and 1996 for age group 4 and 5. Surveys previously considered inappropriate for this stock have not been explored this year. The Autumn ScoGFS data were not considered for SURBA exploration because of the short series, the small number of stations and the presence of anomalous low catch-rates at all ages in the 2001 survey. The abundance indices for the different surveys available to the WG are given in Table 10.3.2.1. This includes data for three different configurations of the NIGFS surveys; West, East and a combined East and West index. These surveys were previously made available as disaggregated east and west components. However a decision was made at WGNSDS 2005 that both the east and west components of the March and October NIGFS surveys should be considered as a combined East and West index. Conclusions drawn previously from a working document presented to WGNSDS 2005 have indicated that there is no strong evidence at present to justify keeping these indices separate.

The following survey series were updated for exploratory analysis this year:

- UK (Northern Ireland) Groundfish survey in March (NIGFS-March) East and West
- UK (Northern Ireland) Groundfish survey in October (NIGFS-Oct) East and West
- Scottish Groundfish survey in Spring (ScoGFS-Spring)

Log-mean standardised indices for the UK Northern Ireland March groundfish survey are presented in(Figure 10.6.1.2.2 (a)). The survey appears to track the 1991, 1994 for ages older than 1 and 1996 year classes well. Examination of the internal consistency via scatter plots of log index at age of the survey indicates a very poor correlation between the various age classes (Figure 10.6.1.2.3 (a)). Catch curves for the NIGFS-Mar are plotted in Figure 10.6.1.2.4 (a) and show a step decline in log numbers at age.

The log mean-standardised survey indices for the UK Northern Ireland October groundfish Survey also appears to track the 1991, 1994 and 1995 year classes (Figure 10.6.1.2.2(b)). However comparative scatter plots at age are noisy and don’t show any strong positive correlations (Figure 10.6.1.2.3 (b)). Figure 10.6.1.2.4 (b) shows the unsmooth catch curves for the NIGFS-Oct, which are not as steep for the NIGFS-Mar.

Investigation of the log mean-standardised survey indices for the UK Scotland March groundfish Survey shows a relatively inconsistent pattern with no year-classes obvious and declines in older ages during the time period of the survey (Figure 10.6.1.2.2 (c)). Figure 10.6.1.2.3(c) shows scatter plots of log index-at-age for the Scotland March groundfish survey. There are negative correlations between the 1 year old and older ages and mainly weak positive correlations at older ages. The ScoGFS catch curves are slightly domed for the first part for the time series (Figure (10.6.1.2.4 (c)).

Empirical SSB estimates are presented in Figure 10.6.1.2.5 for the NIGFS March NIGFS Oct and the ScoGFs. Both NIGFS surveys show a decline in SSB in the last two years whereas the ScoGFS shows a slight increase however this survey was previously considered as inappropriate for use in the whiting VIIa assessment.

10.6.1.3 Exploratory Assessment Runs

No assessment was carried out for this stock in 2005

10.6.2 Estimating recruiting year class abundance

The general approach to estimating recruitment is described in Section 2.9.

10.6.3 Long-term trends in biomass, fishing mortality and recruitment

The decline in fishery landings to under 1,000 t since 2000 has been interpreted in all assessment models as a collapse in biomass,despite the absence of an analytical assessment.

10.6.4 Short term stock predictions

It was not possible to carry out short-term projections for this stock.

10.6.5 Medium Term Projections

It was not possible to carry out long-term equilibrium projections for this stock.

10.6.6 Yield and Biomass per Recruit

It was not possible to carry out medium-term projections for this stock.

10.6.7 Reference Points

There is no basis for the evaluation of reference points for this stock.

10.6.8 Quality of the Assessment

No assessment was carried out for this stock in 2005.

10.6.9 Management considerations

Landings of whiting by all vessels, and discards of whiting estimated for *Nephrops* fisheries, have declined substantially since the 1990s and whiting is now a relatively minor bycatch in the demersal fisheries. Due to the small catches and low value of the catch, a high proportion of whiting are discarded. Age profiles observed on these survey is very steep indicating either a continuing high mortality or some emigration effect.

Fishing mortality cannot be managed by a TAC on whiting, and measures restricting landings alone will not be sufficient to allow recovery of the stock. Various technical measures have been introduced in the past to mitigate bycatch of whiting in the *Nephrops* fishery, which operates on the whiting nursery grounds. It has proved difficult to evaluate the success of measures such as the mandatory use of square mesh panels in *Nephrops* trawls since 1994, as there have been very few direct observations of size and age compositions of catches prior to discarding (much of the discards data are from fisher self-sampling schemes that do not record total catch). Acknowledgement of the discard problem in the *Nephrops* fishery by the Northern Ireland industry recently resulted in the Anglo-North Irish Fish Producers Organisation Ltd (ANIFPO) embarking upon a project to improve gear selectivity. The aim of the project is to examine the effectiveness of the technical conservation measures proposed as part of the Irish Sea Cod Recovery Programme, in an attempt to reduce discard levels in the *Nephrops* fishery. The study is funded by DARD through the Financial Instrument for Fisheries Guidance (FIFG) scheme. Multi-national EC funded studies such as RECOVERY and NECESSITY have included extensive trials with a range of net configurations and novel devices to exclude catches of unwanted by-catch species including whiting.

In 2005 Ireland introduced a decommissioning scheme aimed at removing around 6,000 GT/18,000 kW from the Irish fleet. This follows from the two Whitefish Renewal Schemes, which introduced around 32 new vessels into the Irish fleet. The decommissioning scheme is targeted at demersal and scallop vessels over 18m. The scheme is split into three rounds, with around 8 vessels already scrapped as part of the first phase and a total of 44 vessels in all due to be scrapped by the end of 2006.

As the human consumption fishery has collapsed and mortality rates continue at high levels, the perception that whiting continues to be one of the most abundant species caught on ground fish surveys in the Irish sea may not be true. With the addition of 2005 and 2006 data evidence from the NIGFS survey distribution maps indicate that there has been a decline in catch rate of whiting since 2003 in both the eastern and western parts.

Due to the bycatch of cod in fisheries taking whiting, the regulations affecting Division VIIa whiting remain linked to those implemented under the Irish Sea cod recovery plan. The regulations implemented for cod are detailed in the single-species advice for cod (Section 4.6.1.a). The closure of the western Irish Sea to whitefish fishing from mid-February to the end of April, designed to protect cod, has been continued, but is unlikely to have affected whiting catches, which are mainly bycatch in the derogated *Nephrops* fishery.

Similarly the extension of days-at-sea limitations into the Irish Sea in 2006 is not expected to result in a significant reduction in fishing mortality for whiting since the *Nephrops* fleet are still permitted to fish for up to 227 days a year.

The minimum landing size for whiting is 27 cm. Discarding data shows that individuals in excess of the MLS are discarded. In addition, the discard data indicates that very large numbers of whiting below this size are caught in the *Nephrops* fishery and discarded.

Table 10.1.3.1 Nominal catch (t) of WHITING in Division VIIa, 1988-2005, as officially reported to ICES and Working Group estimates of discards.

Country	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005*
Belgium	90	92	142	53	78	50	80	92	80	47	52	46	30	27	22	13	11	9.5
France	1,063	533	528	611	509	255	163	169	78	86	81	150	59	25	33	29	8	5.61
Ireland	4,394	3,871	2,000	2,200	2,100	1,440	1,418	1,840	1,773	1,119	1,260	509	353	482	347	265	96	n/a
Netherlands									17	14	7	6	1					
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	1,229	670	506	284	130	82	
Spain																85		
UK (Isle of Man)	15	26	75	74	44	55	44	41	28	24	33	5	2	1	1	1	1	
UK (N.Ireland)	4,621																	
UK (Scotland)	107	154	236	223	274	318	208	198	48	30	22	44	15	25	27	31	6	
UK																		47.1
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	1,989	1,130	1,066	714	554	204	62.21
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	1,092	2,118	1,012	740	n/a	n/a	n/a
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	2,762	2,880	1,745	1,487	676	184	158

[a] 1989-2002 Northern Ireland included with England and Wales.

[b] Based on UK(N.Ireland) and Ireland data.

*** Preliminary.**

Table 10.3.1.1 Whiting VIIa (Irish Sea)
Effort (Hours fishe Hours fished: UK (E&W and NI) trawlers in VIIa

	seine nets 70-99 m	otter trawls 70-99	Single Nephrops mainly	Twin-rig Nephrops mainly 7	Midwater demersal 70-99	Midwater demersal 100+	otter trawls 100mm+	seine nets 100mm+
1985	2097	121903			38227	0	2780	946
1986	576	191207			48852	0	3122	441
1987	1194	256364			70750	0	2821	207
1988	1598	279135			71886	0	2325	873
1989	2268	300658			86753	0	2371	20
1990	833	289761			98918	0	3665	0
1991	586	292643			90131	0	2309	231
1992	2384	287509			100584	12	2095	459
1993	19063	289037			76244	125	3764	912
1994	1065	145356	126475	5413	75915	0	3321	651
1995	534	87422	157656	17187	54885	36	4010	3695
1996	497	86443	142706	21465	55580	176	8178	797
1997	829	74270	153086	24467	56096	106	11239	2093
1998	1098	63786	138682	36482	61759	133	11215	1468
1999	2874	60727	133604	36530	71952	16	6842	723
2000	443	42431	125252	47290	2764	44899	12423	4403
2001	24	37504	129421	40060	388	50708	23037	2735
2002	36	24522	100985	29216	191	56485	21242	1350
2003	30	24197	105923	39110	0	62029	26328	61317
2004	17	37764	101017	39214	608	35291	9307	63748
2005	0	34128	96085	48450	0	27564	5354	645

Table 10.3.1.2 Landings, Effort and LPUE data for Irish beam trawl(IR-TBB) and Scottish seine (IR-SSC) for 1995-2005.

(a)

IR-TBB-7a VIIa			
Year	Landings (t)	Effort (hr)	LPUE (kg/h)
1995	11.557	8.64	1.34
1996	9.533	6.26	1.52
1997	8.159	9.86	0.83
1998	8.963	11.58	0.77
1999	8.906	14.67	0.61
2000	8.385	11.42	0.73
2001	9.846	13.13	0.75
2002	6.451	17.67	0.36
2003	3.2785	18.70	0.18
2004	1.7075	14.19	0.12
2005	2.13225	14.67	0.15

(b)

IR-SSC-7a VIIa			
Year	Landings (t)	Effort (hr)	LPUE (kg/h)
1995	0.08	0.02	3.48
1996	203.23	1.55	131.16
1997	46.514	2.22	20.98
1998	108.92	2.58	42.27
1999	20.96	1.45	14.46
2000	23.685	0.63	37.84
2001	12.559	0.67	18.68
2002	19.851	0.56	35.45
2003	61.36	1.28	48.07
2004	5.209	1.02	5.13
2005	8.9054	0.60	14.93

(c)

IR-OT-7a VIIa			
Year	Landings (t)	Effort (hr)	LPUE (kg/h)
1995	268.451	80.31	3.34
1996	656.747	64.82	10.13
1997	326.889	92.18	3.55
1998	351.943	93.53	3.76
1999	294.988	110.28	2.68
2000	119.765	82.69	1.45
2001	286.146	77.54	3.69
2002	195.139	77.86	2.51
2003	170.420703	73.85	2.31
2004	61.00275	72.51	0.84
2005	58.0451	68.34	0.85

Table 10.3.2.1. Whiting in 7a. Survey data available to the WGNSDS 2006.

```
UKE&W-BTS : Corystes Irish Sea Beam Trawl Survey (Sept) - Prime stations
only - Effort and numbers at age (per km towed)
1988  2005
1     1     0.75  0.79
0     1
1     205   84    1988
1     112   33    1989
1     157   120   1990
1     257   39    1991
1     227   300   1992
1     146   97    1993
1     157   106   1994
1     1570  60    1995
1     136   164   1996
1     306   208   1997
1     700   144   1998
1     464   122   1999
1     282   122   2000
1     468   155   2001
1     234    5    2002
1     438   154   2003
1     797   298   2004
1     706   245   2005
NIGFS-Oct E&W : Northern Ireland October Groundfish Survey - Irish Sea
East & West - Nos. per 3 nm
1992  2005
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
NIGFS-March E&W : Northern Ireland March Groundfish Survey- Irish Sea
East & West - Nos. per 3 nm
1992  2006
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
```

Table 10.3.2.1. (cont'd) Whiting in 7a. Survey tuning data available to the WGNSDS 2005.

```
UKNI-MIK : Northern Ireland MIK Net Survey
1994  2005
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
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
ScoGFS Autumn : Scottish groundfish survey
1997   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
```

Table 10.3.2.1. (cont'd) Whiting in 7a. Survey tuning data available to the WGNSDS 2005.

```
IR-Q4 IBTS: IRISH GFS RV Celtic Explorer: NUMBERS AT AGE
2003  2004
1     1     0.89  0.91
0     5
1     72340 19658 13391 1617  605   0     2003
1     75196 14563 1293  147   5     2     2004
```

Table 10.4.1 Whiting in VIIa (Irish Sea)
International catch at age ('000) for human consumption
1980 to 2002.**Partially corrected for misreporting.**
No 2003 - 2005 estimates were possible.

Age	1980	1981
0	0	0
1	14520	11203
2	21811	29011
3	6468	16004
4	2548	2596
5	350	821
6+	621	339

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	41	0	0	0	0	0	0	0	0	102
1	5427	4886	18254	15540	6306	10149	6983	11645	9502	7426
2	18098	9943	12683	35324	16839	21563	25768	14029	17604	18406
3	19340	9100	5257	8687	10809	6968	6989	13011	4734	5829
4	6108	4530	2571	996	1877	1943	1513	3645	1477	993
5	813	1165	1045	675	285	242	396	490	318	311
6+	400	321	402	372	270	111	197	177	128	84

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0	38	0	0	129	0	0	1	0	0	0
1	8380	2742	3245	1124	1652	610	329	341	319	111	67
2	21907	21468	6983	10095	6162	4239	3287	2806	1364	1189	748
3	7959	7327	18509	3020	7432	2567	4727	2607	1002	1006	1480
4	1374	932	1801	4444	1263	1795	888	741	299	171	376
5	462	135	208	233	1082	87	261	160	115	53	48
6+	93	27	50	21	135	79	95	119	15	20	41

Table 10.4.2 Whiting in VIIa (Irish Sea)
International catch at age ('000) discarded, 1980 to 2002
No 2003 - 2005 estimates were possible.

Age	1980	1981
0	12786	9865
1	32318	24935
2	6888	9162
3	65	162
4	26	26
5	0	0
6+	0	0

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	4047	23847	26394	12380	28364	16594	6922	17247	4216	20349
1	8489	7328	33900	26461	21111	40598	17958	20701	31810	29334
2	560	2036	1568	1859	1464	1875	1940	2476	3353	3823
3	19	9	11	9	33	0	0	26	72	146
4	0	0	0	0	0	0	0	0	0	1
5	0	0	0	0	0	0	0	0	0	0
6+	0	0	0	0	0	0	0	0	0	0

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	1497	12639	3731	7118	12732	8163	6096	20851	7321	16940	8538
1	61451	13979	12063	17613	39647	25497	27131	7677	38922	12631	13412
2	10404	17707	1812	7015	8168	5352	2293	2117	4395	3150	1588
3	97	426	1702	492	1976	689	550	228	564	102	231
4	0	5	29	234	81	141	44	34	55	10	33
5	0	0	0	0	0	0	0	2	1	0	0
6+	0	0	0	0	0	0	0	2	10	0	1

Table 10.4.3 Whiting in VIIa (Irish Sea)
International catch at age ('000) landed and discarded, 1980 to 2002

No 2003 - 2005 estimates were possible.

Age	1980	1981
0	12786	9865
1	46838	36138
2	28699	38173
3	6533	16166
4	2574	2622
5	350	821
6+	621	339

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	4088	23847	26394	12380	28364	16594	6922	17247	4216	20451
1	13916	12214	52154	42001	27417	50747	24941	32346	41312	36760
2	18658	11979	14251	37183	18303	23438	27708	16505	20957	22229
3	19359	9109	5268	8696	10842	6968	6989	13037	4806	5975
4	6108	4530	2571	996	1877	1943	1513	3645	1477	994
5	813	1165	1045	675	285	242	396	490	318	311
6+	400	321	402	372	270	111	197	177	128	84

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	1497	12677	3731	7118	12861	8163	6096	20852	7321	16940	8538
1	69831	16721	15308	18737	41299	26107	27460	8018	39242	12742	13479
2	32311	39175	8795	17110	14330	9591	5580	4923	5758	4338	2336
3	8056	7753	20211	3512	9408	3256	5277	2835	1566	1108	1711
4	1374	937	1830	4678	1344	1936	932	776	354	181	409
5	462	135	208	233	1082	87	261	161	115	53	48
6+	93	27	50	21	135	79	95	121	25	20	42

Table 10.4.4 Whiting in VIIa (Irish Sea)
International mean weight at age (kg) of the human consumption catch, 1980 to 2002.

No 2003 - 2005 estimates were possible.

Age	1980	1981
0	0.133	0.133
1	0.216	0.216
2	0.269	0.269
3	0.365	0.365
4	0.533	0.533
5	0.630	0.630
6+	0.772	0.888

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0.133	0	0.144	0	0.134	0	0	0	0	0.115
1	0.216	0.215	0.208	0.174	0.184	0.173	0.152	0.197	0.198	0.172
2	0.269	0.279	0.257	0.250	0.225	0.223	0.214	0.209	0.220	0.210
3	0.365	0.397	0.403	0.333	0.342	0.363	0.330	0.269	0.313	0.266
4	0.533	0.491	0.550	0.478	0.512	0.535	0.547	0.433	0.436	0.352
5	0.630	0.605	0.699	0.567	0.709	0.720	0.763	0.680	0.676	0.453
6+	0.736	0.655	0.745	0.642	0.940	0.933	1.005	1.079	0.800	0.692

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0	0.117	0	0	0	0	0	0.120	0.064	0	0
1	0.160	0.151	0.169	0.188	0.196	0.171	0.169	0.166	0.179	0.182	0.145
2	0.198	0.186	0.198	0.219	0.217	0.219	0.202	0.218	0.216	0.250	0.214
3	0.274	0.233	0.227	0.273	0.244	0.244	0.240	0.255	0.269	0.319	0.273
4	0.361	0.332	0.304	0.334	0.288	0.296	0.274	0.328	0.317	0.346	0.356
5	0.513	0.454	0.378	0.551	0.365	0.396	0.350	0.352	0.347	0.538	0.449
6+	1.007	0.892	0.496	1.320	0.415	0.537	0.421	0.328	0.412	0.337	0.428

Table 10.4.5 Whiting in VIIa (Irish Sea)
International mean weight at age (kg) of the discarded catch,
1980 to 2002. **No 2003-2005 estimates were possible.**

Age	1980	1981
0	0.034	0.034
1	0.062	0.062
2	0.125	0.125
3	0.230	0.230
4	0	0
5	0	0
6+	0	0

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0.029	0.033	0.024	0.022	0.023	0.024	0.021	0.026	0.034	0.030
1	0.072	0.101	0.075	0.080	0.058	0.078	0.069	0.063	0.060	0.051
2	0.125	0.147	0.130	0.137	0.126	0.157	0.114	0.105	0.113	0.115
3	0.141	0.245	0	0	0.155	0	0.449	0.091	0.115	0.130
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	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0.014	0.029	0.029	0.031	0.026	0.026	0.017	0.028	0.024	0.017	0.016
1	0.050	0.050	0.048	0.055	0.051	0.041	0.034	0.038	0.036	0.034	0.033
2	0.110	0.089	0.123	0.120	0.111	0.101	0.090	0.086	0.100	0.088	0.082
3	0.137	0.143	0.154	0.153	0.161	0.141	0.130	0.147	0.128	0.119	0.127
4	0	0.175	0.149	0.179	0.186	0.170	0.145	0.237	0.150	0.194	0.141
5	0	0	0	0	0	0	0	0.218	0.213	0	0
6+	0	0	0	0	0	0	0	0.174	0.152	0	0.213

Table 10.4.6 Whiting in VIIa (Irish Sea)
International mean weight at age (kg) of the total catch
(landings plus discards) 1980 to 2002.
No 2003 - 2005 estimates were possible.

Age	1980	1981
0	0.034	0.040
1	0.110	0.118
2	0.235	0.240
3	0.363	0.364
4	0.529	0.529
5	0.630	0.630
6+	0.772	0.888

Age	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
0	0.031	0.033	0.032	0.021	0.025	0.024	0.021	0.026	0.036	0.031
1	0.135	0.146	0.125	0.107	0.100	0.101	0.088	0.111	0.094	0.077
2	0.265	0.256	0.244	0.245	0.217	0.217	0.201	0.193	0.204	0.194
3	0.365	0.397	0.403	0.333	0.342	0.363	0.330	0.269	0.310	0.263
4	0.533	0.491	0.550	0.478	0.512	0.535	0.547	0.433	0.436	0.352
5	0.630	0.605	0.700	0.567	0.709	0.720	0.763	0.680	0.676	0.453
6+	0.736	0.655	0.745	0.642	0.940	0.933	1.005	1.079	0.800	0.692

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	0.014	0.029	0.030	0.031	0.027	0.026	0.017	0.028	0.024	0.017	0.016
1	0.063	0.067	0.074	0.063	0.057	0.044	0.035	0.044	0.038	0.036	0.033
2	0.170	0.142	0.183	0.179	0.159	0.153	0.156	0.161	0.127	0.132	0.124
3	0.272	0.228	0.221	0.257	0.230	0.222	0.228	0.246	0.218	0.301	0.253
4	0.361	0.331	0.301	0.326	0.284	0.287	0.268	0.324	0.291	0.338	0.339
5	0.513	0.454	0.378	0.551	0.364	0.396	0.350	0.351	0.347	0.538	0.449
6+	1.007	0.892	0.496	1.320	0.715	0.679	0.421	0.325	0.310	0.337	0.425

Table 10.4.7 Whiting in VIIa (Irish Sea)

Estimate of Discarding from *Nephrops* fleet as proportion of total International Catch at age.
This does not include discards from the fleets other than the *Nephrops* fleet.

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 10.4.8 Whiting in VIIa (Irish Sea)
Estimated landed and discarded catch.
Partially corrected for misreporting

	Catch ('000 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 10.4.9 Whiting in VIIa (Irish Sea)
2005 Length Distributions by ('000)Fleet

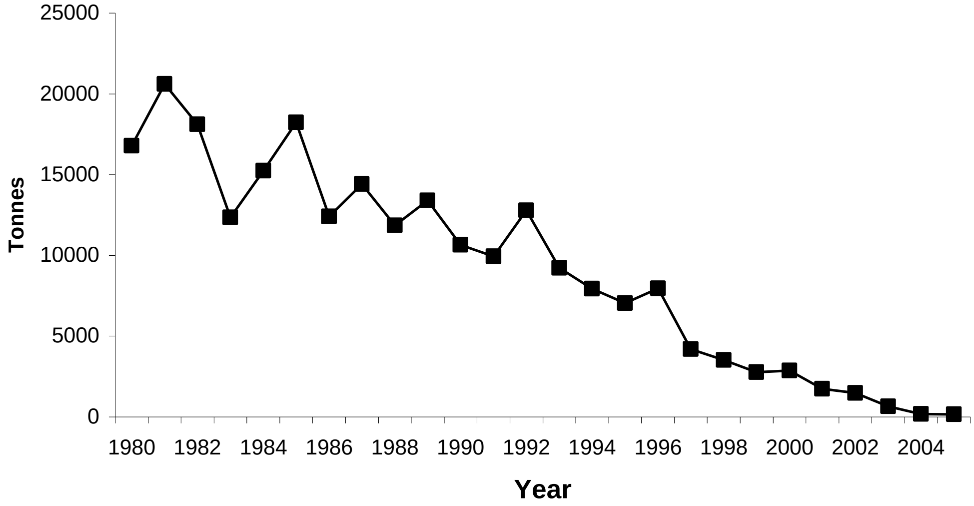
Length (cm)	**Ireland** All Gears **Landings**	**Ireland** *Nephrops* Otter **Discards**	**UK (NI)** All Gears **Landings Sampled**	**UK (NI)** *Nephrops* Otter **Discards**	**UK (E&W)** All Gears **Landings**	**UK (E&W) % Length freq. Discards**	**UK (E&W) Proportion retained**
5							
6		1					
7		2					
8		7					
9		8					
10		16				0.03	
11		17				0.09	
12		31				0.21	
13		49				0.37	
14		47				0.40	
15		39				0.36	
16		28				0.37	
17		21				0.24	
18		16				0.11	
19		14				0.08	
20		16				0.09	
21		21		n/a		0.09	
22		29		n/a		0.08	
23		30		n/a	0.01	0.18	0.06
24		27		n/a		0.24	
25		23		n/a	0.06	0.31	0.16
26		15		n/a	0.19	0.25	0.43
27	3	11	2	n/a	0.31	0.30	0.51
28	7	9	1	n/a	0.87	0.29	0.75
29	21	4	1	n/a	1.30	0.18	0.88
30	26	4	2	n/a	2.18	0.11	0.95
31	20	1	1	n/a	2.42	0.08	0.97
32	27	4	1	n/a	1.92	0.05	0.98
33	13	1		n/a	2.07	0.04	0.98
34	12	3	1	n/a	1.63	0.05	0.97
35	8			n/a	0.87	0.01	0.99
36	8			n/a	0.80		1.00
37	8	6		n/a	0.25		1.00
38	7			n/a	0.36		1.00
39	8			n/a	0.15		1.00
40	15			n/a	0.22		1.00
41	13			n/a	0.02		1.00
42	13			n/a	0.07		1.00
43	4			n/a	0.07		1.00
44	16			n/a	0.01		1.00
45	9			n/a	0.00		1.00
46	3			n/a	0.01		1.00
47	2			n/a			
48	2			n/a			
49	1			n/a			
50					0.01		
51							
52							
53							
54							
55							
56							
57							
58							
Total Numbers	**245**	**500**	**9**	**0**	**16**		

Table10.4.10. Whiting VIIa Discard Numbers and Weights at Age of Irish otter trawl fleet 1996-2005

	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		1024.1		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

Figure 10.2.1.1 Whiting VIIa. Working group estimates of landings 1980-2005. Note landings data has prior to 2003 has been adjusted for misreporting and includes estimates of discards.



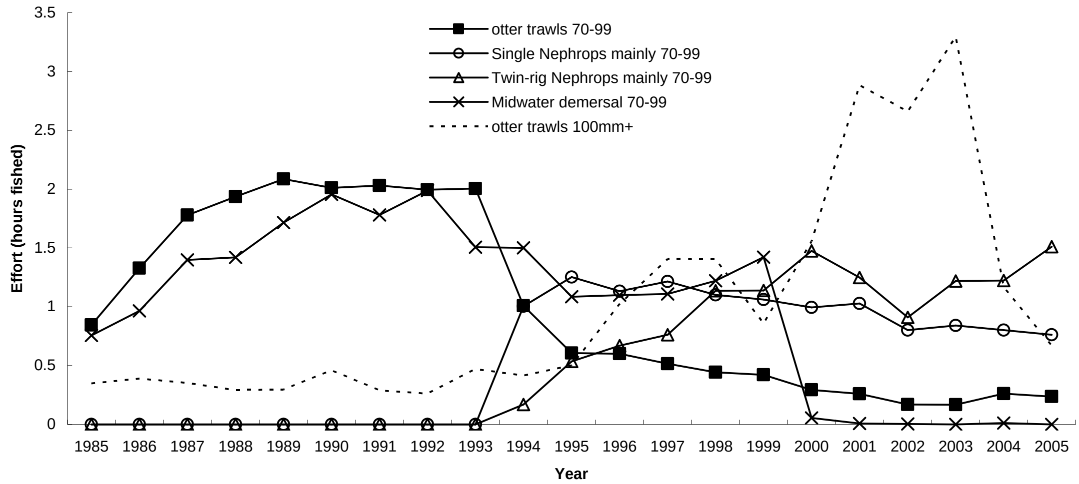


Figure 10.3.1.1(a) Whiting VIIa (Irish Sea)
Trends in effort for commercial tuning fleets. All series are expressed relative to their series mean.

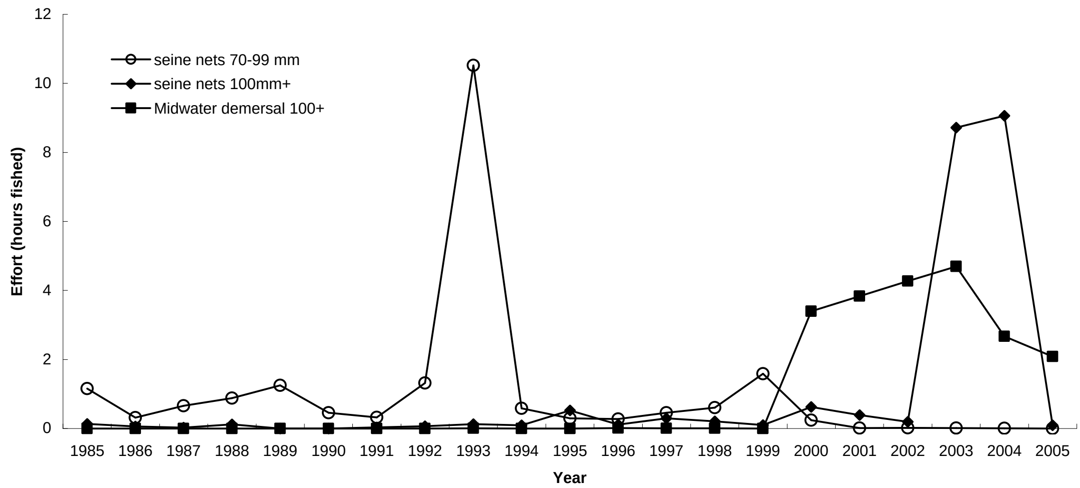


Figure 10.3.1.1(b) Whiting VIIa (Irish Sea)
Trends in effort for commercial tuning fleets. All series are expressed relative to their series mean.

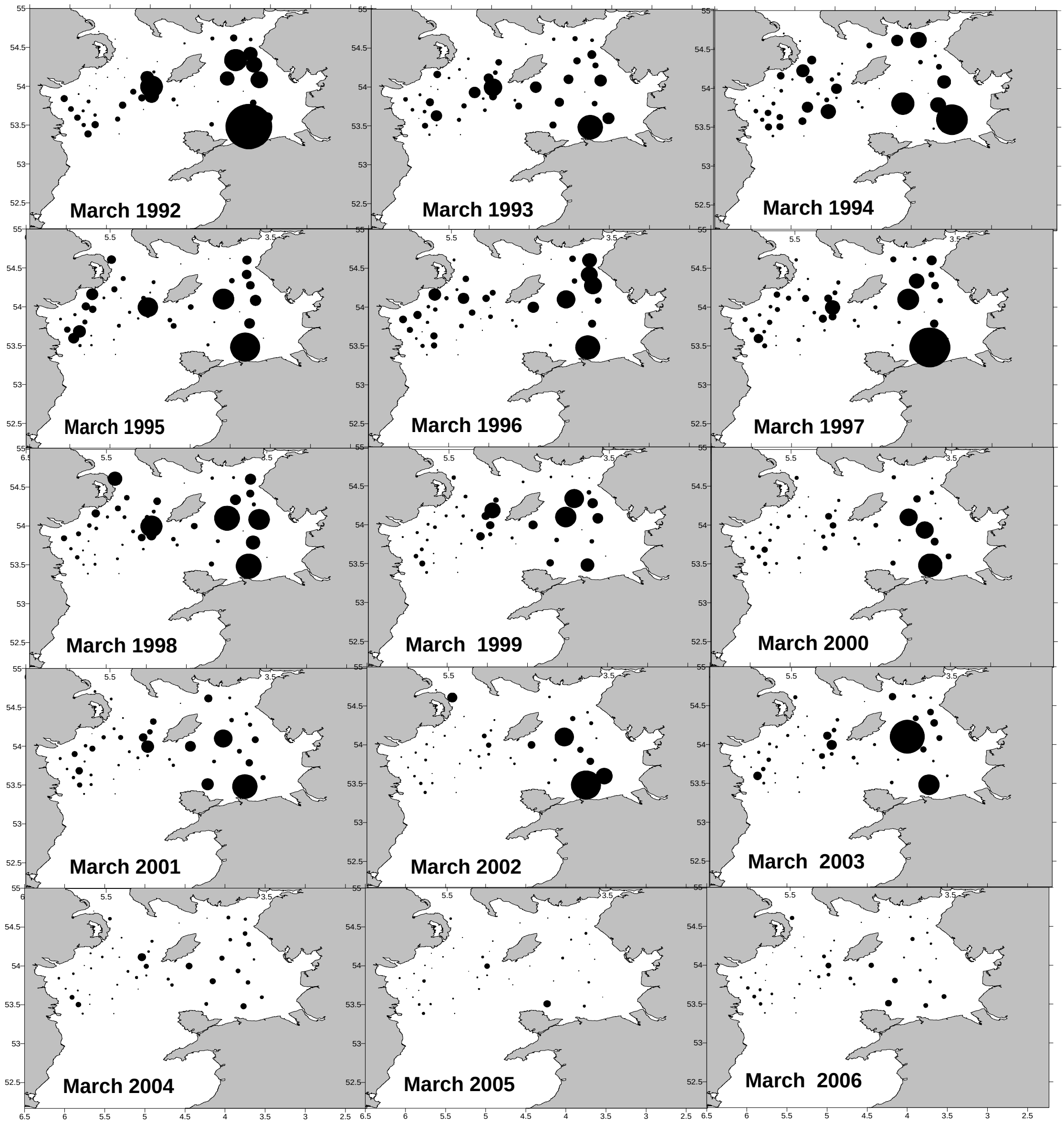


Figure 10.3.2.1 (a) Distribution of whiting above MLS in spring, based on DARD groundfish surveys. Areas of circles are proportional to catch rate in kg per 3 miles, with the largest circle relating to a catch rate of 1090 kg per 3 miles (all stations where fish of this size have been caught during the survey series are marked on each map with a spot. Stations in the St George s Channel have only been fished since autumn 2001).

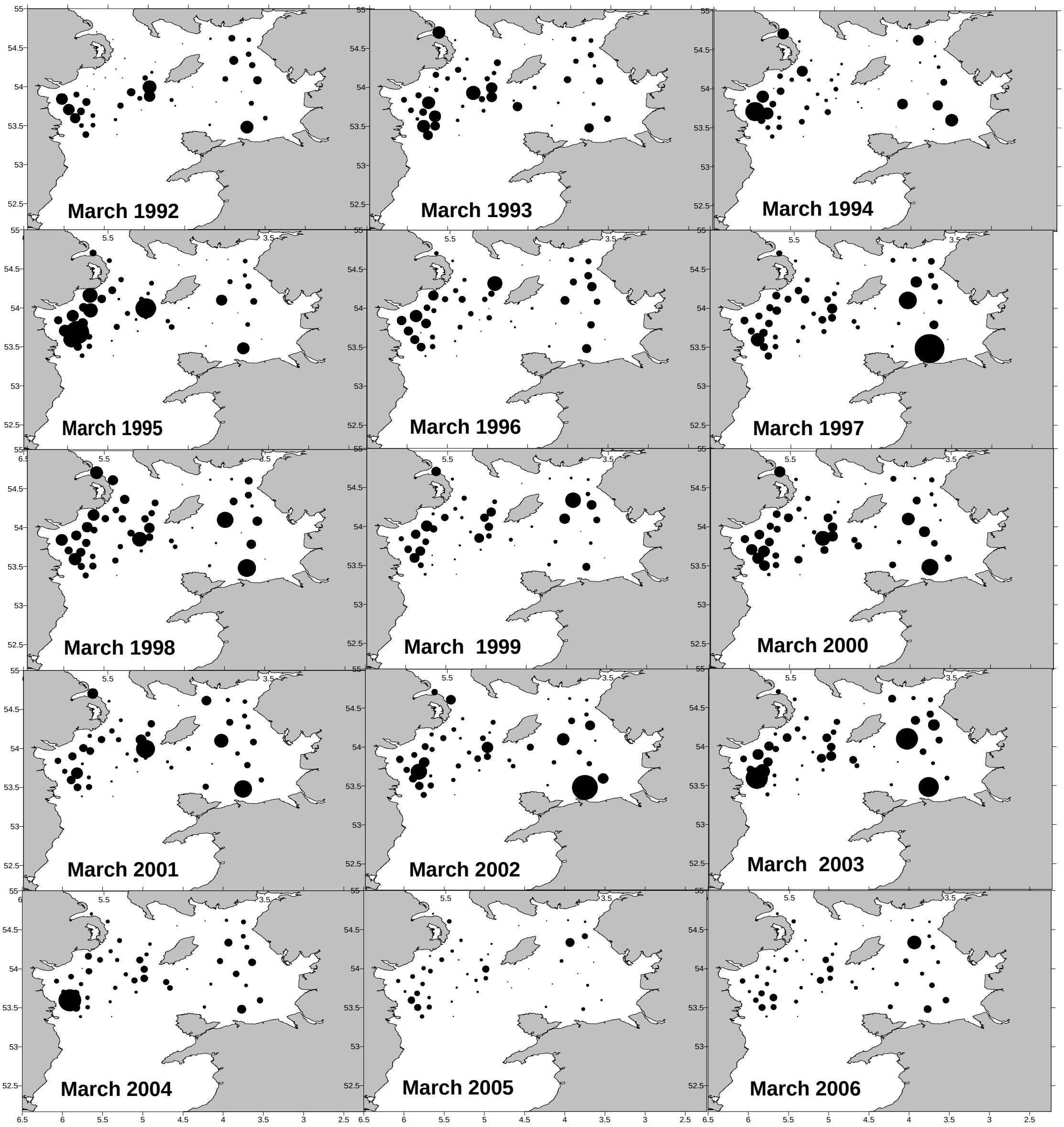


Figure 10.3.2.1 (b) Distribution of whiting less than MLS in spring, based on DARD groundfish surveys. Areas of circles are proportional to catch rate in kg per 3 miles, with the largest circle relating to a catch rate of 2200 kg per 3 miles (all stations where fish of this size have been caught during the survey series are marked on each map with a spot.)

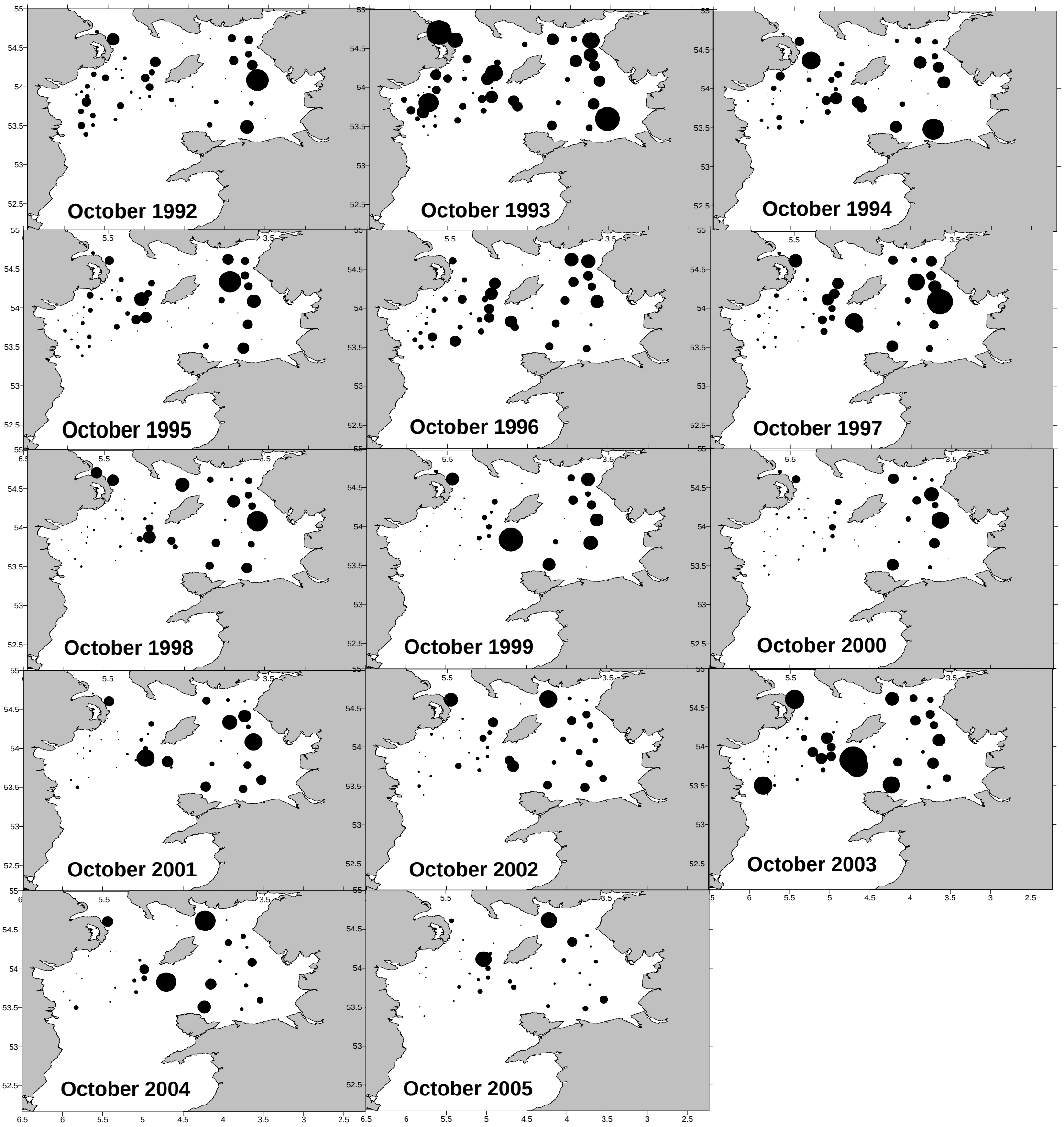


Figure 10.3.2.1 (c) Distribution of whiting above MLS in autumn, based on DARD groundfish surveys. Areas of circles are proportional to catch rate in kg per 3 miles, with the largest circle relating to a catch rate of 375 kg per 3 miles (all stations where fish of this size have been caught during the survey series are marked on each map with a spot.)

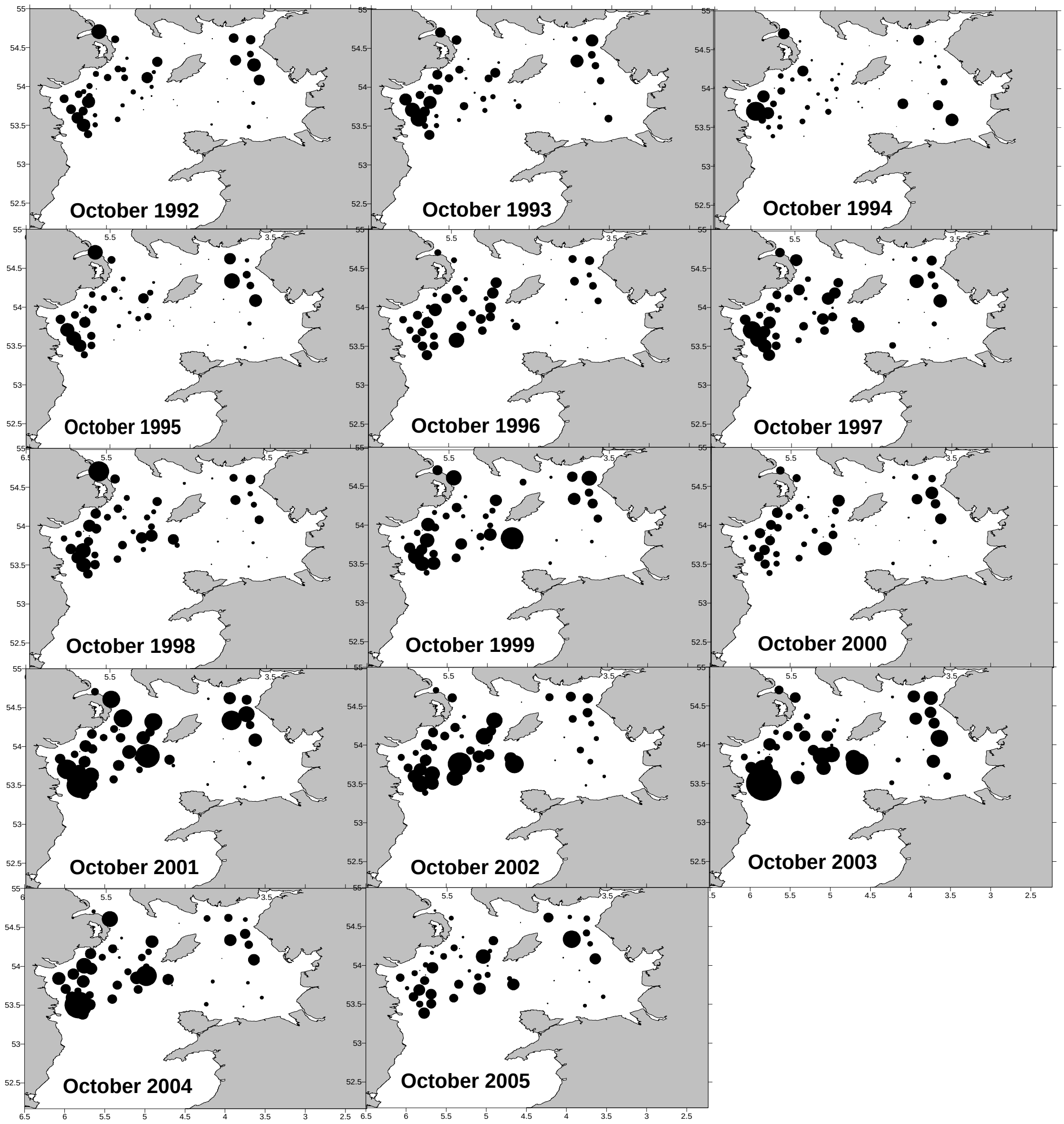


Figure 10.3.2.1 (d) Distribution of whiting less than MLS in autumn, based on DARD groundfish surveys. Areas of circles are proportional to catch rate in kg per 3 miles, with the largest circle relating to a catch rate of 3140 kg per 3 miles (all stations where fish of this size have been caught during the survey series are marked on each map with a spot).

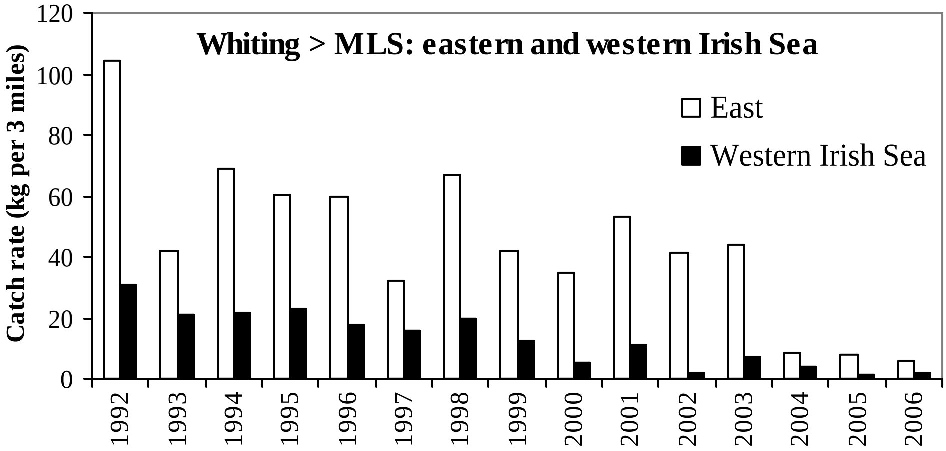


Fig. 10.3.2.2. Mean catch rates in eastern and western Irish Sea of whiting in kg per 3-mile tow, for fish at and above the minimum landing size (27 cm) for DARD groundfish surveys in March 1992 - 2006.

Figure 10.6.1.2.1 Trends in log mean standardised survey indices for Whiting VIIa
Survey data for whole of northern Irish Sea

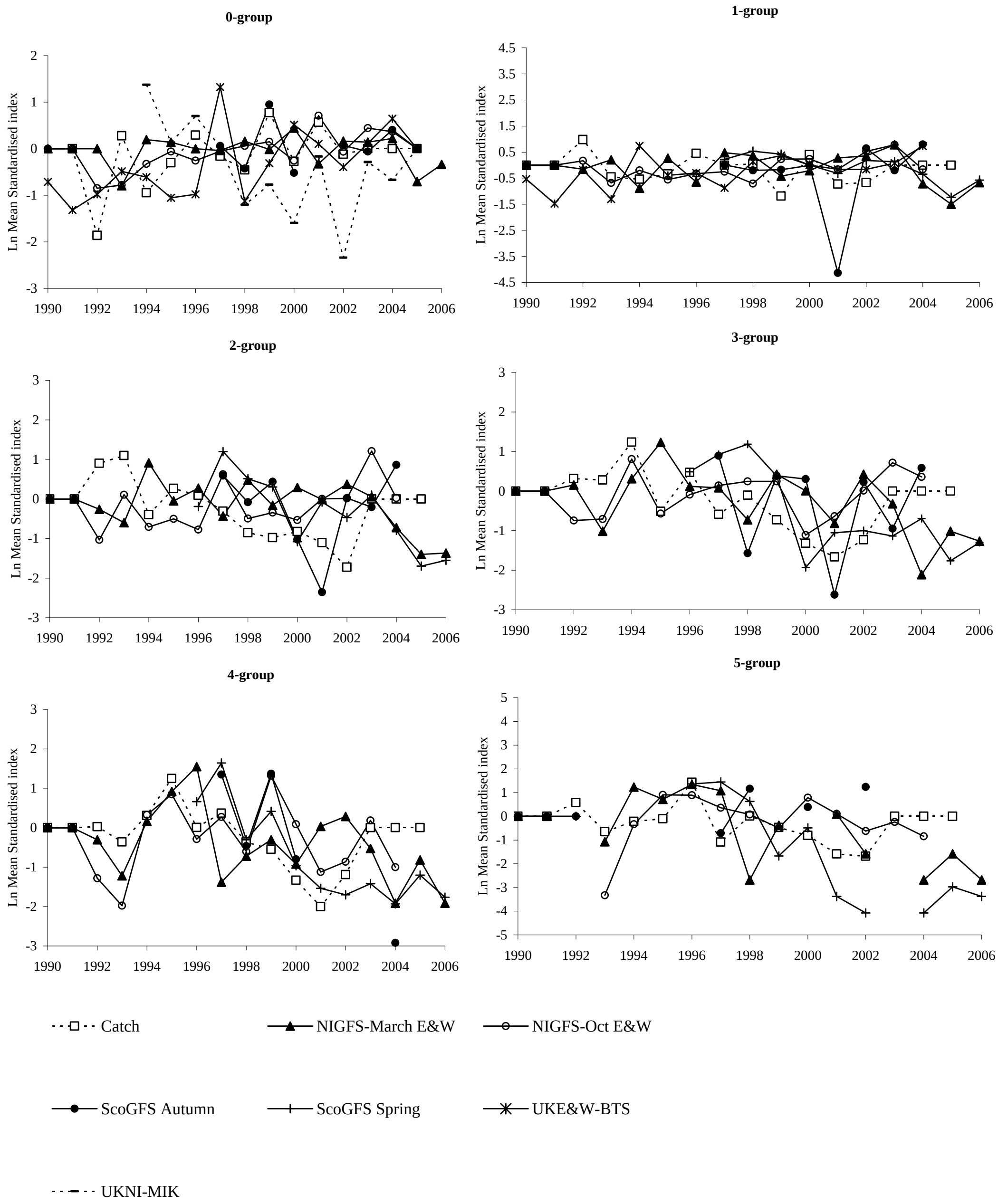
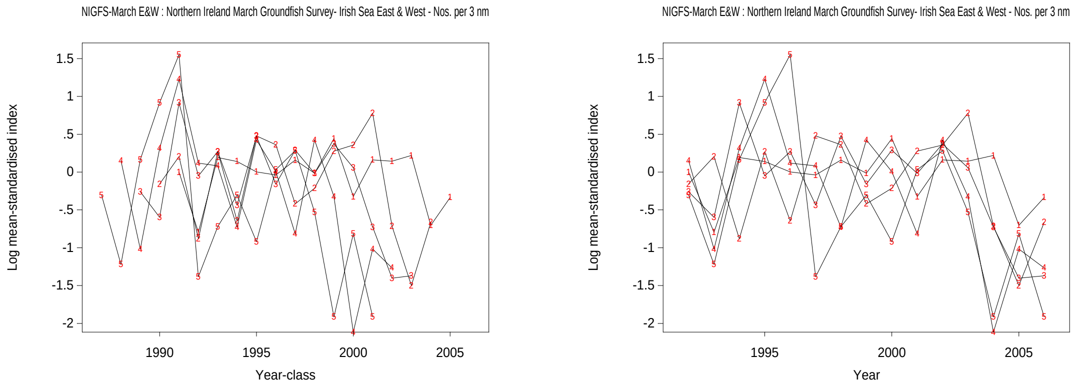
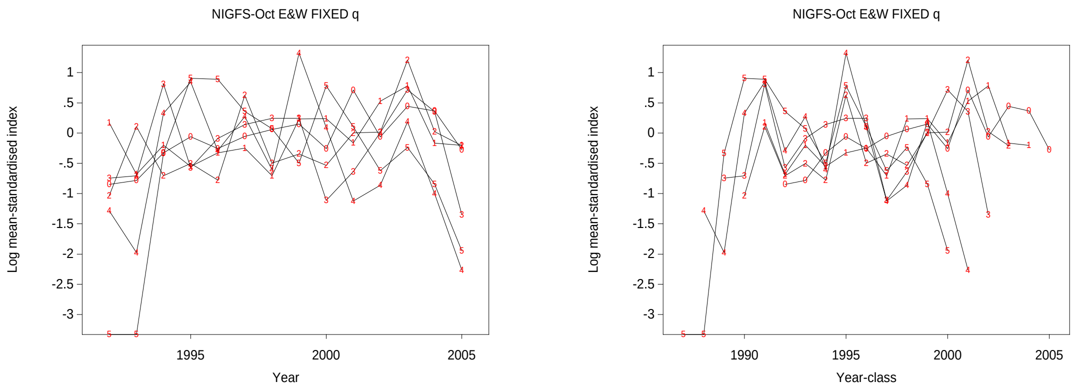


Figure 10.6.1.2.2 Log Mean Standardized Indices By Year-class and Year for NIGFS March (a), NIGFS October (b) and ScoGFS (c)

(a)



(b)



(c)

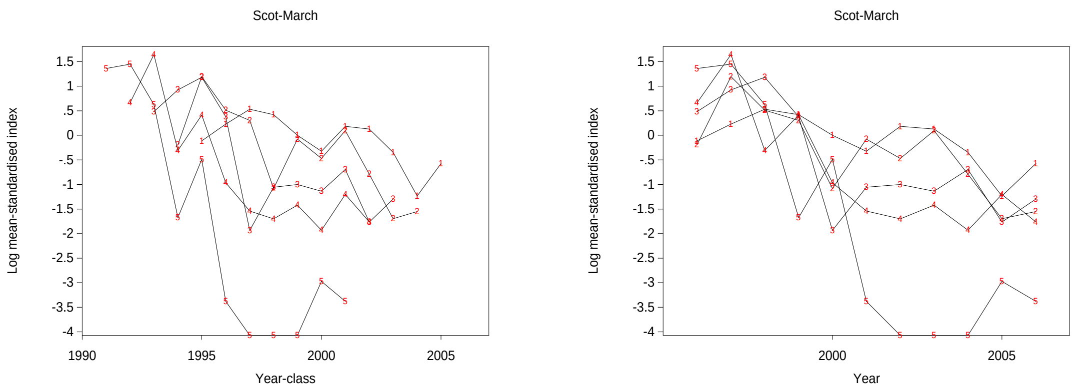
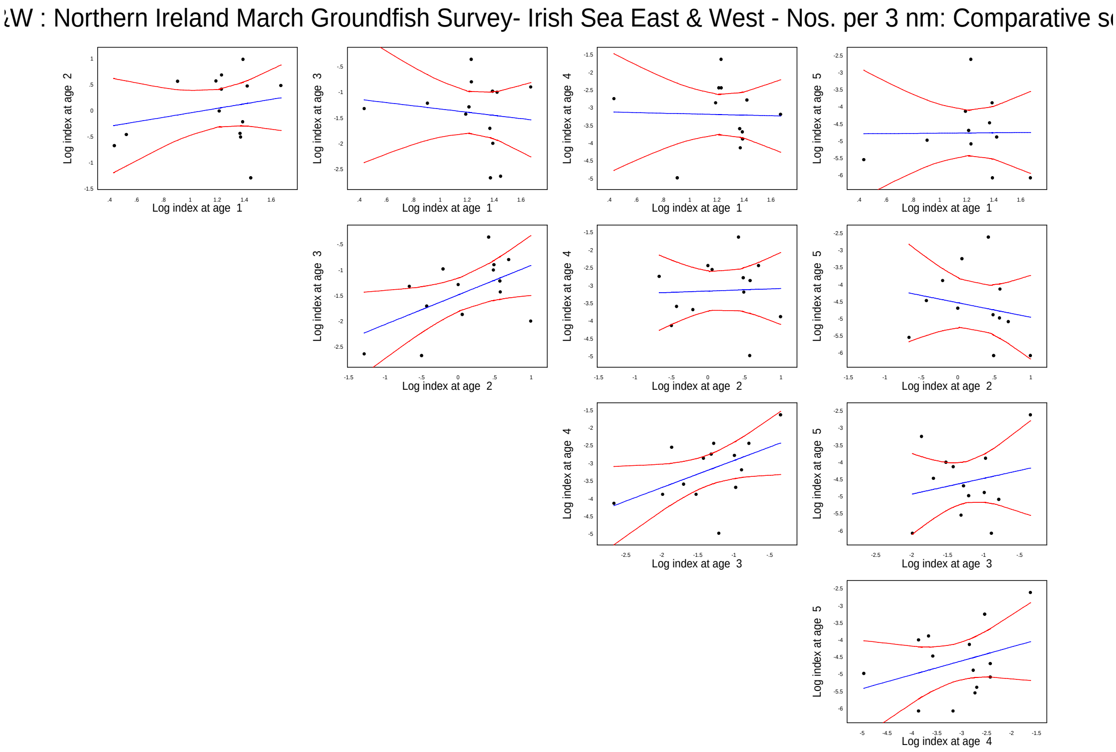
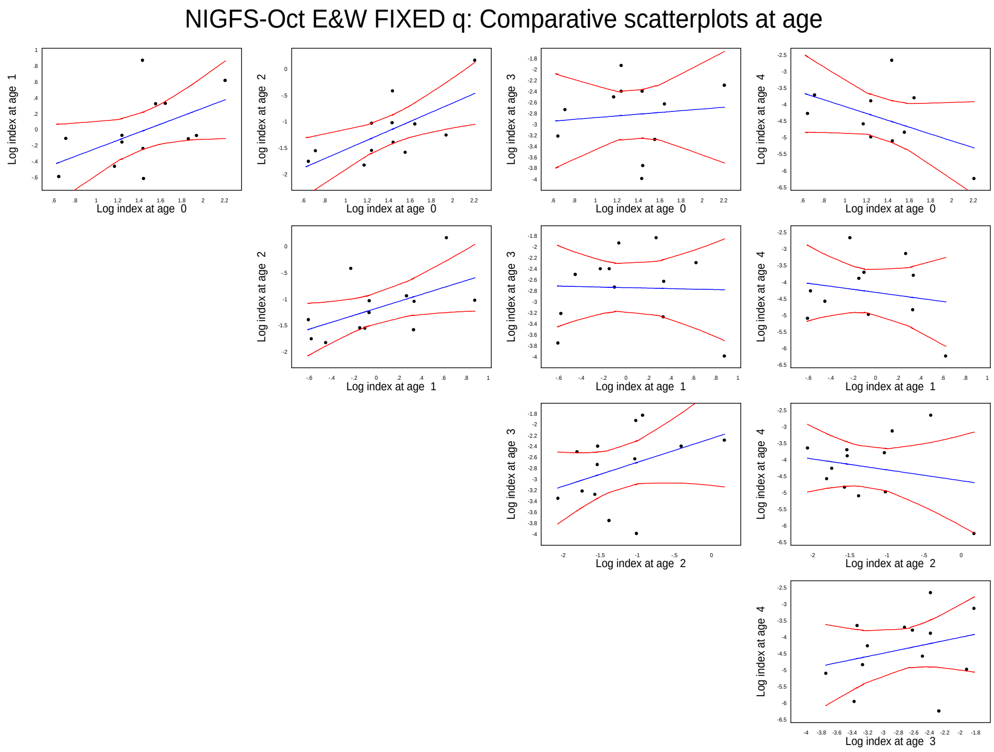


Figure 10.6.1.2.3 Scatter Plots of Log index at age for the NIGFS March (a),NIGFS October (b) and ScoGFS (c).

(a)



(b)



(c)

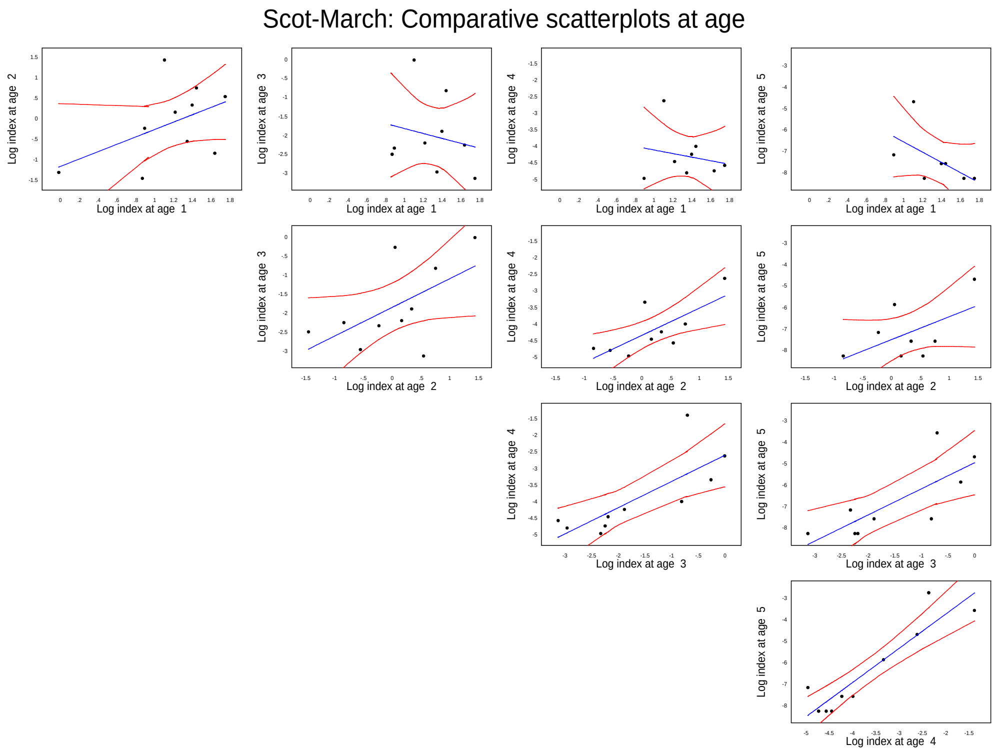
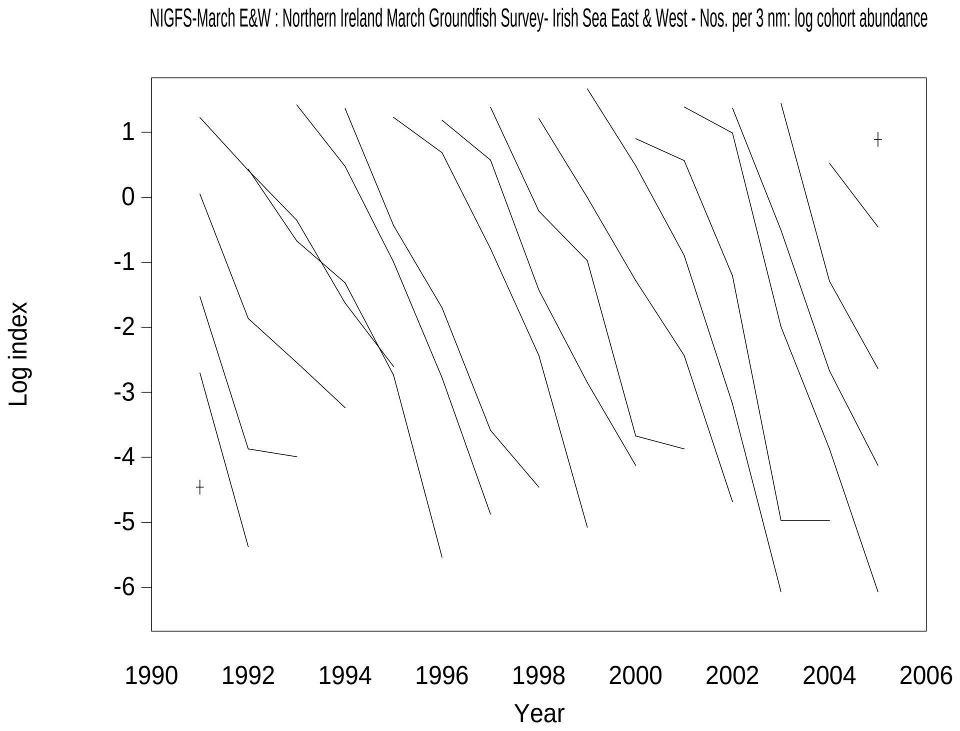


Figure 10.6.1.2.3 contd.

(a)



(b)

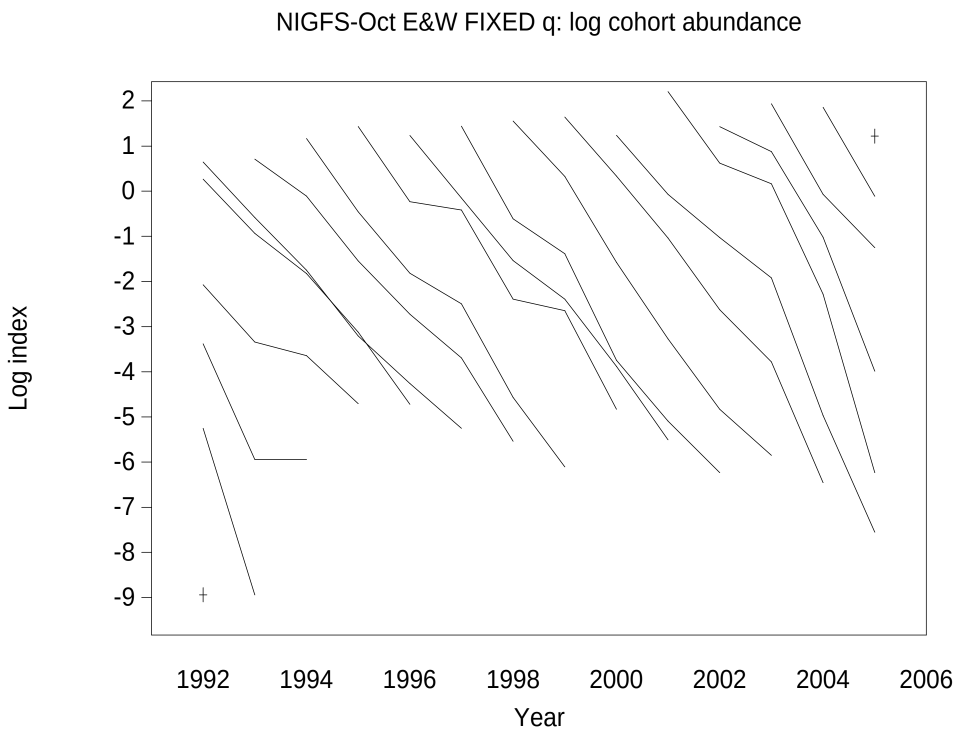


Figure 10.6.1.2.4 Catch Curves for NIGFS-March (a), NIGFS-Oct (b) and ScoGFS (c)

(c)

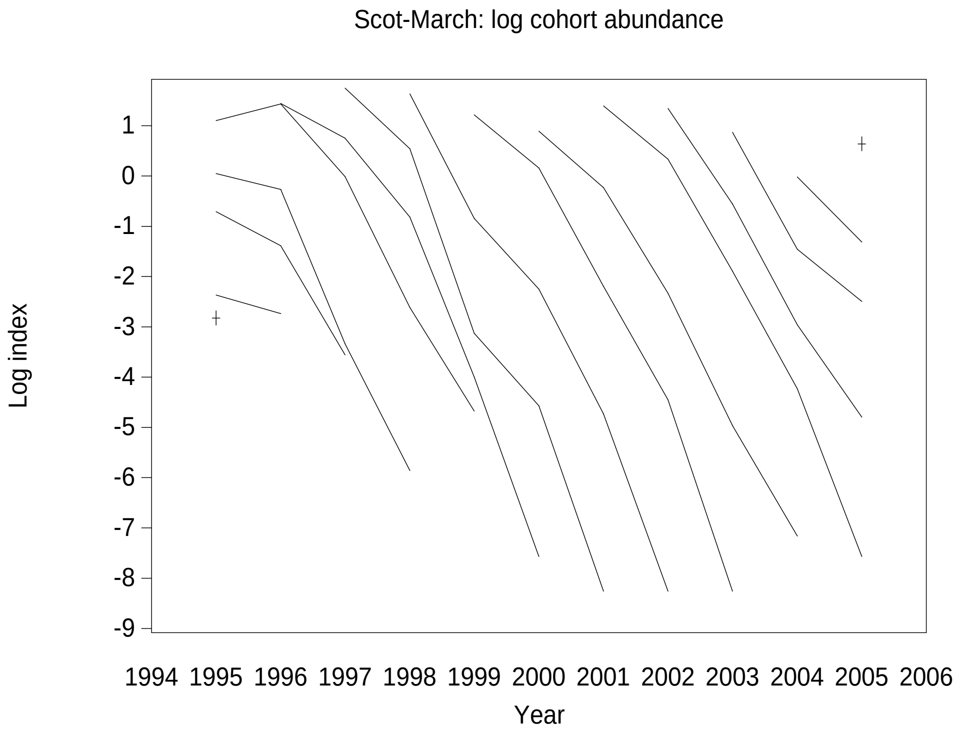
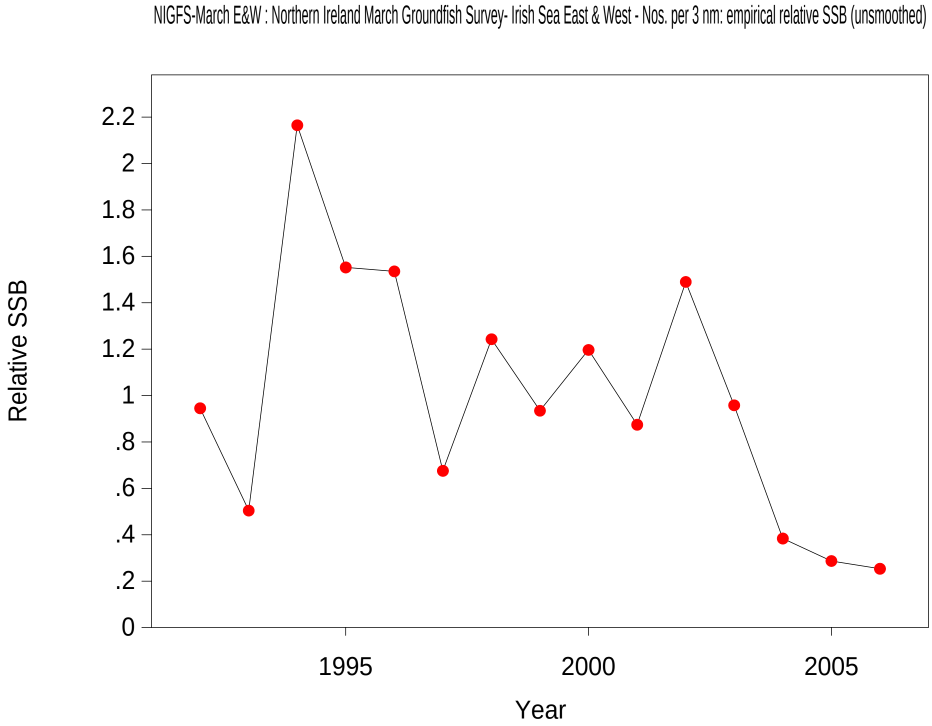


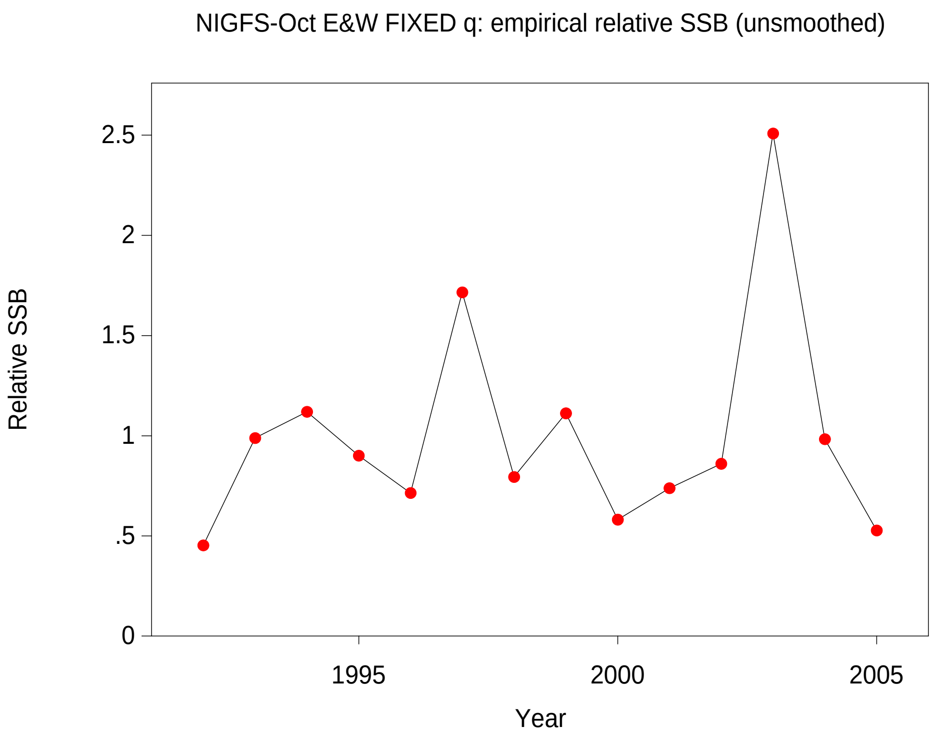
Figure 10.6.1.2.4 Continued

Figure 10.6.1.2.5 Empirical Estimates of SSB for NIGFS-March (a), NIGFS-Oct (b) and ScoGFS (c)

a)



b)



c)

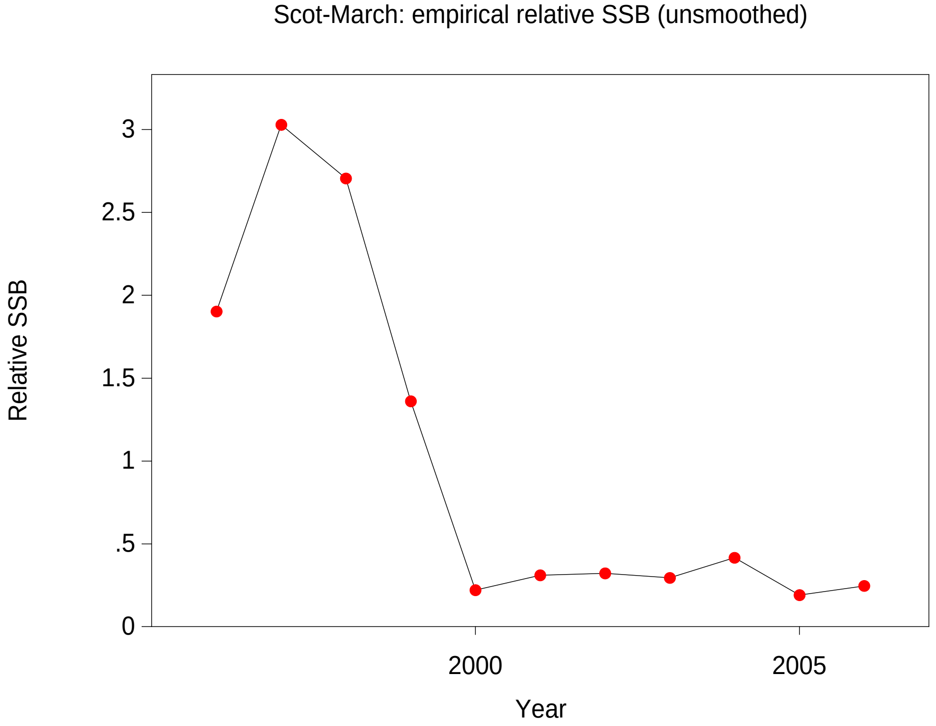


Figure 10.6.1.2.4 contd.

11 Plaice in sub- DIvision VII

In 2005 ICES provided advice based on an ICA assessment tuned solely by survey tuning information. Previously XSA had been used to assess this stock. A revision of the 2003 assessment markedly changed the perception of the stock. The 2005 WG carried out substantial further investigation of the available data to substantiate the results of the revised assessment. The 2005 ICES review group voiced concerns regarding the UK(E&W) beam trawl survey catchabilities particularly as discarding of Irish Sea plaice is substantial. Further work conducted by the review group was unable to shed light on catchability trends in the UK beam trawl survey, the effect of discarding or the apparently very low levels of F implied by the assessment. The revised assessment was accepted as the basis for advice in 2005. A benchmark assessment was conducted by the working group this year.

11.1 The fishery

A general description of the fishery can be found in the stock annex.

11.1.1 ICES advice applicable to 2005 and 2006

ICES advice for 2006

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

Fishing mortality is estimated to be below $\mathbf{F_{max}}$ (0.36) and close to $\mathbf{F_{0.1}}$ (0.13). There will be little gain to the long-term yield by increasing fishing mortalities above current levels. Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits.

Exploitation boundaries in relation to precautionary limits

In order to harvest the stock within precautionary limits, fishing mortality should be kept below $\mathbf{F}_{pa}$ (0.45). This corresponds to catches less than 5 900 t in 2006 and will lead to a reduction in SSB to 11 200 t in 2007. Average fishing mortality in the last three years has been below $\mathbf{F}_{pa}$ and no long-term gains are obtained by increasing the current fishing mortality towards $\mathbf{F}_{pa}$.

ICES advice for 2005

Exploitation boundaries in relation to high long term yield, low risk of depletion of production potential and considering ecosystem effects: There will be no gain in the long term yield to have fishing mortalities above $F_{0.1}$ (0.14). Fishing at such lower mortalities would lead to higher SSB and, therefore, lower risks of fishing outside precautionary limits.

Exploitation boundaries in relation to precautionary limits: In order to harvest the stock within precautionary limits, fishing mortality should be kept below F_{pa} (0.45). This corresponds to catches less than 2,970 t in 2005 and will lead to a reduction in SSB to 6370 t in 2006. However, there are no long term gains in increasing the current fishing mortality towards Fpa.

For general mixed fisheries advice applicable to this stock and other species taken in the samefisheries, please se section 1.7

11.1.2 Management applicable in 2005 and 2006

There is a minimum landing size in force for VIIa plaice of 27 cm

Management of plaice in division VIIa is by TAC and technical measures. The agreed TACs and and associated implications for plaice in division VIIa are detailed in the table below.

Management regulations for Irish Sea fisheries applicable in 2005 and 2006 are detailed in Section 1.7.

WG YEAR	SINGLE SPECIES EXPLOITATION BOUNDARY(TONNES	BASIS	TAC	% CHANGE IN F ASSOCIATED WITH TAC[2]	WG LANDINGS
2003	<1.9	Maintain F below $\mathbf{F}_{pa}$	1,675	-12%	
2004[1]	<1.6	Maintain F below $\mathbf{F}_{pa}$	1,340	-2%	1,520
2005[1]	< 3.0	Maintain F below $\mathbf{F}_{pa}$	1,608	-31%	1,115
2006[1]	<5.9	Maintain F below $\mathbf{F}_{pa}$	1,608	0	1,221

[1] additional mixed fishery considerations

11.1.3 The fishery in 2005

Effort levels have varied slightly for some fleets between 2004 and 2005 but overall levels appear relatively constant and anecdotal information from the fishing industry suggests an abundance of plaice in area VIIa

Belgian vessels operating in Division VII typically move in and out of the Irish Sea depending on catch rates in adjacent areas, specifically the Bristol Channel and Celtic Sea, the Bay of Biscay and the southern North Sea. Effort levels by this peaked fleet in 2005 in the second quarter. For the UK(E&W), otter trawl fleet reports the majority (approximately 90%) of plaice landings. Landings are typically low in the first quarter when the fish are generally found further offshore in deeper water. Paradoxically, the recent reductions of days at sea for otter trawlers using nets between 100 and 120mm in line with measures to protect cod has lead to an increase in the use of 80mm mesh gear (WGFTFB, 2006).

High levels of discarding are known to occur in this fishery as well as potential mis-reporting. Recent sampling studies for discards in the Irish Sea indicate that discarding of plaice is substantial and that only a small proportion of the total catch may be retained on-board. The time series of discard observations is relatively short and discards are not currently incorporated in the assessment. Despite attempts by last years WG and the RG to improve the estimation of discards of plaice it has not been possible to quantify discarding with any confidence.

11.2 Official catch statistics

11.2.1 Revisions to catch data

National landings data reported to ICES, and Working Group estimates of total landings, are given in Table 11.1.2.1. The 2003 working group estimate of landings has been amended following minor revisions by France to 1,554 tonnes. The 2004 working group estimate of landings has been amended following minor revisions by the UK and France to 1,115 tonnes. The TAC in 2006 was 1,608 tonnes. The working group estimate of landings in 2005 is 1,221 tonnes, 24% less than the allowable catch and representing a 7 % increase over 2004 landings. The shortfall of estimated landings from the total allowable catch in 2005 is consistent with previous years. It seems unlikely that the poor uptake of the quota is a consequence of an inability to catch sufficient quantities of plaice. A shortfall in uptake of the TAC is common for this stock and a significant proportion of the TAC is redistributed between nations through quota swaps.

11.2.2 Quality of the catch data

The level of discarding in this fishery is substantial. Discards are not currently incorporated into the assessment and therefore represent a substantial component of un-accounted mortality. The omission of a substantial portion of the total catch through the lack of sufficient discards information results in a reduced ability to effectively track cohort strengths through the population and poor determination of recruitment levels in the fishery.

Routine sampling of discards has been conducted in recent years but there are no reliable estimates of the level of discarding in the earlier years for this stock, nor is it necessarily possible to raise discards from those fleets providing information to the total international levels of discarding due to the spatial and temporal characteristics of individual fleets.

The issue of mis-reporting has, in recent assessments, not been considered to be a serious problem for this stock. It is apparent that the practice of mis-reporting is widespread throughout the Irish Sea fisheries and it is no longer considered plausible to assume that this stock is unaffected, however, the full scale of the problem is very unclear.

11.3 Commercial catch effort data and research vessel surveys

11.3.1 Commercial effort and LPUE data

Effort trends (reported hours fished, corrected for fishing power) for the main fleets operating in the fishery are given in Table 11.3.1.1. and Figure 11.3.1.1. Following a 37% decrease in effort in 2003 by the Belgian beam trawl fleet effort has been increasing again since then reaching high levels in 2005. Current effort is still lower than the 2002 value, which was the highest observed since 1990. The UK(E&W) otter trawl fleet and beam trawl fleet effort has been in gradual decline over the last decade and levels in 2005 showed a further drop to the lowest observed values. UK beam trawl effort has been variable over recent years but much lower than observed in the late 1980’s to early 1990’s. Irish otter trawl fleet effort also appear to be declining from the high value in 1999.

LPUE for the Belgian beam trawl fleet and UK(E&W) otter trawl fleet show very similar trends in the early part of the time series but divergent patterns from the early 1990’s onwards when effort levels in the otter trawl fleet declined markedly. LPUE for the UK(E&W) beam trawl fleet show large fluctuations over the time series with little apparent trend. LPUE in 2005 has increased slightly for 3 of the 4 fleets but terminal values show little change in recent years (Table 11.3.1.1).

11.3.2 Survey CPUE data

CPUE values for the CEFAS autumn beam trawl surveys (UK(E&W)BTS) are shown in conjunction with the spawning biomass indices derived from NIGFS_MAR and NIGFS_OCT (table 11.3.2; figure 11.3.2). All three surveys show a similar overall trend of increasing abundance though there is less consistency in terms of year to year variability.

All three surveys indicate an increase in SSB over the time period, although rates are not comparable on the absolute scale. The issue is discussed further under section 11.6.1.

11.4 Age compositions and mean weights at age

11.4.1 Landings age composition and mean weights at age

Catch numbers at age are given in Table 11.4.1. Weights at age in the catch and stock are given in Tables 11.4.2 and 11.4.3. Last year the catch weights and stock weights were calculated using a cohort based growth model. Although this model fitted the observed weights more appropriately, it was difficult to project weights for the forecast. Especially cohorts with few data points represented a problem to the fitting procedure. Consequently the WG decided to return to the previously employed in year smoothing, but suggests more appropriate methods continue to be investigated. The history of the derivation of the catch weights and stock weights used in this assessment is described in the stock annex.

Quarterly age compositions for 2005 were available for Ireland (beam trawl and otter trawl) and UK(E+W otter trawl, E+W beam trawl). These fleets together represented 45% of the landings in 2005.

Age compositions for Belgium were not available for 2003 and 2005, so that Belgium landings were raised to combined Irish age compositions.

Sampling levels for those countries providing age compositions are given in Table 2.3 The aggregation procedure (as in previous years) was as follows: UK(E+W) quarterly catch numbers at age were raised to include Scotland and Isle of Man landings; Ireland quarterly catch at age data were raised to include N. Ireland and France landings. The composition of the total international catch was calculated from the summation of the UK(E&W), Ireland catch numbers at age and Belgium landings raised to Irish age compositions.

Catch weights at age were obtained from the weighted mean total international weights at age (weighted by catch numbers), smoothed using a quadratic fit and representing 1 July values (i.e. age = 1.5, 2.5 etc.) :

$$Wt = 0.436 - 0.1091*age + 0.0142*age^2$$

and scaled to give a SOP of 100% Stock weights at age were derived from the same quadratic fit, but representing 1 January values (i.e. age = 1.0, 2.0 etc.), and scaled by the same SOP-correction factor as the catch weights.

11.4.2 Discards age composition

Discards are not currently included in this assessment. Routine discard sampling has been conducted by the UK(E&W) since 2000, since 1993 by Ireland and more recently by Belgium. Length distributions of landed and discarded fish for UK(E&W) and Irish fleet estimates are presented in figure 11.4.2. An investigation into methods of determining age based estimates of discards for the entire time series of catch has been undertaken. However, these values are not yet considered to be estimated with sufficient reliability to warrant their inclusion in the assessment.

11.5 Natural mortality and maturity at age

Natural mortality is taken as 0.12 yr^{-1} and assumed constant across all ages and all years. Maturity at age was taken as

Age	1	2	3	4	5	6
Maturity	0	0.24	0.57	0.74	0.93	1.0

The proportion of F and M before spawning was taken as 0, such that SSB values are calculated as of the 1st January.

Details of the methods by which the above values have been derived are provided in the stock annex.

11.6 Catch-at-age analysis

See section 2.7 for the general approach adopted at the WG.

11.6.1 Data screening

The assessment of this stock has traditionally been conducted using XSA, however, to facilitate the use of spawning biomass indices an ICA assessment has been carried out since 2003.

Commercial catch data

For catch data screening, a separable VPA was carried out using a reference age of 4 and F and S values set to 0.35 and 0.8 respectively. The separable model was fitted over the entire time series and equal weighting was given to all years and all ages. The residuals from the fitted model are shown in figure 11.6.1.1. Residuals for the partially recruited age 1 data were generally large as were those for the older age groups, particularly in recent years. Ages comprising the bulk of the landings showed smaller residuals.

Log catch at age for the time series up to 2004 data are shown in figure 11.6.1.2a. these illustrate a progressive change in the selection pattern over time. During the 1970’s and 1980’s full selectivity in the fishery occurred at around age 3 whereas in the more recent time series full selection occurs around age 4. For ages 4 and above there is little apparent change over time in either the level or the gradient of the slope although data from age 10 onwards appear quite noisy. The gradient of a straight line fitted through the curve for each cohort between ages 3 and 6 (the Fbar age range) is shown in figure. It can be seen that the gradient of the curve has become progressively less negative since the early 1970’s indicating a shallowing of the catch curve when examining the change in the slopes (figure 11.6.1.2b). This can be interpreted as a reduction in total mortality levels across these ages. The process was repeated using different age groups to determine the sensitivity to the age range over which the straight line was fitted but no marked changes in the results were observed.

Tuning data

All available tuning data is shown in table 11.6.1 Age based tuning data available for this assessment comprise 3 commercial fleets; the UK(E&W) otter trawl fleet (UK(E&W)OTB, 1987-2005), the UK(E&W) beam trawl fleet (UK(E&W)BT, 1989-2005) and the Irish otter trawl fleet (IR-OTB, 1995-2005), 4 age-based survey series; the UK beam trawl survey (September: 1989-2005), the UK beam trawl survey (March: 1993-1999), the Irish juvenile plaice survey (1976-2004) and the R.V. Celtic Explorer groundfish survey which replaced the Irish Sea Celtic Sea groundfish survey and operated in 2003-2004 and 2 spawning biomass indices; the UK(NI) groundfish survey (Spring 1992-2006) and the UK(NI) groundfish survey (Autumn 1992-2005).

Plots of the mean standardised indices and comparative scatter plots of adjacent age classes for the UK beam trawl survey are shown in figures 11.6.1.3 to 11.6.1.4. The UK(E&W) beam trawl survey shows good ability to track year-class strengths in some years, though, this ability is less apparent at the beginning and end of the time series. Internal consistency of this survey appears to be good for ages greater than 1. Plotting indices by year shows increasing trend in abundance (figure 11.6.1.5), with variability spread more evenly across all years. (figure 11.6.1.5).

The review group still expressed doubts regarding the assumption of constant catchability of the survey urging the WG to undertake further examination of the issue.

A simulation was carried out to investigate how changes in the stock dynamics would be likely to affect catch rates in the survey compared with potential changes in catchability. These results were compared with observed age and year effects in the UK(E&W) beam trawl survey. Scenarios examined were, a sudden drop in F from equilibrium conditions, a linear decline in F from equilibrium conditions, a linear increase in catchability of the survey and a linear increase in recruitment. Means standardized abundance indices at age were plotted for each of the simulations (figure 11.6.1.6).

The linear change in q indicated that indices should increase linearly with no crossing over of ages. A sudden drop in F produced very jagged rises in the index for each age with the effect being most exaggerated at the oldest ages. Linear decreases increased the period over which the age crossed. The picture for a linear increase in recruitment was virtually identical to this, except that the prerecruit age remained stable in the F scenario whilst increasing linearly in the recruit scenario.

The UK beam trawl survey means standardized indices interpolated using bicubic-polynomals are plotted in figure 11.6.1.7. They clearly indicate a crossing over of lines and an increasing effect with increasing age, suggesting there is a consistent increase in recruitment or a sustained decrease in F. Both age 0 and age 1 indices show an increasing trend over the time period stabilizing in the later part, implying that the change is recruitment driven. However, given the high level of discards for younger ages it is not safe to assume that mortality is not linked to fishing. It is currently not possible to clearly differentiate between a recruitment increase or progressive F reduction, but it is clear that the data is neither consistent with a sudden drop in F or an age independent increase in catchability of the survey.

The SSB indices of the UK beam trawl survey indicates a rise in SSB over the time period, however this survey covers only the eastern part of the Irish Sea so that the picture is not necessarily representative of the whole stock. Disaggregating the UK (NI) ground fish survey into areas corresponding to the UK beam trawl survey (Strata 6-7 in the UK (NI)) ground fish survey further complicates the picture, in part because the stimates a much more variable since this survey is not designed to target plaice. However, indications are that SSB has increased in the eastern part of the Irish Sea in both the spring and autumn survey, while no increase is observed in the western section during the spring survey, with a marked increase in the autumn survey : figure 11.6.1.8. This is consistent with the timing of the UK beam trawl survey, but fails to quantify which portion of the stock each of the trends is applicable to. Movement of plaice in the Irish Sea are most likely to occur NS, rather than EW (Pawson & Dunn), so that the more dramatic increase in plaice in the autumn survey in the west cannot be explained by the lack of an increase in the east. The observed tendencies are therefore likely to be associated with movement in and out of the eastern survey area between spring and autumn.

The evidence suggests only that SSB has been increasing in the Irish Sea since all indices have increased or remained stable, but no estimation of the rate of increase in the stock as a whole is possible from the survey data alone.

Exploratory survey and catch at age analyses

Surba

Survey based analyses were conducted using SURBA 3.0, an updated version of the software which can now include SSB indices. Considerable time was spent examining the SURBA analysis last year and with only a single additional years worth of data it was considered it did not warrant re-examining all available data series. Consequently only tuning series used in last years assessment were considered, producing a single run using the UK beam trawl survey and the two SSB indices using the settings of last years final run. The new scan facility in the software was utilised to examine the sensitivity of the analysis to this settings choice.

The results of the analysis show little variation in the age effect, except at age 1, little variation in the cohort effects and a slowly decreasing year effects with reasonable distribution of residuals, particularly since 1996 (Figure 11.6.1.9). Age disaggregated tuning data shows reasonable internal consistency, although more than 5% of the residuals are found to be outside the 95% confidence limits, particularly at the older ages. SSB has trebled since 1991 with most of this increase occurring in the last five years with little retrospective bias (Figure 11.6.1.10). Total mortality has been steadily decreasing over the time period with some small scale variation, again with only small retrospective variability, but some bias for upward revisions(Figure 11.6.1.11)

The SURBA analysis is mostly robust to the choice of parameters, except at very low lambda and low catchability estimated for the survey at age 1(Figure11.6.1.12-11.6.1.14).

Eight ICA assessments were run to explore the sensitivity of settings and data inclusions on the diagnostic outputs. The following combinations were explored:

LABLE	TERMINAL S	REF AGE	WEIGHT AT AGE 1	YEARS OF SEPERABLE PERIOD
Spally ICA	1	4	0.1	5
ICA 1	0.7	4	1	5
ICA 2	0.8	5	1	5
ICA 3	1	5	1	5
ICA 4	1	6	1	5
ICA 5	1	4	0.1	5
ICA 6	1	5	0.1	6
ICA 7	1	4	0.1	6
ICA 8	1	5	Removed	5

Diagnostics of the results are graphically displayed in Figure 11.6.1.15. Residual plots from the ICA diagnostics indicated that there was little to chose between the various settings.

Choosing a separable period of 6 years had a tendency to increase the residuals at younger ages. Given the instability in fleets and gear usage, as well as the probably variable rates of discarding it seemed inappropriate to increase the separable period to 6 years (ICA 6,7).

Selectivity curves appeared to be unrealistically constrained (ICA 1,2), when examining the selection pattern for setting of less than 1. Investigation of the catch data did not indicate a decline in catchability at older ages in contrast to many other flatfish stocks.

Changing the reference age had little impact on the shape of residuals for an age, but tended to shift the residual curves relative to each other. The reference age always had positive residuals with other ages having mostly negative mean residuals. Age 8 always showed large negative residuals, with the younger ages having small residuals. Year residuals were largest in the 2003 but tended to vary little with any of the chosen setting. The selectivity patterns appeared to be unrealistically constrained with a choice of an age 4 reference age (SPALLY ICA,ICA 5,7) or 6 (ICA 4).

Weighting of age 1 had little impact, since the residuals for this age were small compared to other ages given the very small estimate of catchability. Excluding the year from the data entirely (ICA 8) provided little improvement in the diagnostics over the model with the same setting, but including age 1 (ICA 3).

Retrospectives from the two model runs (ICA3,8) (figure11.6.1.17, 11.6.1.18), indicated that trend were more consistent with regards to recruitment trends, mainly because the scale of recruits at age 2 was smaller than at age 1, but also because information on age 2 seem to be more indicative of YC-strength. Numbers of two year olds in the final year are still poorly estimated, but the effect on forecast variability is greatly reduced, so that ICA 8 represented the most practical option.

11.6.2 Final ICA run

Final assessment settings for this year and the previous two years assessments are shown in the text table below. Changes to the previous years settings are shown in bold.

ASSESSMENT YEAR	2004	2005	2006
Assessment model	**ICA**	ICA	ICA
Tuning fleets	UK(E&W)OTB	**UK(E&W)OTB**	UK(E&W)OTB
	1987 – 2003	**Series omitted**	Series omitted
	ages 5-8		
	UK(E&W)BTS Sept	UK(E&W)BTS Sept	UK(E&W)BTS Sept
	1989 – 2003	1989 – 2004	1989 – 2005
	ages 1-7	ages 1-7	ages 1-7
	UK(E&W)BTS March	**UK(E&W)BTS March**	UK(E&W)BTS March
	1993-1999	**Survey omitted**	Survey omitted
	ages 1 – 4		
	UK(E&W)BT	**UK(E&W)BT**	UK(E&W)BT
	1989 – 2003	**Series omitted**	Series omitted
	ages 5-8		
	IR-OTB	**IR-OTB**	IR-OTB
	1995-2003	**Series omitted**	Series omitted
	ages 5-8		
	UK(NI) GFS Mar	UK(NI) GFS Mar	UK(NI) GFS Mar
	1992-2003	1992-2004	1992-2005
	Biomss index	Biomss index	Biomss index
	UK(NI) GFS Oct	UK(NI) GFS Oct	UK(NI) GFS Oct
	1992-2003	1992-2004	1992-2005
	Biomass index	Biomass index	Biomss index
Time series weights	Full time series unweighted	full time series unweighted	full time series unweighted
Num yrs for separable	3	**5**	5
Reference age	4	4	**5**
Terminal S	0.7	**1.0**	1.0
Catchability model fitted	Linear	linear	linea
SRR fitted	No	No	No
Catch-no_at_age ange	1-9+	1-9+	2-9+

ICA diagnostics output for the final assessment are shown in table 11.6.2.1. Catch-at-age and tuning index residuals are shown in figure 11.6.2.1, and the remaining diagnostics are available in figure 11.6.1.15 as ICA 8 final. The 95% confidence intervals (shown as error bars) about the fitted selection pattern are generally large, particularly for the older ages which may be less well represented in the survey data. Catchability residuals for the 3 tuning series show no clear trends to be apparent in either the age based or biomass indices though.

Population numbers at age, fishing mortality at age and the stock summary are shown in Table 11.6.2.2-11.6.2.4

SSB and F from a retrospective analysis conducted for the final assessment are shown in figure 11.6.2.3 for the period 1980 to 2005. They show a slight retrospective tendency for an upward revision of F and a downward revision of SSB but the effect is not pronounced.

Summary plots for the final assessment are shown in Figure 11.6.2.2. Estimates. SSB in 2005 is estimated to be at the highest levels observed in the 41 year time series and fishing mortality appears to be the lowest on record. The stock size is estimated to have increased markedly in recent years. Similar increases in stock size have previously occurred in Irish Sea plaice and it is noted that such increases in the past occurred at relatively higher levels of fishing mortality. Estimates of annual egg abundance in the Irish Sea (figure 11.6.2.3) show an increase in estimated egg abundance in recent years and support the results of the assessment that spawning biomass is increasing in this stock.

11.6.3 Comparison with last year's assessment

A comparison of this years assessment and last years is shown in figure 11.6.3. The results show no revisions with regards to the previous assessment although settings have changed and previous assessments an upward revision of SSB and a downward revision of Fin the most recent years. Whilst the absolute levels of estimated SSB and F have been revised in recent years, the overall trends apparent in this stock remain unchanged.

11.7 Estimating recruiting year-class abundance

ICA estimates the strength of the 2003 year-class at 22.2 million two year olds in 2005, 70% above GM64-03 and 63% above the arithmetic mean (1964-2003). The final recruitment values is derived entirely from the survey estimate used in the assessment model. Although moving recruitment to age 2 has reduced the scale of the retrospective bias on a relative scale this has not improved sufficiently to use this as an estimate of recruitment in 2005 in the short-term forecast.

Previous assessments of this stock have shown a step change in recent recruitment levels. Reduced recruitment is apparent in the mid 1990’s but recruitment appears to have recovered to higher level. It is difficult to assess whether the recent increase represents a shift in recruitment dynamics or stochastic variability.

11.8 Long-term trends in biomass, fishing mortality and recruitment

Trends in F, SSB, recruitment and landings, for the full time series, are shown in Table 11.6.2.1 and Figure 11.6.2.2. Fishing mortality is estimated to have risen to very high levels in the mid 1970’s but to have declined from these levels over the subsequent 30 years. Fishing mortality since the early 1990’s has shown a marked and almost continuous decline and in 2005 is estimated to be at it lowest level in the time series (Fsq=0.126).

Spawning biomass levels show a sinusoidal pattern over the 41year time series. High SSB levels occurred at the beginning of the time series, however, current SSB levels are estimated to be increasing to similarly high levels. Estimated recruitment levels have been variable over the time series. Recruitment levels declined markedly in the early 1990’s but have since shown a gradual increase in recent years and are close to long term geometric mean levels.

11.9 Short-term catch predictions

Population numbers for short term forecasts were taken from the ICA output of survivors at ages 4 and above in 2006. Numbers at age 2 were taken as the long-term (64-04) geometric mean. Because of the considerable uncertainty of the estimate of recruitment at age 2 in 2005, populations numbers at age 3 in 2006 have been overwritten with the long term geometric mean estimate depreciated for Fsq and M (11,053 age 3’s in 2006). Recruitment estimates from various sources are shown below. Those used for the short term forecasts are shown in bold.

	ICA ESTIMATE	**GM 64-04**
2005 recruitment (000's) at age 2	22,200	**12,630**
2006 recruitment (000's) at age 2		**12,630**
2007 recruitment (000's) at age 2		**12,630**

Fishing mortalities were the mean F's at age over the period 2003-2005. Estimates of fishing mortality show a marked decline over the last 15 years and the 2005 value is estimated to be the lowest level observed in the history of the fishery. Fluctuations in the level of fishing mortality are evident earlier in the time series with sharp increases following similar declines.

In the light of this a three year unscaled mean fishing mortality was considered most appropriate for the short term forecasts.

Catch and stock weights used in this assessment are subject to in-year smoothing. Observation of the raw catch weight at age data indicate a trend of declining weight at age, particularly for the older age groups. This trend is apparent over the last 15 to 20 years in the commercial catches but cannot be identified in the surveys. Catch and stock weights at age were taken as three year mean values over the period 2003-2005. They have not been rescaled since weights at age appear to decline gradually over a 15 year period but also appear to be quite noisy and the effect over a 3 year period is small. The smoothing of catch and stock weights at age has been commented on in section 11.4.

The short term forecast was run as a status quo projection. Input data are shown in Table 11.9.1 The predicted landings in 2005 and 2006 and SSB in 2005, 2006 and 2007 are given in table 11.9.2. and summarised in the table below. The management option output is shown in table 11.9.3. and the results shown graphically in figure 11.9.1.

Year	Landings (t)	Source	SSB (t) Jan 1st	Source
2005	1,281	WG Estimate	11,579	ICA
2006	1,987	SQ Forecast	13,940	SQ Forecast
2007	2,139 (1,500-2,900)	SQ Forecast	15,102	SQ Forecast
2008	2,265	SQ Forecast	15,998 (13,500-19,000)	SQ Forecast

A sensitivity analysis has been conducted for the short term forecast. The CVs for parameter estimates used in the forecast are shown in table 11.9.4.

Proportions that the 2001 to 2005 year-classes will contribute to landings and SSB in 2006 and 2007 are shown in table 11.9.5. Approximately 30% of the predicted landings in 2006 and 43% of the predicted landings in 2007 rely on year-classes for which geometric mean recruitment has been assumed. Delta coefficient plots from the Mar-Lab software indicate that yield in 2006 is largely dependent on F in 2006, whilst SSB in 2007 is strongly dependent on age 3 and age 2 Figure 11.9.2.

The predicted catch for 2006 assuming status quo F is 1,987 t. The TAC for 2006 is 1,610 t. SSB is predicted to increase rapidly to over 15,000 t. in 2007. The probability that SSB in 2007 will fall below 3,100 t. ($\mathbf{B}_{pa}$) assuming 1.2 times Fsq is less than 1%.

11.10 Medium-term projections

There appears to be little or no relationship between spawning biomass and recruitment levels at age 1 and no attempt to fit a stock recruitment relationship to these data has been made.

Given the lack of any clear stock and recruitment relationship the working group has in the past considered that the calculation of medium term projections was inappropriate for this stock. Particularly high discard rates result in very poor estimation of the both the overall level and the inter-annual variability of recruitment. In addition the use of age 2 in this years assessment knowing that there are considerable and variable rates of discarding and presumably mortality at age 1, precludes a useful examination of the relationship between stock and recruitment. Medium term projection were conducted using the MAR-Lab software, but little useful information could be gained from the analysis, as F is well below Fpa and SSB is well above Bpa.

11.11 Yield and Biomass Per Recruit

Yield per recruit results, long-term yield and SSB (conditional on the current exploitation pattern) are shown in Table 11.11.1 and Figure 11.9.1. *Status quo* F (0.12) is around 33% of $\mathbf{F}_{max}$ (0.36) and is 3% greater than $\mathbf{F}_{0.1}$ (0.12). The stock-recruitment scatter plot is shown in Figures 11.11.1. The equilibrium yield and SSB at *status quo* F are estimated at 2,570 and 18,370 tonnes respectively, based on GM recruitment (12.6 million).

11.12 Reference points

Biological reference point values for $\mathbf{F}_{pa}$ and $\mathbf{B}_{pa}$ were considered in detail in previous WG and ACFM reports, and are given below:

$\mathbf{B}_{pa}$ **= 3100t**, set on the basis of $\mathbf{B}_{loss}$, and evidence of high recruitment at the lowest biomass observed.

$\mathbf{F}_{pa}$ **= 0.45**, based on $\mathbf{F}_{med}$ and long-term considerations.

11.13 Quality of the assessment

It has been noted in previous years that aspects of this assessment appear to be deteriorating. Specific concerns in recent years have been the contradictory signals provided by the commercial tuning indices and the surveys, the lack of contrast in the strength of incoming year-classes and a retrospective bias in estimates of F and SSB.

Estimates of F are very low in this stock in recent assessments. There is little doubt that F has declined in recent years and the relative trends in F seem to be appropriate. However this assessment does not take account of discarding as suitable data for inclusion is not available. This years assessment moved the recruitment range from age 1 to age 2 which should decrease the effects of discarding at age 1, but still indicates a small but consistent retrospective bias in F and SSB. This suggests that Fsq is still an underestimate of the true F.

11.13.1 Commercial data

Biological sampling levels for this stock have typically been high with 80 to 90% of the reported landings being represented by age compositions that are derived from market sampling at either a separate sex or combined sex level. Age determination is not considered to be a serious problem in plaice though mis-ageing may occur more often in older fish.

Discard levels in this fishery are estimated to be very high and fish at the younger ages may be subject to substantially higher mortality levels than currently estimated. The landings of young fish represent only a small proportion of those caught and the lack of adequate information on mortality rates at these ages seriously impairs the ability to estimate recruitment levels in the population. There remain no sufficiently reliable estimates of discard levels for the entire time series of catch for this stock.

Catches at age may be poorly estimated particularly in the most recent years due to the lack of information on discard levels. In addition to high discarding levels it is also possible that mis-reporting levels may have increased as the TAC for plaice has been reduced in recent years in line with effort reductions required in other fisheries in the Irish Sea. It is apparent that plaice may be subject to both over-reporting as well as under-reporting depending on the quota allocation available to the different components of the international fleet. The stock is currently assessed using VPA, tuned by the ICA methodology. This method provides the option to down-weight the influence of the catch in different years, however, the resulting model fit using this approach seems particularly poor. The use of equal weighting of the catch data for all years forces the assumption that the catch is known without error.

11.13.2 Survey data

The stock of plaice in the Irish Sea is considered to be separated into 2 components, one in the eastern Irish Sea the other in the west. A similar spatial separation of the fishing fleets exits with the UK(E&W) and Belgian vessels fishing predominantly on the eastern side and Irish vessels on the western side though vessels may travel further afield and shift their distribution on a seasonal basis. The inclusion of the two UK(NI)GFS surveys (which cover the whole of the Irish Sea) reduces the dependency of this assessment on tuning information derived from the eastern Irish Sea only.

The only age based tuning data in this assessment is restricted to the area where the increase in the plaice stock appears to be most dramatic. Further work needs to be carried out to determine to which degree the rise in SSB predicted by the UK(E&W) beam trawl survey is representative of the stock as a whole.

11.13.3 Biological information

There is evidence of a decline in weight at age from the raw commercial landings data. This is less apparent in the available survey data.

11.14 Management considerations

Status quo F (average 2003-2005) is estimated to be 0.13; equal to $\mathbf{F}_{0.1}$ and well below $\mathbf{F}_{max}$ and $\mathbf{F}_{pa}$. SSB in 2006 is estimated at 13,934 t, and at 15,096 t in 2007, both of which are well above $\mathbf{B}_{pa}$ (3100 t). The stock is considered to be within safe biological limits.

The considerable level of discarding in this fishery indicates a mismatch between the minimum landing size and the mesh size of the gear being used. A decrease in the minimum landing size would not resolve the discarding problem as the market for small plaice is generally poor.

Table 11.2.1 Nominal landings (t) 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
Belgium	321	128	332	327	344[3]	459	327	275	325	482	636	628	431	566
France	42	19	13	10	11	8	8	5	14	9[1]	8	7	2	7
Ireland	1,355	654	547	557	538	543	730	541	420	378	370	490	328	
Netherlands	-	-	-	-	69	110	27	30	47	-	-	-		
UK (Eng.&Wales)[2]	1,381	1,119	1,082	1,050	878	798	679	687	610	607	569	409	369	421
UK (Isle of Man)	24	13	14	20	16	11	14	5	6	1	1	1	0	1
UK (N. Ireland)	…	…	…	…	…	…	…	…	…	…	…	…	…	…
UK (Scotland)	70	72	63	60	18	25	18	23	21	11	7	9	4	
UK (Total)														
Total	3,193	2,005	2,051	2,024	1,874	1,954	1,803	1,566	1,443	1,488	1,591	1,544	1,134	995
Discards	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unallocated	74	-9	15	-150	-167	-83	-38	34	-72	-15	31	10	-19	286
Total figures used by the Working Group for stock assessment	3,267	1,996	2,066	1,874	1,707	1,871	1,765	1,600	1,371	1,473	1,622	1,554	1,115	1,281

[1]Provisional.

[2]Northern Ireland included with England and Wales.

{UK (Total) excludes Isle of Man data}.

Table 11.3.1 Irish Sea plaice: English standardised LPUE and effort, Belgian beam trawl LPUE and effort and Irish otter trawl LPUE and effort series.

Year			LPUE						Effort ('000hrs)	
			English [1]		Belgian [3]	Ireland	English [2]		Belgian [5]	Ireland
	Beam [4] trawl survey		Otter Trawl	Beam Trawl	Beam Trawl	Otter Trawl	Otter Trawl	Beam Trawl	Beam Trawl	Otter Trawl
	March	September								
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	3.97	9.50	5.0	-	78.9	21.5	24.4	-
1994	128	225	4.90	7.79	9.2	-	43.0	20.1	31.6	-
1995	134	169	5.08	7.69	9.5	3.18	43.1	20.9	27.1	80.3
1996	-[6]	210	5.37	12.96	11.8	4.24	42.2	13.3	22.2	64.8
1997	147	262	5.25	7.66	13.9	3.24	39.9	10.8	29.3	92.2
1998	113	249	5.00	5.66	12.3	3.86	36.9	10.4	23.8	93.5
1999	-[6]	264	5.38	7.76	12.0	2.32	22.9	11.0	22.1	110.3
2000	-[6]	357	5.02	13.04	11.6	2.09	27.0	6.3	18.2	82.7
2001	-	281	3.35	8.33	13.6	2.54	33.0	12.5	28.5	77.5
2002	-	340	5.66	5.46	10.7	2.78	24.8	8.0	36.2	77.9
2003	-	503	2.60	3.76	8.8	4.08	23.9	14.0	23.0	73.8
2004	-	540	3.17	4.20	14.9	2.06	23.5	7.4	27.6	72.5
2005	-	367	4.85	4.67	15.3	2.05	16.7	11.6	31.8	68.3

1 Whole weight (kg) per corrected hour fished, weighted by area
2 Corrected for fishing power (GRT)
3 Kg/hr
4 Kg/100km
5 Corrected for fishing power (HP)
6 Carhelmar survey, Kg/100km not available

Fishing power corrections are detailed in Appendix 2 of the 2000 working group report

Table 11.3.2 Irish Sea Plaice: UK (NI) index of relative SSB trends by region

NI_GFS Mar

	Estimated Mean Abundance			Estimated Variances		
	Combined	West	East	Combined	West	East
Year	Str1-7	Str1-4	Str6-7	Str1-7	Str1-4	Str6-7
1992	9.59	4.94	11.77	4.39	2.13	5.66
1993	13.27	15.59	12.19	2.22	5.56	2.36
1994	10.09	4.09	12.91	2.56	1.83	3.27
1995	7.59	4.95	8.82	1.39	1.66	1.74
1996	7.96	10.6	6.72	1.68	5.94	1.28
1997	13.73	11.95	14.56	3.99	6.78	4.76
1998	12.5	14.73	11.45	3.62	10.88	3.39
1999	9.37	13.97	7.21	2.34	7.42	2.09
2000	15.79	25.8	11.1	5.4	22.56	1.97
2001	13.52	17.46	11.67	2.11	6.21	2.02
2002	13.36	19.18	10.64	3.24	8.93	3.25
2003	26.79	40.59	20.33	8.36	32.38	4.95
2004	10.55	7.02	12.2	4.77	5.23	7.58
2005	15.86	19.96	13.94	3.54	8.59	3.82
2006	9.57	12.26	8.31	1.8	6.15	1.45

NI_GFS Oct

	Estimated Mean Abundance			Estimated Variances		
	Combined	West	East	Combined	West	East
Year	Str1-7	Str1-4	Str6-7	Str1-7	Str1-4	Str6-7
1991		2.53			1.71	
1992	4.83	2.03	6.15	0.85	1.26	1.04
1993	4.64	2.25	5.76	0.95	1.18	1.18
1994	9.2	6.35	10.54	2.27	3.74	2.72
1995	4.77	6.11	4.14	1.28	3.52	1.29
1996	8.69	7.8	9.11	2.15	5.67	2.22
1997	8.22	5.92	9.3	2.18	2.8	2.71
1998	5.39	3.38	6.33	1.45	2.39	1.75
1999	6.9	3.86	8.33	2.29	3.12	2.82
2000	10.5	2.32	14.33	6.42	1.16	8.33
2001	13.93	3.12	19	6.45	1.96	8.35
2002	9.98	4.89	12.37	3.8	3.45	4.82
2003	18.65	7.65	23.8	5.41	4.87	6.87
2004	8.49	2	11.54	1.9	1.1	2.44
2005	11.58	2.9	15.65	4.39	2.39	5.66

Table 11.3.3 Irish Sea Plaice: tuning fleet data available to the working group. Figures shown in bold are those used in the assessment

UK(E+W)TRAWL FLEET (revised 2/4/2004 - calculated using ABBT age compositions)
1987 2005
1 1 0 1
2 8

130.597	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	31.7	134.1	92.6	54.3	24.1	7.7	5.2	3.8	1.0	0.7	0.1	0.1	0.0
16.683	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

UK(E+W)BEAM TRAWL FLEET
1989 2005
1 1 0 1
2 8

25.291	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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	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
11.559	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

UK BT SURVEY (Sept) - Prime stations only - stn 43 omitted
1989 2005
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
124.336	**1171**	**368**	**169**	**80**	**16**	**18**	**0**	1
127.486	**1645**	**582**	**123**	**71**	**45**	**9**	**11**	2
132.860	**1450**	**713**	**342**	**76**	**52**	**24**	**10**	9
129.339	**1181**	**808**	**221**	**103**	**35**	**24**	**14**	3
125.263	**1090**	**951**	**339**	**113**	**38**	**18**	**9**	6
123.225	**2002**	**635**	**288**	**141**	**69**	**22**	**7**	4
127.301	**1445**	**661**	**219**	**131**	**89**	**30**	**12**	8
120.260	**1570**	**1510**	**612**	**231**	**75**	**47**	**15**	16
121.001	**1354**	**1718**	**784**	**287**	**114**	**59**	**37**	10
113.960	**1653**	**1075**	**1085**	**371**	**248**	**53**	**53**	13
119.704	**727**	**1142**	**599**	**467**	**265**	**100**	**19**	16

UK BT SURVEY (March) - Prime stations only

Table 11.3.3 Contd.

```
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    2005
1       1       0       1
2 8
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       1
72507  25       105     116      90      31      23      16      12      1        4       0
68336   1        45      89     129      80      43      17      10      8        1       2

IR-GFS : Irish Groundfish survey - Celtic Explorer - Effort in minutes
2003  2004
1 1 0.89 0.91
0 12
1170  3  76  396  377 219 71 31 21 6 4 0 0 0 1
1030  0  119  88    71  38 19  2  1 0 0 0 0 0 0

UK(NI) GFS Spring and autumn spawning biomass indices
2 13 2
'Year''VPA'  'DARDS' 'DARDA'
1992   1      9.59    4.84
1993   1     13.27    4.65
1994   1     10.09    9.28
1995   1      7.59    4.77
1996   1      7.96    8.71
1997   1     13.73    8.24
1998   1     12.50    5.41
1999   1      9.37    6.91
2000   1     15.79   10.51
2001   1     13.52   13.93
2002   1     13.36   10.01
2003   1     26.79   18.65
2004   1     10.55    8.50
2005   1     15.86   11.58
```

Table 11.4.1 Irish Sea plaice: Catch numbers at ages 1 to 15

	1964	1965
1	0	28
2	997	1416
3	1911	3155
4	1680	2841
5	446	1115
6	851	555
7	480	309
8	140	300
9	26	17
10	155	20
11	30	5
12	2	2
13	1	1
14	1	1
15	10	1

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	0	0	0	59	9	0	0	0	7	18
2	120	164	171	430	803	427	142	925	1200	1370
3	4303	1477	1961	2317	2278	3392	3254	4091	2530	4313
4	3605	5593	3410	2932	2179	3882	5136	5233	2694	1902
5	2182	4217	4641	2080	1877	1683	1461	2682	2125	1158
6	620	995	1611	2227	1028	1371	752	642	1045	933
7	588	642	319	779	899	491	555	345	191	152
8	386	267	113	184	239	497	627	238	139	119
9	181	210	135	58	64	244	353	183	56	81
10	13	176	24	100	29	60	169	238	47	94
11	20	86	17	80	52	65	55	129	95	47
12	7	35	3	22	51	36	40	40	40	72
13	7	5	4	9	20	11	38	14	5	18
14	3	6	1	4	3	9	19	11	5	16
15	6	1	1	1	2	1	12	17	5	4

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	23	565	22	12	3	22	27	51	41	4
2	2553	4124	3063	3380	2783	1742	715	2924	3159	2357
3	4333	2767	5169	5679	6738	5939	3288	2494	5179	6152
4	2425	2470	1535	1835	2560	2984	3082	3211	1182	3301
5	902	839	542	363	646	837	1358	1521	1054	614
6	563	236	202	187	312	222	330	648	459	429
7	391	150	98	109	125	105	137	211	299	262
8	198	112	54	61	64	53	69	110	113	181
9	59	63	52	68	24	52	44	53	60	78
10	79	21	43	68	54	41	36	30	13	36
11	47	15	10	17	16	28	11	13	22	21
12	22	8	9	5	13	35	15	15	15	8
13	58	8	4	6	7	13	11	9	10	7
14	11	10	4	4	5	3	14	11	6	3
15	5	3	2	6	5	11	13	11	13	6

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	31	62	46	24	15	180	151	28	98	21
2	1652	3717	2923	1735	1019	2008	1958	910	1146	961
3	5280	5317	5040	5945	2715	1506	3209	1649	2173	1703
4	2942	5252	2552	2671	2935	1929	1435	1357	1309	1936
5	1287	1341	1400	854	1132	1205	1358	474	644	764
6	344	1072	750	436	465	465	903	556	318	318
7	371	123	316	214	259	182	388	377	245	138
8	112	121	84	153	98	122	118	179	134	70
9	92	75	112	56	51	49	74	42	86	47
10	54	74	44	47	22	34	44	50	18	23
11	24	25	41	26	15	5	27	16	6	9
12	9	8	28	38	15	6	15	8	9	4
13	5	10	38	18	9	3	9	2	6	1
14	3	12	21	7	6	3	3	3	1	1
15	9	13	37	19	7	4	4	2	3	3

Table 11.4.1 Contd.

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	37	28	5	68	0	14	1	0	7	13
2	856	830	691	803	450	374	205	285	198	234
3	1345	1590	1739	1505	1174	1138	939	1028	965	466
4	1196	1513	1025	1294	1283	1083	1480	1311	1103	947
5	943	1003	612	696	685	767	841	705	704	963
6	370	482	476	280	212	408	538	414	246	588
7	128	285	403	196	219	178	317	252	114	265
8	44	139	177	117	102	90	96	127	88	134
9	25	42	91	69	55	45	48	48	74	89
10	37	53	52	43	19	18	17	22	11	61
11	14	12	25	6	14	6	4	12	11	21
12	7	7	17	4	7	2	3	7	1	19
13	5	1	19	1	2	4	0	1	1	8
14	1	2	2	0	2	0	0	3	0	3
15	2	1	1	1	2	0	0	0	0	1

Table 11.4.2 Irish Sea plaice: catch weights at ages 1 to 9+

	1964	1965
1	0.201	0.201
2	0.230	0.237
3	0.283	0.264
4	0.345	0.333
5	0.285	0.386
6	0.479	0.465
7	0.554	0.512
8	0.617	0.425
9	0.498	0.828

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	0.201	0.201	0.201	0.201	0.210	0.206	0.206	0.206	0.212	0.203
2	0.349	0.299	0.257	0.222	0.209	0.223	0.216	0.220	0.236	0.225
3	0.266	0.268	0.255	0.292	0.236	0.233	0.256	0.244	0.278	0.261
4	0.313	0.312	0.325	0.320	0.308	0.273	0.304	0.290	0.299	0.326
5	0.369	0.365	0.379	0.385	0.341	0.350	0.386	0.349	0.397	0.372
6	0.557	0.495	0.475	0.463	0.414	0.391	0.527	0.451	0.439	0.468
7	0.531	0.509	0.594	0.543	0.516	0.556	0.617	0.601	0.656	0.578
8	0.554	0.704	0.866	0.681	0.633	0.626	0.611	0.625	0.652	0.742
9	0.738	0.730	0.929	0.888	0.817	0.757	1.036	0.800	1.002	0.910

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.211	0.209	0.214	0.209	0.206	0.171	0.135	0.252	0.281	0.289
2	0.228	0.224	0.219	0.214	0.209	0.229	0.241	0.262	0.316	0.319
3	0.276	0.277	0.279	0.250	0.248	0.266	0.278	0.270	0.307	0.340
4	0.309	0.365	0.355	0.354	0.309	0.341	0.377	0.302	0.356	0.382
5	0.386	0.368	0.509	0.604	0.463	0.476	0.447	0.393	0.397	0.479
6	0.486	0.514	0.520	0.665	0.451	0.564	0.671	0.455	0.500	0.563
7	0.513	0.557	0.275	0.661	0.659	0.671	0.756	0.601	0.563	0.663
8	0.677	0.697	0.956	0.684	0.749	0.790	0.883	0.609	0.585	0.779
9	0.965	1.022	0.708	0.875	0.978	1.099	1.232	0.849	0.750	0.789

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.268	0.264	0.240	0.267	0.251	0.234	0.233	0.253	0.215	0.200
2	0.284	0.287	0.263	0.296	0.269	0.258	0.249	0.280	0.249	0.237
3	0.327	0.283	0.280	0.315	0.302	0.296	0.268	0.303	0.273	0.274
4	0.376	0.352	0.359	0.385	0.376	0.330	0.321	0.329	0.372	0.344
5	0.425	0.435	0.419	0.451	0.429	0.429	0.388	0.392	0.424	0.391
6	0.440	0.434	0.491	0.599	0.429	0.488	0.483	0.445	0.515	0.436
7	0.526	0.654	0.537	0.674	0.635	0.569	0.535	0.426	0.646	0.461
8	0.620	0.676	0.746	0.606	0.714	0.577	0.669	0.533	0.671	0.707
9	0.861	0.966	0.843	0.909	0.734	0.779	0.708	0.758	0.802	0.787

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.205	0.230	0.182	0.206	0.212	0.232	0.228	0.228	0.213	0.175
2	0.224	0.233	0.224	0.224	0.257	0.245	0.273	0.235	0.239	0.209
3	0.257	0.241	0.249	0.240	0.275	0.272	0.281	0.289	0.258	0.247
4	0.312	0.272	0.310	0.287	0.311	0.320	0.319	0.335	0.297	0.288
5	0.392	0.383	0.375	0.347	0.361	0.368	0.405	0.383	0.347	0.332
6	0.438	0.414	0.411	0.395	0.478	0.416	0.493	0.458	0.415	0.378
7	0.550	0.476	0.478	0.454	0.480	0.487	0.538	0.567	0.541	0.428
8	0.696	0.502	0.484	0.467	0.464	0.451	0.630	0.566	0.546	0.481
9	0.772	0.733	0.824	0.525	0.606	0.575	0.693	0.831	0.579	0.600

Table 11.4.3 Irish Sea plaice: stock weights at ages 1 to 9+

	1964	1965
1	0.024	0.023
2	0.109	0.105
3	0.226	0.213
4	0.348	0.327
5	0.412	0.480
6	0.545	0.587
7	0.767	0.641
8	0.981	0.680
9	0.767	1.024

	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975
1	0.019	0.018	0.018	0.019	0.019	0.018	0.020	0.019	0.021	0.024
2	0.087	0.082	0.083	0.084	0.087	0.082	0.091	0.085	0.094	0.109
3	0.177	0.169	0.168	0.170	0.175	0.164	0.186	0.173	0.192	0.218
4	0.266	0.251	0.263	0.261	0.272	0.249	0.280	0.267	0.282	0.336
5	0.366	0.336	0.360	0.355	0.365	0.346	0.379	0.363	0.390	0.463
6	0.480	0.464	0.458	0.485	0.472	0.442	0.504	0.445	0.468	0.582
7	0.643	0.482	0.541	0.593	0.599	0.550	0.678	0.596	0.634	0.695
8	0.652	0.716	0.732	0.742	0.647	0.709	0.672	0.655	0.798	0.873
9	0.927	0.713	0.873	0.790	0.838	0.726	1.004	0.860	1.031	1.228

	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
1	0.020	0.020	0.024	0.023	0.022	0.023	0.020	0.019	0.020	0.020
2	0.090	0.089	0.106	0.104	0.099	0.103	0.090	0.087	0.100	0.100
3	0.181	0.179	0.213	0.208	0.201	0.210	0.209	0.213	0.230	0.240
4	0.272	0.286	0.330	0.317	0.307	0.318	0.309	0.300	0.350	0.360
5	0.368	0.375	0.457	0.481	0.422	0.446	0.408	0.348	0.430	0.430
6	0.475	0.461	0.602	0.599	0.474	0.537	0.478	0.397	0.520	0.510
7	0.548	0.550	0.668	0.733	0.623	0.630	0.568	0.455	0.610	0.590
8	0.679	0.696	0.859	0.862	0.833	0.814	0.658	0.523	0.710	0.680
9	0.927	0.930	1.073	1.024	1.119	1.104	0.954	0.766	1.061	0.929

	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
1	0.020	0.020	0.245	0.206	0.173	0.241	0.147	0.259	0.133	0.190
2	0.120	0.100	0.258	0.249	0.229	0.256	0.193	0.263	0.180	0.214
3	0.260	0.240	0.288	0.296	0.286	0.280	0.245	0.280	0.236	0.247
4	0.380	0.345	0.335	0.347	0.346	0.312	0.305	0.308	0.302	0.288
5	0.440	0.405	0.401	0.402	0.408	0.353	0.372	0.350	0.376	0.338
6	0.520	0.480	0.484	0.460	0.471	0.403	0.445	0.404	0.459	0.396
7	0.610	0.560	0.585	0.522	0.537	0.462	0.525	0.470	0.551	0.464
8	0.720	0.660	0.704	0.588	0.604	0.529	0.612	0.549	0.652	0.540
9	0.988	0.962	1.234	0.820	0.795	0.707	0.839	0.772	0.867	0.718

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	0.117	0.110	0.197	0.158	0.183	0.112	0.167	0.185	0.199	0.158
2	0.173	0.158	0.211	0.193	0.208	0.173	0.204	0.223	0.217	0.192
3	0.234	0.211	0.236	0.234	0.238	0.237	0.247	0.266	0.244	0.228
4	0.302	0.268	0.272	0.282	0.278	0.303	0.297	0.314	0.279	0.267
5	0.375	0.330	0.319	0.337	0.328	0.372	0.353	0.367	0.323	0.309
6	0.454	0.396	0.377	0.397	0.388	0.443	0.415	0.424	0.375	0.355
7	0.539	0.466	0.445	0.465	0.458	0.517	0.484	0.487	0.435	0.403
8	0.630	0.540	0.525	0.538	0.538	0.593	0.560	0.554	0.504	0.454
9	0.871	0.705	0.748	0.674	0.733	0.730	0.684	0.702	0.618	0.571

Table 11.6.2.1. Irish Sea plaice: Final ICA diagnostics and output

Fitted Selection Pattern

AGE	1964	1965	1966	1967	1968	1969	1970	1971
2	0.2651	0.1150	0.0120	0.0169	0.0261	0.0798	0.0919	0.0374
3	1.0566	0.4375	0.2914	0.1658	0.2987	0.6411	0.5004	0.3662
4	2.1250	0.9991	0.4800	0.5368	0.6720	0.9472	0.8993	1.1509
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	2.3429	0.7460	0.6491	0.9954	1.0652	1.4426	0.7862	1.1232
7	2.0546	0.5619	0.9521	1.4935	0.8311	1.6550	1.1235	0.4380
8	2.0327	0.8817	0.7607	0.8957	0.8653	1.3234	1.0100	0.9335
9	2.0327	0.8817	0.7607	0.8957	0.8653	1.3234	1.0100	0.9335

Fitted Selection Pattern

AGE	1972	1973	1974	1975	1976	1977	1978	1979
2	0.0166	0.1298	0.1474	0.1694	0.3376	0.3589	0.3124	0.4644
3	0.3405	0.5886	0.6304	0.8495	0.7380	0.6708	1.1987	1.7489
4	0.9126	0.8506	0.9697	0.9695	0.9733	1.1680	1.1532	1.8707
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	0.9561	0.9345	1.3824	1.1066	1.1280	0.6979	0.8023	1.2445
7	1.0578	0.9043	0.7816	0.4863	1.1320	0.9610	0.8224	1.5168
8	0.9614	1.0244	1.1345	1.1183	1.2039	1.0957	1.3238	1.9601
9	0.9614	1.0244	1.1345	1.1183	1.2039	1.0957	1.3238	1.9601

Fitted Selection Pattern

AGE	1980	1981	1982	1983	1984	1985	1986	1987
2	0.2700	0.2335	0.1750	0.2143	0.3181	0.2248	0.2630	0.3773
3	1.0172	0.9928	0.6590	0.7049	0.8146	1.0715	0.9168	1.0340
4	1.2454	1.0218	1.1385	0.9554	0.9255	1.0549	1.3535	1.5179
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.0883	0.7098	0.7952	0.7347	0.9774	0.8301	1.4862	1.3558
7	1.1274	0.8025	0.7994	0.7275	0.9621	1.2666	2.0027	0.8571
8	1.3813	1.1791	1.0706	1.0242	1.1634	1.3402	1.6169	1.4479
9	1.3813	1.1791	1.0706	1.0242	1.1634	1.3402	1.6169	1.4479

Fitted Selection Pattern

AGE	1988	1989	1990	1991	1992	1993	1994	1995
2	0.2347	0.2914	0.3234	0.4735	0.3380	0.1999	0.3084	0.3404
3	0.7571	0.9998	0.7392	0.7988	0.8283	0.6493	0.6679	0.7566
4	1.0229	1.0612	1.1023	1.0502	0.9441	1.0897	0.8507	1.1812
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	1.2077	0.8701	1.2648	0.8506	0.9996	1.5086	1.3769	1.0474
7	0.8946	1.1314	1.1067	1.2035	0.8711	1.5522	1.6942	1.5651
8	1.1913	1.2898	1.2552	1.2073	1.1597	1.3510	1.3090	1.3298
9	1.1913	1.2898	1.2552	1.2073	1.1597	1.3510	1.3090	1.3298

Fitted Selection Pattern

AGE	1996	1997	1998	1999	2000	2001	2002	2003
2	0.2957	0.1826	0.1886	0.2077	0.1775	0.0898	0.0898	0.0898
3	0.6221	0.6621	0.6829	0.4824	0.6765	0.4426	0.4426	0.4426
4	0.7961	1.0024	0.9303	0.7078	1.0374	0.9058	0.9058	0.9058
5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
6	0.7644	0.7584	1.2237	0.6850	0.8653	0.9976	0.9976	0.9976
7	0.6573	0.8386	1.6427	0.8239	1.5281	0.9869	0.9869	0.9869
8	0.9433	1.0425	1.2922	0.8785	1.2179	1.0000	1.0000	1.0000
9	0.9433	1.0425	1.2922	0.8785	1.2179	1.0000	1.0000	1.0000

Table 11.6.2.1. Irish Sea plaice: Final ICA diagnostics and output continued

```
        Fitted Selection Pattern
        ------------------------
------+---------------
AGE   |    2004    2005
------+---------------
  2   |  0.0898  0.0898
  3   |  0.4426  0.4426
  4   |  0.9058  0.9058
  5   |  1.0000  1.0000
  6   |  0.9976  0.9976
  7   |  0.9869  0.9869
  8   |  1.0000  1.0000
  9   |  1.0000  1.0000
------+---------------


 -----------------------------------------------------------------
 No of years for separable analysis : 5

 -----------------------------------------------------------------
 No of years for separable analysis : 5
 Age range in the analysis : 2  . . . 9
 Year range in the analysis : 1964  . . . 2005
 Number of indices of SSB : 2
 Number of age-structured indices : 1

 Parameters to estimate : 29
 Number of observations : 162

 Conventional single selection vector model to be fitted.



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 PARAMETER ESTIMATES

 ³Parm.³      ³ Maximum ³    ³         ³         ³         ³         ³ Mean of ³
 ³ No. ³      ³ Likelh. ³ CV ³  Lower ³ Upper   ³  -s.e.  ³   +s.e. ³ Param.  ³
 ³     ³      ³ Estimate³ (%)³ 95% CL ³ 95% CL  ³         ³         ³ Distrib.³
 Separable model : F by year
    1   2001     0.3214  17    0.2275    0.4543    0.2695    0.3835    0.3265
    2   2002     0.2761  17    0.1958    0.3892    0.2317    0.3290    0.2804
    3   2003     0.2106  17    0.1501    0.2955    0.1772    0.2503    0.2138
    4   2004     0.1213  17    0.0868    0.1694    0.1023    0.1438    0.1230
    5   2005     0.1188  17    0.0843    0.1674    0.0997    0.1415    0.1206

 Separable Model: Selection (S) by age
    6      2     0.0898  21    0.0590    0.1366    0.0724    0.1112    0.0918
    7      3     0.4426  18    0.3064    0.6394    0.3669    0.5340    0.4505
    8      4     0.9058  16    0.6496    1.2630    0.7645    1.0732    0.9189
           5     1.0000     Fixed : Reference Age
    9      6     0.9976  14    0.7469    1.3325    0.8607    1.1564    1.0085
   10      7     0.9869  14    0.7418    1.3130    0.8531    1.1416    0.9974
           8     1.0000     Fixed : Last true age

 Separable model: Populations in year 2005
   11      2      22161  32      11638     42199     15954     30783     23391
   12      3      12396  23       7813     19665      9795     15686     12744
   13      4      12299  18       8534     17725     10207     14820     12515
   14      5       7669  15       5613     10480      6540      8994      7767
   15      6       4860  14       3645      6480      4197      5629      4913
   16      7       2317  15       1708      3144      1983      2708      2346
   17      8       1234  17        879      1731      1038      1467      1252

Separable model: Populations at age
   18   2001        351  30        194       633       260       474       367
   19   2002        432  23        272       686       341       547       444
   20   2003        796  20        530      1195       647       980       813
   21   2004       1026  19        700      1503       844      1247      1046

 SSB Index catchabilities
   DARDS
 Linear model fitted. Slopes at age :
   22   1  Q  .2479E-02   7 .2304E-02 .3108E-02 .2479E-02 .2888E-02 .2684E-02
   DARDA
 Linear model fitted. Slopes at age :
   23   2  Q  .1676E-02   7 .1558E-02 .2101E-02 .1676E-02 .1953E-02 .1815E-02
```

Table 11.6.2.1. Irish Sea plaice: Final ICA diagnostics and output continued

Age-structured index catchabilities

UKBTSURVEY(Sept)-Prime stations only

Linear model fitted. Slopes at age :

24	2	Q	.6632E-03	16	.5684E-03	.1067E-02	.6632E-03	.9145E-03	.7889E-03
25	3	Q	.3973E-03	15	.3412E-03	.6352E-03	.3973E-03	.5455E-03	.4714E-03
26	4	Q	.2643E-03	15	.2271E-03	.4216E-03	.2643E-03	.3623E-03	.3133E-03
27	5	Q	.1950E-03	15	.1676E-03	.3111E-03	.1950E-03	.2674E-03	.2312E-03
28	6	Q	.2017E-03	15	.1732E-03	.3227E-03	.2017E-03	.2771E-03	.2394E-03
29	7	Q	.2285E-03	16	.1948E-03	.3736E-03	.2285E-03	.3185E-03	.2735E-03

RESIDUALS ABOUT THE MODEL FIT

Separable Model Residuals

Age	2001	2002	2003	2004	2005
2	0.1111	-0.4409	-0.0405	0.3174	0.0546
3	0.1624	-0.2179	0.0245	0.2915	-0.2508
4	-0.0761	0.1745	-0.0546	0.1523	-0.2233
5	-0.1097	0.1283	-0.0438	0.0544	0.1721
6	-0.1541	0.1102	0.0577	-0.2542	0.1370
7	0.0322	0.1747	-0.0031	-0.3819	0.0905
8	-0.0173	-0.0283	-0.1191	-0.2296	0.0261

SPAWNING BIOMASS INDEX RESIDUALS

DARDS

	1992	1993	1994	1995	1996	1997	1998	1999
1	-0.1745	0.3023	0.0524	-0.2009	-0.2098	0.4030	0.2442	-0.0563

DARDS

	2000	2001	2002	2003	2004
1	0.3732	0.0126	-0.1846	0.2398	-0.8023

DARDA

	1992	1993	1994	1995	1996	1997	1998	1999
1	-0.4669	-0.3550	0.3600	-0.2741	0.2716	0.2837	-0.2019	0.0305

DARDA

	2000	2001	2002	2003	2004
1	0.3575	0.4338	-0.0820	0.2690	-0.6271

Table 11.6.2.1. Irish Sea plaice: Final ICA diagnostics and output continued

AGE-STRUCTURED INDEX RESIDUALS

UKBTSURVEY(Sept)-Prime stations only

Age	1989	1990	1991	1992	1993	1994	1995	1996
2	-0.569	-0.090	-0.270	-0.193	0.121	0.102	-0.261	0.220
3	0.274	-0.487	-0.849	0.289	-0.494	0.125	-0.238	-0.478
4	-0.375	-0.358	-0.741	-0.787	0.408	-0.193	-0.196	-0.228
5	-0.782	0.271	-2.488	-0.545	-0.181	0.285	-0.766	0.120
6	0.909	0.826	-1.758	-0.477	-0.562	0.335	0.248	-0.896
7	-0.871	-1.181	1.256	0.068	0.704	1.088	*******	0.073

UKBTSURVEY(Sept)-Prime stations only

Age	1997	1998	1999	2000	2001	2002	2003	2004
2	0.109	0.212	0.481	-0.029	-0.348	0.376	0.353	0.111
3	0.617	-0.135	0.222	0.119	-0.370	0.136	0.482	0.632
4	0.055	0.385	0.104	0.187	0.100	0.535	0.310	0.428
5	0.388	0.209	0.336	0.364	0.438	0.560	0.427	0.783
6	-0.013	0.286	0.031	0.201	-0.099	0.625	0.366	-0.054
7	-0.371	0.152	-0.221	-0.465	-0.136	0.268	0.198	0.451

UKBTSURVEY(Sept)-Prime stations only

Age	2005
2	-0.328
3	0.154
4	0.365
5	0.583
6	0.030
7	-1.016

PARAMETERS OF THE DISTRIBUTION OF ln(CATCHES AT AGE)

Separable model fitted from 2001 to 2005	
Variance	0.0776
Skewness test stat.	-1.5847
Kurtosis test statistic	-0.1138
Partial chi-square	0.1864
Significance in fit	0.0000
Degrees of freedom	14

PARAMETERS OF DISTRIBUTIONS OF THE SSB INDICES

DISTRIBUTION STATISTICS FOR DARDS

Linear catchability relationship assumed

Variance	0.1091
Skewness test stat.	-1.3186
Kurtosis test statistic	0.4785
Partial chi-square	0.4853
Significance in fit	0.0000
Number of observations	13
Degrees of freedom	12
Weight in the analysis	1.0000

Table 11.6.2.1. Irish Sea plaice: Final ICA diagnostics and output continued

```
   DISTRIBUTION STATISTICS FOR   DARDS


 Linear catchability relationship assumed

 Variance                           0.1091
Skewness test stat.                -1.3186
Kurtosis test statistic             0.4785
Partial chi-square                  0.4853
Significance in fit                 0.0000
Number of observations                  13
Degrees of freedom                      12
Weight in the analysis              1.0000


   DISTRIBUTION STATISTICS FOR   DARDA


 Linear catchability relationship assumed

 Variance                           0.1278
Skewness test stat.                -0.5205
Kurtosis test statistic            -0.9414
Partial chi-square                  0.7105
Significance in fit                 0.0000
Number of observations                  13
Degrees of freedom                      12
Weight in the analysis              1.0000

 PARAMETERS OF THE DISTRIBUTION OF THE AGE-STRUCTURED INDICES
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   DISTRIBUTION STATISTICS FOR UKBTSURVEY(Sept)-Prime stations only


 Linear catchability relationship assumed

 Age                          2         3         4         5         6         7
 Variance                0.0144    0.0306    0.0275    0.1038    0.0706    0.0801
Skewness test stat.     -0.3110   -0.4950   -0.9347   -3.3718   -1.8651    0.0741
Kurtosis test statisti  -0.7458   -0.7224   -0.6295    3.2163    1.1122   -0.4804
Partial chi-square       0.1293    1.0677   11.1962   21.4787    0.6494    0.6020
Significance in fit      0.0000    0.0000    0.2028    0.8392    0.0000    0.0000
Number of observations       17        17        17        17        17        16
Degrees of freedom           16        16        16        16        16        15
Weight in the analysis   0.1667    0.1667    0.1667    0.1667    0.1667    0.1667

 ANALYSIS OF VARIANCE
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 Unweighted Statistics


Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                       34.8398     162          29  133   0.2620
Catches at age                         1.0866      35          21   14   0.0776

SSB Indices
  DARDS                                1.3089      13           1   12   0.1091
  DARDA                                1.5331      13           1   12   0.1278

 Aged Indices
UKBTSURVEY(Sept)-Prime stations only   30.9112     101           6   95   0.3254


 Weighted Statistics


Variance
                                       SSQ     Data    Parameters d.f. Variance
Total for model                        4.7872     162          29  133   0.0360
Catches at age                         1.0866      35          21   14   0.0776

SSB Indices
  DARDS                                1.3089      13           1   12   0.1091
  DARDA                                1.5331      13           1   12   0.1278

 Aged Indices
UKBTSURVEY(Sept)-Prime stations only    0.8586     101           6   95   0.0090
```

Table 11.6.2.2. Irish Sea plaice: Final ICA population numbers at age

Population Abundance (1 January)

AGE	1964	1965	1966	1967	1968	1969	1970	1971
2	21559.	28909.	14914.	13535.	10866.	12470.	18507.	17255.
3	11144.	18183.	24308.	13115.	11850.	9477.	10655.	15659.
4	5352.	8089.	13163.	17518.	10243.	8668.	6231.	7312.
5	2734.	3172.	4512.	8293.	10294.	5889.	4940.	3485.
6	2506.	2006.	1769.	1963.	3417.	4790.	3275.	2624.
7	1572.	1425.	1258.	988.	811.	1524.	2166.	1941.
8	463.	944.	974.	566.	279.	421.	624.	1080.
9	743.	148.	598.	1101.	456.	627.	577.	926.

x 10 ^ 3

Population Abundance (1 January)

AGE	1972	1973	1974	1975	1976	1977	1978	1979
2	11807.	8722.	11689.	11492.	9635.	14979.	16125.	20028.
3	14902.	10338.	6866.	9239.	8905.	6150.	9417.	11425.
4	10704.	10162.	5339.	3720.	4162.	3849.	2867.	3528.
5	2861.	4693.	4126.	2219.	1523.	1430.	1114.	1110.
6	1518.	1172.	1661.	1674.	886.	510.	486.	481.
7	1047.	643.	441.	500.	614.	262.	232.	242.
8	1261.	410.	249.	212.	301.	181.	92.	114.
9	1379.	1090.	453.	592.	427.	207.	212.	324.

x 10 ^ 3

Population Abundance (1 January)

AGE	1980	1981	1982	1983	1984	1985	1986	1987
2	18159.	13517.	7363.	18680.	18738.	19745.	14349.	17537.
3	14588.	13491.	10351.	5858.	13821.	13651.	15297.	11173.
4	4827.	6639.	6410.	6099.	2862.	7408.	6354.	8620.
5	1416.	1891.	3097.	2804.	2411.	1433.	3483.	2885.
6	644.	652.	895.	1477.	1068.	1152.	696.	1883.
7	252.	280.	370.	484.	704.	517.	620.	296.
8	113.	107.	150.	200.	232.	344.	214.	204.
9	219.	368.	313.	258.	286.	302.	375.	366.

x 10 ^ 3

Population Abundance (1 January)

AGE	1988	1989	1990	1991	1992	1993	1994	1995
2	18779.	11466.	6581.	10186.	9003.	9882.	8282.	7203.
3	12064.	13910.	8539.	4880.	7149.	6147.	7909.	6268.
4	4940.	5984.	6774.	5029.	2916.	3339.	3905.	4976.
5	2751.	1998.	2809.	3263.	2654.	1245.	1692.	2236.
6	1305.	1132.	973.	1432.	1765.	1085.	661.	897.
7	670.	458.	596.	428.	834.	722.	443.	289.
8	147.	299.	206.	286.	209.	377.	288.	165.
9	563.	413.	263.	244.	312.	259.	278.	207.

x 10 ^ 3

Population Abundance (1 January)

AGE	1996	1997	1998	1999	2000	2001	2002	2003
2	6817.	8698.	8975.	8476.	9193.	12485.	13808.	16814.
3	5485.	5242.	6934.	7311.	6763.	7730.	10758.	11947.
4	3962.	3603.	3158.	4518.	5071.	4895.	5946.	8444.
5	2601.	2393.	1780.	1841.	2794.	3294.	3245.	4107.
6	1268.	1423.	1183.	1005.	981.	1835.	2118.	2184.
7	498.	777.	811.	604.	629.	671.	1181.	1426.
8	127.	322.	423.	342.	352.	352.	433.	798.
9	263.	273.	494.	366.	349.	296.	329.	519.

x 10 ^ 3

Population Abundance (1 January)

AGE	2004	2005	2006
2	14131.	22163.	16028.
3	14633.	12397.	19448.
4	9653.	12300.	10432.
5	6188.	7671.	9796.
6	2951.	4862.	6041.
7	1570.	2319.	3830.
8	1028.	1235.	1829.
9	910.	1911.	2478.

x 10 ^ 3

Table 11.6.2.4. Irish Sea plaice: Final ICA stock summary

STOCK SUMMARY

Year	Recruits Age 2 thousands	Total Biomass tonnes	Spawning Biomass tonnes	Landings tonnes	Yield /SSB ratio	Mean F Ages 3- 6	SoP (%)
1964	21550	11452	8020	2879	0.3589	0.3094	122
1965	28900	13960	9193	3664	0.3985	0.3692	117
1966	14910	13600	9738	4268	0.4383	0.4311	102
1967	13530	13087	9952	5059	0.5083	0.5172	98
1968	10860	11899	9397	4695	0.4996	0.4896	101
1969	12460	11046	8822	4394	0.4980	0.4705	101
1970	18500	10703	8111	3583	0.4417	0.4084	110
1971	17250	10674	7936	4232	0.5332	0.6472	106
1972	11800	11634	8770	5119	0.5836	0.6193	106
1973	8720	9057	6900	5060	0.7333	0.7749	105
1974	11680	7253	5347	3715	0.6947	0.7784	104
1975	11490	7778	5562	4063	0.7304	0.7826	119
1976	9630	5529	3843	3473	0.9035	0.9350	92
1977	14970	4768	2958	2904	0.9817	0.8477	87
1978	16120	5925	3481	3231	0.9279	0.7466	100
1979	20020	7008	4074	3428	0.8412	0.6216	100
1980	18150	7610	4556	3903	0.8566	0.7136	104
1981	13510	8199	5315	3906	0.7349	0.5854	101
1982	7360	7104	5067	3237	0.6388	0.5575	94
1983	18670	6787	4471	3639	0.8138	0.7179	100
1984	18730	8543	5419	4241	0.7826	0.5746	106
1985	19740	9941	6295	5075	0.8061	0.5952	99
1986	14340	10910	7156	4806	0.6715	0.5883	108
1987	17530	10134	6793	6220	0.9156	0.8261	106
1988	18770	12900	7216	5005	0.6935	0.7654	109
1989	11460	11125	6589	4372	0.6635	0.5892	97
1990	6580	8551	5665	3275	0.5780	0.5687	102
1991	10180	7793	4735	2554	0.5393	0.4572	98
1992	9000	6979	4605	3267	0.7094	0.7300	102
1993	9880	6968	3955	1996	0.5046	0.5458	100
1994	8280	6148	3862	2066	0.5349	0.5006	95
1995	7200	6005	3742	1874	0.5007	0.4461	94
1996	6810	5787	3959	1707	0.4311	0.3841	105
1997	8690	5527	3701	1871	0.5055	0.4997	100
1998	8970	6355	3949	1765	0.4469	0.4331	99
1999	8470	6351	3998	1600	0.4002	0.3663	108
2000	9190	6961	4385	1371	0.3126	0.2687	97
2001	12480	8285	5384	1473	0.2736	0.2689	107
2002	13800	10303	6481	1622	0.2503	0.2310	96
2003	16810	13512	8501	1554	0.1828	0.1762	99
2004	14130	14198	9492	1142	0.1203	0.1014	100
2005	22160	17048	11579	1281	0.1106	0.0994	100

Table 11.9.1 VIIa plaice, input to short-term forecast

MFDP version 1a
Run: p7a-update
Time and date: 16:11 11/08/2006
Fbar age range: 3-6

2006

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	12630	0.12	0.24	0	0	0.211	0.0134	0.228
3	11053	0.12	0.57	0	0	0.246	0.0665	0.265
4	10432	0.12	0.74	0	0	0.287	0.1361	0.307
5	9796	0.12	0.93	0	0	0.333	0.1502	0.354
6	6041	0.12	1	0	0	0.385	0.1499	0.417
7	3830	0.12	1	0	0	0.442	0.1483	0.512
8	1829	0.12	1	0	0	0.504	0.1502	0.531
9	2478	0.12	1	0	0	0.63	0.1502	0.67

2007

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	12630	0.12	0.24	0	0	0.211	0.0134	0.228
3	.	0.12	0.57	0	0	0.246	0.0665	0.265
4	.	0.12	0.74	0	0	0.287	0.1361	0.307
5	.	0.12	0.93	0	0	0.333	0.1502	0.354
6	.	0.12	1	0	0	0.385	0.1499	0.417
7	.	0.12	1	0	0	0.442	0.1483	0.512
8	.	0.12	1	0	0	0.504	0.1502	0.531
9	.	0.12	1	0	0	0.63	0.1502	0.67

2008

Age	N	M	Mat	PF	PM	SWt	Sel	CWt
2	12630	0.12	0.24	0	0	0.211	0.0134	0.228
3	.	0.12	0.57	0	0	0.246	0.0665	0.265
4	.	0.12	0.74	0	0	0.287	0.1361	0.307
5	.	0.12	0.93	0	0	0.333	0.1502	0.354
6	.	0.12	1	0	0	0.385	0.1499	0.417
7	.	0.12	1	0	0	0.442	0.1483	0.512
8	.	0.12	1	0	0	0.504	0.1502	0.531
9	.	0.12	1	0	0	0.63	0.1502	0.67

Input units are thousands and kg - output in tonnes

Table 11.9.2 VIIa plaice, Single option prediction detailed forecast

MFDP version 1a
Run: p7a-update
Time and date: 16:11 11/08/2006
Fbar age range: 3-6

Year:	2006	F multiplier:	1	Fbar:	0.1257				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
2	0.0134	158	36	12630	2665	3031	640	3031	640
3	0.0665	671	178	11053	2719	6300	1550	6300	1550
4	0.1361	1253	385	10432	2994	7720	2216	7720	2216
5	0.1502	1289	456	9796	3262	9110	3034	9110	3034
6	0.1499	794	331	6041	2326	6041	2326	6041	2326
7	0.1483	498	255	3830	1693	3830	1693	3830	1693
8	0.1502	241	128	1829	922	1829	922	1829	922
9	0.1502	326	219	2478	1561	2478	1561	2478	1561
Total		5230	1987	58089	18142	40339	13940	40339	13940

Year:	2007	F multiplier:	1	Fbar:	0.1257				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
2	0.0134	158	36	12630	2665	3031	640	3031	640
3	0.0665	671	178	11053	2719	6300	1550	6300	1550
4	0.1361	1101	338	9172	2632	6788	1948	6788	1948
5	0.1502	1063	376	8075	2689	7510	2501	7510	2501
6	0.1499	982	410	7477	2878	7477	2878	7477	2878
7	0.1483	600	307	4612	2039	4612	2039	4612	2039
8	0.1502	385	205	2929	1476	2929	1476	2929	1476
9	0.1502	433	290	3287	2071	3287	2071	3287	2071
Total		5393	2139	59235	19169	41933	15102	41933	15102

Year:	2008	F multiplier:	1	Fbar:	0.1257				
Age	**F**	**CatchNos**	**Yield**	**StockNos**	**Biomass**	**SSNos(Jan)**	**SSB(Jan)**	**SSNos(ST)**	**SSB(ST)**
2	0.0134	158	36	12630	2665	3031	640	3031	640
3	0.0665	671	178	11053	2719	6300	1550	6300	1550
4	0.1361	1101	338	9172	2632	6787	1948	6787	1948
5	0.1502	934	331	7100	2364	6603	2199	6603	2199
6	0.1499	810	338	6163	2373	6163	2373	6163	2373
7	0.1483	742	380	5708	2523	5708	2523	5708	2523
8	0.1502	464	246	3527	1777	3527	1777	3527	1777
9	0.1502	624	418	4744	2989	4744	2989	4744	2989
Total		5505	2265	60097	20043	42864	15998	42864	15998

Input units are thousands and kg - output in tonnes

Table 11.9.3 VIIa Plaice, Prediction with management options

MFDP version 1a
Run: p7a-update
ICA8MFDP Index file 16/05/2006
Time and date: 16:11 11/08/2006
Fbar age range: 3-6

2006				
Biomass	**SSB**	**FMult**	**FBar**	**Landings**
18142	13940	1.0000	0.1257	1987

2007					2008	
Biomass	**SSB**	**FMult**	**FBar**	**Landings**	**Biomass**	**SSB**
19169	15102	0.0000	0.0000	0	22166	18035
.	15102	0.1000	0.0126	227	21940	17818
.	15102	0.2000	0.0251	451	21718	17604
.	15102	0.3000	0.0377	673	21498	17393
.	15102	0.4000	0.0503	891	21281	17186
.	15102	0.5000	0.0628	1106	21068	16981
.	15102	0.6000	0.0754	1318	20857	16779
.	15102	0.7000	0.0880	1528	20649	16579
.	15102	0.8000	0.1005	1734	20444	16383
.	15102	0.9000	0.1131	1938	20242	16189
.	15102	1.0000	0.1257	2139	20043	15998
.	15102	1.1000	0.1382	2338	19846	15810
.	15102	1.2000	0.1508	2534	19652	15624
.	15102	1.3000	0.1634	2727	19461	15441
.	15102	1.4000	0.1759	2917	19272	15260
.	15102	1.5000	0.1885	3106	19086	15082
.	15102	1.6000	0.2011	3291	18902	14907
.	15102	1.7000	0.2136	3474	18721	14734
.	15102	1.8000	0.2262	3655	18542	14563
.	15102	1.9000	0.2388	3833	18366	14395
.	15102	2.0000	0.2514	4009	18192	14229

Input units are thousands and kg - output in tonnes

Table 11.9.4 Input to sensitivity analysis, PLE,VIIA

```
 2, 9, 2005, 3
 1, 0, 0
 ' N2'    , 12630, 0.359
 ' N3'    , 11053, 0.359
 ' N4'    , 10432, 0.187
 ' N5'    , 9796, 0.159
 ' N6'    , 6041, 0.147
 ' N7'    , 3830, 0.156
 ' N8'    , 1829, 0.173
 ' N9'    , 2478, 0.173
 'SH2'    , 0.013, 0.429
 'SH3'    , 0.067, 0.375
 'SH4'    , 0.136, 0.339
 'SH5'    , 0.150, 0.320
 'SH6'    , 0.150, 0.295
 'SH7'    , 0.148, 0.291
 'SH8'    , 0.150, 0.291
 'SH9'    , 0.150, 0.291
 'WH2'    , 0.227, 0.077
 'WH3'    , 0.264, 0.086
 'WH4'    , 0.306, 0.084
 'WH5'    , 0.353, 0.077
 'WH6'    , 0.417, 0.097
 'WH7'    , 0.512, 0.146
 'WH8'    , 0.531, 0.084
 'WH9'    , 0.671, 0.207
 'WS2'    , 0.210, 0.087
 'WS3'    , 0.245, 0.084
 'WS4'    , 0.286, 0.088
 'WS5'    , 0.332, 0.093
 'WS6'    , 0.384, 0.095
 'WS7'    , 0.441, 0.097
 'WS8'    , 0.504, 0.099
 'WS9'    , 0.631, 0.104
 ' M2'    , 0.120, 0.1
 ' M3'    , 0.120, 0.1
 ' M4'    , 0.120, 0.1
 ' M5'    , 0.120, 0.1
 ' M6'    , 0.120, 0.1
 ' M7'    , 0.120, 0.1
 ' M8'    , 0.120, 0.1
 ' M9'    , 0.120, 0.1
 'MT2'    , 0.240, 0.100
 'MT3'    , 0.570, 0.100
 'MT4'    , 0.740, 0.100
 'MT5'    , 0.930, 0.100
 'MT6'    , 1.000, 0.000
 'MT7'    , 1.000, 0.000
 'MT8'    , 1.000, 0.000
 'MT9'    , 1.000, 0.000
 'R05'    , 12630, 0.36
 'R06'    , 12630, 0.36
 'HF05'   , 0.126, 0.17
 'HF06'   , 0.126, 0.17
 'HF07'   , 0.126, 0.17
 'K05'    , 1, 0.10
 'K06'    , 1, 0.10
 'K07'    , 1, 0.10
Plaice
IrishSea
 1
  2  9  1
 1
H.cons.
  3  6
 1964      2005
 Stock numbers > age 2 2005 are VPA survivors
```

Table 11.9.5 Plaice in 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			2001	2002	2003	2004	2005
Stock No. (thousands) of 2 year-olds			16810	14130	12630	12630	12630
Source			ICA	ICA	GM64-03	GM64-03	GM64-03
Status Quo F:							
% in	2006	landings	22.9	19.4	9.0	1.8	-
% in	2007		19.2	17.6	15.8	8.3	1.7
% in	2006	SSB	21.9	16.0	11.2	4.6	-
% in	2007	SSB	19.1	16.6	12.9	10.3	4.2
% in	2008	SSB	15.8	14.8	13.7	12.2	9.7

GM : geometric mean recruitment

Plaice in VIIa : Year-class % contribution to

a) 2007 landings **b) 2008 SSB**

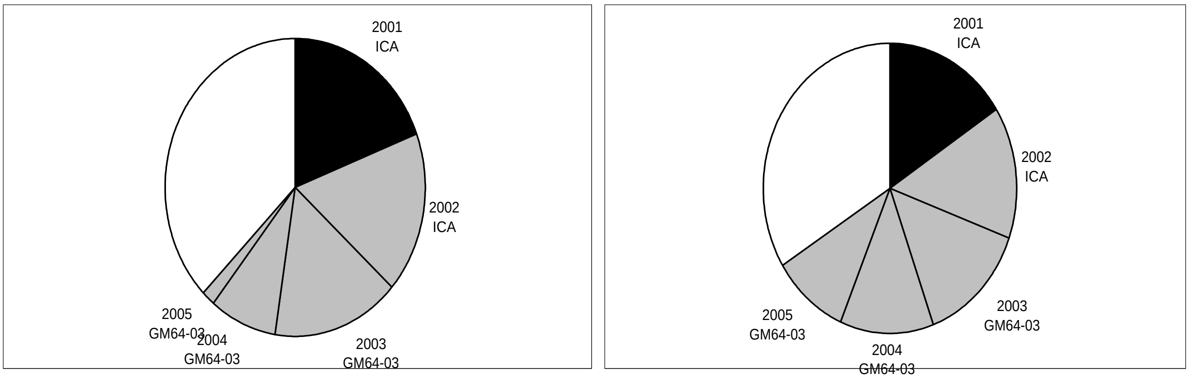


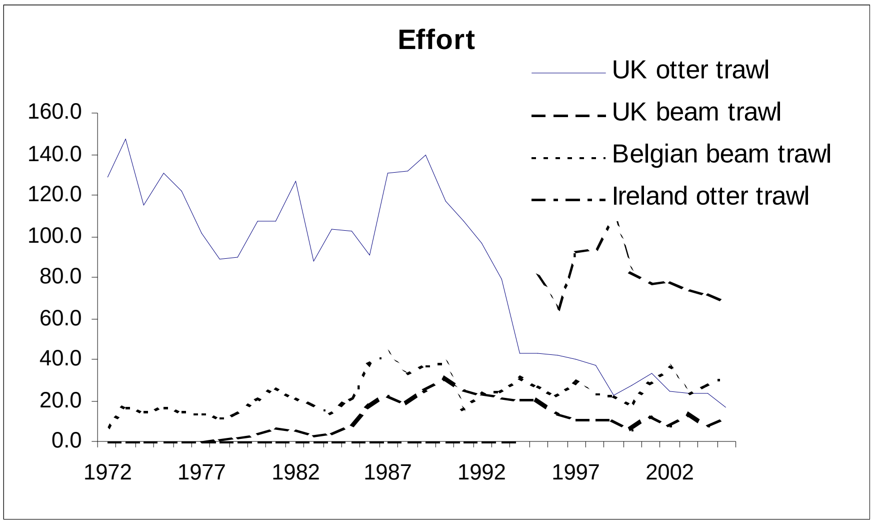
Table 11.11.1 Yield per Recruit table under current selection pattern

MFYPR
Run:
Time
Yield

FMult	Fbar	CatchNos	Yield	StockNos	Biomass	SpwnNosJan	SSBJan	SpwnNosSpwn	SSBSpwn
0.0000	0.0000	0.0000	0.0000	8.8433	4.0189	7.4486	3.6901	7.4486	3.6901
0.1000	0.0126	0.0926	0.0485	8.0726	3.5548	6.6811	3.2269	6.6811	3.2269
0.2000	0.0251	0.1668	0.0853	7.4556	3.1867	6.0672	2.8598	6.0672	2.8598
0.3000	0.0377	0.2275	0.1138	6.9504	2.8883	5.5651	2.5623	5.5651	2.5623
0.4000	0.0503	0.2782	0.1363	6.5289	2.6419	5.1467	2.3168	5.1467	2.3168
0.5000	0.0628	0.3212	0.1541	6.1719	2.4355	4.7928	2.1113	4.7928	2.1113
0.6000	0.0754	0.3581	0.1685	5.8656	2.2603	4.4894	1.9370	4.4894	1.9370
0.7000	0.0880	0.3901	0.1802	5.5997	2.1100	4.2265	1.7875	4.2265	1.7875
0.8000	0.1005	0.4181	0.1897	5.3667	1.9798	3.9965	1.6582	3.9965	1.6582
0.9000	0.1131	0.4430	0.1975	5.1608	1.8661	3.7935	1.5453	3.7935	1.5453
1.0000	0.1257	0.4651	0.2039	4.9775	1.7660	3.6131	1.4461	3.6131	1.4461
1.1000	0.1382	0.4849	0.2092	4.8133	1.6774	3.4517	1.3584	3.4517	1.3584
1.2000	0.1508	0.5028	0.2136	4.6652	1.5985	3.3065	1.2803	3.3065	1.2803
1.3000	0.1634	0.5190	0.2172	4.5310	1.5278	3.1750	1.2104	3.1750	1.2104
1.4000	0.1759	0.5338	0.2202	4.4087	1.4642	3.0555	1.1476	3.0555	1.1476
1.5000	0.1885	0.5473	0.2227	4.2969	1.4068	2.9464	1.0910	2.9464	1.0910
1.6000	0.2011	0.5597	0.2248	4.1941	1.3546	2.8464	1.0396	2.8464	1.0396
1.7000	0.2136	0.5712	0.2266	4.0994	1.3071	2.7544	0.9928	2.7544	0.9928
1.8000	0.2262	0.5818	0.2280	4.0118	1.2636	2.6694	0.9502	2.6694	0.9502
1.9000	0.2388	0.5917	0.2292	3.9306	1.2238	2.5907	0.9111	2.5907	0.9111
2.0000	0.2513	0.6008	0.2301	3.8549	1.1871	2.5177	0.8752	2.5177	0.8752

Reference	point	F
Fbar(3-6)	1.0000	0.1257
FMax	2.9820	0.3748
F0.1	1.0224	0.1285
F35%SPR	1.1849	0.1489

Weights in kilograms



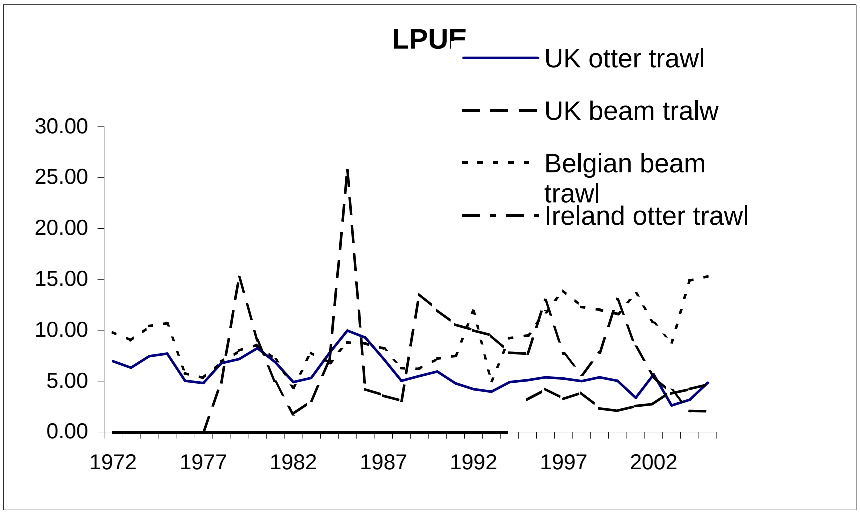


Figure 11.3.1 Irish Sea plaice: effort and LPUE for commercial fleets

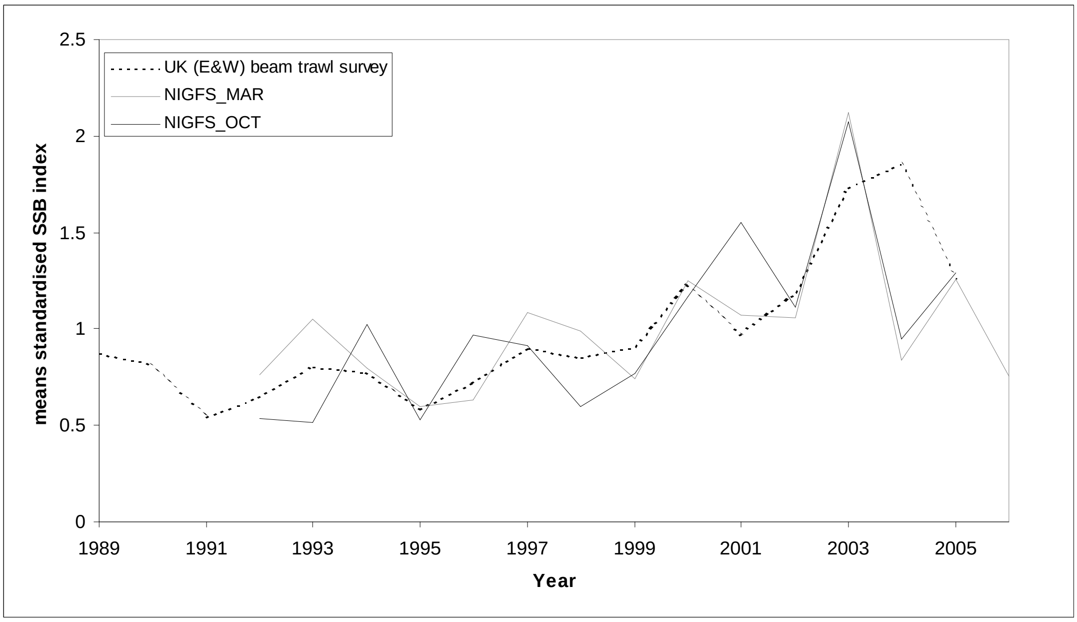
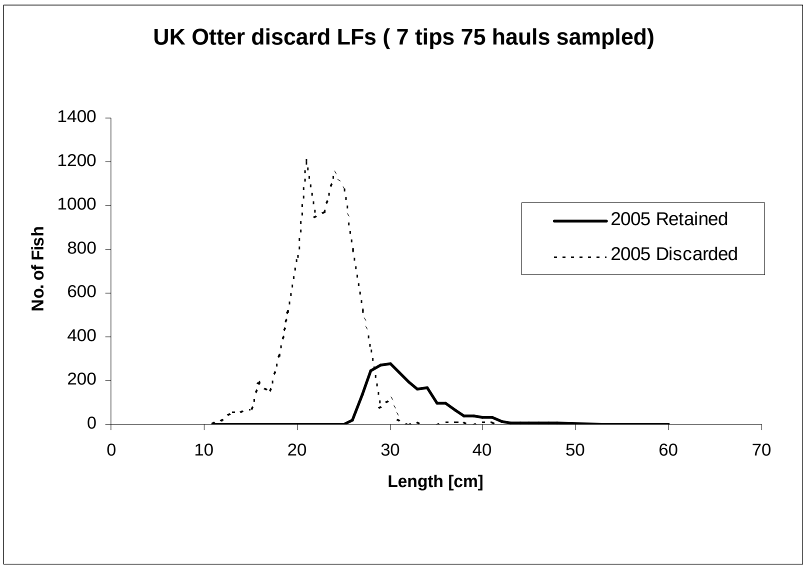
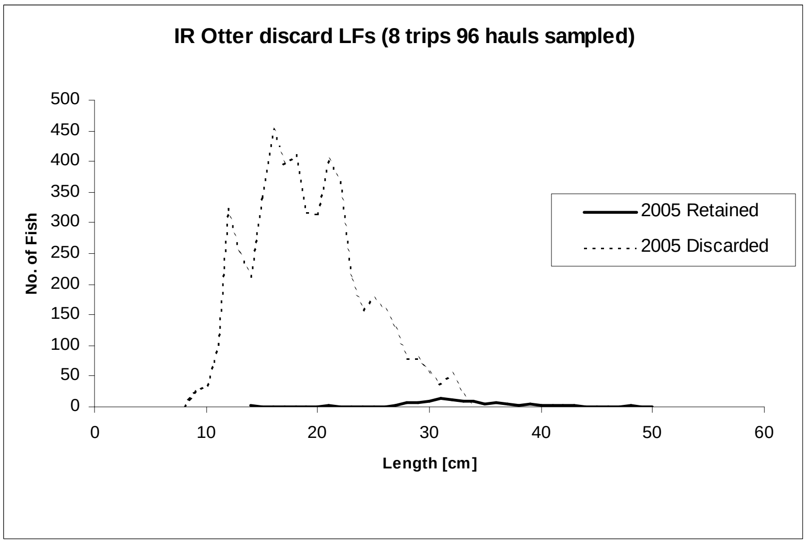


Figure 11.3.2 Mean standardised indices of spawning biomass derived from NIGFS_MSR, NIGFS_OCT and UK(E&W)beam trawl survey





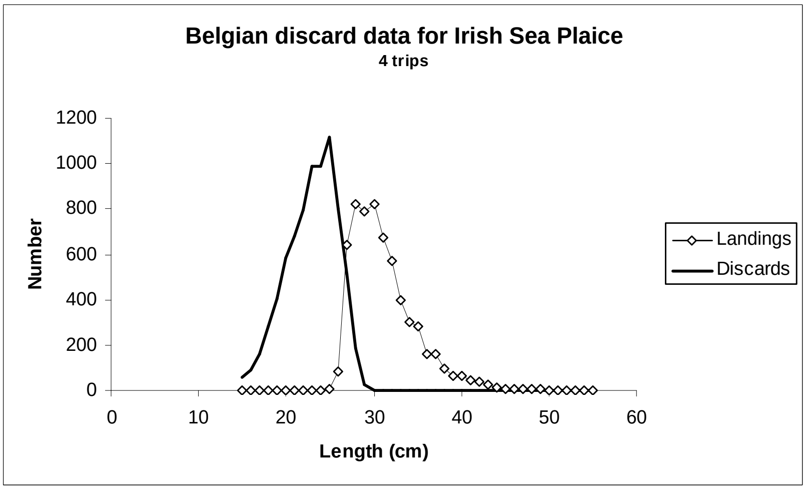


Figure 11.1.4.2 Length distributions of discarded (dotted) and retained (solid) fish by sex from discard sampling studies by the UK, Ireland and Belgium in 2005

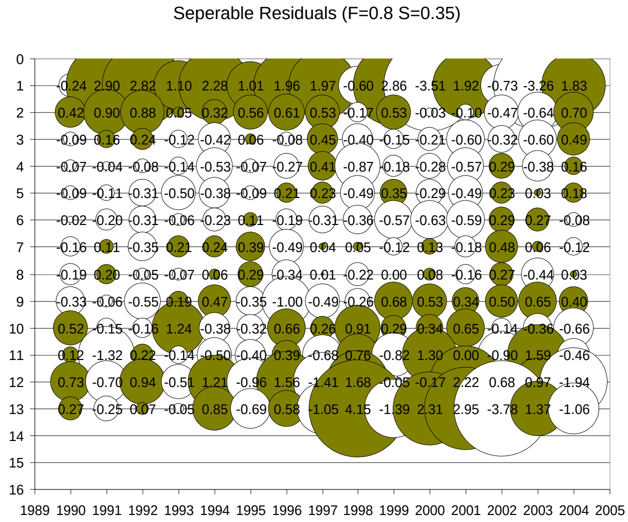


Figure 11.6.1.1 Irish Sea Plaice: Separable residuals

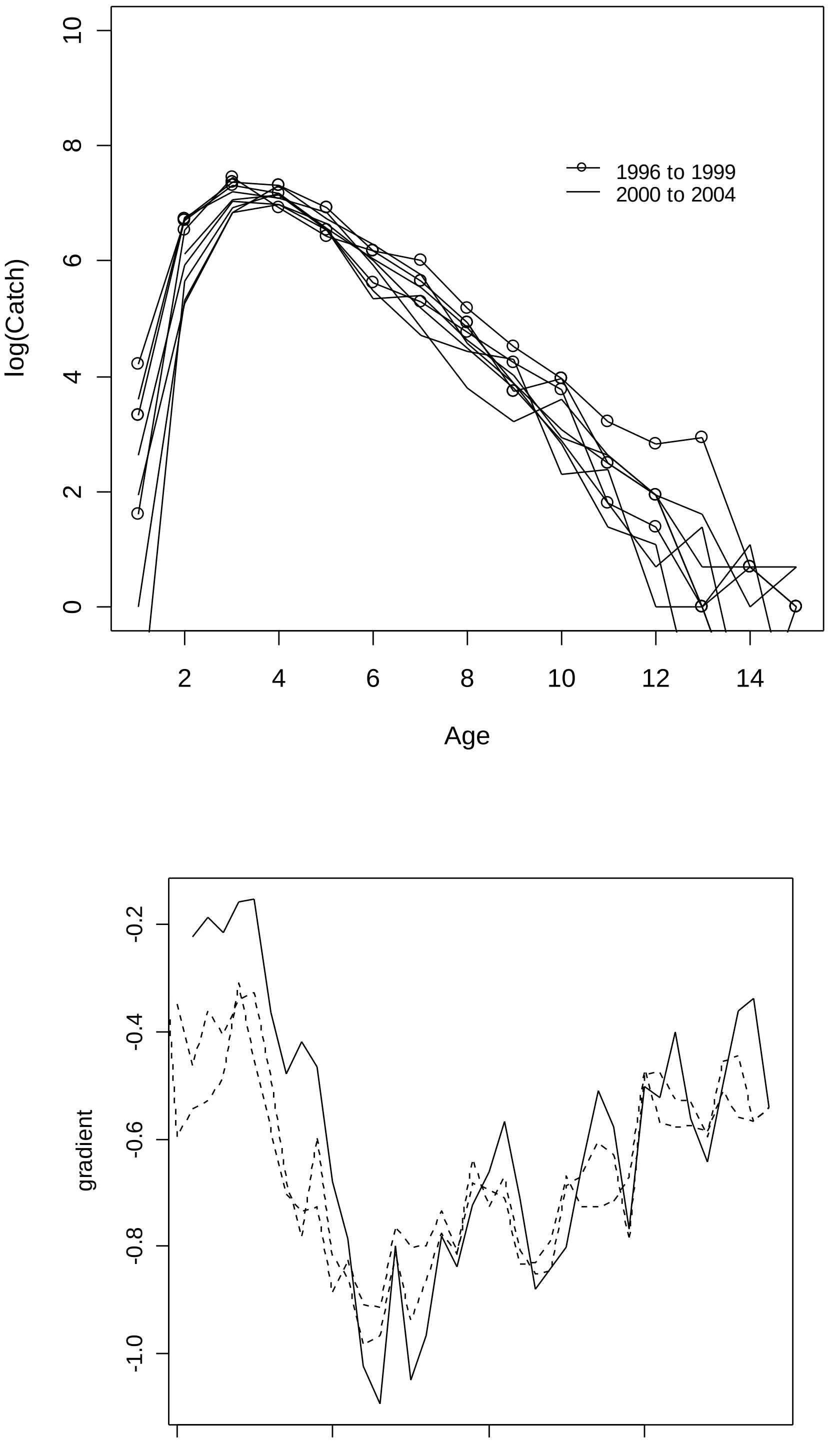


Figure 11.6.12 a) Irish Sea plaice: log catch numbers and b)the change in gradient over the F-bar range. Dotted lines show gradients calculated over age ranges 3:7 and 3:8.. Produced by the 2005 WG

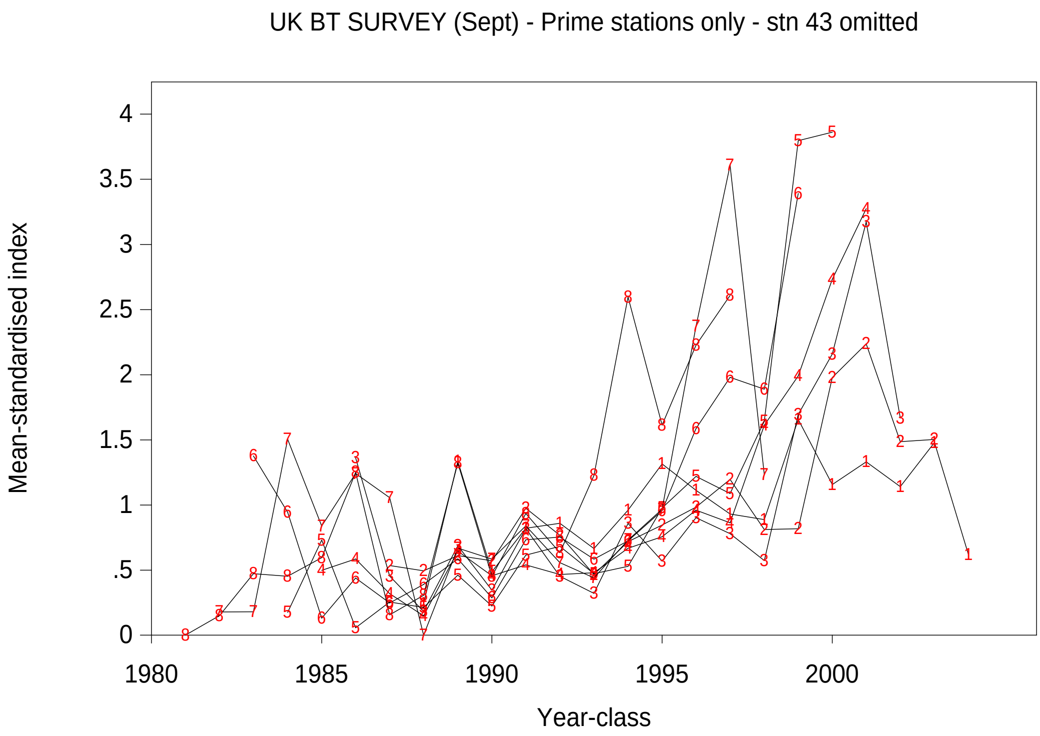


Figure 11.6.1.3 Mean standardised indices by year-class for UK(E&W) beam trawl survey 1 to 8

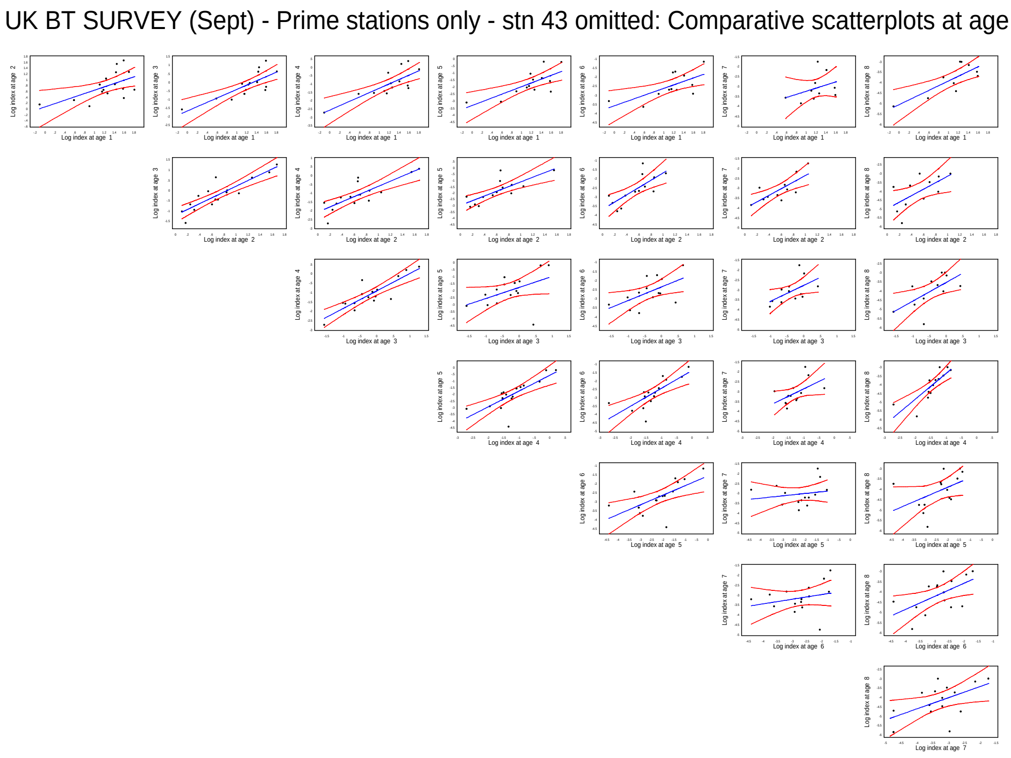


Figure 11.6.1.7 Comparative scatter plots of adjacent age groups showing the internal consistency of the UK(E&W) beam trawl survey.

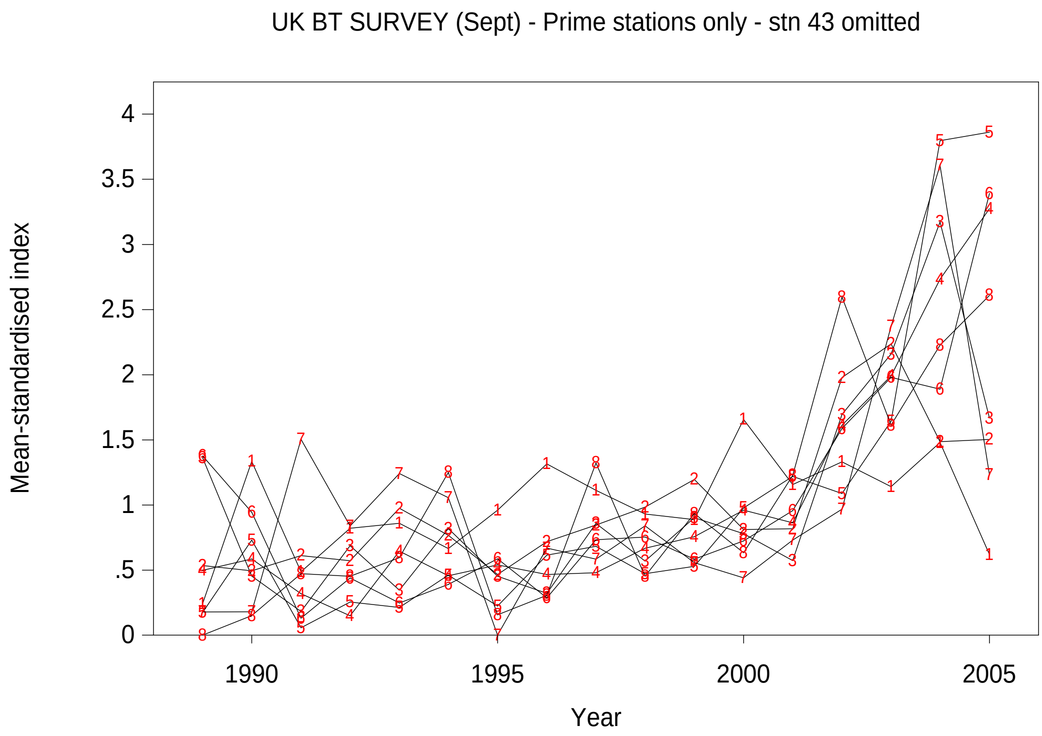


Figure 11.6.1.5 Mean standardised indices by year for UK(E&W) beam trawl survey ages 1 to 8

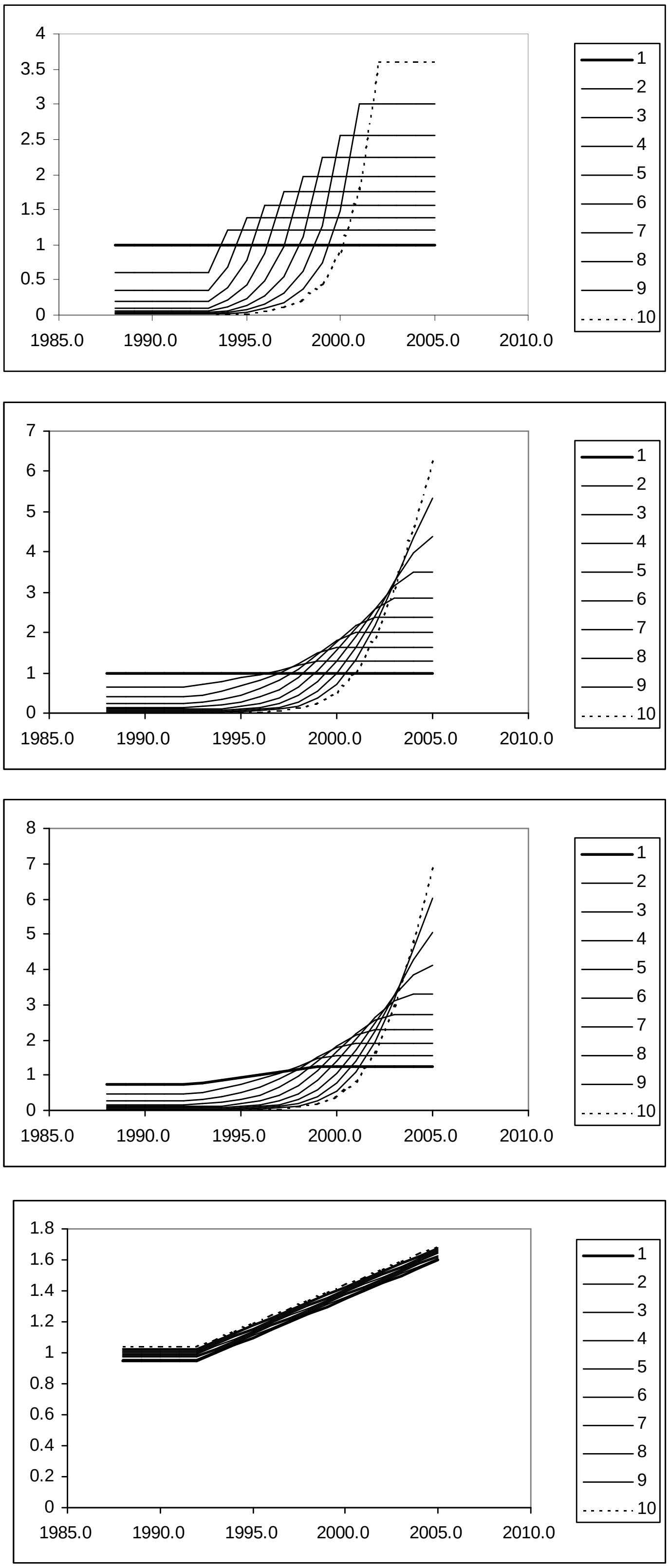


Figure 11.6.1.6 Results of expected changes in survey tuning index with a) sudden change in F, b) slow linear change in F, c) Slow linear change in recruitment, d) linear change in catchability of the survey.

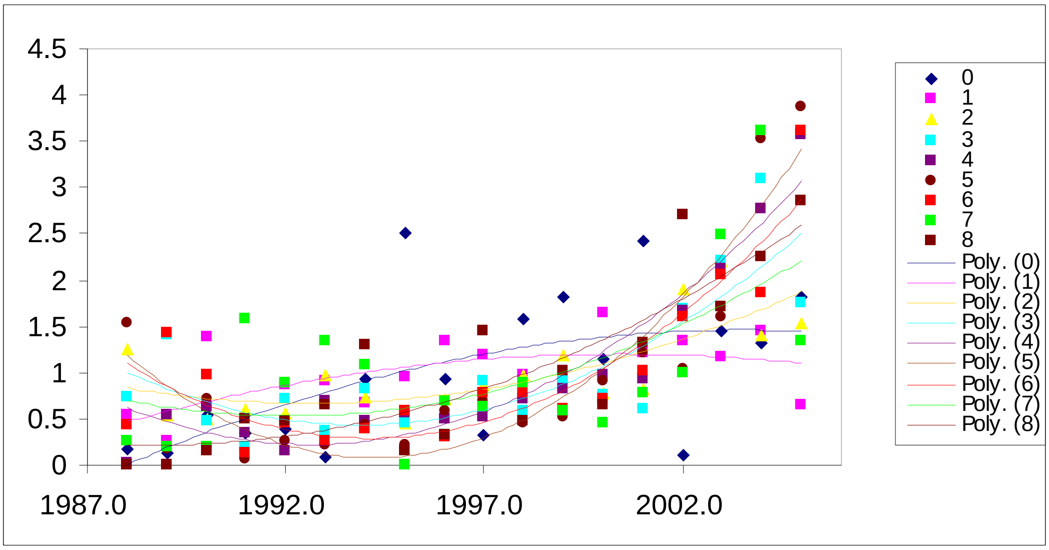
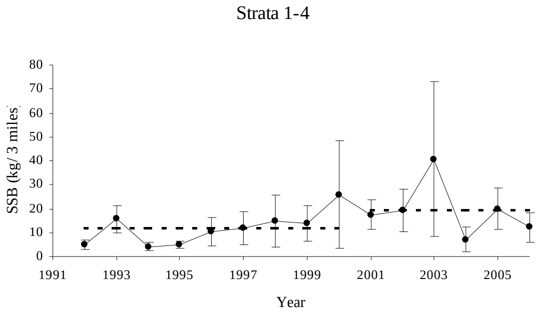


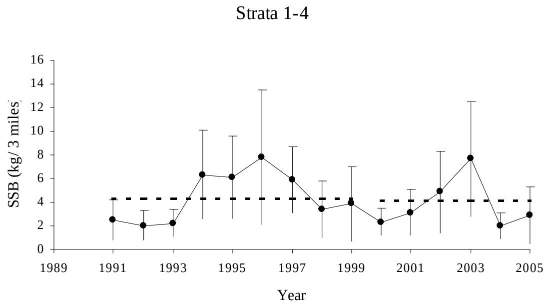
Figure 11.6.1.7 Mean standardised indices by year-class for the UK(E&W) beam trawl survey ages 0-8 with 2nd order polynomial fits

Spring

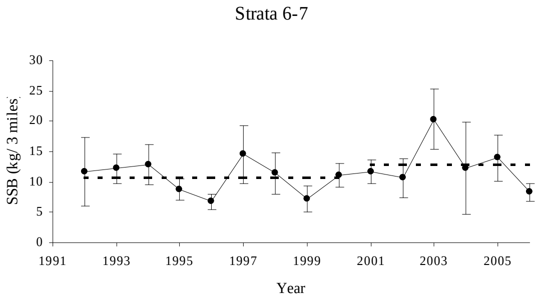
Autumn

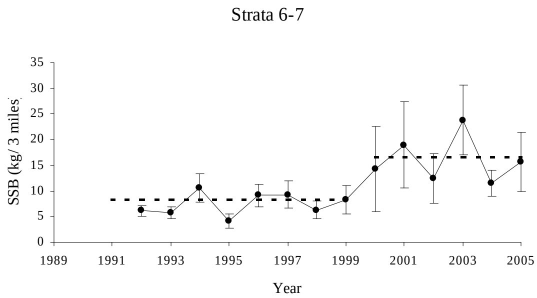
West



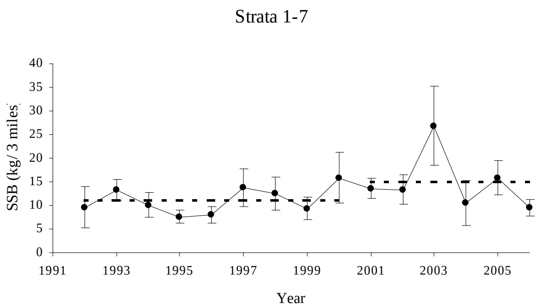


East





Combined



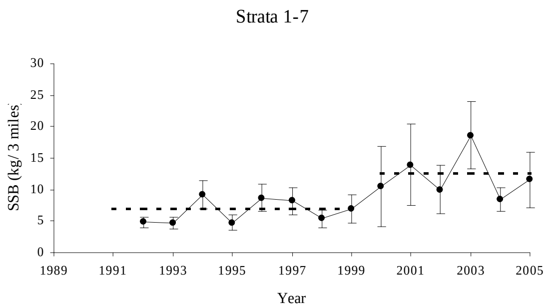


Figure 11.6.1.13 UK (NI) groundfish survey SSB indices split into spring and autumn sampling and eastern (strata 6,7) and western (strata 1-4) and total (starat 1-7) Irish Sea. Dashed lines indicate average levels prior to 1999 and post 2000.

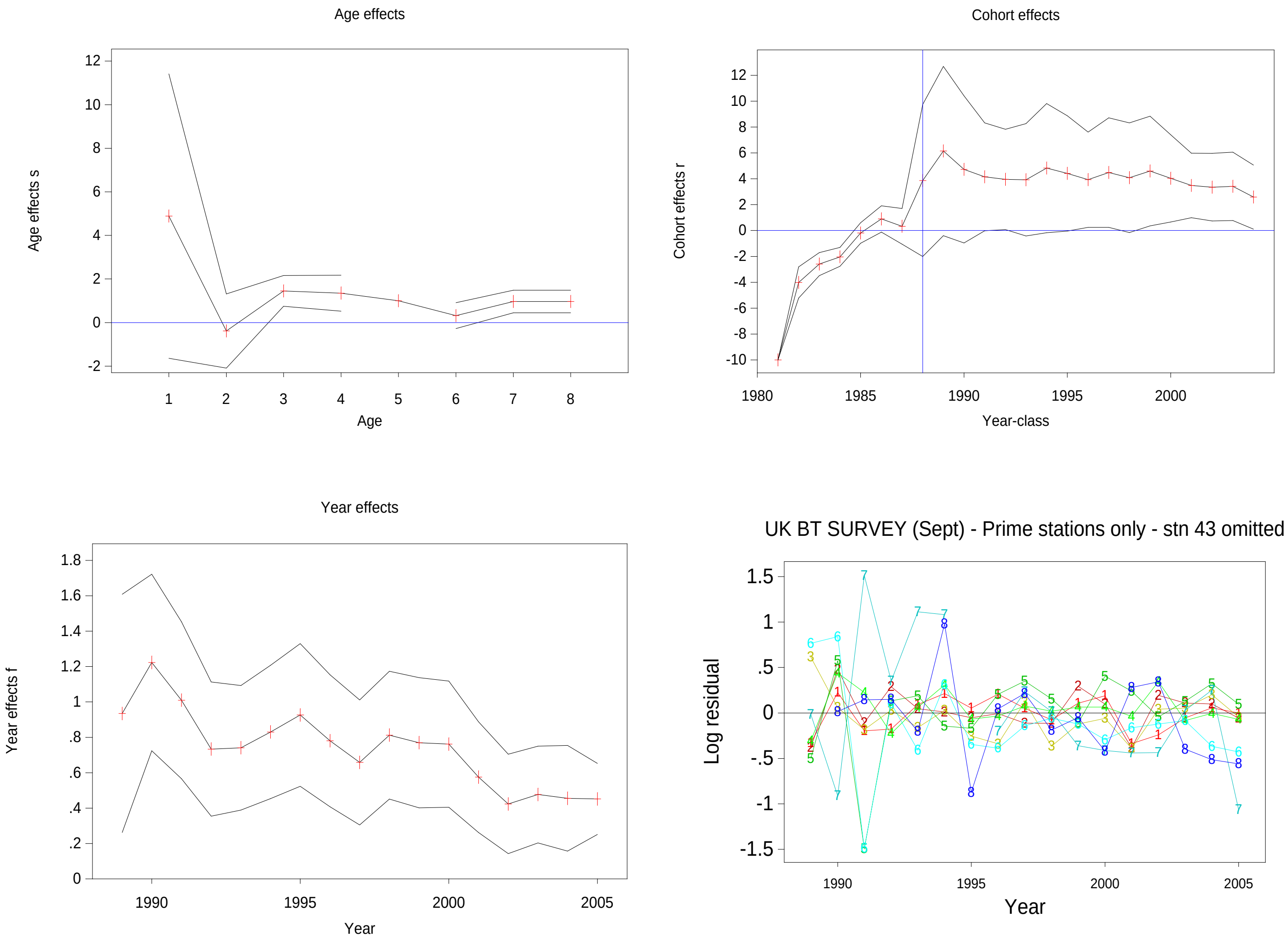


Figure 11.6.1.9 Surba diagnostic output

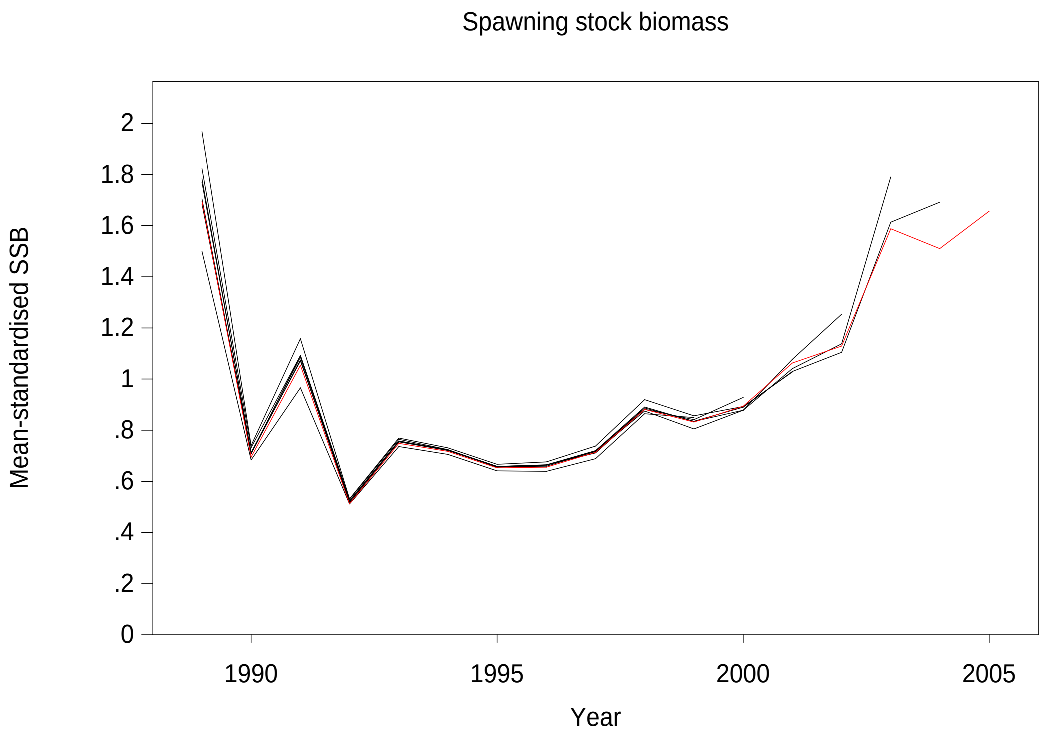


Figure 6.1.10 Surba retrospective analysis of SSB trends

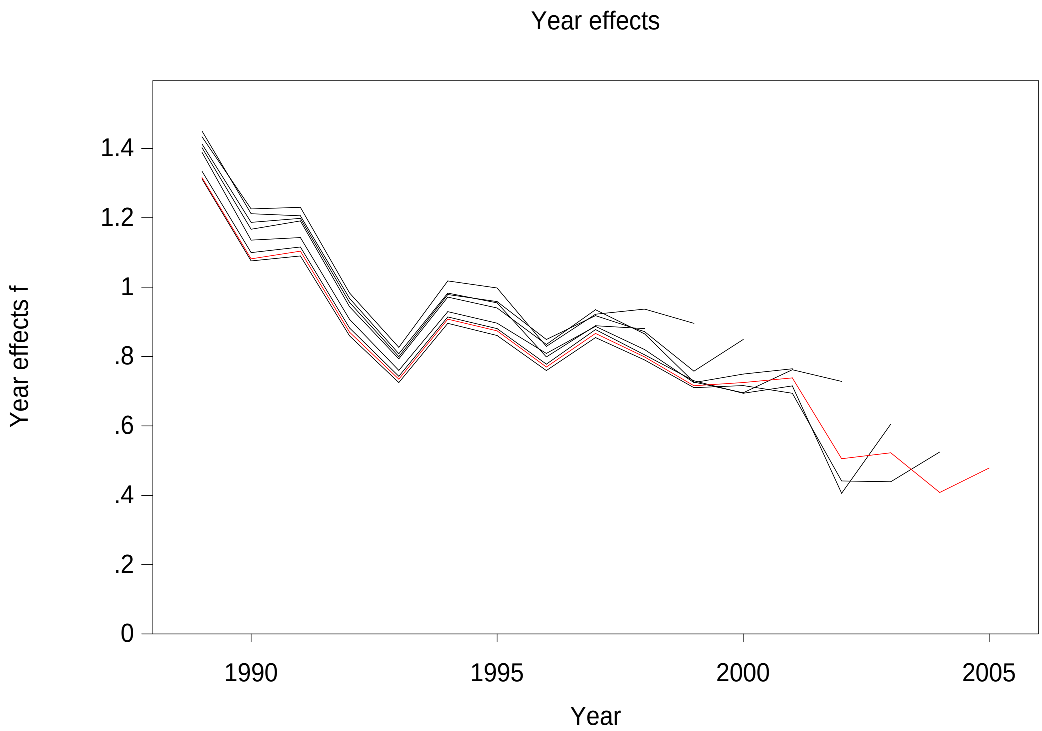


Figure 6.1.11 Surba retrospective analysis of F trends

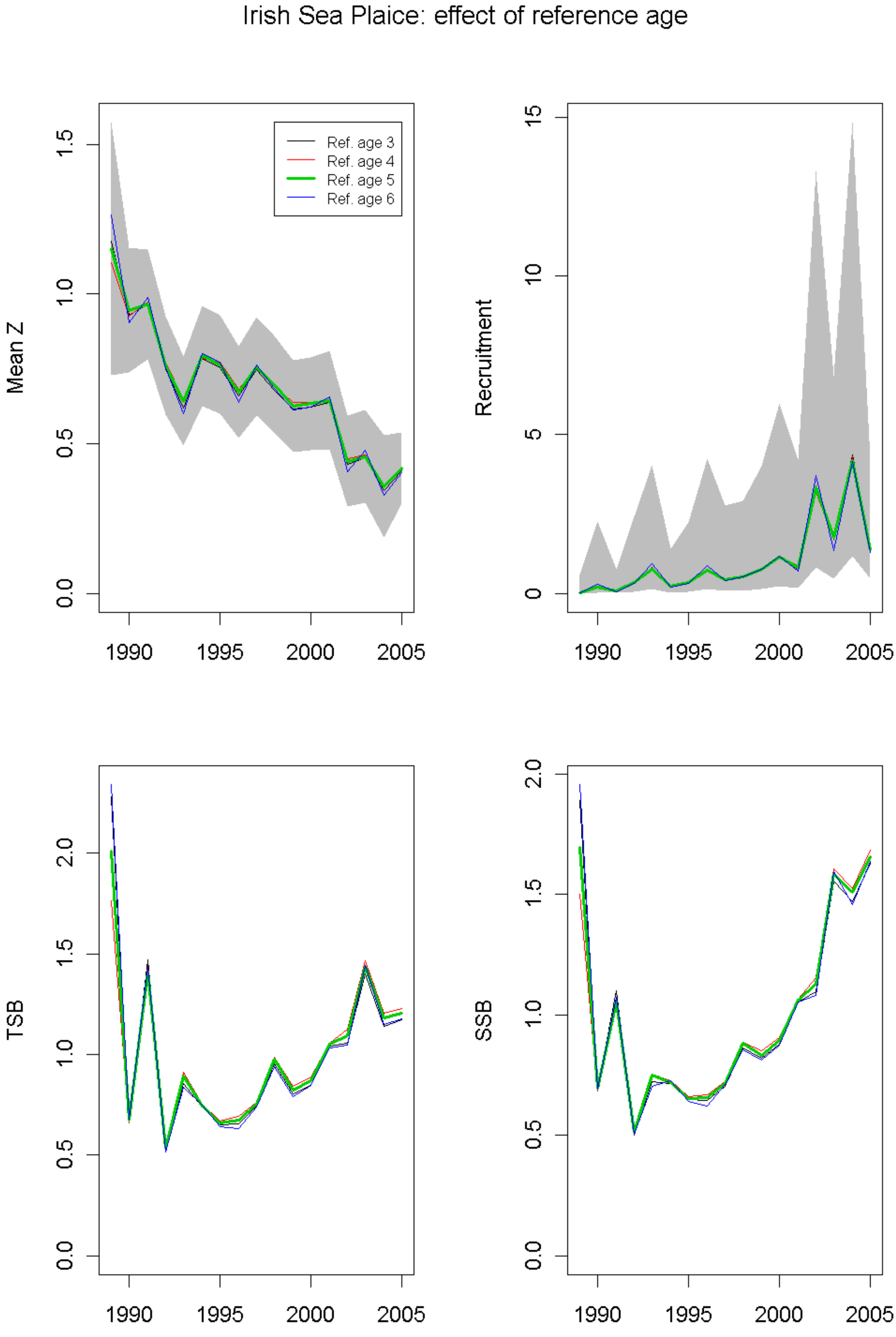


Figure 11.6.1.12 Surba sensitivity to choice of reference age

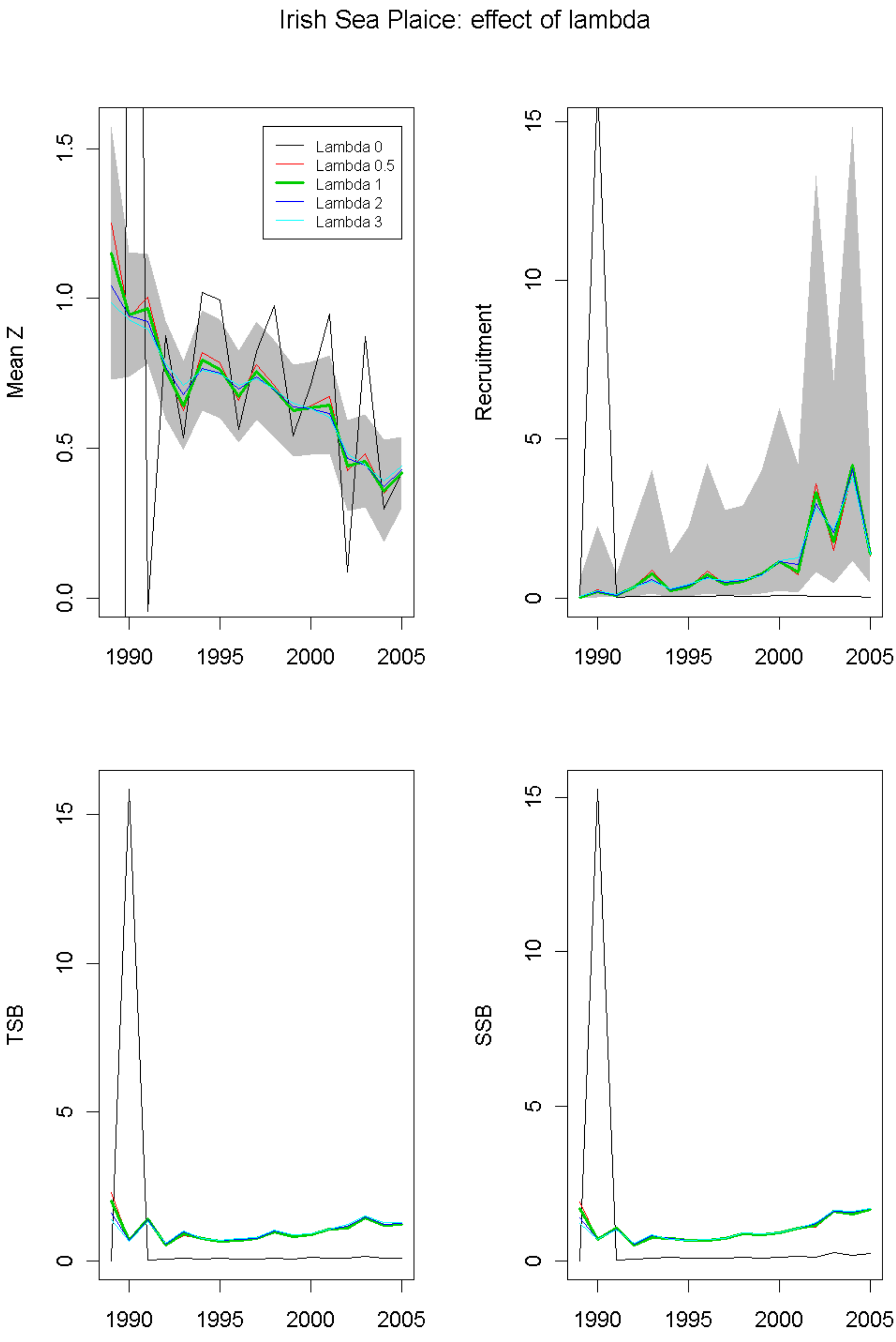


Figure 11.6.1.12 Surba sensitivity to choice of lambda smoothing value

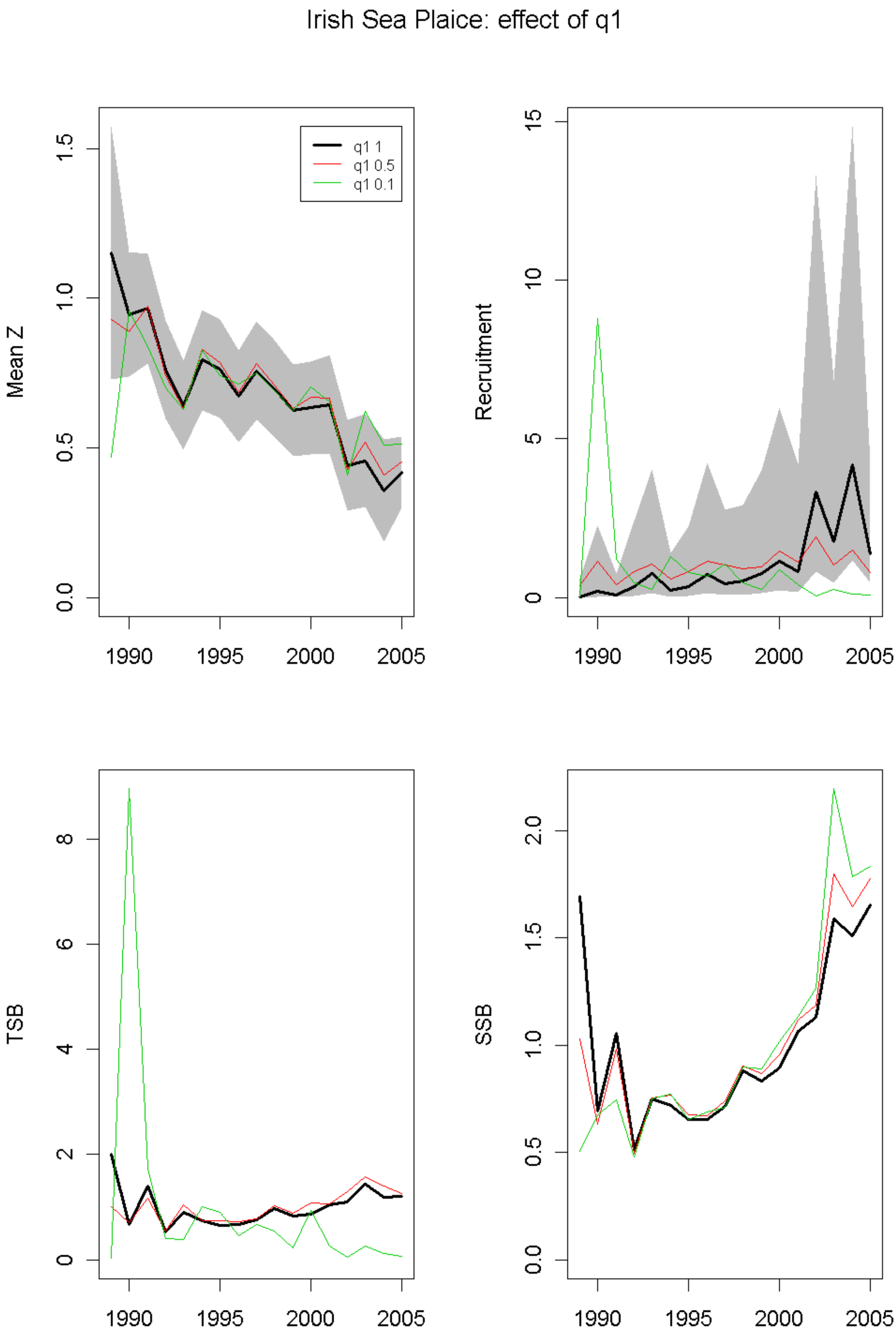


Figure 11.6.1.12 Surba sensitivity to choice of survey selectivity at age 1

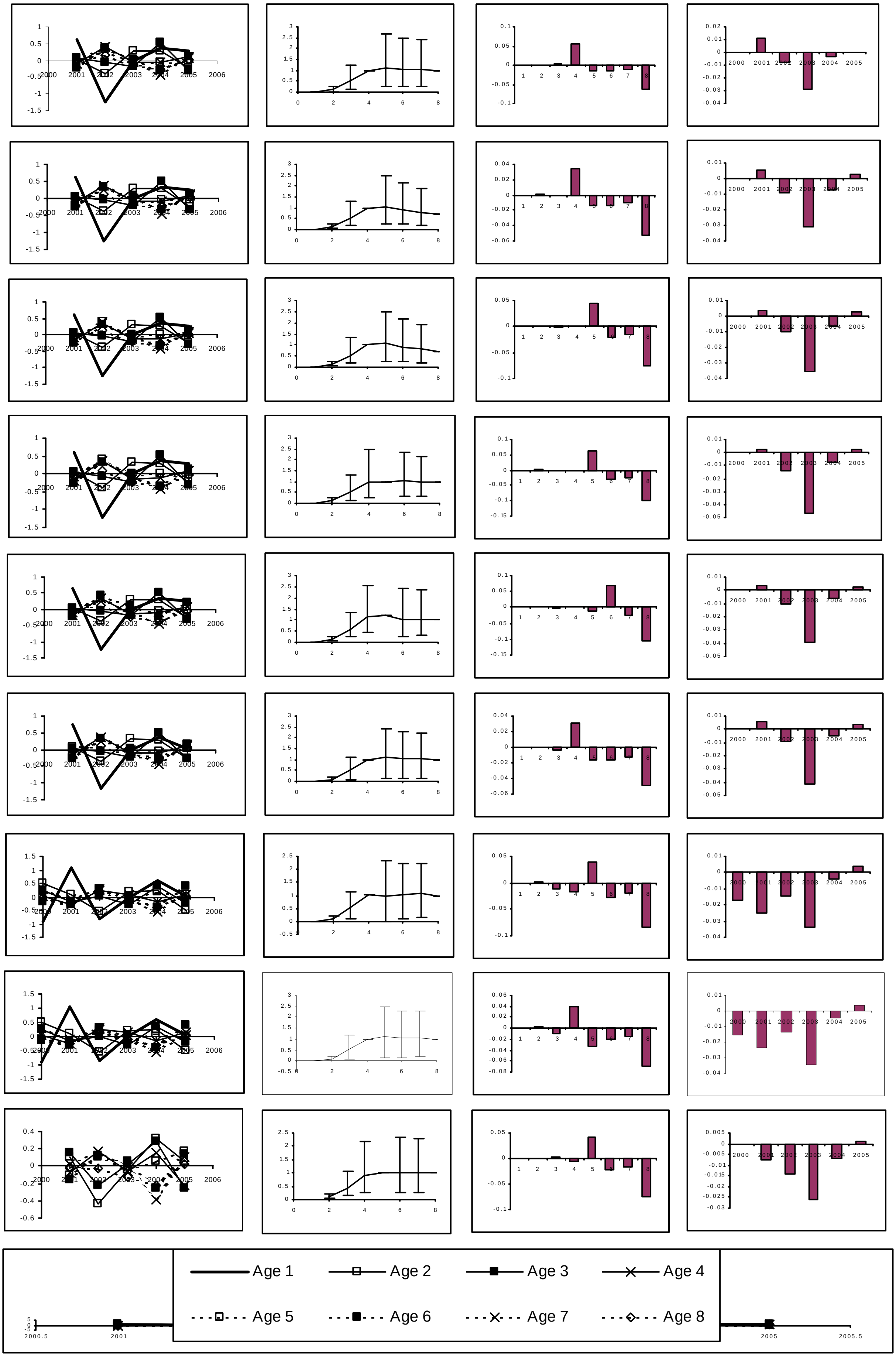


Figure 11.6.1.15 ICA diagnostic output for experimental runs (from top to bottom), SPALLY run, ICA1, ICA2, ICA3, ICA4, ICA5, ICA6, ICA7, ICA8

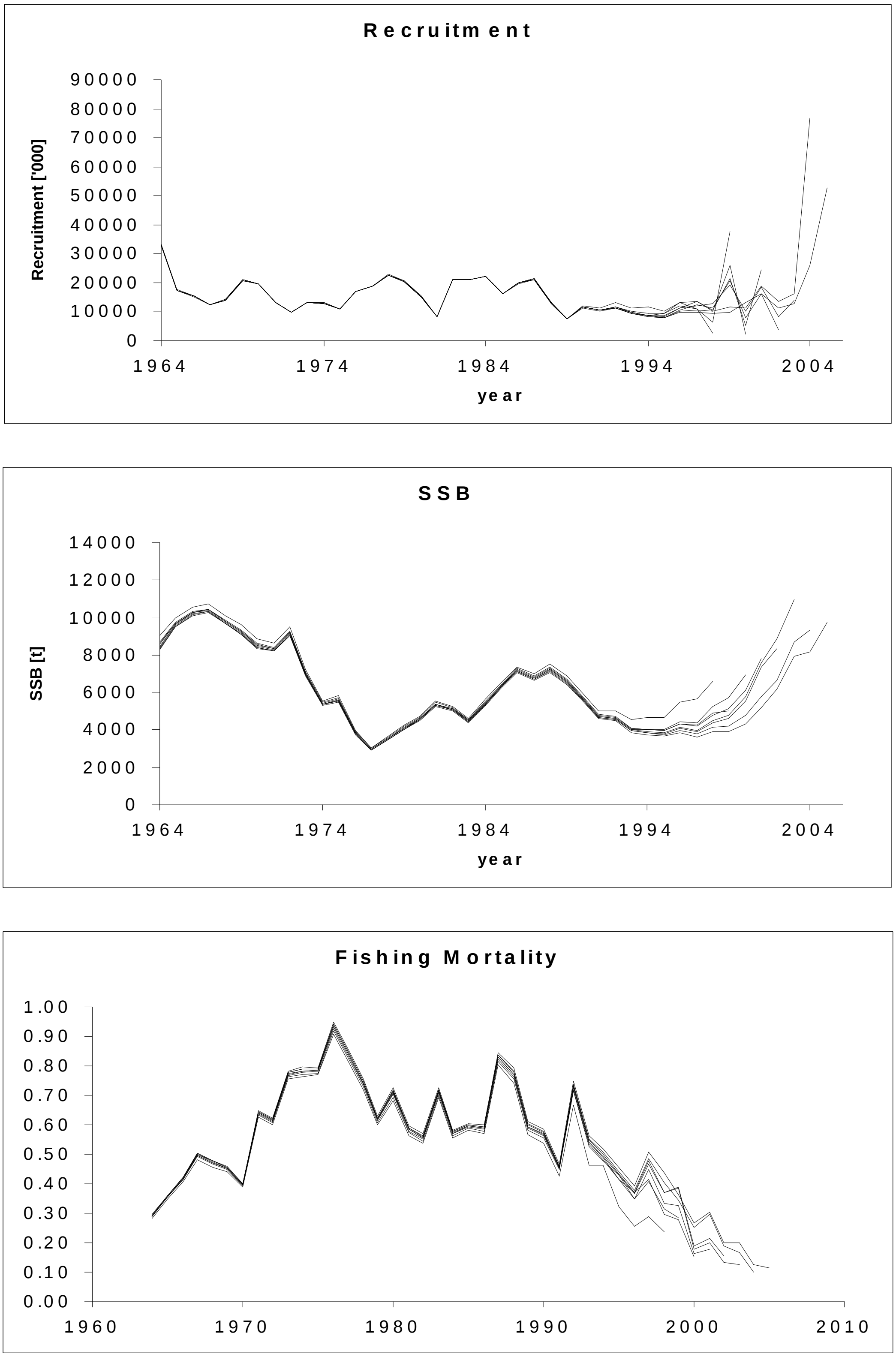


Figure 11.6.1.16 Retrospective pattern for ICA 3

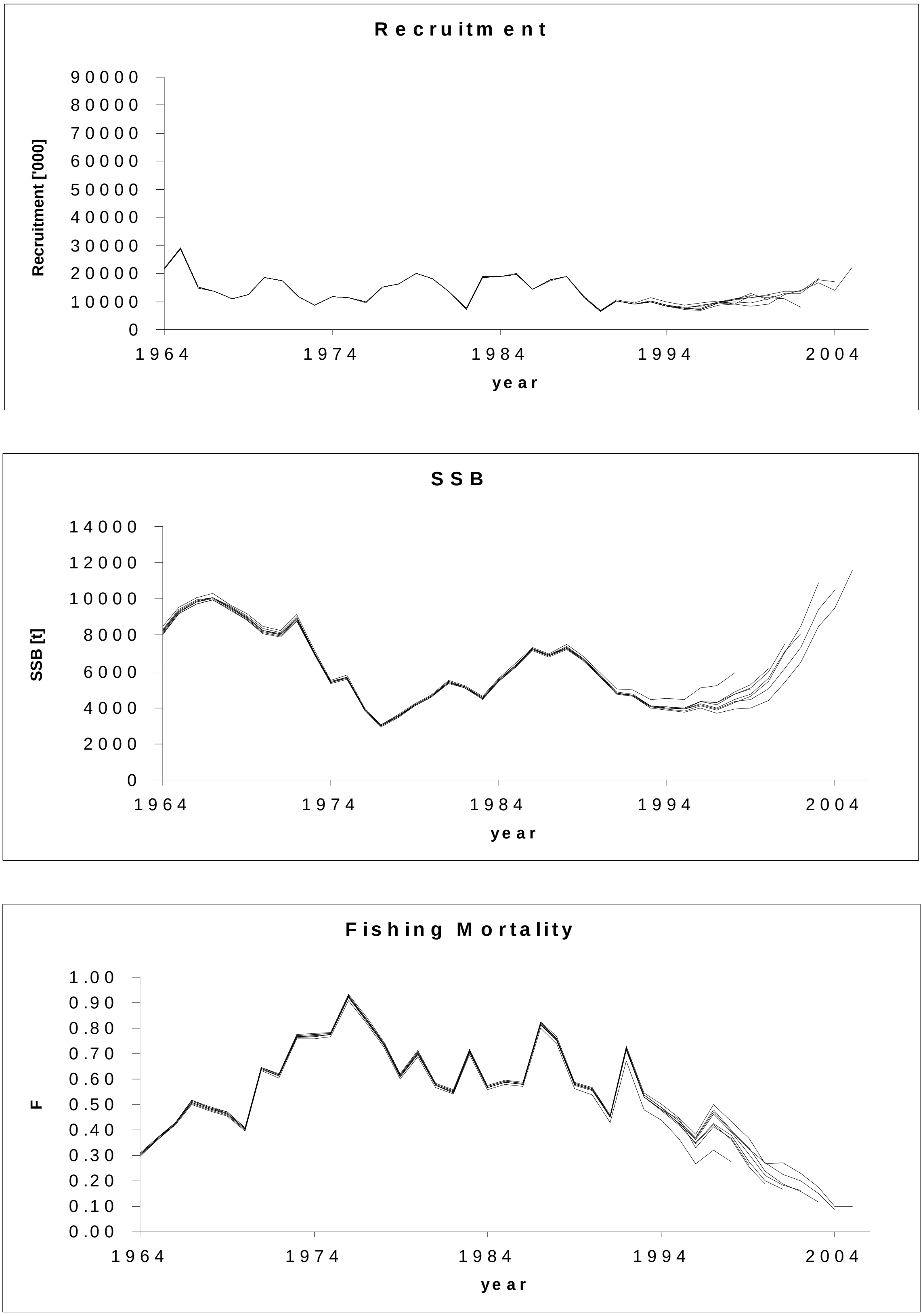


Figure 11.6.1.17 Retrospective pattern for ICA 8

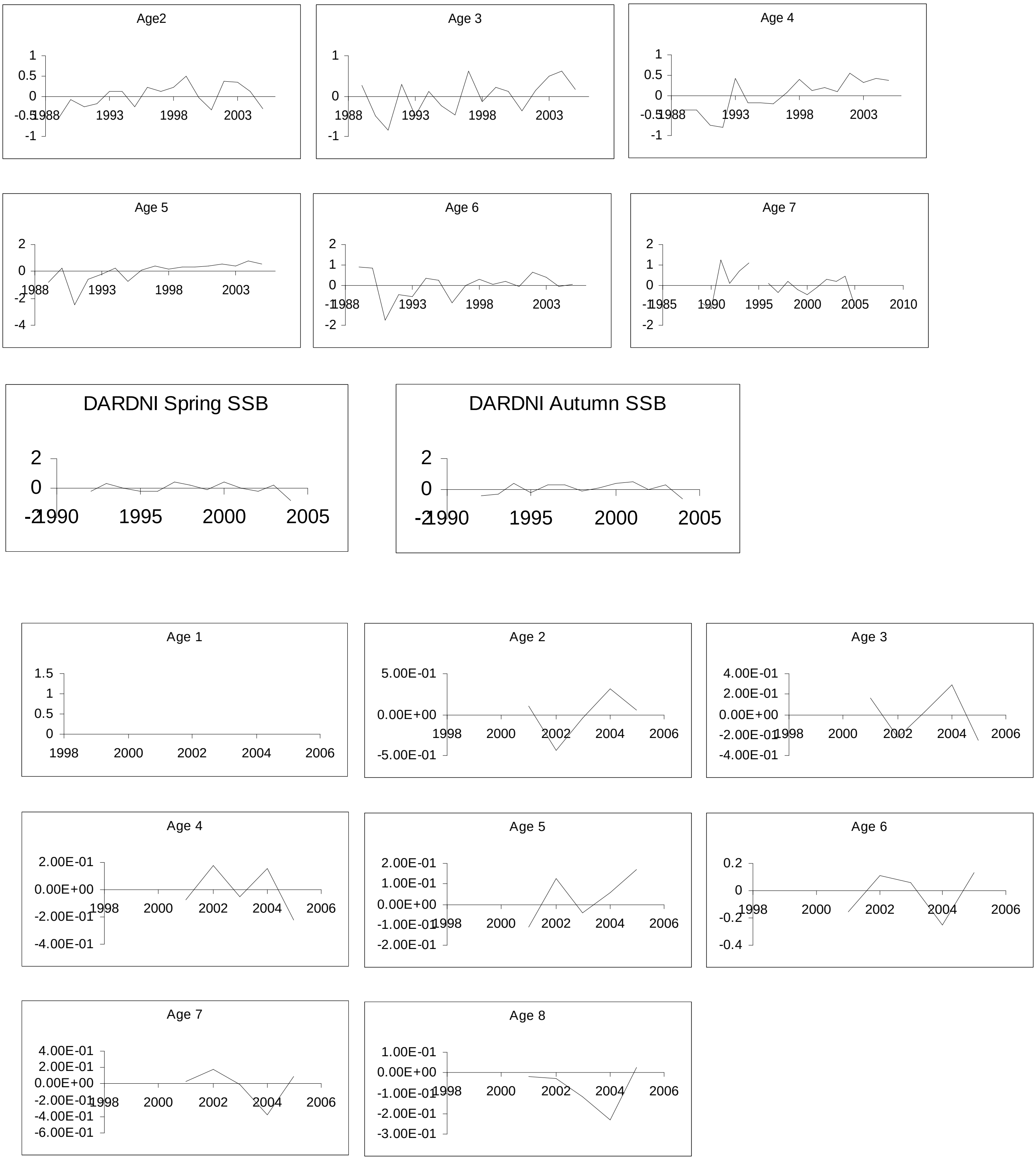


Figure 11.6.2.1 ICA residuals for(top to bottom) UK(E&W) beam trawl survey (at age), NIGFS_MAR, NIGFS_OCT (SSB index) and catch at age

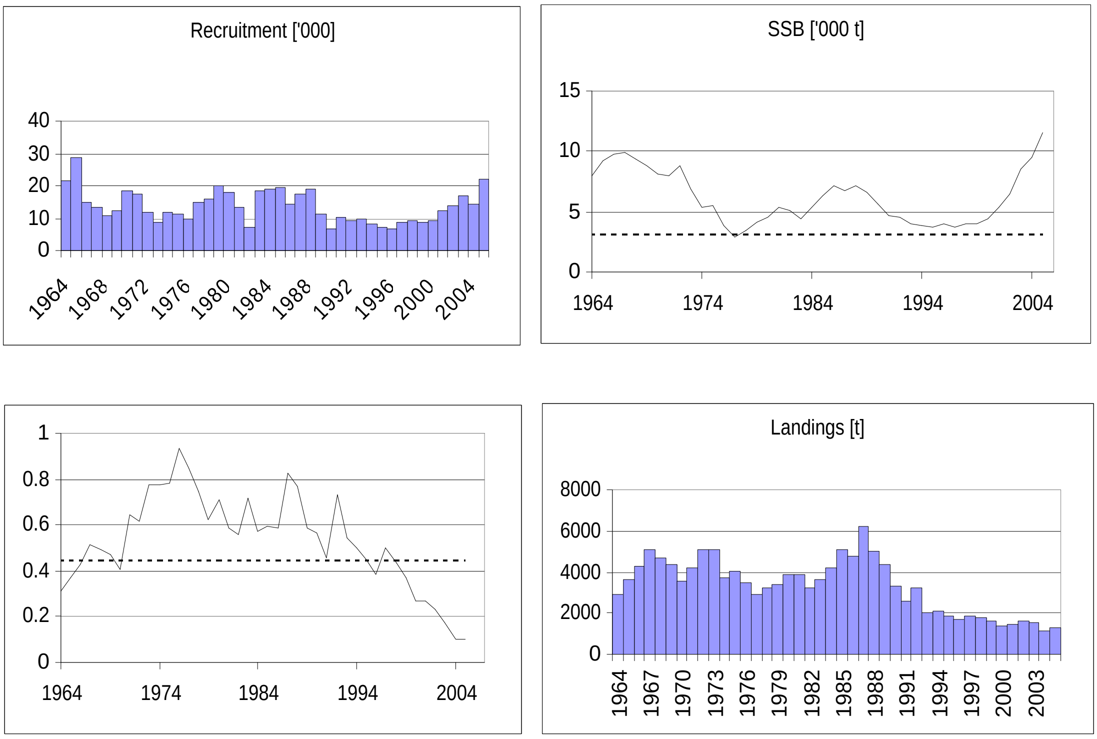


Figure 11.6.2.2 Irish Sea plaice: Summary plot for the final ICA assessment. Dotted lines show Fpa and Bpa

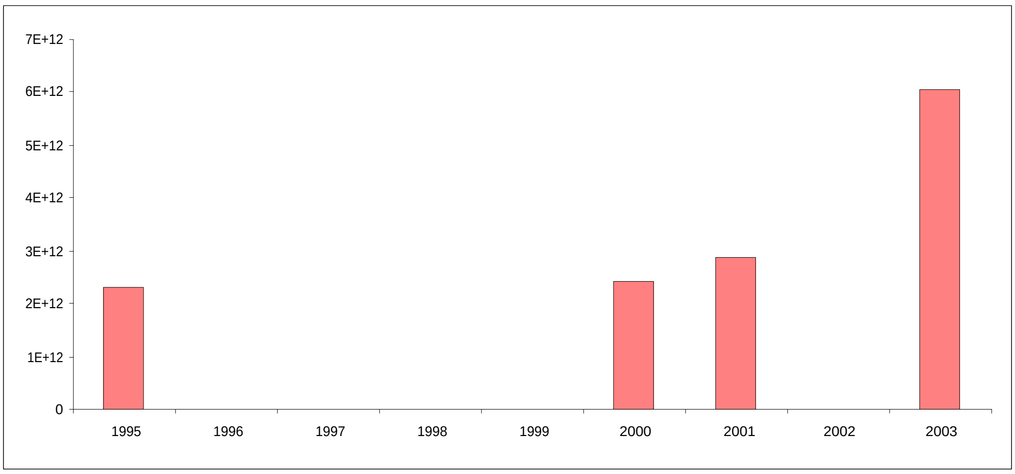
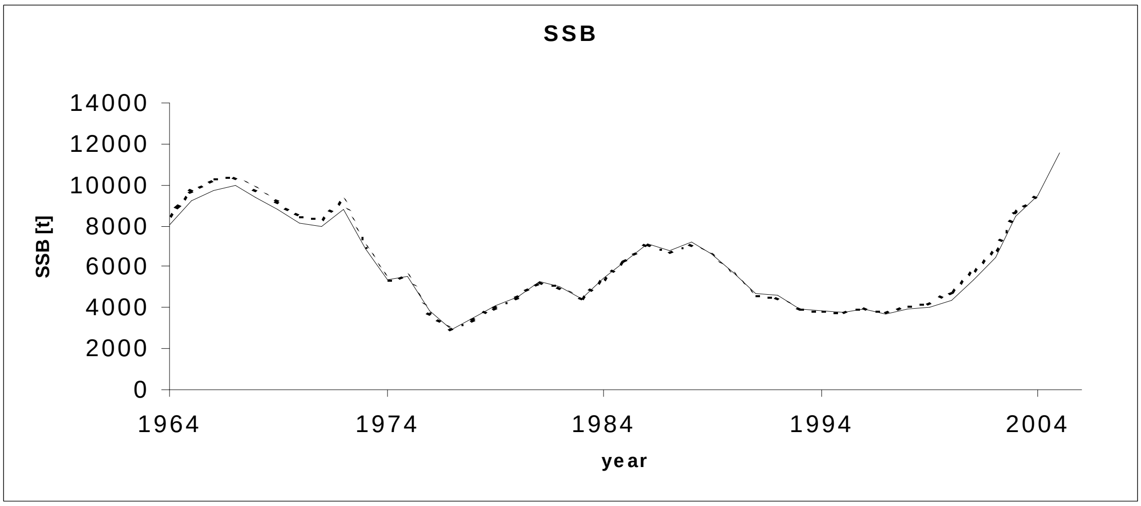


Figure 11.6.2.3 Estimated total (all stages) egg abundance for plaice in the Irish Sea. (Fox, (CEFAS) unpublished data)



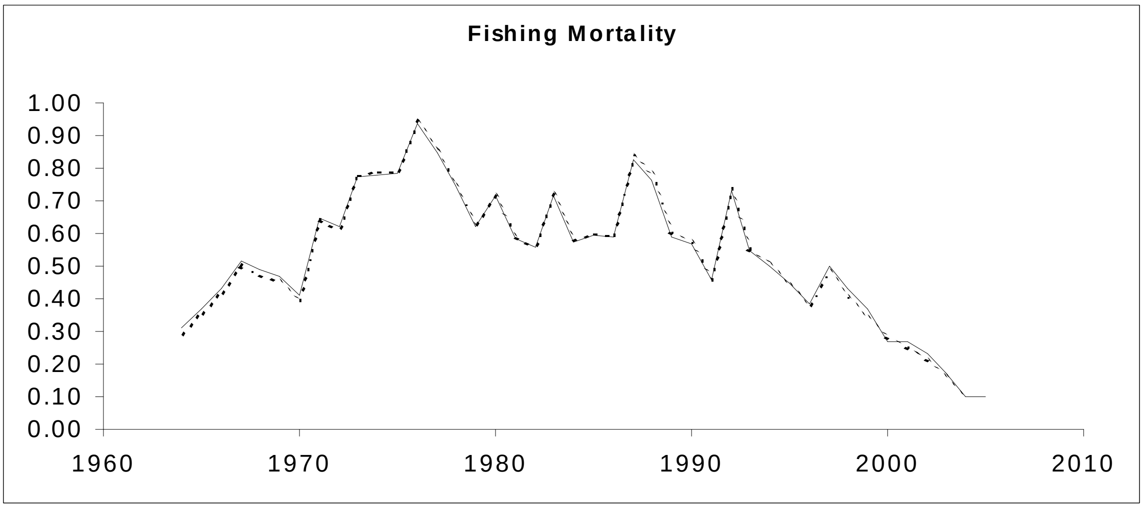
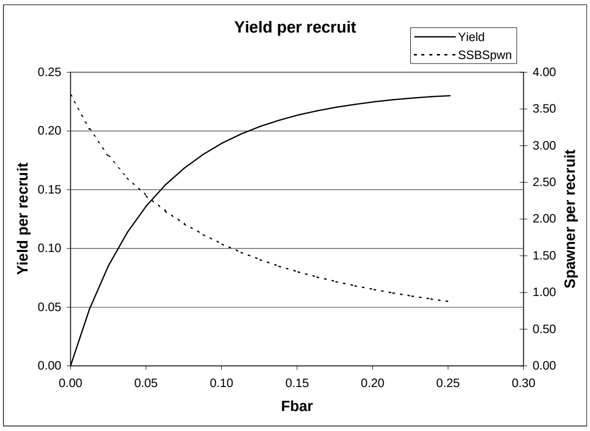
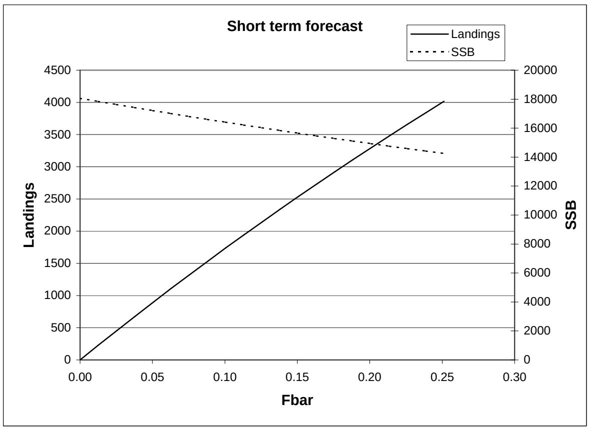


Figure 1.6.3 Comparison of recruitment (previous assessment used recruitment at age one so that recruitment is lagged), SSB and fishing mortality with last years assessment.

Figure 11.9.1 VIIa plaice, yield per recruit and short term forecast





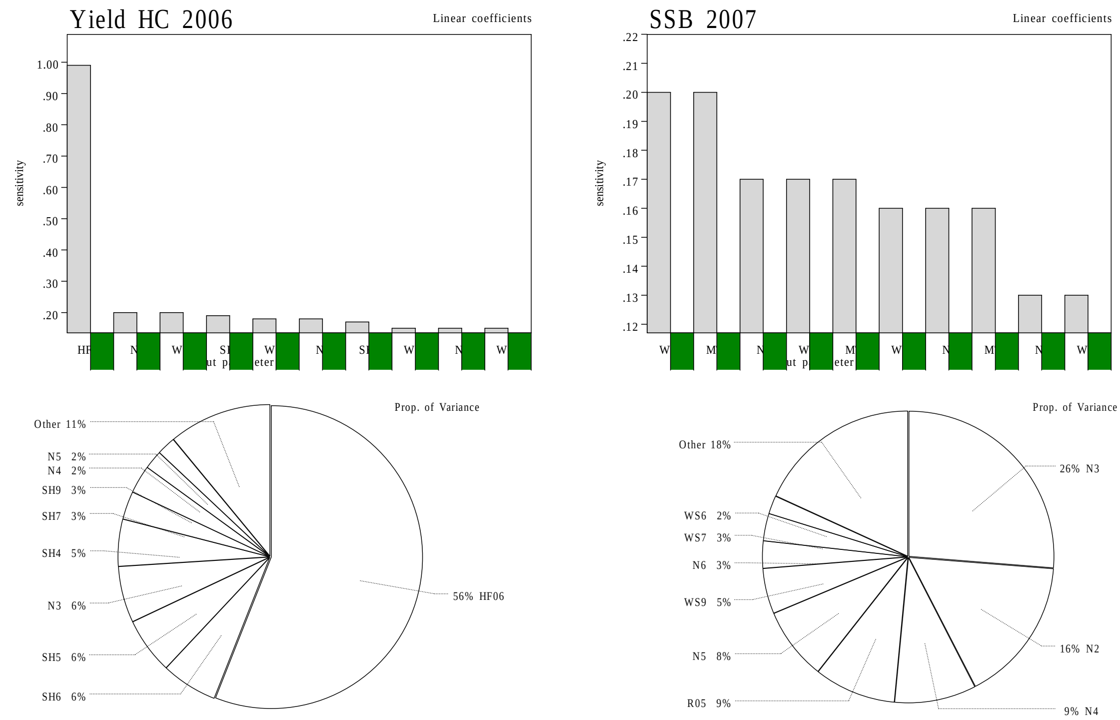
MFYPR
Run:
Time

Reference	point	F
Fbar(3-6)	1.0000	0.1257
FMax	2.9820	0.3748
F0.1	1.0224	0.1285
F35%SPR	1.1849	0.1489
Weights	in	kilograms

MFDP version 1a
Run: p7a-sqf
p7a-stf1MFDP Index file 18/05/2005
Time and date: 11:28 11/07/2006
Fbar age range: 3-6

Input units are thousands and kg - output in tonnes

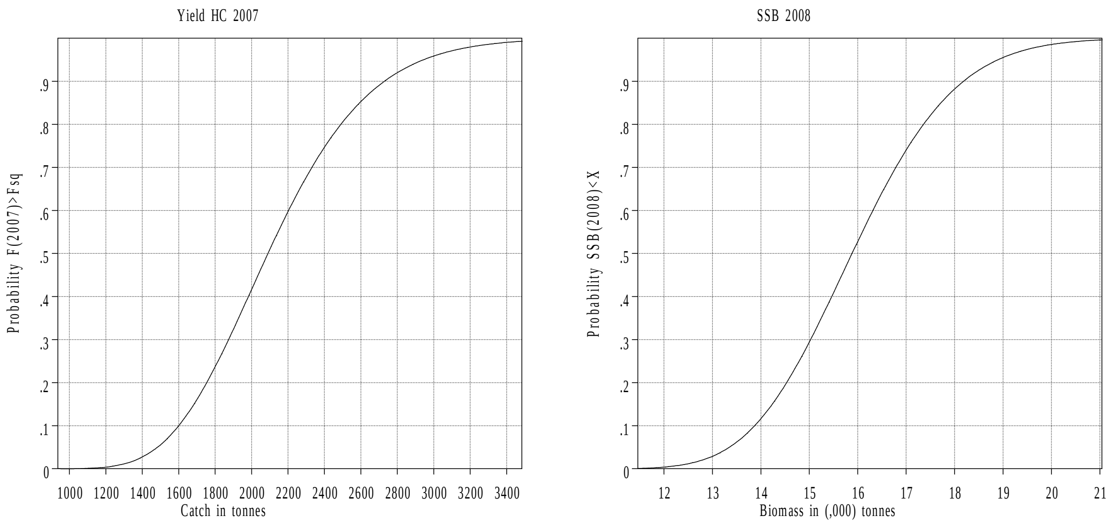
Figure Plaice,IrishSea. Sensitivity analysis of short term forecast.



Data from file:C:\med\plaice7a.sen on 13/08/2006 at 15:28:30

Figure 11.9.2 Delta profiles from sensitivity analysis

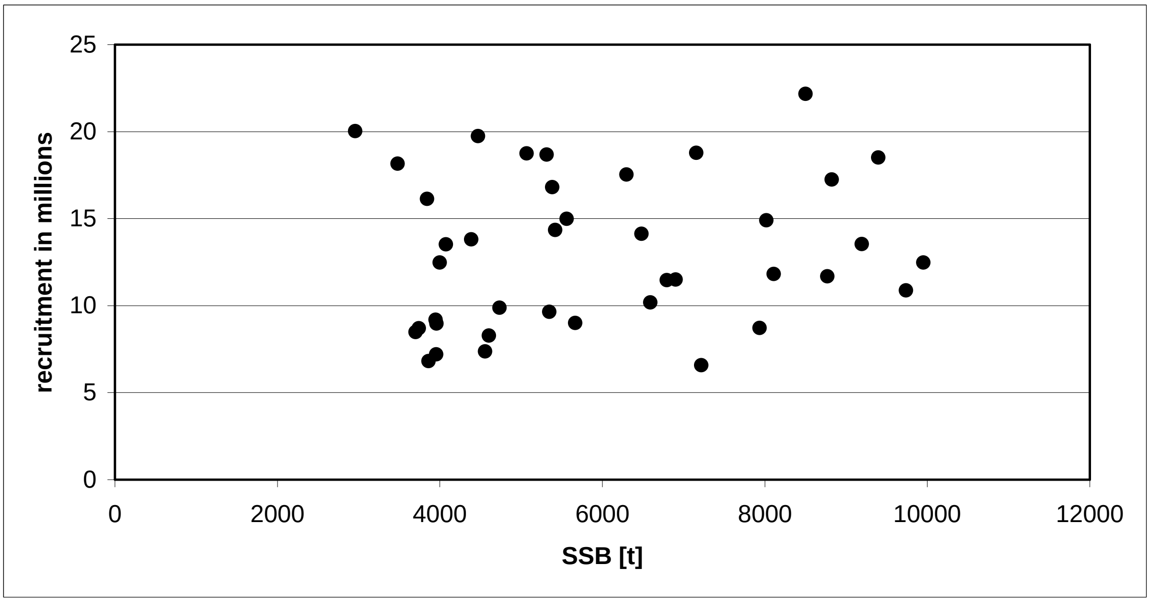
Figure Plaice,IrishSea. Probability profiles for short term forecast.



Data from file:C:\med\plaice7a.sen on 14/08/2006 at 10:33:25

Figure 11.9.3 Probability plots for yield in 2006 and SSB in 2007

Figure 11.11.1 Stock recruit scatter plot for plaice VIIa



12 SOLE IN DIVISION VIIa

The assessment of sole in Division VIIa was scheduled as a Benchmark-assessment.

The addition of one extra year of data gave XSA results which were in line with last years run but the large stepwise change in stock perception compared to the 2004 assessment was still apparent. On the basis that this was due to a problem with the 2004 data, last year the WGNSDS adopted a stochastic projection approach based on the estimated stock in 2003 from the 2004 assessment. However, the WGNSDS review group noted that the main data problem actually appears to be in 2003 (anomalously low weights-at-age, very odd exploitation pattern) rather than in 2004. The problem seems to have occurred as a consequence of adding an extra year’s data and was not apparent until the 2005 assessment.

The WGNSDS review group concluded that the SURBA-based analyses indicate that SSB is similar to last year so provides a basis for advising no expansion of effort. The WGNSDS review group further noted that if it is possible to revise the recent catch-at-age data before the October 2005 ACFM meeting then an updated XSA will be available as the basis of advice.

The use of numerous assessment methods was investigated. However, the Working Group was not able to resolve the problem with the catch at age data which appear to be the result of low sampling levels in some quarters. Numerous approaches were attempted to resolve the problem but the working group was unable to agree on a final assessment during the meeting.

12.1 The fishery

A description of the fishery is available in the stock annex file.

12.1.1 ICES advice applicable to 2005 and 2006

ICES advice for 2005

Single-stock exploitation boundaries

For 2005, ICES recommended that Single-stock boundary and the exploitation of this stock should be conducted in the context of mixed fisheries. In relation to precautionary limits fishing mortality should remain below $\mathbf{F}_{pa}$, corresponding to landings of less than 1 000 t.

ICES advice for 2006

Single-stock exploitation boundaries

For 2006, ICES recommended that there are not sufficient data available to complete a quantitative catch prediction. Indications from recent CPUE and effort data are that the stock situation has been stable in recent years. Therefore as a precautionary measure a TAC based on recent catch levels is recommended (2002–2004).

For general mixed fisheries advice applicable to this stock and other species taken in the same fisheries, please se section 1.7

12.1.2 Management applicable in 2005 and 2006

The sole fisheries in the Irish Sea are managed by TAC (see text table below) and technical measures.

YEAR	SINGLE STOCK EXPLOITATION BOUNDERIES	BASIS	TAC	% CHANGE IN F ASSOCIATED WITH TAC *	WG LANDINGS
2004	<790t	SSB > $\mathbf{B}_{pa}$ in short-term	800t	- 10	699t
2005	<1000t	Keep F below $\mathbf{F}_{pa}$	960t	+ 3	800t
2006	< 930t	Recent catch levels (2002-2004)	960t	-	-

*** F calculated, based on a *Status quo* forecast**

Technical measures in force are minimum mesh sizes and minimum landing size (24 cm). When fishing in VIIa it shall be prohibited to carry on board or deploy any beam trawl of mesh size equal to, or greater than, 80 mm unless the entire upper half of the anterior part of such a net consists of a panel of diamond-meshed netting material of which no individual mesh is of mesh size less than 180 mm attached directly to the headline or to no more than three rows of netting material of any mesh size attached directly to the headline (Reg 254/2002, Art. 3(2)). (See Section 1.7 for other regulations applicable to area VIIa).

12.1.3 The fishery in 2005

Belgian vessels have been subject to trip catch controls throughout 2005.

The spawning closure for cod that has been in force since 2000 is unlikely to have had a big impact on the sole fishery. In 2000 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.

12.2 Catch data

12.2.1 Official Catch Statistics

National landings data reported to ICES, and Working Group estimates of total landings are given in Table 12.2.1. The total international landings in 2005, as used by the Working Group, were 800t, which is 17% below the agreed TAC (see section 12.2.3 for discussion).

12.2.2 Revisions to Catch data

Only minor revisions have been made in the landing data for 2004. Ireland, France and Belgium have revised landings figures slightly. There were no revisions to the UK (E&W) or Northern Ireland data series.

There was not enough age sampling in 2003 for the Belgian data. The 2004 Working Group used the UK age-length key's to raise the Belgian length frequencies. However given the difference in age data between the two countries this was probably not appropriate. In 2006 it was decided to raise the Belgian length frequency data by Belgian age length keys borrowed from the 3rd and 4th quarters in 2002 and the 1st and 2nd quarters in 2004. The data was subsequently raised to international level as usual.

12.2.3 Quality of the Catch data

At the 2004 Working Group, the inclusion of the 2004 data in the assessment revealed a substantial difference to the assessment results in comparison with previous years. The total 2004 landings of 699t not only were 13% below the agreed TAC, but also 26% below the predicted catch from the previous assessment at F status quo. Without an accepted assessment last year, a comparison between a status quo prediction and the 2005 landings is not possible.

However the working group wants to note that for 2005 landings are again 17% below the agreed TAC.

Although not conclusive, last year trial-runs were carried out investigating possible underreporting for this stock. However they indicated that the 2004 data may represent an under-reporting of the catch and an incorrect age distribution. Without a status quo predicted catch for 2005, the working group was not in a position to evaluate any real magnitude of possible underreporting but wanted to stress an undershooting of the TAC in 2005 in the same magnitude as in 2004, although no data are available on the extent of misreporting of landings from this stock.

Given the above concerns, the Working Group considers that the quality of the catch data in recent years has deteriorated. Furthermore, there are specific concerns regarding the 2003 catch at age data, relating to the raising procedure.

Discarding of sole based on Belgian vessel trips ranged between 0 to 5% by weight in 2004 (5 trips and 115 hauls) and between 0 to 8% in 2005 (4 trips and 90 hauls). This information is in line with sparse discard information from previous years. It is therefore unlikely that the non-inclusion of discard data in the assessment is seriously undermining the quality of the assessment.

12.3 Commercial catch-effort and research vessel surveys

CPUE and effort series were available from the Belgium beam trawlers, UK (E&W) beam and otter-trawlers, Irish beam and otter trawlers and from two UK beam trawl surveys (September and March) (Table 12.3.1 and Figure 12.3.1).

Effort from both Belgian and UK commercial beam trawl fleets increased from the early seventies until the late eighties. Since then UK beam trawl effort has declined to a minimum in 2000, and has fluctuated between that level and the level of the late nineties. The Belgian beam trawl effort fluctuated in the nineties around a lower level than the late eighties. The sharp increase in effort in two consecutive years since 2000, back to the high levels of the late eighties was only halted in 2003 with a value around the lower level of the nineties. The short effort series from the Irish beam trawl fleet show a steady increase from the start of the series in 1995, reaching about twice its starting value in 2003. The 2005 effort is around the average of the time series.

It should be noted that the Belgian beam trawl indices for 2003 will be subject to similar raising problems noted above for the catch data.

CPUE for both UK and Belgian beam trawlers has declined since the beginning of the time series. Apart from a record low value in the time series for the Belgian CPUE, both series have remained relatively constant over the last decade. Irish CPUE has declined constantly since 1995 to a third of its initial value in 2002 and has remained stable since.

Available tuning data are given in Table 12.3.2.

12.4 Age compositions and mean weights at age

12.4.1 Landings age composition and mean weight-at-age

Quarterly age compositions for 2005 were available from Belgium, UK (E&W) and Ireland as well as quarterly landings from Northern Ireland and France. The sampled fleets are those taking the bulk of the international landings.

Catch numbers-at-age data are given in Table 12.4.1.1. Table 2.2 shows the countries that provide data; Table 2.3 gives their sampling levels.

Catch weights at age for 2005 were calculated from Belgium, UK and Ireland data, weighted by national catch numbers at age, and then quadratically smoothed (using age = 1.5, 2.5 etc.) and SOP-corrected. The quadratic fit used was:

$$Wt = 0.0916 + (0.0416*(AGE+0.5)) - (0.0009*(AGE+0.5)^2)$$

The new quadratic fit used for the revised 2003 data was:

$$Wt = -0.0462 + (0.0846*(AGE+0.5)) - (0.0036*(AGE+0.5)^2)$$

Table 12.4.1.2 gives catch weights and SOP checks.

Stock weights at age were derived from the smoothed catch weight at age by setting age = 1.0, 2.0 etc. Stock weights-at-age are given in Table 12.4.1.3.

Annual length compositions for 2004 are given by fleet in Table 12.4.1.4

12.4.2 Discards age composition

Information from Belgium, UK(E&W) and Ireland indicates that discarding ranges by weight between 0 and 5%. Length distributions for 2004 and 2005 from onboard sampling on Belgium vessels for discard and landings during the same trips are presented in Figure 12.4.2.1.

12.5 Natural mortality, maturity

Natural mortality, maturity and proportions of natural mortality and fishing mortality before spawning were set as in previous years.

Natural mortality was set at 0.1 yr^{-1} (all ages and all years).

The maturity ogive used is as previously:

Age	1	2	3	4	5	6 and older
	0.00	0.38	0.71	0.97	0.98	1.00

The proportions of natural mortality and fishing mortality before spawning were both set to 0 to reflect the SSB calculation date of 1 January.

12.6 Catch-at-age analysis

The results of exploratory XSA runs, which are not included in this report, are available in ICES files.

General approaches and methods are described in Section 2

12.6.1 Data screening and exploratory runs

A preliminary inspection of the quality of international catch-at-age data (for ages 2-15) was carried out using separable VPA, with a reference age of 4, terminal F = 0.5 and terminal S = 0.8 (Same settings as in previous WG's). There were large residuals for ages 2/3 caused by partial recruitment to the fisheries at age 2. The log-catch ratios for the fully recruited ages (up to 10) did not show large residuals. Some high residuals appeared at older ages (+10); therefore, ages were kept between 2 and 10+ in further XSA analysis (Figure 12.6.1).

12.6.1.1 Commercial catch data

Commercial tuning data were available for Belgium beam trawlers (1975-2005), UK (E&W) beam and otter trawlers (both 1991-2005) and Irish otter trawlers (1995-2005) (Table 12.3.2).

12.6.1.2 Survey data

Survey tuning data were available from a UK(E&W) September beam-trawl survey (1988-2005), a UK March beam-trawl survey (1993-1999) and two years of data from the Irish groundfish survey (Celtic Explorer) (Table 12.3.2).

12.6.1.3 Exploratory assessment runs

The assessment was updated using identical settings and tuning fleets as in the previous years, with one year additional data for 2005.

Single fleet XSA runs were carried out for all available fleets (except for the UK (E&W) and Irish otter trawl fleets), to screen tuning data for catchability trends and high residuals. The UK (E&W) and Irish otter trawl fleets have never been used before in tuning as they are considered not to be representative for this stock. For this reason these fleets were not further explored. Since the late eighties, the Belgian beam trawl fleet has shown an increase of catchability for the younger ages, as well as a noisy pattern in the age 3 log q residuals. Therefore, the Working Group decided, as in previous years, to exclude age 3 from the Belgian beam trawl fleet.

There were no apparent trends in the surveys, and no reason to exclude any of them.

Retrospective trends in estimates of recruitment, SSB and F(4-7) are given in Figure 12.6.1.3.1. Prior to the inclusion of the 2004 data there very little retrospective bias observed. The addition of 2004 and 2005 data caused a split in the retrospective bias. Whilst the absolute level has shifted, the overall trends are the same

As the inclusion of the 2004 and 2005 data was not found to provide a basis for a final XSA, using previous settings, a number of different models were explored.

<u>SURBA Exploration</u>

SURBA 3.0 was used for survey based analyses. As SURBA is normally used for survey exploration the effort is normally standardized eg a value of 1 in the catchability file. In order to investigate how well the commercial fleets tracked year class strengths the commercial tuning data was standardised by effort which facilitated its exploration in SURBA.

Catchabilities at age were set to 1.

Diagnostic plots of the mean standardised indices for the different tuning fleets are shown in Figures 12.6.1.3.2a,e,j and n respectively. The UK(E&W) September beam-trawl survey seems to have the ability to track year-class strengths relatively consistently and show good internal consistency. The two commercial fleets tend to track year-class strengths better for older fish. Comparative scatter plots of adjacent age classes are shown in Figures 12.6.1.3.2b,f and o (no plots could be produced for the UK (E&W) beam trawl fleet). Log cohort abundances seem to be rather noisy (Figure 12.6.1.3.2c,g,k and p). Trend in empirical SSB and summary plots are presented in Figure 12.6.1.3.2d,h,l and q. For the two commercial fleets no SSB and TSB trends were given by the model. Retrospective plots (Figures 12.6.1.3.2i,m and r) were also not always available.

A full comparison of SSB trends from SURBA was not possible due to software problems.

<u>ICA Exploration</u>

As the XSA model appeared not to be deemed suitable for the assessment, an ICA assessment in which the 2003 catch data was downweighted was therefore explored.

Figure 12.6.1.3.3a –d shows the ICA log residuals for the different fleets. The Belgian beam trawl feet shows no particular trends but residuals are noisy from age 8 onwards. The

UK(E&W) September beam trawl survey shows no pattern for the younger ages. For ages 6 and older the residuals are noisy and there is an apparent trend for age 7. although the UK(E&W) March beam trawl survey shows no apparent trends it is a short time series and ceased in 1999. The UK(E&W) beam trawl shows noisy residuals without any apparent trends. A number of different exploratory runs were explored in ICA. Different ICA settings were tried as well as the inclusion or exclusion of some survey and commercial fleets. These are outlined in the text table below.

RUNS	N°YEARS IN SEPERABLE	CATCH DOWNWEIGHTED IN YEAR 2003	BELGIAN BEAM-TUNING FILE	UK(E&W) BEAM-TUNING FILE	UK(E&W) SEP-SURVEY TUNING FILE	UK(E&W) MARCH-SURVEY TUNING FILE
ICA-1	6	0.0001	2003=-99	in	in	in
ICA-2	6	no downweighting	2003=-99	in	in	in
ICA-3	6	0.0001	in	in	in	in
ICA-4	6	no downweighting	in	in	in	in
ICA-5	15	0.0001	in	in	in	in
ICA-6	6	0.0001	out	out	in	out
ICA-7	6	CN=-99	in	in	in	in
ICA-8	6	0.0001	out	in	in	in

Eight runs were carried out in total. For 7 out of the 8 runs the number of years used in the separarable was six, however in one run the number of years was extended to 15 to examine if the divergence in F,SSB and recruitment extended beyond 1998. For a number of runs the assumed problematic 2003 year was downweighted to the lowest possible weighting (0.0001), not downweighted and in one of the runs this year was excluded from the catch at age matix. For the different tuning files the data was either excluded or included but for Run 1 and 2 the 2003 data from the Belgian beam trawls was removed from the tuning file. For SSB, the results of the runs showed a wide range making it highly uncertain to estimate SSB from the model (Figures 12.6.1.3.5a). The F range also varied considerably (Figures 12.6.1.3.5b). Although there is a huge variation in 2003 due to downweighting or not downweighting the year, the time series still shows a high divergence in F and therefore the F estimate was also highly uncertain. Because of the varying results in SSB, F and Recruitment (Figures 12.6.1.3.5c), the model was not deemed suitable. The input files for the different runs are available in ICES files.

12.6.1.4 Final assessment run

No final assessment or catch forecast could be carried out at the 2006 WGNSDS. However a paper examining the problems with the assessment will be submitted to the WGNSDS-review group.

12.6.1.5 Comparison with last years assessment

12.6.2 Estimating recruitment year class abundance

12.6.3 Long-term trends in biomass, fishing mortality and recruitment

12.6.4 Short-term catch predictions

12.6.5 Medium-term predictions

12.6.6 Yield and biomass per recruit

12.6.7 Reference points

Biological reference points are:

$\mathbf{B}_{lim}$ = 2800t Basis: $\mathbf{B}_{lim}$ = $\mathbf{B}_{loss}$ The lowest observed spawning stock in an earlier assessment.

$\mathbf{B}_{pa}$ = 3800t Basis: $\mathbf{B}_{pa}$ ~ $\mathbf{B}_{lim}$ * 1.4

$\mathbf{F}_{lim}$ = 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 probability of avoiding $\mathbf{F}_{lim}$.

12.6.8 Quality of the assessment

The Working Group considered that this stock should be taken up as a benchmark assessment for the next year.

12.6.8.1 Landings

The Working Group had no information to correct for inaccuracies in reported landings in 2005.

12.6.8.2 Effort

Effort is not suspected to be misreported for sole in subdivision VIIa.

12.6.8.3 Discards

The absence of discard data is unlikely to affect the quality of the assessment as information from 2003, 2004 and 2005 indicates that discarding ranges by weight between 0 and 8%.

12.6.8.4 Surveys

12.6.8.5 Model Formulation

12.6.9 Management considerations

Table 12.2.1 Irish Sea Sole. Nominal landings (tonnes) as officially reported by ICES

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005*
Belgium	930	987	915	1010	786	371	531	495	706	675	533	570	525	469	493	674	817	687	527	662
France	17	5	11	5	2	3	11	8	7	5	5	3	5 *	1 *	3	4	4	4	1	2
Ireland	235	312	366	155	170	198	164	98	226	176	133	130	134	120	135	135	96	103	77	n/a
Netherlands	-	-	-	-	-	-	-	-	-	-	149	123	60	46	60	-	-	-	-	-
UK (Engl.& Wales)[1]	637	599	507	613	569	581	477	338	409	424	194	189	161	165	133	...	...	...	...	...
UK (Isle of Man)	1	3	1	2	10	44	14	4	5	12	4	5	3	1	1	+	+	+	+	+
UK (N. Ireland)[1]	50	72	47																	
UK (Scotland)	46	63	38	38	39	26	37	28	14	8	5	7	9	8	8	4	3	3	1	n/a
United Kingdom																195	165	217	106	103
Total	1,916	2,041	1,885	1,823	1,576	1,223	1,234	971	1,367	1,300	1,023	1,027	897	810	833	1,012	1,085	1,014	712	767
Unallocated	79	767	114	10	7	-11	25	52	7	-34	-21	-24	14	54	-15	41	2	0	-13	33
Total used by Working Group in Assessment	1,995	2,808	1,999	1,833	1,583	1,212	1,259	1,023	1,374	1,266	1,002	1,003	911	863	818	1,053	1,087	1,014	699	800

* Preliminary

[1] 1989 onwards: N. Ireland included with England & Wales

Table 12.3.1 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	otter	beam	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	49.2	1.39	-	-	-	-	-	12.3	-	130.7	-	-
1976	48.7	0.94	-	-	-	-	-	11.8	-	122.3	-	-
1977	40.8	0.80	-	-	-	-	-	10.7	-	101.9	-	-
1978	31.8	1.04	34.32	-	-	-	-	9.9	0.9	89.1	-	-
1979	60.6	1.43	32.01	-	-	-	-	11.2	1.7	89.9	-	-
1980	54.1	1.01	31.70	-	-	-	-	16.7	4.3	107.0	-	-
1981	35.8	0.75	21.32	-	-	-	-	22.6	6.4	107.1	-	-
1982	29.9	0.53	29.94	-	-	-	-	19.5	5.5	127.2	-	-
1983	19.4	0.57	37.31	-	-	-	-	20.5	2.8	88.1	-	-
1984	32.7	0.71	16.24	-	-	-	-	12.0	4.1	103.1	-	-
1985	28.3	0.56	17.34	-	-	-	-	19.6	7.4	102.9	-	-
1986	22.4	0.84	19.23	-	-	-	-	38.0	17.0	90.3	-	-
1987	21.2	0.77	14.82	-	-	-	-	43.2	22.0	130.6	-	-
1988	26.7	0.46	11.81	158.7	-	-	-	30.5	18.6	132.0	-	-
1989	27.2	0.70	9.17	145.9	-	-	-	34.0	25.3	139.5	-	-
1990	20.6	0.61	9.52	190.1	-	-	-	36.1	31.0	117.1	-	-
1991	23.2	1.12	10.43	170.5	-	-	-	13.8	25.8	107.3	-	-
1992	20.2	1.02	9.50	158.3	-	-	-	23.9	23.4	96.8	-	-
1993	19.5	0.54	7.60	97.3	104.7	-	-	24.5	21.5	78.9	-	-
1994	20.0	0.74	11.76	107.7	91.9		-	31.0	20.1	43.0	-	-
1995	19.7	0.95	14.96	89.5	79.3	0.38	12.69	26.2	20.9	43.1	80.3	8.64
1996	19.0	0.53	9.44	86.8	-	0.25	14.94	21.6	13.3	42.2	64.8	6.26
1997	17.9	0.73	10.49	151.2	63.3	0.23	8.53	28.5	10.8	39.9	92.2	9.86
1998	20.1	0.48	8.42	140.8	89.3	0.38	7.77	23.3	10.4	36.9	93.5	11.58
1999	20.4	0.60	9.94	107.3	-	0.29	9.22	21.7	11.0	22.9	110.3	14.67
2000	19.6	0.44	12.90	122.6	-	0.29	8.49	18.6	6.3	27.0	82.7	11.42
2001	18.2	0.15	11.72	96.9	-	0.38	7.86	30.5	12.5	32.8	77.5	13.13
2002	18.2	1.48	16.73	76.0	-	0.32	4.67	38.6	8.0	24.8	77.9	17.67
2003	18.3	0.15	13.20	89.0		0.34	4.20	24.5	14.0	23.9	73.9	18.70
2004	13.1	0.17	13.86	99.0	-	0.14	4.31	37.2	7.4	23.5	72.5	14.19
2005*	19.7	0.19	9.11	49.0		0.16	4.70	29.5	11.6	16.7	68.3	14.67

	Effort				CPUE			
Year	BB	UKO	UKB	IRLO	BB	UKO	UKB	Sep BTS
1972		1.6323283				1.407263		
1973		1.8764148				1.407263		
1974		1.4645189				1.447091		
1975	0.5138992	1.6615679			1.8232678	1.845373		
1976	0.493009	1.55478			1.8047387	1.24795		
1977	0.4470505	1.2954381			1.5119782	1.062085		
1978	0.4136262	1.1327138	0.069235		1.1784536	1.380711	2.1129752	
1979	0.4679407	1.1428841	0.130776		2.2457323	1.898477	1.9707557	
1980	0.697733	1.3602736	0.330787		2.0048534	1.340882	1.95167	
1981	0.9442375	1.3615449	0.492335		1.3266867	0.995705	1.3126058	
1982	0.8147182	1.6170729	0.4231		1.1080428	0.703631	1.8433123	
1983	0.8564986	1.120001	0.215396		0.7189308	0.756736	2.2970602	
1984	0.5013651	1.3106935	0.315402		1.2118061	0.942601	0.9998461	
1985	0.8188963	1.308151	0.569262		1.0487496	0.74346	1.0675696	
1986	1.587656	1.1479692	1.307764		0.8301057	1.115189	1.183931	
1987	1.8049142	1.6602966	1.692401		0.7856357	1.022257	0.9124211	
1988	1.2743028	1.6780946	1.430848		0.9894563	0.610699	0.7271048	1.336984
1989	1.4205343	1.7734408	1.946261		1.0079855	0.929324	0.5645683	1.2291491
1990	1.5082732	1.4886733	2.384746		0.7634008	0.80984	0.5861167	1.6015164
1991	0.5765698	1.3640875	1.984724		0.8597523	1.486919	0.6421425	1.4363943
1992	0.9985521	1.2306027	1.800099		0.7485774	1.354159	0.5848853	1.3336142
1993	1.0236203	1.0030429	1.653937		0.7226366	0.716907	0.4679083	0.8197136
1994	1.2951931	0.546652	1.546239		0.7411658	0.982429	0.7240265	0.9073294
1995	1.094647	0.5479233	1.607781	0.9883043	0.7300483	1.261226	0.9210405	0.7540017
1996	0.9024571	0.5364817	1.023133	0.7976961	0.7041075	0.703631	0.5811913	0.7312553
1997	1.1896695	0.5072422	0.830815	1.1342983	0.6644551	0.969153	0.6458365	1.2737995
1998	0.9734838	0.4691037	0.800044	1.1509753	0.7448716	0.637251	0.5183931	1.1861837
1999	0.9066351	0.291124	0.8462	1.3569917	0.7559891	0.796564	0.6119748	0.9039596
2000	0.7771158	0.3432466	0.484642	1.017541	0.7263425	0.584147	0.7942127	1.0328559
2001	1.2743028	0.4172353	0.961591	0.9541776	0.6726079	0.199141	0.7215638	0.8163437
2002	1.6127243	0.3147699	0.616957	0.9581435	0.6744609	1.964857	1.0300139	0.6402696
2003	1.0236203	0.3038368	1.076982	0.9087627	0.6781667	0.199141	0.8126828	0.7497894
2004	1.5542317	0.2987517	0.569262	0.8921502	0.4869459	0.225693	0.8533169	0.8340354
2005*	1.2325224	0.2123044	0.88928	0.8409593	0.7300483	0.252245	0.5608742	0.4128054

All CPUE values in Kg/hr except UK beam survey (Kg/100 km)

[1]Kg/000'hr corrected for fishing power using P = 0.000204 BHP^1.23

[2]000' hours fishing corrected for fishing power using P = 0.000204 BHP^1.23

[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 12.3.2 Sole in VIIa. Available tuning data

Belgian beam trawl * Effort = hours fishing corrected for fishing power using P = 0.000204 BHP^1.23

1975	2005												
1	1	0	1										
3	14												
12.3	327	1045	275	393	69	105	94	61	72	11	15	64
11.8	62	568	1066	80	263	64	58	35	5	56	5	5
10.7	112	434	307	509	76	93	45	23	20	2	35	32
9.9	197	169	304	155	258	41	90	12	29	12	7	17
11.2	411	1455	510	323	193	162	37	36	9	41	0	0
16.7	403	958	1644	296	268	247	210	30	64	31	14	7
22.6	204	909	721	998	62	92	44	161	13	92	10	8
19.5	56	451	608	378	394	52	64	11	29	24	5	0
20.5	8	259	310	394	238	216	44	38	28	49	3	26
12.0	299	107	204	143	188	91	121	2	1	4	14	0
19.6	692	606	171	186	99	150	125	83	27	13	4	23
38.0	1221	1531	468	138	135	90	104	69	69	20	8	21
43.2	922	1527	881	297	167	69	39	54	59	40	13	9
30.5	118	2027	1012	480	21	33	37	34	42	35	0	7
34.0	242	376	2423	751	250	59	15	9	2	14	0	1
36.1	419	307	223	1263	276	142	13	9	11	11	8	5
13.8	120	253	78	60	588	115	40	16	1	1	11	3
23.9	951	298	330	68	40	203	93	36	12	0	0	0
24.5	196	862	253	149	89	79	160	66	77	0	0	0
31.0	336	680	786	164	103	39	117	58	19	15	0	7
26.2	324	729	366	410	52	27	6	28	15	6	11	3
21.6	247	537	334	241	219	53	13	11	14	9	7	2
28.5	350	270	376	180	162	134	28	27	15	9	8	1
23.3	916	248	146	142	89	73	62	20	20	9	10	3
21.7	578	693	199	65	50	37	21	17	9	6	4	6
18.6	542	685	220	107	31	15	33	13	7	9	0.6	8
30.5	655	600	284	248	39	35	44	33	1	3	0.2	4
38.6	379	1138	814	349	109	30	9	2	1	1	1	0
*** 24.45	891	724	436	196	84	20	7	2	1	0	2	1
25.6	825	313	197	159	47	12	11	6	3	0	0	0
29.5	874	448	322	157	55	69	9	7	1	11	3	1

UK September beam trawl survey Effort = Total distance towed

1988	2005								
1	1	0.75	0.85						
1	9								
100.062	118	196	180	410	76	40	4	0	4
129.710	218	304	180	74	284	56	32	8	6
128.969	1712	534	122	42	88	194	40	20	6
123.780	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
124.336	249	148	243	106	29	65	12	6	4
127.486	851	119	30	85	44	25	29	7	2
132.860	1158	593	75	23	57	27	16	30	8
129.339	538	706	291	18	6	23	23	5	18
125.263	285	247	242	194	28	8	26	5	6
123.225	265	454	158	210	114	35	13	2	14
127.301	83	241	200	91	90	70	32	4	8
120.260	183	64	105	107	57	59	54	28	0
119.889	204	191	47	90	76	36	38	26	1
113.960	340	207	108	25	68	41	36	14	17
119.704	50	144	65	23	12	31	24	5	7

UK March beam trawl survey Effort = Total distance towed

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

Table 12.3.2 Sole in VIIa.Continued

UK Beam trawl Effort = hours fished (GRT corrected > 40' vessels)

1991	2005												
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
13.320	0	13	109	98	49	100	37	9	8	6	14	8	3
10.760	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
11.559	10	78	43	15	44	36	16	10	16	3	0	3	3

UK otter trawl ** Effort = hours fished (GRT corrected > 40' vessels)

1991	2005												
1	1	0	1										
2	14												
107.3	265.0	155.3	63.2	29.3	19.2	70.9	19.9	10.8	2.1	0.3	0.9	0.5	0.7
96.8	15.7	223.8	68.8	22.2	15.8	10.1	35.5	10.0	10.0	0.6	0.4	0.1	0.0
78.9	9.1	27.0	77.2	18.6	2.9	6.7	3.7	5.3	1.0	2.4	0.3	0.1	0.0
43.0	3.8	65.8	33.6	49.8	19.9	3.0	3.5	3.5	6.6	1.0	2.2	0.0	0.0
43.1	17.4	50.1	33.9	14.7	24.1	6.8	0.9	1.9	0.4	2.0	1.2	1.0	0.4
42.2	1.6	5.1	18.4	12.3	6.7	12.1	4.0	1.2	0.9	0.9	1.4	1.2	0.5
39.9	13.6	15.3	7.1	13.5	8.6	3.4	6.8	3.1	1.1	1.1	0.2	1.3	0.2
36.9	4.6	24.3	5.1	3.2	4.9	2.9	1.5	2.3	1.4	0.8	0.4	0.2	0.1
22.8	5.4	14.5	12.0	1.5	0.3	2.0	1.0	0.5	1.2	0.5	0.0	0.1	0.0
27.0	2.4	11.6	9.2	7.5	1.2	0.4	1.2	0.5	0.1	0.4	0.2	0.1	0.1
32.9	2.8	9.7	5.7	7.8	5.1	0.4	0.2	0.4	0.1	0.1	0.1	0.3	0.2
24.8	0.7	8.3	15.6	3.0	5.4	2.6	0.5	0.3	0.7	0.2	0.1	0.1	0.1
23.9	0.5	1.7	6.1	4.3	1.6	1.2	2.0	0.2	0.0	0.2	0.1	0.2	0.3
23.5	3.0	5.4	2.5	3.7	2.8	1.5	0.7	0.6	0.2	0.1	0.1	0.3	0.0
16.7	1.7	4.0	2.3	0.8	2.1	1.9	1.0	0.5	0.7	0.1	0.0	0.1	0.1

IR-OTB : Irish Otter trawl ** Effort =hours fished

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
58166	0.0	5.7	12.9	12.7	4.7	4.7	2.2	0.2	0.0
75029	27.8	10.2	4.1	9.2	6.4	3.5	3.9	1.0	0.2
81073	5.5	40.7	14.7	6.6	12.3	5.4	2.7	4.1	1.0
93221	26.6	36.8	30.9	5.1	3.8	5.3	2.4	0.5	1.2
64320	1.6	13.2	13.4	11.0	3.4	1.1	1.0	0.4	0.0
77541	0.2	6.1	18.6	18.6	10.8	2.1	4.1	1.3	0.3
39996	20.3	20.0	30.2	16.4	8.2	2.9	2.4	1.4	0.5
73854	0.9	35.9	21.7	9.8	3.3	0.5	0.8	0.2	0.2
72507	9.0	15.1	4.1	3.2	1.9	1.6	0.3	0.2	0.1
31142	4.0	1.7	1.6	1.6	0.6	0.1	0.0	0.0	0.0

IRGFS : Irish Groundfish Survey (Celtic Explorer) **

2003	2004										
1	1.0	0.89	0.91								
0	10										
1	1	8	18	12	7	5	2	2	3	0	2
1	0	24	20	13	8	7	6	5	5	0	0

*** Age 3 not used in final XSA tuning**
**** Tuning series not used in XSA**
***** Series (year) revised at 2006WG**

Tabl 12.4.1.1 Sole in VIIa. Catch numbers at age.

Run title : IRISH 2006 WG COMBSEX PLUSGROUP.

At 15/05/2006 13:02

Table 1 Catch numbers at age Numbers*10**-3

YEAR		1970	1971	1972	1973	1974	1975
AGE							
	2	29	113	31	368	25	262
	3	895	434	673	363	891	733
	4	1009	2097	730	2195	576	2386
	5	467	1130	1537	557	1713	539
	6	1457	232	537	815	383	842
	7	289	878	172	267	422	157
	8	228	141	522	112	232	227
	9	803	106	97	329	58	158
+gp		1506	1640	881	702	681	621
0 TOTALNUM		6683	6771	5180	5708	4981	5925
TONSLAND		1785	1882	1450	1428	1307	1441
SOPCOF %		100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR		1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE											
	2	29	221	65	108	187	70	8	37	651	154
	3	375	416	958	1027	939	580	346	165	786	1601
	4	1332	1292	649	3433	1968	1668	1241	998	380	1086
	5	2330	774	1009	829	3055	1480	1298	758	610	343
	6	247	1066	442	637	521	1640	711	757	343	334
	7	544	150	638	326	512	114	641	416	424	164
	8	134	218	98	285	361	184	91	334	178	259
	9	151	89	204	65	352	86	113	69	251	188
+gp		454	341	285	270	432	595	193	306	128	292
0 TOTALNUM		5596	4567	4348	6980	8327	6417	4642	3840	3751	4421
TONSLAND		1463	1147	1106	1614	1941	1667	1338	1169	1058	1146
SOPCOF %		100	100	100	100	100	100	100	100	100	100
	1										

Run title : IRISH 2006 WG COMBSEX

At 15/05/2006 13:02

Table 1 Catch numbers at age Numbers*10**-3

YEAR		1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE											
	2	141	189	32	179	564	1317	363	83	122	132
	3	3336	3348	444	771	1185	1270	2433	543	1342	920
	4	3467	4105	4752	775	986	841	918	1966	1069	1444
	5	961	3185	2102	3978	598	300	556	559	1578	737
	6	235	844	1310	1178	2319	226	190	251	394	1010
	7	277	307	203	552	592	1173	156	199	133	179
	8	210	224	83	121	333	255	523	147	98	62
	9	187	139	76	23	38	125	217	257	141	48
+gp		451	445	357	111	95	79	189	282	285	240
0 TOTALNUM		9265	12786	9359	7688	6710	5586	5545	4287	5162	4772
TONSLAND		1995	2808	1999	1833	1583	1212	1259	1023	1374	1266
SOPCOF %		100	100	100	100	100	100	100	100	100	100

Table 1 Catch numbers at age Numbers*10**-3

YEAR		1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE											
	2	60	789	167	301	88	442	108	329	362	555
	3	469	713	1728	1069	1013	995	549	1082	1065	1066
	4	1188	474	466	1258	1180	922	1498	1042	398	559
	5	741	710	256	297	556	608	961	704	302	358
	6	430	408	315	115	190	475	486	308	251	244
	7	509	258	191	136	66	69	177	155	91	119
	8	142	295	126	82	53	62	46	118	28	105
	9	49	85	150	37	63	73	17	20	23	24
+gp		156	151	147	113	108	97	26	63	30	69
0 TOTALNUM		3744	3883	3546	3408	3317	3743	3868	3821	2550	3099
TONSLAND		1002	1003	911	863	818	1053	1087	1014	699	801
SOPCOF %		100	100	100	100	100	100	100	100	100	100

Table 12.4.1.2 Sole in VIIa. Catch weights at age.

Run title : I 2006 WG COMBSEX PLUSGROUP.

At 15/05/2006 13:02

Table 2 Catch weights at age (kg)

	YEAR	1970	1971	1972	1973	1974	1975
	AGE						
	2	0.13	0.152	0.126	0.151	0.138	0.13
	3	0.153	0.178	0.164	0.178	0.174	0.172
	4	0.178	0.204	0.201	0.204	0.209	0.21
	5	0.204	0.23	0.237	0.23	0.241	0.244
	6	0.232	0.257	0.272	0.256	0.272	0.275
	7	0.26	0.284	0.306	0.283	0.301	0.303
	8	0.29	0.312	0.338	0.309	0.328	0.327
	9	0.321	0.34	0.369	0.335	0.353	0.347
	+gp	0.4199	0.4338	0.469	0.4317	0.4223	0.3869
0	SOPCOF/	1	0.9997	1.0004	0.9999	1	0.9999

Table 2 Catch weights at age (kg)

	YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
	AGE										
	2	0.12	0.085	0.093	0.134	0.146	0.162	0.112	0.189	0.191	0.144
	3	0.161	0.146	0.147	0.165	0.169	0.183	0.171	0.212	0.225	0.189
	4	0.2	0.202	0.197	0.199	0.193	0.207	0.225	0.238	0.257	0.231
	5	0.239	0.251	0.243	0.234	0.219	0.234	0.275	0.266	0.288	0.272
	6	0.276	0.293	0.286	0.271	0.247	0.264	0.321	0.298	0.318	0.31
	7	0.313	0.33	0.326	0.311	0.275	0.296	0.362	0.332	0.347	0.346
	8	0.348	0.36	0.361	0.352	0.305	0.331	0.399	0.369	0.374	0.38
	9	0.383	0.384	0.394	0.395	0.337	0.369	0.432	0.41	0.4	0.412
	+gp	0.5145	0.4051	0.4782	0.5683	0.478	0.5014	0.4977	0.5652	0.473	0.485
0	SOPCOF/	0.9996	0.9996	0.9997	0.9997	1.0007	1.0002	1.0002	0.9997	0.9998	0.9994
	1										

Run title : I 2006 WG COMBSEX PLUSGROUP.

At 15/05/2006 13:02

Table 2 Catch weights at age (kg)

	YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	AGE										
	2	0.122	0.135	0.111	0.125	0.135	0.133	0.149	0.102	0.175	0.129
	3	0.164	0.164	0.147	0.163	0.162	0.172	0.177	0.156	0.198	0.182
	4	0.203	0.196	0.183	0.201	0.192	0.208	0.207	0.205	0.227	0.232
	5	0.241	0.231	0.218	0.237	0.227	0.241	0.239	0.248	0.261	0.277
	6	0.277	0.268	0.252	0.271	0.265	0.272	0.274	0.285	0.301	0.318
	7	0.311	0.308	0.286	0.304	0.307	0.3	0.31	0.318	0.346	0.356
	8	0.344	0.35	0.319	0.336	0.354	0.326	0.349	0.345	0.397	0.389
	9	0.375	0.395	0.352	0.366	0.404	0.349	0.39	0.366	0.453	0.419
	+gp	0.4497	0.5385	0.4562	0.4508	0.6281	0.4013	0.4485	0.387	0.5757	0.473
0	SOPCOF/	0.9994	0.9998	0.999	1.0001	1.0004	0.9995	0.9992	0.9994	1.0007	0.9998

Table 2 Catch weights at age (kg)

	YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	AGE										
	2	0.156	0.154	0.187	0.179	0.143	0.2	0.127	0.141	0.145	0.19
	3	0.193	0.197	0.209	0.217	0.19	0.24	0.192	0.206	0.221	0.226
	4	0.228	0.237	0.234	0.252	0.235	0.276	0.253	0.262	0.29	0.261
	5	0.263	0.275	0.263	0.285	0.276	0.309	0.31	0.31	0.353	0.293
	6	0.296	0.311	0.295	0.314	0.315	0.338	0.361	0.352	0.41	0.324
	7	0.327	0.345	0.331	0.341	0.351	0.364	0.408	0.386	0.46	0.353
	8	0.358	0.376	0.369	0.365	0.384	0.387	0.451	0.413	0.504	0.38
	9	0.387	0.406	0.411	0.387	0.415	0.406	0.489	0.433	0.541	0.406
	+gp	0.4654	0.4675	0.5302	0.4279	0.4888	0.4322	0.5475	0.4301	0.6061	0.4638
0	SOPCOF/	1.0003	1.0015	1	1.0005	0.9999	1.0021	1	1.0006	0.9989	1.0008

Tabl 12.4.1.3 Sole in VIIa. Stock weights at age.

Run title 2006 WG COMBSEX PLUSGROUP.

At 15/05/2006 13:02

Table 3 Stock weights at age (kg)

YEAR	1970	1971	1972	1973	1974	1975
AGE						
2	0.118	0.139	0.106	0.138	0.119	0.108
3	0.141	0.165	0.145	0.164	0.156	0.151
4	0.166	0.191	0.183	0.191	0.192	0.191
5	0.191	0.217	0.219	0.217	0.225	0.228
6	0.218	0.244	0.255	0.243	0.257	0.26
7	0.246	0.271	0.289	0.27	0.287	0.29
8	0.275	0.298	0.322	0.296	0.315	0.315
9	0.305	0.326	0.354	0.322	0.341	0.338
+gp	0.4025	0.4188	0.4559	0.4187	0.4126	0.3842

Table 3 Stock weights at age (kg)

YEAR	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985
AGE										
2	0.1	0.052	0.065	0.119	0.135	0.152	0.081	0.179	0.174	0.121
3	0.141	0.116	0.12	0.149	0.157	0.172	0.142	0.2	0.208	0.167
4	0.181	0.175	0.172	0.182	0.181	0.195	0.198	0.224	0.241	0.21
5	0.22	0.227	0.22	0.216	0.206	0.22	0.251	0.252	0.273	0.252
6	0.258	0.273	0.265	0.252	0.233	0.249	0.299	0.282	0.303	0.291
7	0.295	0.312	0.306	0.291	0.261	0.28	0.342	0.315	0.332	0.328
8	0.331	0.346	0.344	0.331	0.29	0.313	0.381	0.35	0.36	0.363
9	0.366	0.373	0.378	0.373	0.321	0.35	0.416	0.389	0.387	0.396
+gp	0.4997	0.4064	0.4697	0.5428	0.4588	0.4783	0.4877	0.5399	0.4617	0.4727

1

Run title 2006 WG COMBSEX PLUSGROUP.

At 15/05/2006 13:02

Table 3 Stock weights at age (kg)

YEAR	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
AGE										
2	0.101	0.121	0.093	0.105	0.123	0.113	0.135	0.073	0.165	0.101
3	0.143	0.149	0.129	0.144	0.148	0.153	0.162	0.13	0.186	0.156
4	0.183	0.18	0.165	0.182	0.176	0.19	0.192	0.181	0.212	0.207
5	0.222	0.213	0.2	0.219	0.209	0.225	0.223	0.227	0.243	0.255
6	0.259	0.249	0.235	0.254	0.245	0.257	0.256	0.267	0.28	0.298
7	0.294	0.287	0.269	0.288	0.286	0.286	0.292	0.302	0.323	0.338
8	0.328	0.328	0.302	0.32	0.33	0.313	0.33	0.332	0.371	0.373
9	0.36	0.372	0.335	0.351	0.378	0.337	0.369	0.356	0.424	0.405
+gp	0.4367	0.512	0.4409	0.4386	0.5958	0.3948	0.4262	0.3837	0.5416	0.4642

Table 3 Stock weights at age (kg)

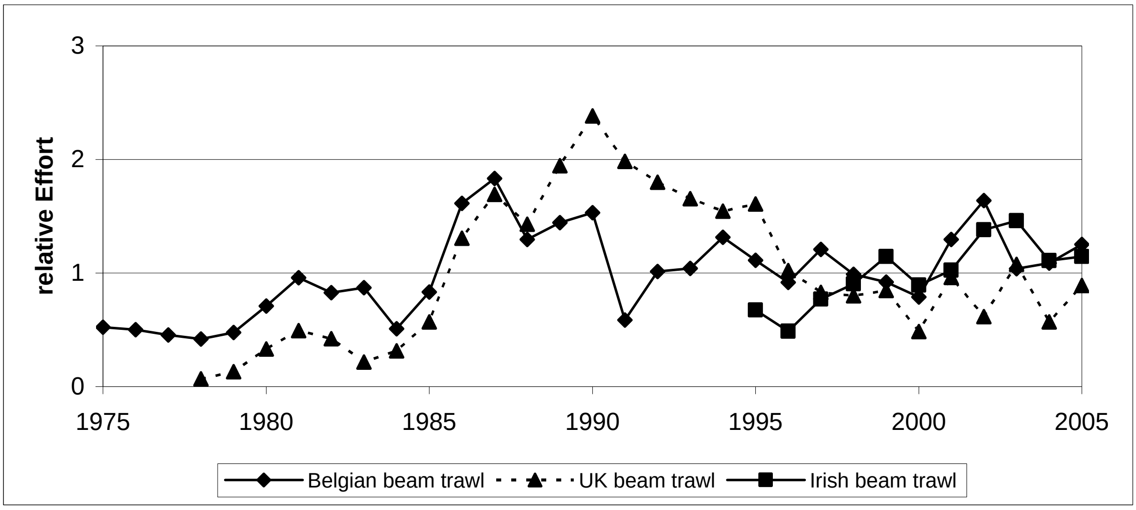
YEAR	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
AGE										
2	0.136	0.132	0.177	0.159	0.119	0.179	0.092	0.109	0.104	0.171
3	0.174	0.176	0.198	0.199	0.167	0.221	0.16	0.175	0.183	0.208
4	0.211	0.217	0.221	0.235	0.213	0.259	0.223	0.235	0.256	0.244
5	0.246	0.257	0.248	0.269	0.256	0.293	0.282	0.287	0.322	0.277
6	0.279	0.294	0.279	0.3	0.296	0.324	0.336	0.332	0.382	0.309
7	0.312	0.328	0.312	0.328	0.334	0.352	0.385	0.37	0.435	0.339
8	0.343	0.361	0.349	0.354	0.368	0.376	0.385	0.4	0.482	0.367
9	0.372	0.391	0.39	0.377	0.4	0.397	0.43	0.424	0.523	0.393
+gp	0.4534	0.456	0.5046	0.4213	0.4788	0.4273	0.5337	0.4391	0.598	0.454

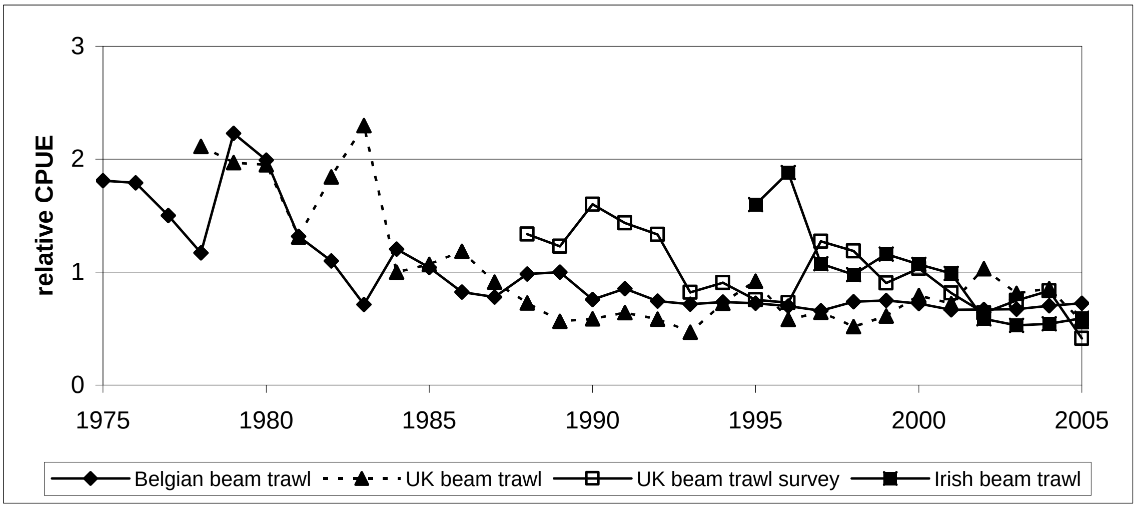
Table 12.4.1.4 Sole in VIIa Annual lenght distributions by fleet (2005)

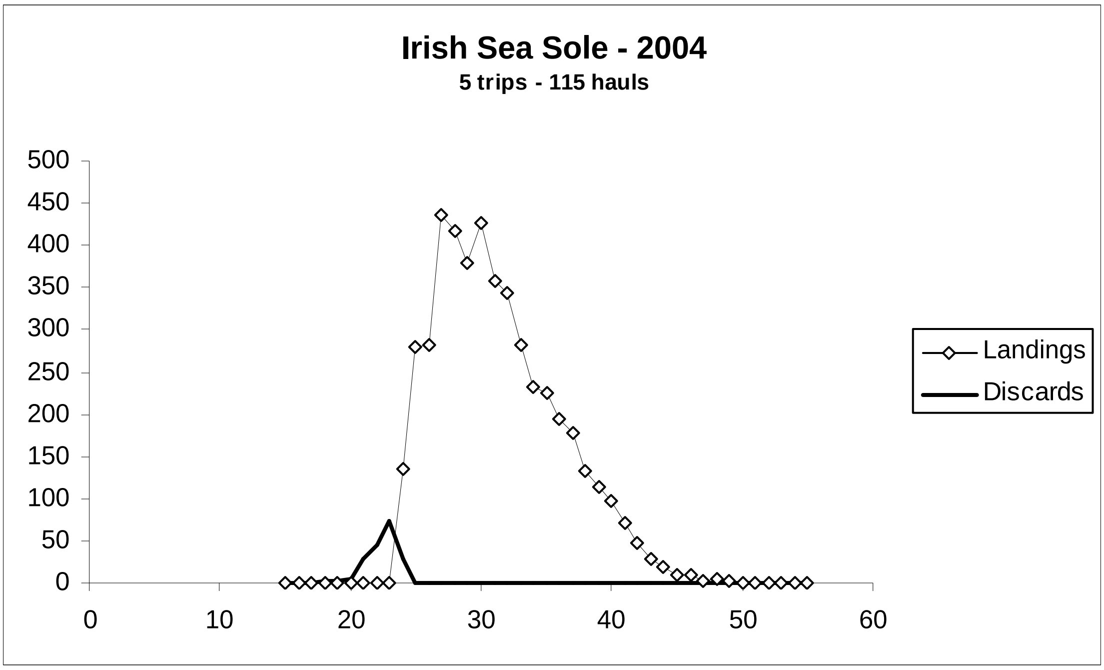
	UK (England & Wales)		Belgium	Ireland
Length (cm)*	Beam trawl	All gears (minus beam)	All gears	All gears
20				
21		47		
22	943	214	47945	261
23	12408	1496	178206	409
24	31754	3399	336831	1360
25	52714	5008	325000	2421
26	43672	6672	358549	3968
27	38184	5903	297318	11749
28	26113	4313	189976	19128
29	18741	3658	149407	24088
30	16927	2991	113191	19976
31	17753	2333	112839	16688
32	10841	2531	81067	17918
33	10805	1887	53448	9609
34	10996	2247	56911	11236
35	6786	1310	45061	10934
36	6586	911	29752	11329
37	5084	768	33161	11216
38	3197	475	28144	10579
39	2516	688	16655	10385
40	1802	336	14079	4023
41	1458	299	13936	2344
42	1058	160	6618	3394
43	655	62	5018	2233
44	470	106	840	2119
45	73	58	764	771
46	132	0	1528	927
47	183	0	1143	602
48	61	12	0	279
49	43	12	1027	303
50	41		1436	125
51				
52				
53				
54				
55				
56				
57				
58				
Total	321996	47896	2499850	210374

* Lower limit for UK and Ireland, nearest for Belgium.

Figure 12.3.1 Sole in VIIa. Relative CPUE and effort series for the commercial fleets used in tuning, and relative CPUE for the UK beam trawl survey







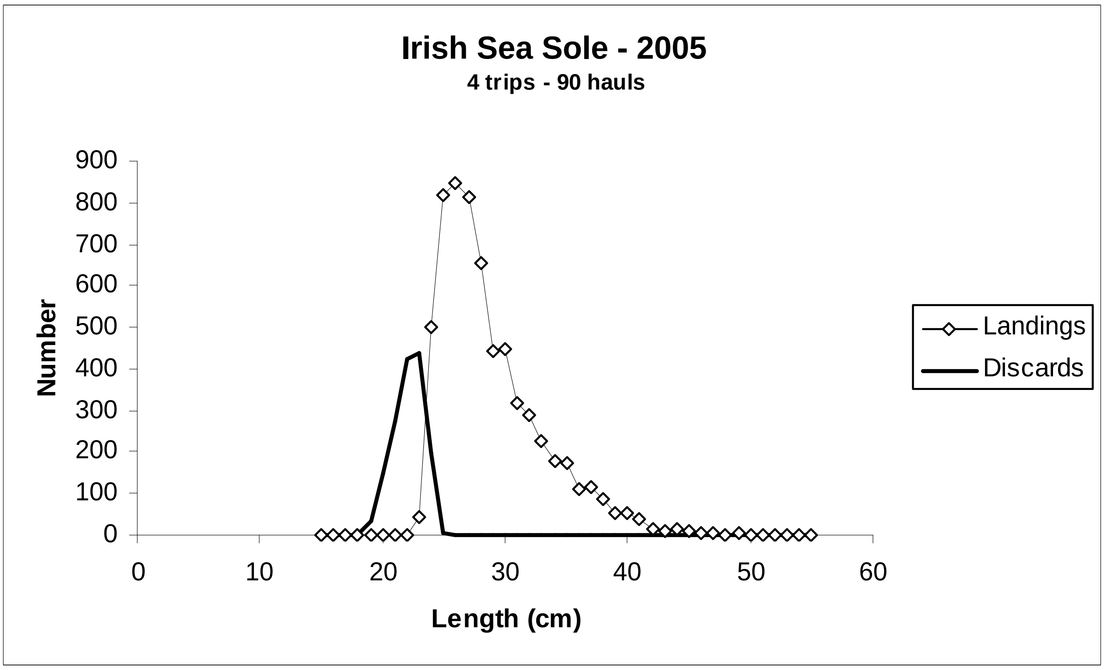
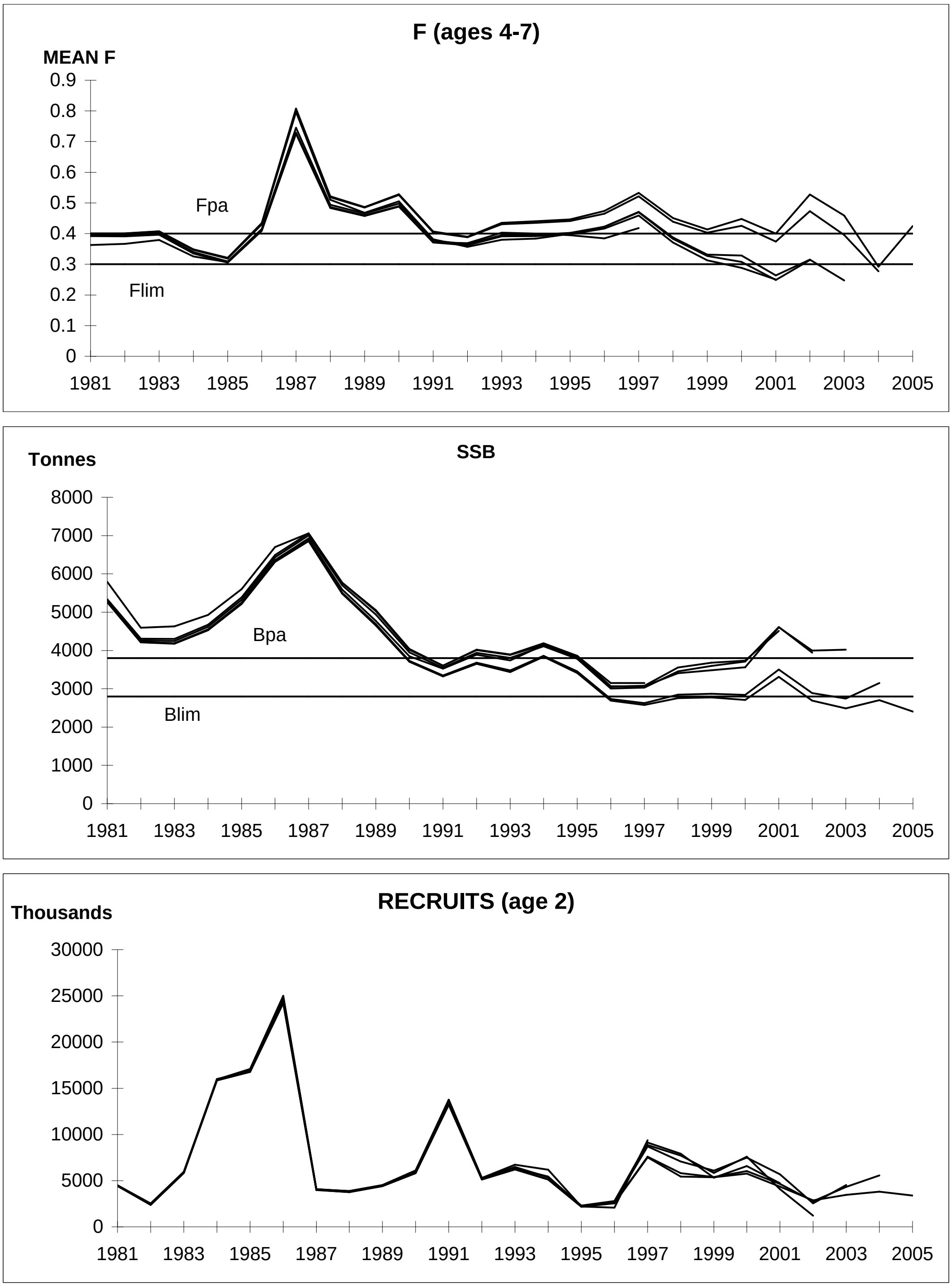


Figure 12.4.2.1 – Length distribution of retained and discarded sole in VIIa from 4 trips and 95 hauls from Belgian beam trawls in 2004 and 2005

Figure 12.6.1.3.1 - Sole VIIa retrospective XSA analysys (shinkage SE=0.8)
Same settings as previous years



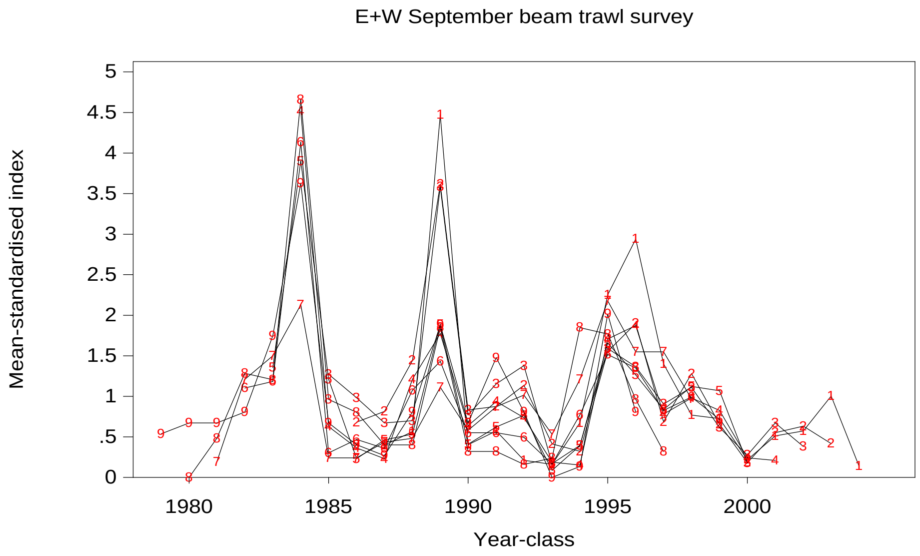


Figure 12. 6.1.3.2 a - Results from Surba analysis for UK(E&W) September beam trawl survey

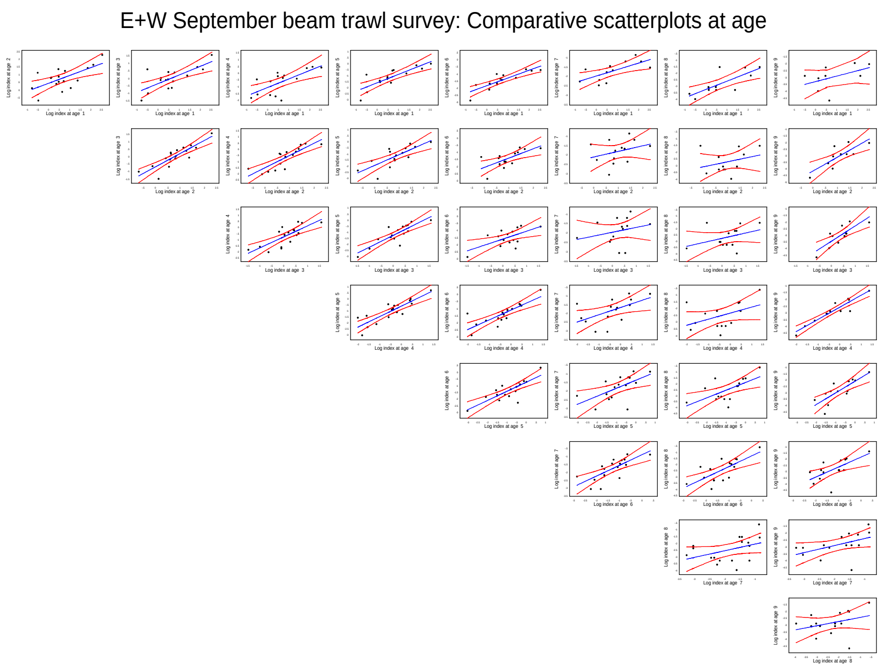


Figure 12. 6.1.3.2b - Results from Surba analysis for UK(E&W) September beam trawl survey

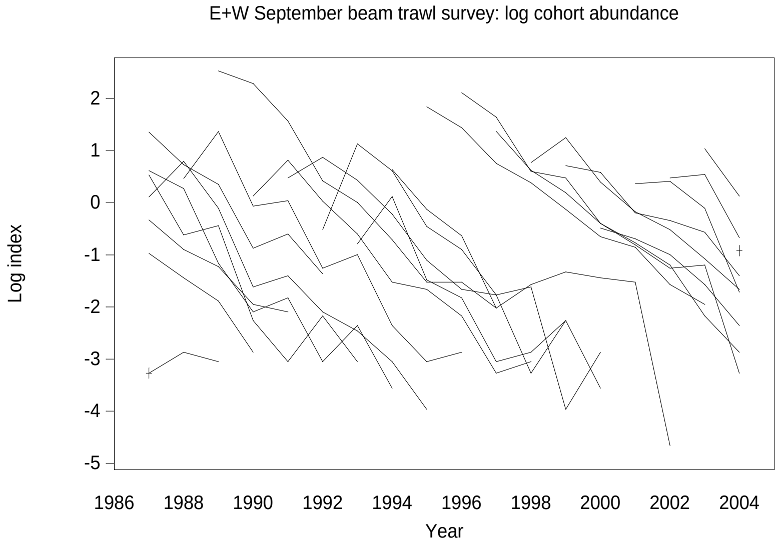


Figure 12. 6.1.3.2c - Results from Surba analysis for UK(E&W) September beam trawl survey

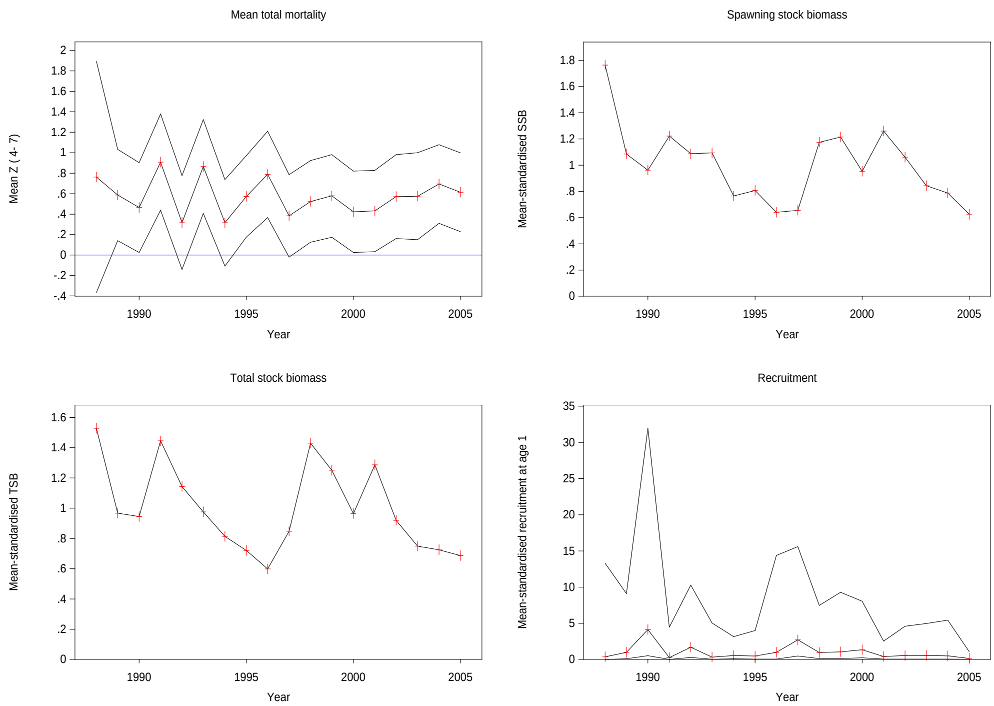


Figure 12. 6.1.3.2d - Results from Surba analysis for UK(E&W) September beam trawl survey

BELGIUM BEAM TRAWL EFFORT 107A (HRS*aBHP**b).

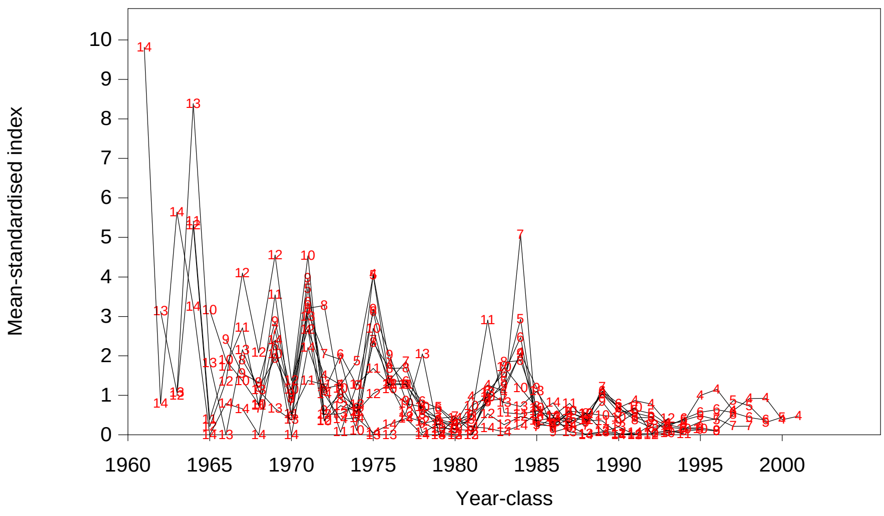


Figure 12. 6.1.3.2e - Results from Surba analysis for Belgium beam trawl fleet

BELGIUM BEAM TRAWL EFFORT 107A (HRS*aBHP**b).: Comparative scatterplots at age

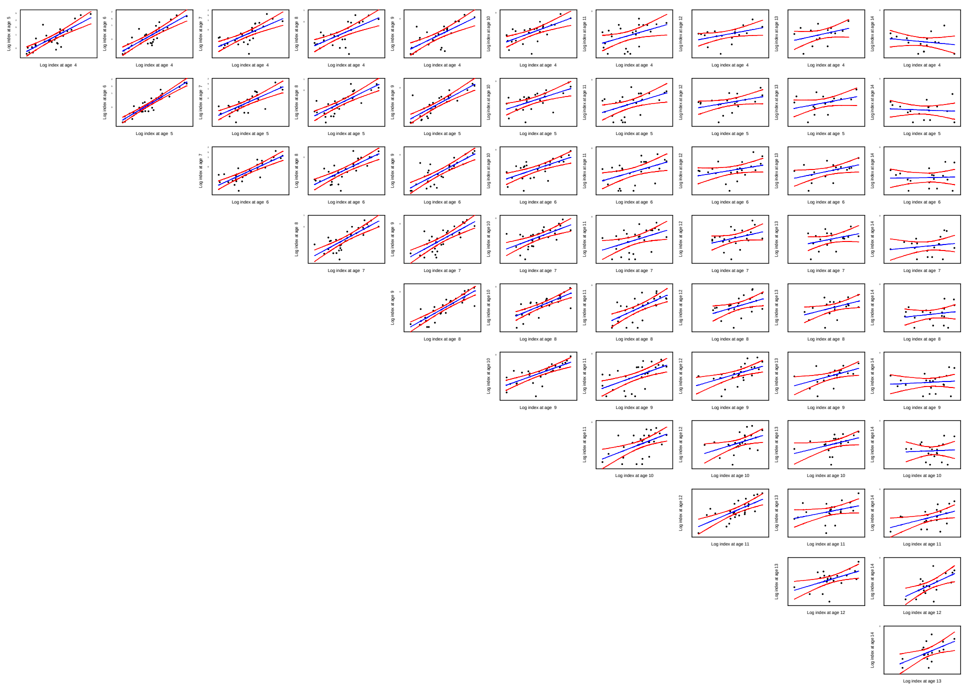


Figure 12. 6.1.3.2f - Results from Surba analysis for Belgium beam trawl fleet

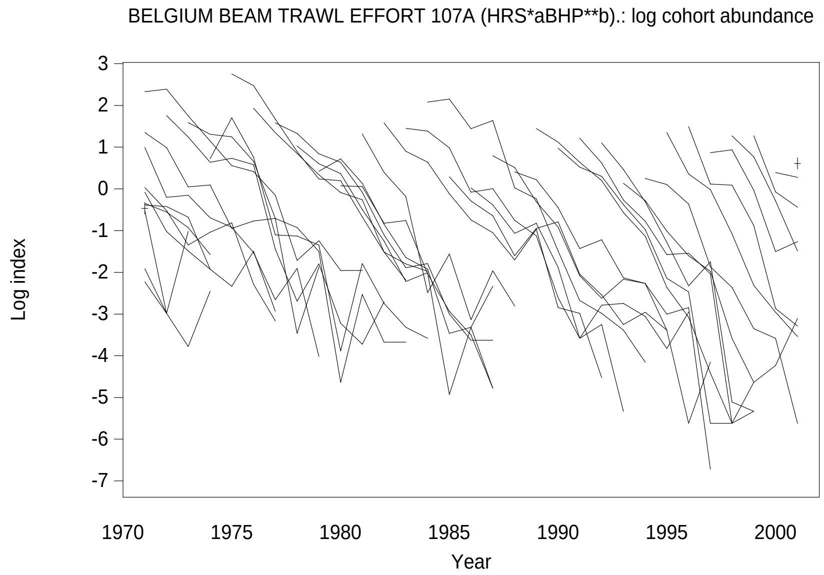


Figure 12. 6.1.3.2g - Results from Surba analysis for Belgium beam trawl fleet

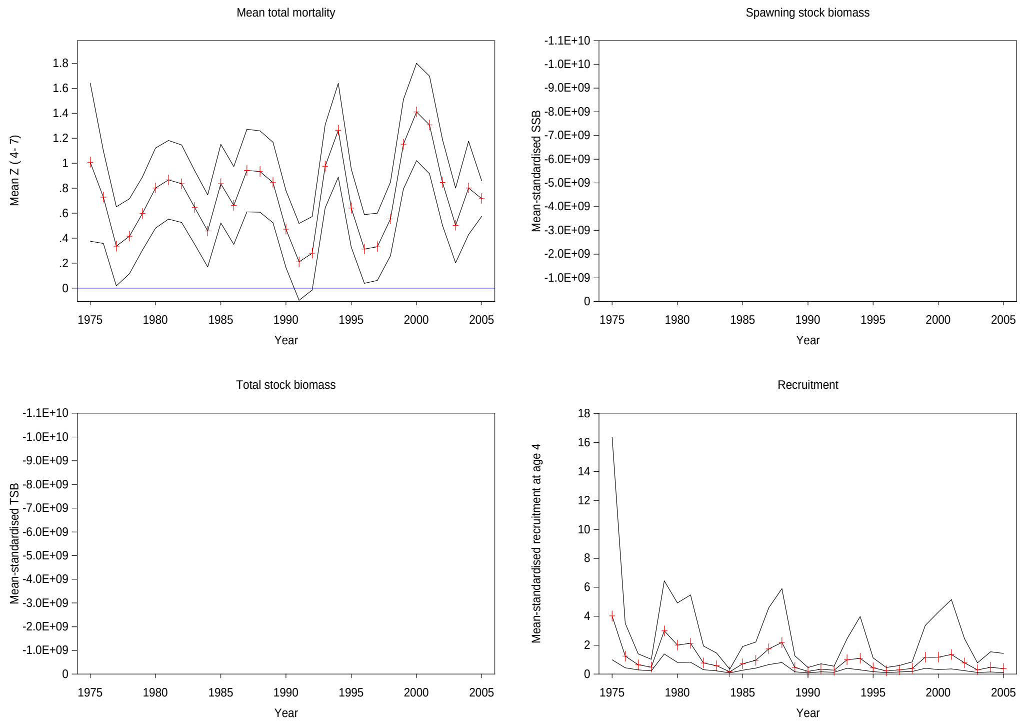


Figure 12. 6.1.3.2h - Results from Surba analysis for Belgium beam trawl fleet

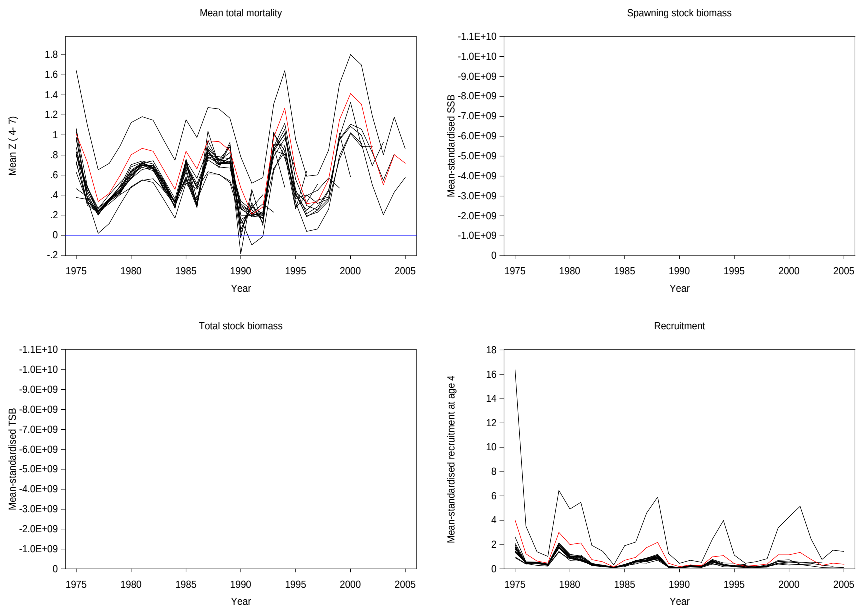


Figure 12. 6.1.3.2i - Results from Surba analysis for Belgium beam trawl fleet

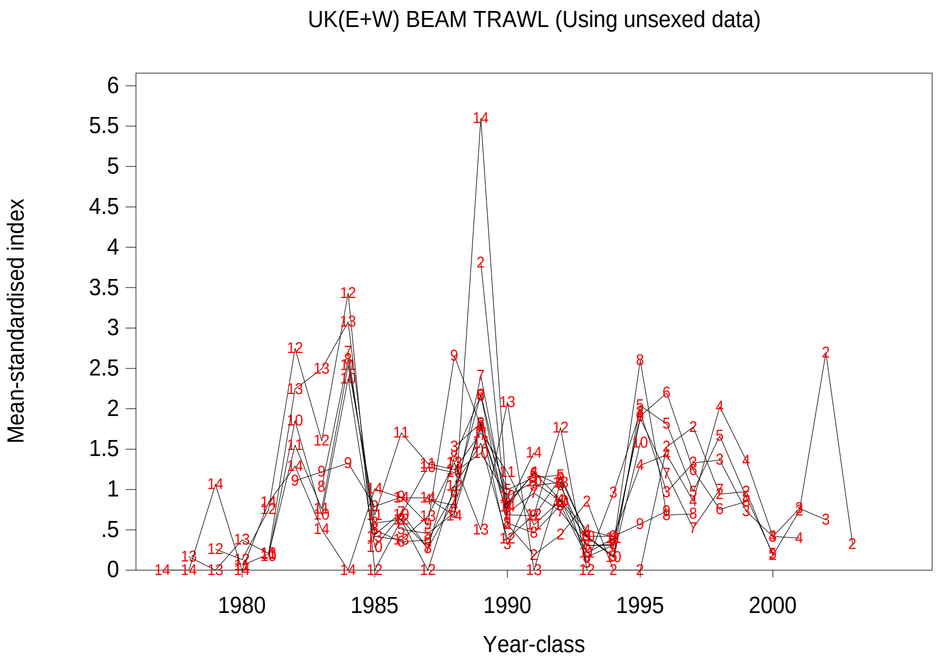


Figure 12. 6.1.3.2j - Results from Surba analysis for UK(E&W) beam trawl fleet

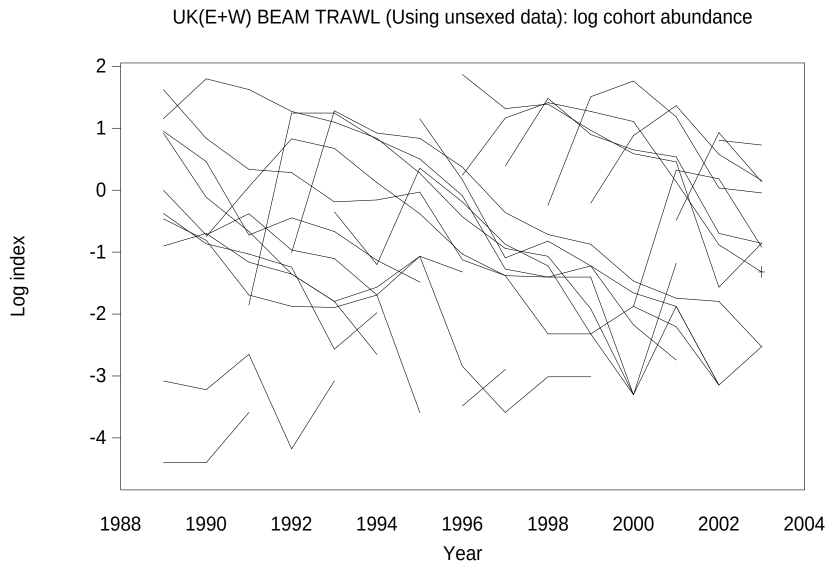


Figure 12. 6.1.3.2k - Results from Surba analysis for UK(E&W) beam trawl fleet

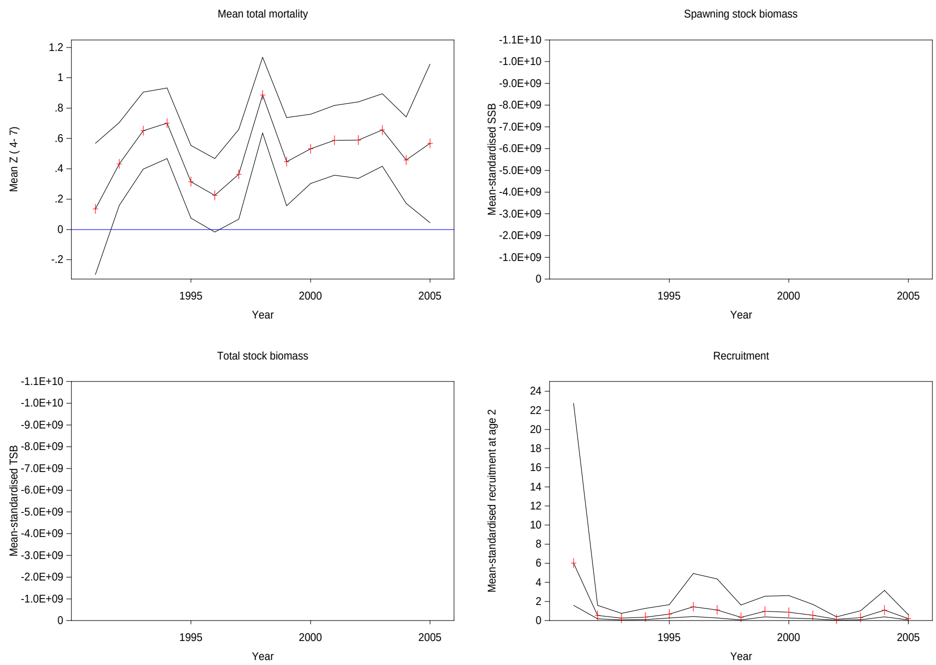


Figure 12. 6.1.3.2l - Results from Surba analysis for UK(E&W) beam trawl fleet

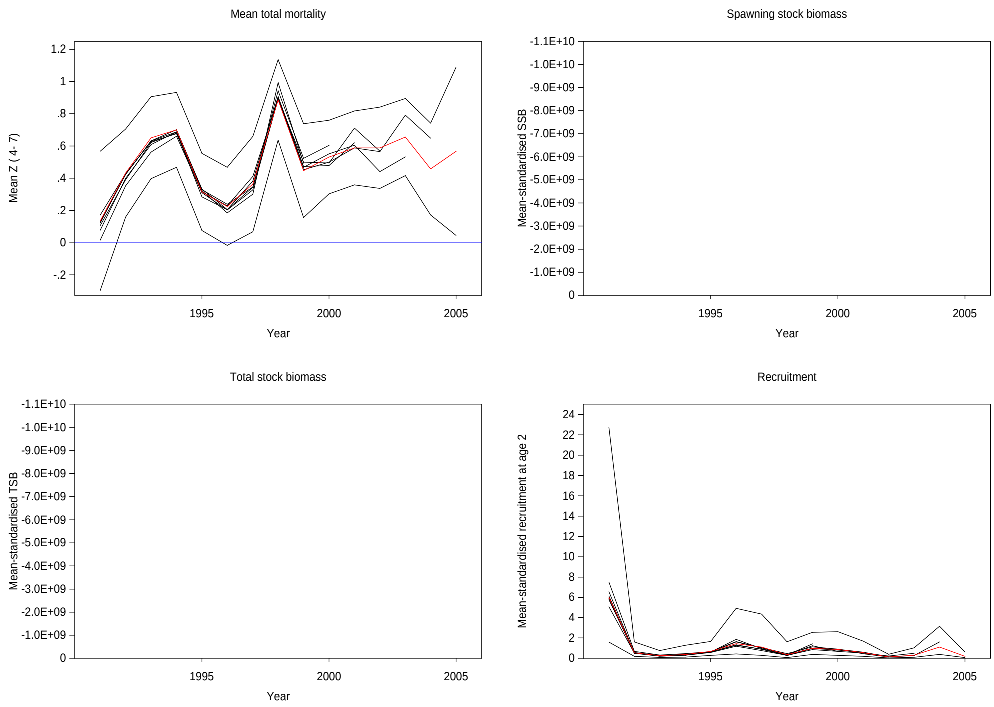


Figure 12. 6.1.3.2m - Results from Surba analysis for UK(E&W) beam trawl fleet

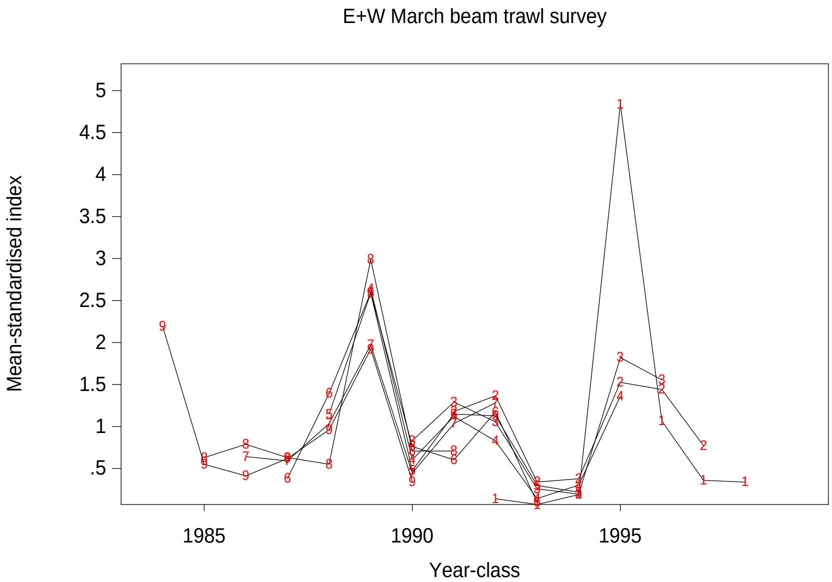


Figure 12. 6.1.3.2n - Results from Surba analysis for UK(E&W) March beam trawl survey

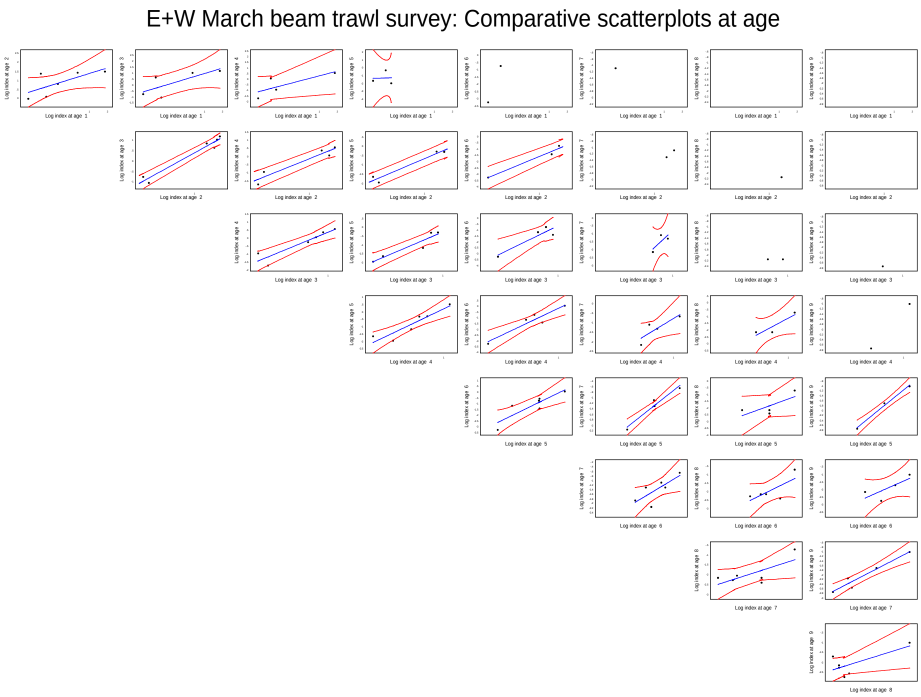


Figure 12. 6.1.3.2o - Results from Surba analysis for UK(E&W) March beam trawl survey

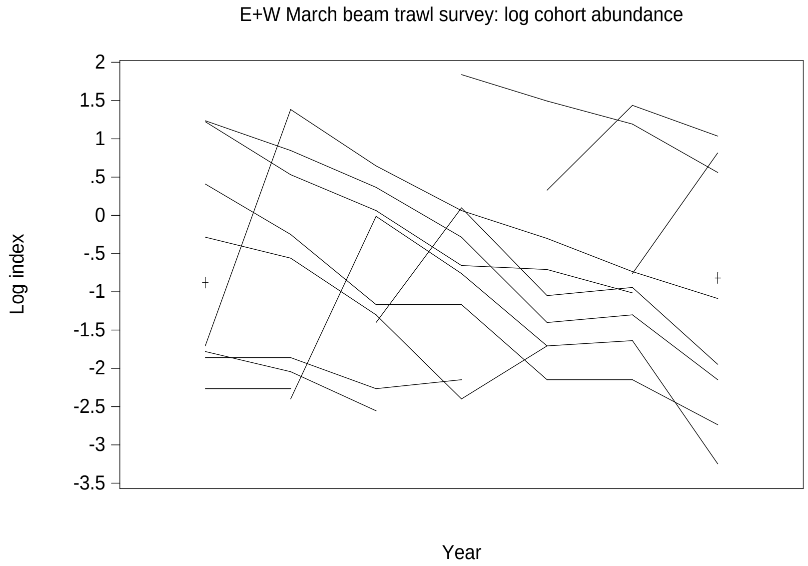


Figure 12. 6.1.3.2p - Results from Surba analysis for UK(E&W) March beam trawl survey

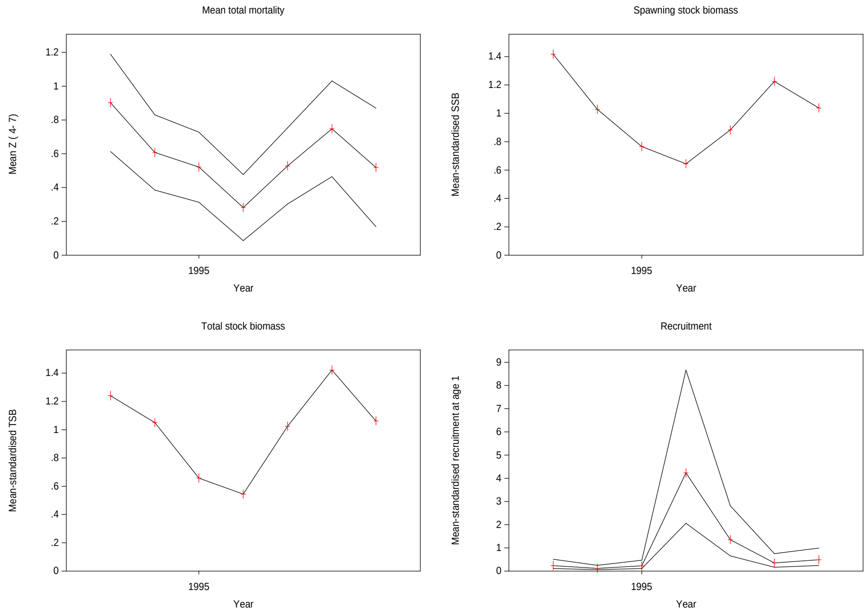


Figure 12. 6.1.3.2q - Results from Surba analysis for UK(E&W) March beam trawl survey

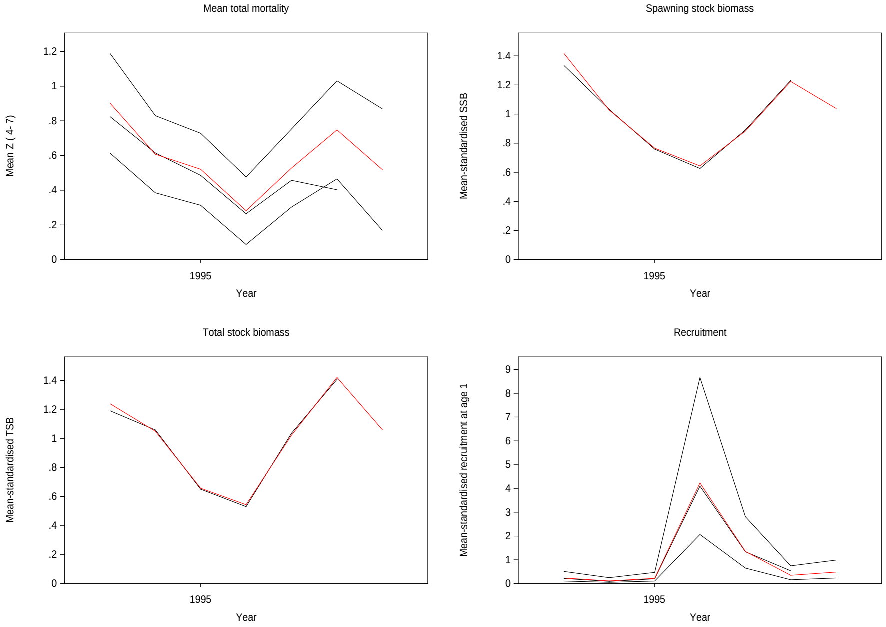


Figure 12. 6.1.3.2r - Results from Surba analysis for UK(E&W) March beam trawl survey

Figure 12.6.1.3.3a - Sole VIIa - Belgian Beam trawl residuals from ICA analysis

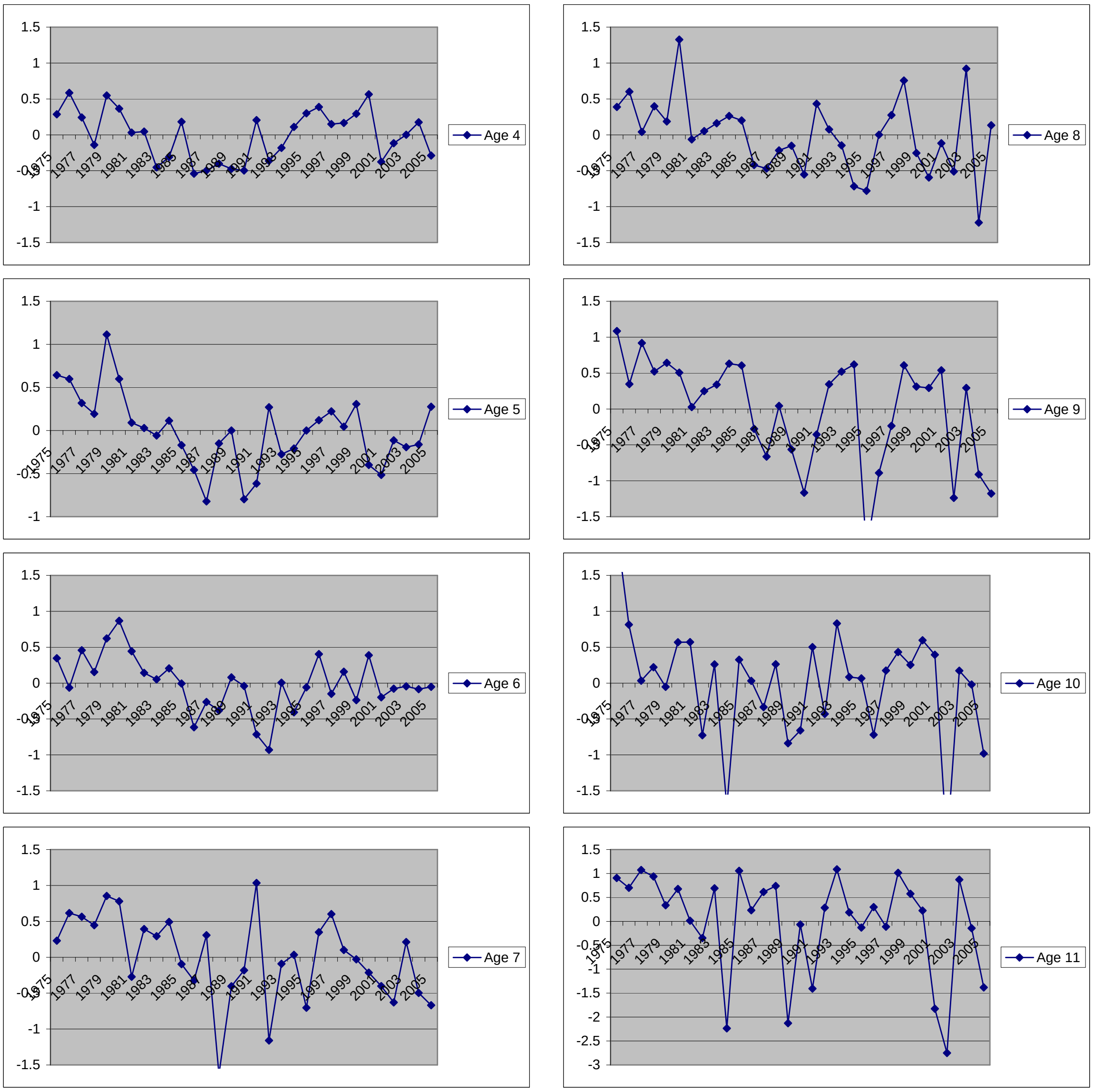


Figure 12.6.1.3.3b - Sole VIIa - UK(E&W) September Beam trawl survey residuals from ICA analysis

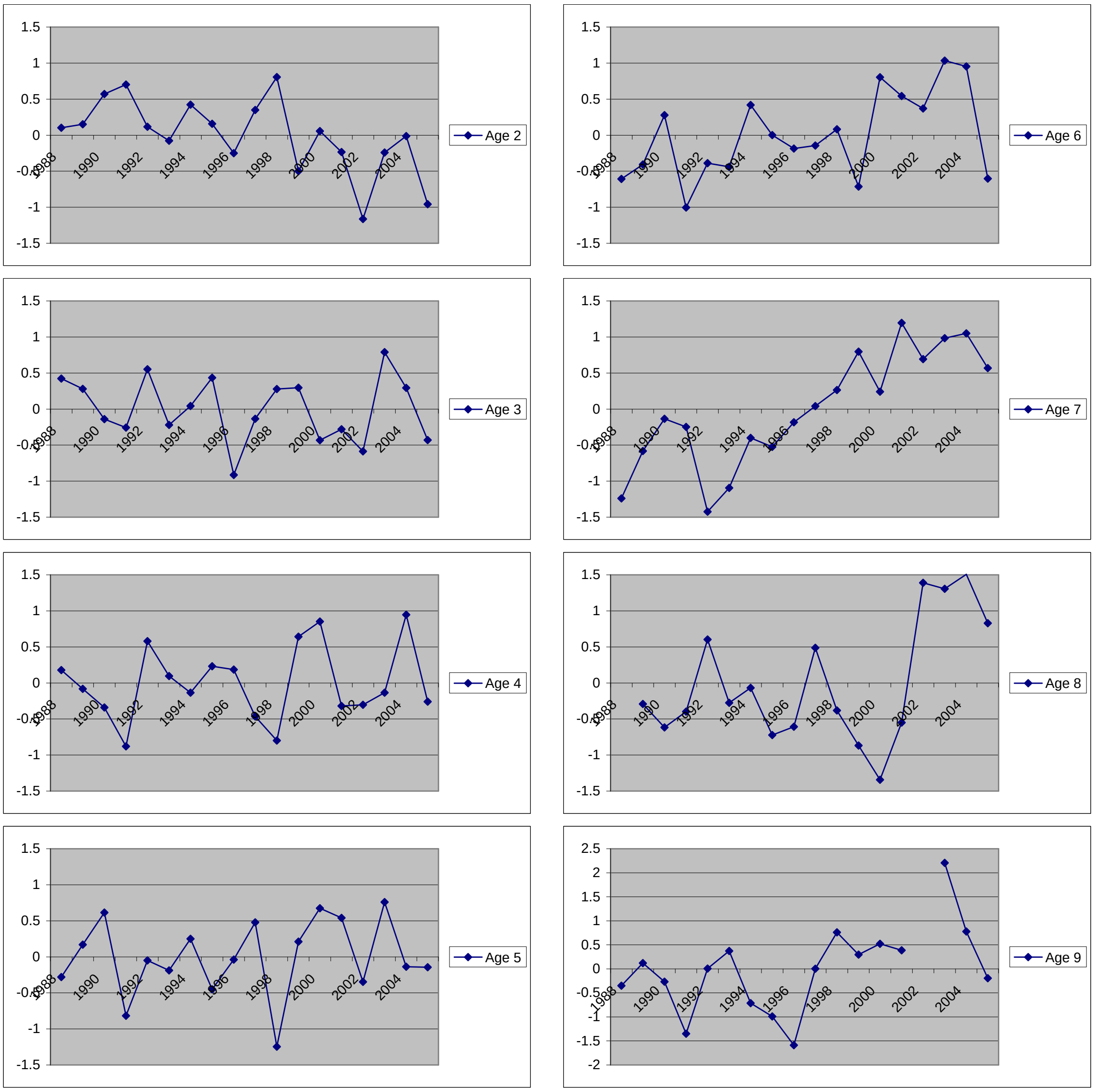


Figure 12.6.1.3.3c - Sole VIIa - UK(E&W) March Beam trawl survey residuals from ICA analysis

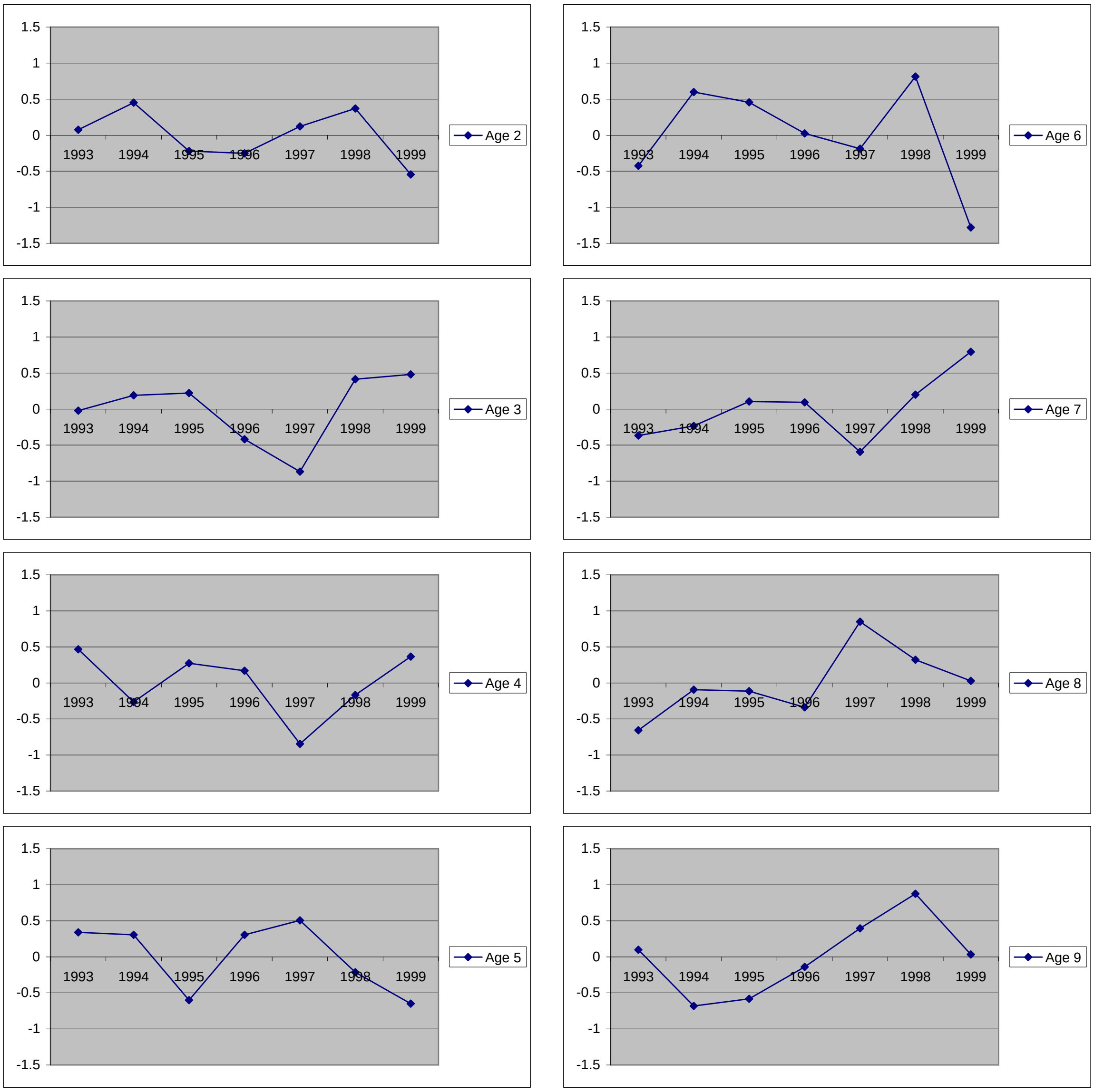


Figure 12.6.1.3.3d - Sole VIIa - UK(E&W) Beam trawl residuals from ICA analysis

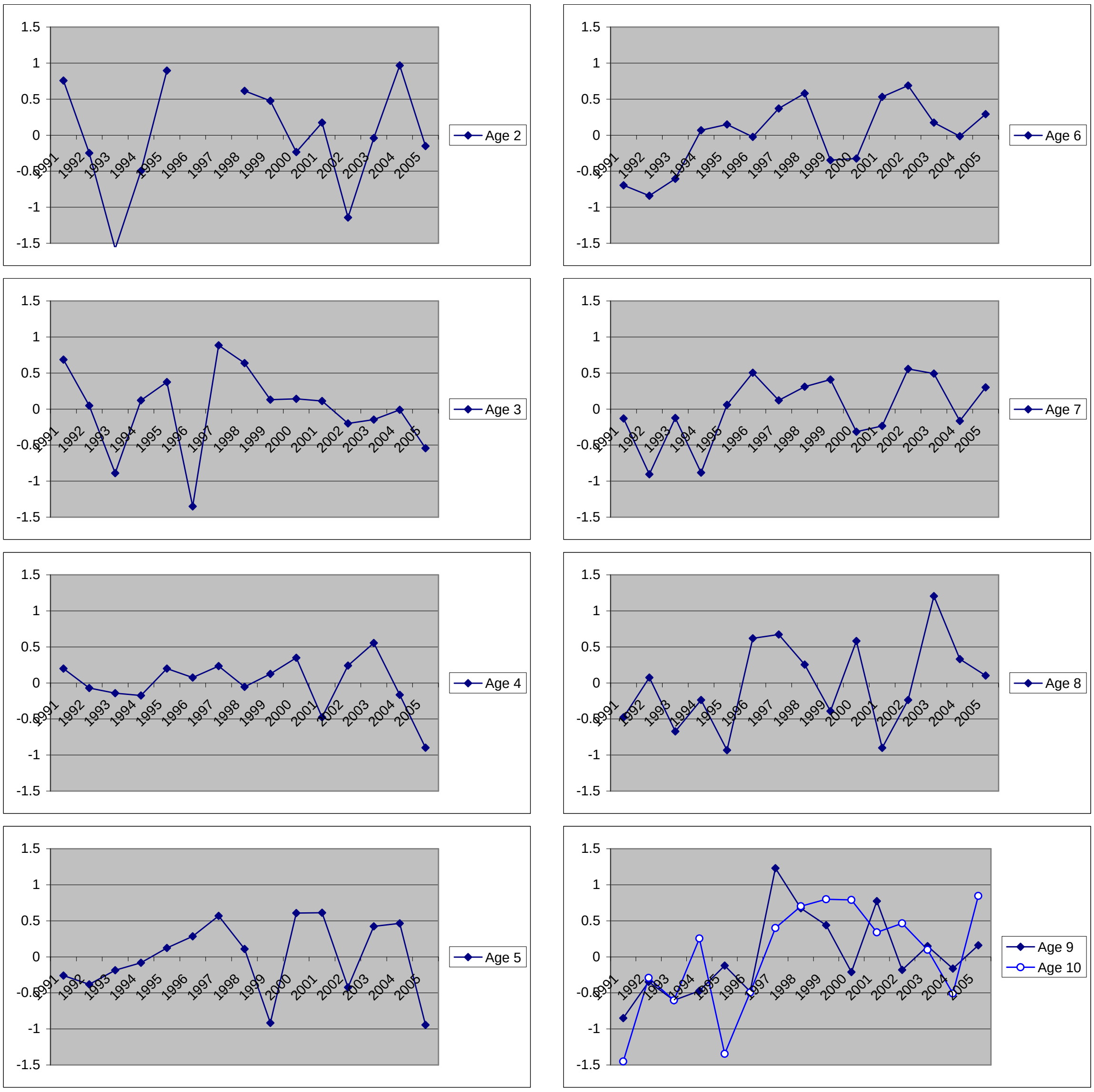
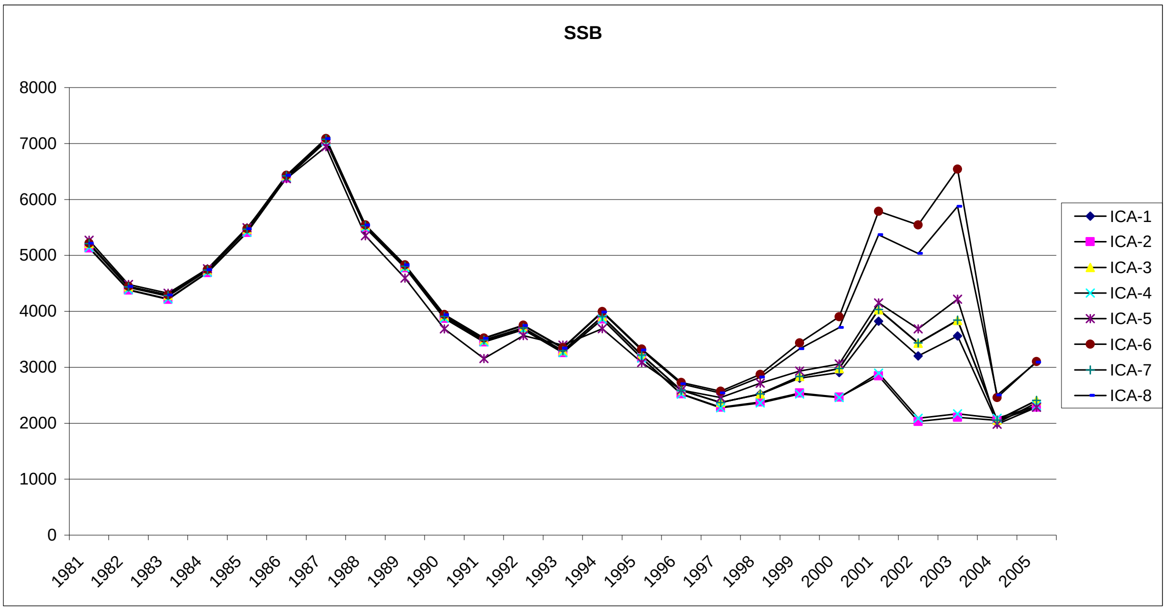
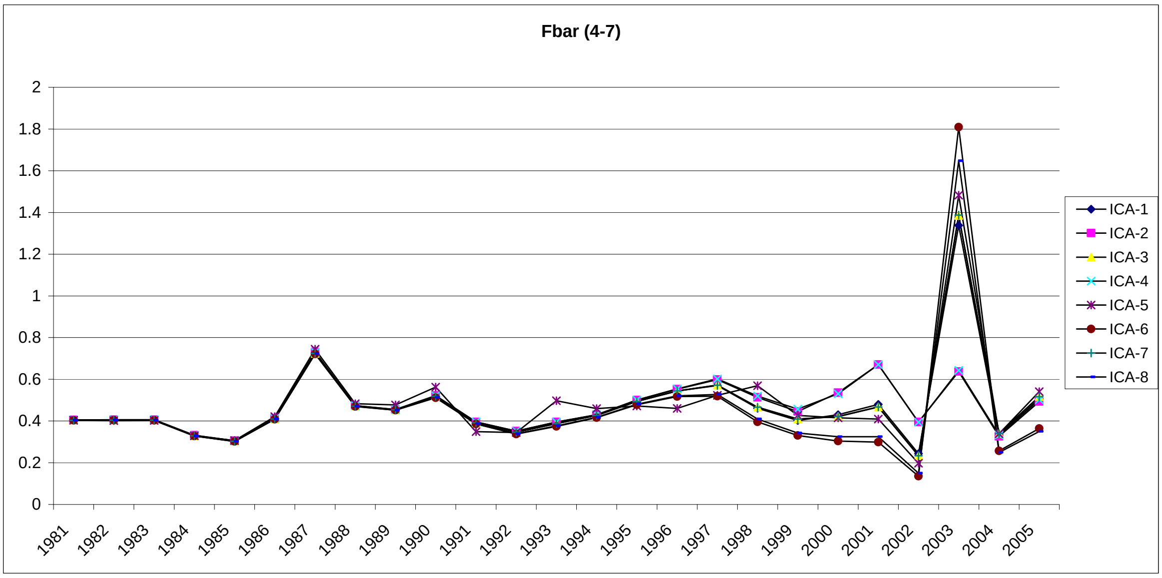


Figure 12.6.1.3.5a - Sole VIIa - Exploratory ICA-runs



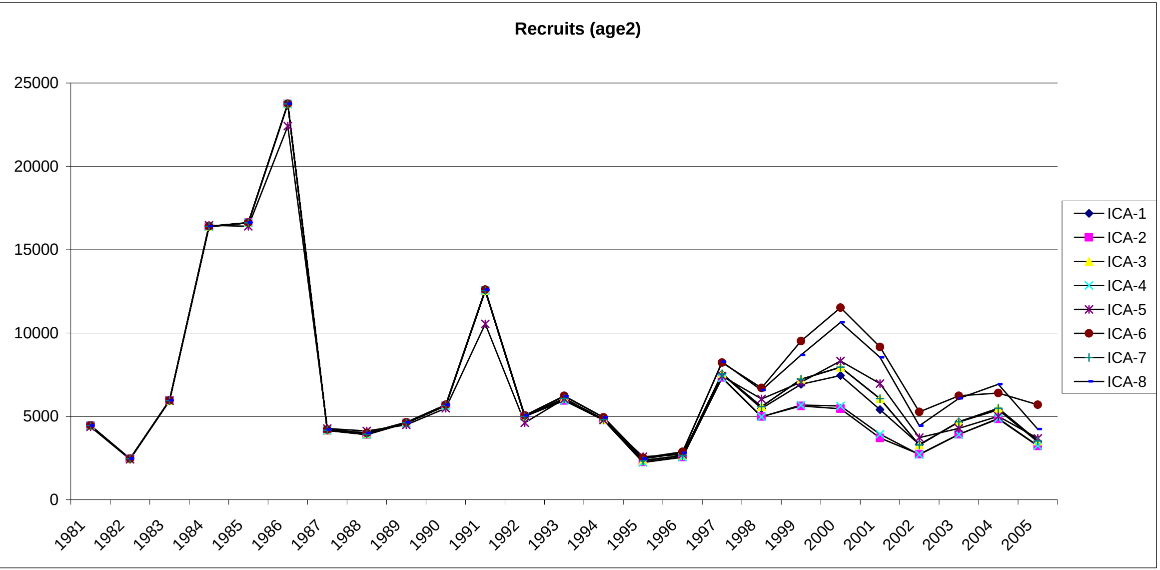
Runs	n°Years sep	year 2003	Bel-beam-tun	UK-beam-tun	Sep-survey-tun	March-survey-tun
ICA-1	6	0.0001	2003=-99	in	in	in
ICA-2	6	no downweighting	2003=-99	in	in	in
ICA-3	6	0.0001	in	in	in	in
ICA-4	6	no downweighting	in	in	in	in
ICA-5	15	0.0001	in	in	in	in
ICA-6	6	0.0001	out	out	in	out
ICA-7	6	CN=-99	in	in	in	in
ICA-8	6	0.0001	out	in	in	in

Figure 12.6.1.3.5b - Sole VIIa - Exploratory ICA-runs



Runs	n°Years sep	year 2003	Bel-beam-tun	UK-beam-tun	Sep-survey-tun	March-survey-tun
ICA-1	6	0.0001	2003=-99	in	in	in
ICA-2	6	no downweighting	2003=-99	in	in	in
ICA-3	6	0.0001	in	in	in	in
ICA-4	6	no downweighting	in	in	in	in
ICA-5	15	0.0001	in	in	in	in
ICA-6	6	0.0001	out	out	in	out
ICA-7	6	CN=-99	in	in	in	out
ICA-8	6	0.0001	out	in	in	in

Figure 12.6.1.3.5c - Sole VIIa - Exploratory ICA-runs



Runs	n°Years sep	year 2003	Bel-beam-tun	UK-beam-tun	Sep-survey-tun	March-survey-tun
ICA-1	6	0.0001	2003=-99	in	in	in
ICA-2	6	no downweighting	2003=-99	in	in	in
ICA-3	6	0.0001	in	in	in	in
ICA-4	6	no downweighting	in	in	in	in
ICA-5	15	0.0001	in	in	in	in
ICA-6	6	0.0001	out	out	in	out
ICA-7	6	CN=-99	in	in	in	in
ICA-8	6	0.0001	out	in	in	in

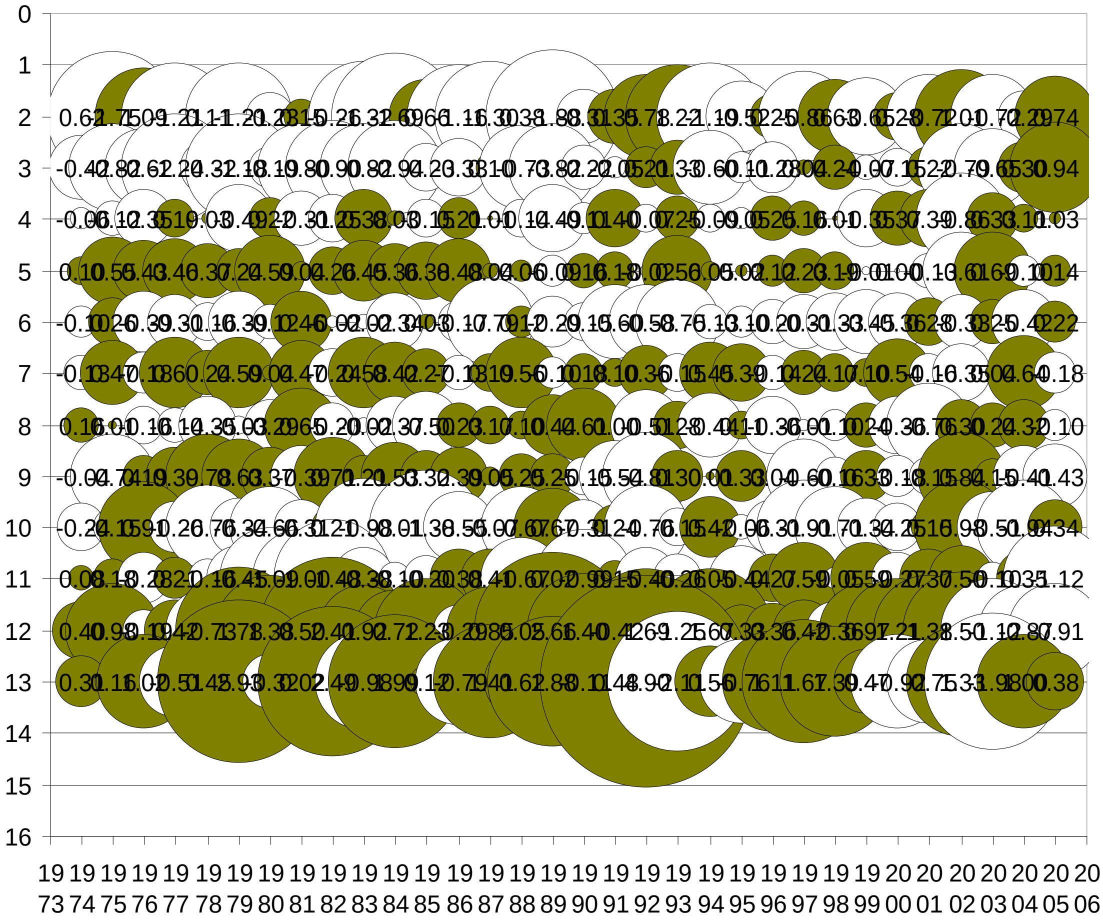


Figure 12.6.1 – Sole VIIa – Seperable VPA – log catchability residuals

13 NEPHROPS IN DIVISION VI

13.1 Nephrops in Management Area C

The Nephrops stocks in VIa were assigned ‘experimental assessment’ status reflecting the continuing developments in the quantification of stock abundance and dynamics from fishery independent surveys. In 2005, WGNSDS and WGNSSK decided that continued attempts to conduct ‘age’ based assessments using ‘knife-edge sliced’ age compositions from length data were ill-advised. Other ICES groups (eg WKNEPH and SGASAM) will continue to investigate emerging techniques that facilitate size based approaches and tackle spatial issues. This Working Group updated the available underwater television survey data and attempted to make further progress in providing landings options from the survey abundance information.

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 13.1 and illustrated in Figure 13.. 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.

Functional Units are aggregated into Management Areas (MA) (Table 13.1), the level at which WGNEPH and ACFM have previously recommended management should take place. Nominal landings as reported to ICES, along with WG estimates of landings are presented in Table 13.2. Landings are also made from Management Area C outside Functional Units, although at relatively low levels (Table 13.3).

Examination and analysis of the data available is provided on a stock by stock basis, with the North Minch (FU11) in Section 13.2, the South Minch (FU12) in Section 13.3 and the Clyde in Section 13.4. *Nephrops* stocks outside the Functional Units are considered in Section 13.5 and management considerations for Management Area C as a whole are discussed in Section 13.6.

Section 17 describes broad scale changes in effort expressed in KW days. UK effort in VIa has generally declined through marked reductions in the larger whitefish trawl categories. Effort directed at Nephrops by the UK fleet (by far the main contributor to landings of Nephrops fron VIa has been fairly stable and there is no evidence of shifts of effort from other sectors into the Nephrops fishery.

13.1.1 ICES advice applicable to 2005 and 2006

2005

ICES advice is provided for Management Area C as a whole, rather than individual stocks.

Until 2005, ICES assessed and provided advice for *Nephrops* stocks on a bi-annual cycle. The original advice for 2005 was provided along with the 2004 advice and based on WGNEPH assessments conducted in 2003.

Because of the nature of *Nephrops* assessments, it has not been possible for ICES to provide formal catch predictions in its previous advice. TAC advice has previously been based on average historical landings. In 2003 ICES concluded that

“all stocks in this Management Area appear to be exploited at sustainable levels”

and advised that

"there is no basis to revise the advice given previously. ICES continues to advise a Management Area TAC of 11300 t for 2004 and 2005."

After ICES provided its 2003 advice, results from underwater TV surveys of the three stocks conducted in the summer of 2003 became available (Tuck et al 2004), and were submitted to ICES for consideration "in year". The results showed increases in abundance in FU 11 and FU 13 since 2000, and stable but high abundance in FU12. An increase in harvestable biomass would result in an increase in landings with the same fishing mortality. An analysis of this data by an ICES Fast Track Review Group suggested that the calculated landing for the same fishing mortality as used in the advice was between 11 to 33 % above the prediction on which the 2003 advice was based, the two estimates differing by including catch data (a cohort analysis as was the basis for the advice in the past) or relying entirely on the survey data.

ICES considered that the most appropriate basis for a revision would be the 11% increase prediction (since there was no justification for changing the assessment procedure). ICES also considered that revision of the advice based on new data would only be justified when there was firm evidence of significant changes in stock status, and since there is considerable uncertainty about landings, discard and effort data for these stocks, an increase in the predicted landings (for the same fishing mortality) in the order of 10% was considered to be within the uncertainty in the assessments, and did not justify an in year increase.

ICES effectively therefore maintained its advice of a Management Area TAC of 11 300 t for 2004 and 2005.

2006

ICES advice on Management Area C Nephrops for 2006 was based on underwater television assessments provided by WGNSSDS in 2005.

ACFM concluded that "All stocks in this Management Area appear to be exploited at sustainable levels."

and advised

"Single stock exploitation boundaries
Exploitation boundaries in relation to precautionary limits
Information on these stocks is considered inadequate to provide an advice based in precautionary limits. The effort in this fishery should not be allowed to increase and the fishery must be accompanied by mandatory programmes to collect catch and effort data on both target and by-catch species.

Short term implications
Outlook for 2006:
The harvest ratio is a proxy for relative effort. Historically for this stock the harvest ratio has been around 15%. As an indication of relation between landings (tonnes) and effort the table below shows calculated landings for the three functional units for a range of harvest ratios applied to TV survey biomass results.

HARVEST RATIO %	NORTH MINCH	SOUTH MINCH	CLYDE	TOTAL
15	3150	7037	3068	13255
20	4201	9383	4091	17675
25	5251	11729	5113	22093

Shaded options are not in accordance with the advice as this implies increased effort

Mixed fishery considerations
The *Nephrops* trawl fisheries take considerable by-catches of other species. The management of these fisheries should be seen in the context of mixed fisheries (see ICES Advice 2005 Report of ACFM and ACE Volume 5 Section 1.1.2).

Demersal fisheries in SubArea VI should in 2006 be managed according to the following rules which should be applied simultaneously:

They should fish:

- Without catch or discards of cod in Subarea VI;
- Without catch or discards of spurdog
- No directed fishery for haddock in Division VIb
- Concerning deepwater stocks fished in Subarea VI
- Within the biological exploitation limits of all other stocks"

Bullet points 1, 2 and 5 have relevance to Nephrops fisheries.

13.1.2 Management applicable in 2005 and 2006

2005

The 2005 TAC for *Nephrops* in ICES area VI was 12 700 tonnes.

Following the in year presentation of the new west coast survey data (Tuck et al 2004), STECF examined the analysis conducted by the ICES Fast Track Review Group. STECF concluded that while not justifying an in year increase, the 11% increase prediction would have justified a change in TAC had it been from the annual assessment process. STECF therefore recommended a TAC of 12 700 tonnes.

2006

The 2006 TAC for *Nephrops* in ICES area VI is 17 675 tonnes

The ACFM adoption of a 15% harvest rate for these stocks based on the observation that historically, harvest rates had been at this level, was founded on the time series of reported landings. Both the WGNSDS and ACFM reports draw attention to the likelihood of misreporting in these fisheries and it therefore cannot be concluded that harvest rates at this level are a proxy for recent effort. STECF were asked to consider what appropriate harvest rates for Nephrops might be, consistent with long term sustainable objectives and concluded that a harvest rate based on a fishing mortality rate equivalent to $F_{0.1}$ from a yield per recruit curve was likely to be sustainable providing that fishing effort was controlled and providing Nephrops were managed at the Functional Unit level. The harvest rate equivalent to $F_{0.1}$ for these stocks is close to 20% and when applied to the TV abundance estimates from the 2005 WGNSDS report gave a predicted aggregate landing of 17675 tonnes. This became the TAC for 2006.

An additional management measure continued in place in the Firth of Clyde (FU13). UK legislation has been applied in the southern areas of the Firth of Clyde in recent years, aimed at protecting the aggregating cod in the south of the Clyde during February, March and April (14th February to 30th April - Scottish Statutory Instrument 2002 No. 58 - The Sea Fish (Prohibited Methods of Fishing) (Firth of Clyde) Order 2002.

The minimum landings size for *Nephrops* in area VI is 20mm carapace length.

EU effort regulations relevant to these stocks are found in Section 1.7.

13.2 North Minch

Prior to 2005, WGNEPH conducted a variety of analyses on the *Nephrops* data for this stock, including analytical assessments and a review of a number of stock indicators. Owing to serious concerns about the quality of landings statistics and uncertainty about model assumptions, the 2005 meeting of WGNSDS did not base its advice on XSA assessments but used underwater television survey information instead. This approach was continued at the 2006 meeting

13.2.1 The Fishery

General information on the fishery can be found in the Stock Annex (A.2).

13.2.1.1 ICES advice applicable to 2005 and 2006

ICES advice for this stock is included in advice for Management Area C as a whole, and is described in 13.1.1.

13.2.1.2 Management applicable in 2005 and 2006

Management applicable to this stock is included in management for Management Area C as a whole, and is described in 13.1.2.

13.2.1.3 The fishery in 2005

The fishery in 2005 was generally similar to previous years with a fleet of mainly smaller trawlers working 1 -4 day trips from the main ports of Lochinver, Ullapool, Stornaway and Gairloch. The largest part of the North Minch fleets continued to be based at Stornaway. The reported effort by Nephrops trawlers in the North Minch was slightly down in 2005. Fishing was conducted throughout the year with slightly more reported effort in the second and third quarter.

Little if any marketable fish by-catch was reported by the boats fishing in the North Minch, this was confirmed during Nephrops discard trips on board North Minch boats.

Some local boats left the North Minch after July to fish in the Moray Firth squid fishery and a number of larger North Minch boats were fairly mobile making journeys north to the Noup (ICES Area IV) or down to the South Minch depending on catch rates and the weather

Creel fishing continued to expand in 2005 with anecdotal reports of creels being fished more widely in the Minch and significant increases in creel numbers being fished inshore along the outer Hebrides side of the Minch.

13.2.2 Catch data

13.2.2.1 Official Catch Statistics

Catch statistics reported to ICES are shown in Table 13.2; these relate to the whole of VIa of which the North Minch is a part. Official catch statistics for FU 11 provided through national laboratories are presented in Table 13.4. Landings from this fishery are only reported from Scotland. A variety of gear types make landings of Nephrops. Total reported landings in 2005 was 2984 tonnes, consisting of 2285 tonnes landed by trawlers and 699 tonnes landed by creel vessels. These estimates for total landings have declined from a recent high of 3440 tonnes in

2002. Landings from creel vessels have risen since the mid 1990s, and in 2005 contributed 23% of the total landings. Reported effort by Scottish *Nephrops* trawlers has declined steadily since 1999, the 2005 value being 63% of that in 1999 (Figure 13.2 and Table 13.5). Scottish *Nephrops* trawler LPUE remains at a high level and in 2005 rose to over 39Kg/hr – the highest since 1984. The reliability of these data and the trends observed are further discussed in sections 13.2.6.6.1 and 13.2.6.6.2.

13.2.2.2 Revisions to Catch data

The last assessment of Management Area C *Nephrops* stocks was conducted by WGNSDS in 2005. Some minor revisions have been made to 2004 catch data.

13.2.2.3 Quality of the Catch data

Prior to 1992 the TAC for Division VIa *Nephrops* was 16000 tonnes. Following preliminary assessments in the early 1990s suggesting that stocks were fully exploited, the TAC was revised downwards. In the absence of a more suitable means of providing catch forecasts, average historical landings was used to provide catch advice. The TAC remained between 11 300 t 12 700 tonnes for a number of years. During this period, the fishery has developed spatially and anecdotal evidence suggests that the TAC has been unnecessarily restrictive, and has been exceeded. These developments have affected the North Minch component and also the other stocks in Management Area C.

13.2.3 Commercial catch-effort data and research vessel surveys

13.2.3.1 Commercial catch-effort

In general, males make the largest contribution to the landings and the LPUEs, though in some years (e.g. 1998 and 2004) the contributions from the two sexes were more equal (Figure 13.3). Effort has traditionally been higher in the 2nd and 3rd quarters of the year in this fishery, but has declined in the 3rd quarter in the most recent years and is now more equally spread. Male LPUE declined between 1996 and 1998, but has increased since then. There were generally lower LPUEs in 2004 the reason for which is not known. Male LPUE has been particularly high in the 1st and 4th quarters of recent years. The LPUE for females has shown a gradual steady increase since 1995 and is highest in the summer months between the hatching and spawning periods.

Discarding of undersize and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discarding rates averaged over the period 2003 to 2005 for this stock were 24% by number. This represents an increase in discarding rate compared to the 2002 to 2004 period. An indication of the size distribution of discards compared to landings is provided in Figure 13.4. CPUE data for each sex, for *Nephrops* above and below 35 mm CL, are shown in Figure 13.5. This size was chosen for all the Scottish stocks examined as the general size limit above which the effects of discarding practices and the addition of recruits were likely to be small. The data show a peak in CPUE for smaller individuals in 1994 (and for females in 1995), with values declining to the longer term average until 2001. Since then, values have been increasing and reached a peak in 2005. The CPUE for larger males showed a similar pattern. CPUE for the larger females appears to be very stable with an aberrant peak in the fourth quarter of 2004, this appears to be due to a sample fill-in problem which will be corrected for 2007.

Owing to the decision not to proceed with tuned assessments in 2006 (see below), tuning files were not updated in 2006. The available commercial CPUE data are, however, described in the Stock Annex (Sections B.3 and B.4). A CPUE tuning series is available for Scottish *Nephrops* trawlers since 1981. The Stock Annex (Section B.4) describes how the tuning series is calculated. However, recording of effort in hours has become erratic, and there are concerns over the accuracy of official landings and effort statistics and the implications of technological creep in the fleet.

13.2.3.2 Research vessel surveys

Underwater TV surveys are available for this stock since 1994 (missing surveys in 1995 and 1997). The available research-vessel survey data are described in the Stock Annex (Sections B.3 and B.4), and are tabulated in Table 13.7 and table 13.8. Figure 13.6 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. Figure 13.7 shows the time series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates.

13.2.4 Size Composition, Age composition and mean weights-at-age

Quarterly landings and discard at length data were available from Scotland. The sampling levels are shown in Table 2.2. The sampling, raising and collation procedures for length-compositions are described in the Stock Annex (Sections B.1 and B.2).

A summary of mean size information is given in Table 13.6. Mean size of all categories appears to have been relatively stable since 1996. Examination of the CPUE data in conjunction with the changes in mean size of the two size categories (Figure 13.2), leads to the suggestion that a strong year class entered the fishery in 1994, since mean size dropped in the < 35 mm CL category but was stable in the larger animals. The progression of this year class through the fishery may have led to the increase and then decrease in CPUE of the larger individuals. The rise in catch rates of small animals in the most recent year (Figure 13.5) accompanied by the recent increase in discard rate and the drop in the mean size of small animals in 2005 suggests that another period of good recruitment has occurred.

Length composition data for 2003-2005 were used to generate LCA male and female input data files to provide a recent average length composition for use in the TV survey predicted catch calculations (Figure 13.4– the data have been added to the stock files)

In previous years when XSA has been performed, length compositions of combined landings and dead discards were raised to annual values of removals and sliced using the WGNEPH program L2AGE into numbers at nominal age and weights at age. These were not prepared in 2006.

13.2.5 Natural mortality, maturity at age and other biological parameters

Input parameter values for this stock are poorly known. WKNEPH (2006) has drawn attention to the need to update and improve basic data, especially growth rates, for most *Nephrops* stocks. A summary of values is provided in the Stock Annex (Sections B1 and B2).

13.2.6 Catch-at-age-analyses

This method was not conducted at this year's WG meeting.

13.2.6.1 Data screening and exploratory runs

13.2.6.1.1 Commercial catch data

Levels of market and discard sampling are good, and the length structure of removals in the fishery is considered to be well represented.

Justification for discontinuing age disaggregated assessments relate to concerns earlier raised at both WGNEPH and WGNSDS about the implications of the use of the knife edge slicing technique for catch at age analysis of the resulting year classes. The increase in variability in length at age for older individuals may lead to a number of “real” ages being included within a sliced age, leading to an overestimation of F. This applies to each of the main *Nephrops* stocks in Management Area C.

13.2.6.1.2 Survey data

General analysis methods for underwater TV survey data are similar for each of the Scottish surveys, and are described in Section 2.5.1. Survey runs are excluded where underwater visibility is considered to impair accurate counting, and discrepancies between observer counts are investigated. Total survey variance in the abundance is estimated by summing the variance across strata, to calculate 95% confidence limits of the estimate. The abundance is estimated over the same survey area in each year. The numbers of valid stations used in the final analysis in each year are shown in Table 13.8. On average, 40.5 stations have been considered valid each year, and then raised to a stock area of 1774.6 km^2. Greater sampling levels were possible in 2001 as poor weather meant the vessel was unable to work elsewhere.

13.2.6.1.3 Exploratory assessment runs

Analytical assessments

The XSA method was not applied in 2006.

Underwater TV Survey

The approach used to provide a stock abundance estimate from the TV survey is outlined in section 13.2.6.1.2. Scrutiny of the 45 video recordings of the 2005 survey showed that 4 stations could not be used through problems of poor visibility or location at the margins of the *Nephrops* ground on coarse sediment. Most stations at the North Minch had densities in the range 0.5 to 0.7 per m^2.

13.2.6.1.4 Final assessment run

Underwater TV Survey

The underwater TV survey is presented as the best available information on the North Minch *Nephrops* stock. This survey provides a fishery independent estimate of *Nephrops* abundance. The details of the 2005 survey is shown in Table 13.7 compared with the 2004 outcome. At present it is not possible to extract any length or age structure information from the survey, and it therefore only provides information on absolute abundance over the area of the survey.

13.2.6.1.5 Comparison with last years assessment

The new TV survey data presented at the meeting extends the time series by 1 year and has not changed overall perceptions of the state of this stock. Table 13.7 provides a comparison with the previous year’s outcome.

13.2.6.2 Long-term trends in biomass, fishing mortality and recruitment

Details of the 12 year span covered by TV surveys in the North Minch are provided in Table 13.8. The TV survey estimates of abundance for *Nephrops* in the North Minch suggest that the population remained relatively stable between 1994 and 2001 (although no surveys were conducted in 1995 and 1997). The abundance then increased significantly between 2001 and 2003, remaining at a level of around 1100 million individuals in 2004 and 2005 (Figure 13.7). The increase in abundance observed between 2001 and 2003 coincides with the increases in CPUE observed in the catch data, particularly for the smaller size category, interpreted as increase in recruitment.

13.2.6.3 Medium-term projections

Medium term projections were not conducted. WGNEPH has previously expressed concerns over the appropriateness of such approaches for *Nephrops*, where stock recruit relationships are poorly understood, and WGNSDS had further concerns over the required age structured assessment. This applies to each of the main *Nephrops* stocks in Management Area C.

13.2.6.4 Yield and biomass per recruit

An age based yield and biomass per recruit assessment was not carried out. For providing guidance on candidate harvest rate values in the prediction of landings from TV surveys, a combined sex, length based yield per recruit was performed (see section 13.6).

13.2.6.5 Reference points

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

13.2.6.6 Quality of assessment

13.2.6.6.1 Landings

There are concerns over the accuracy of landings data and because of this the final assessment adopted is independent of official statistics. The length and sex composition of the landings data is considered to be well sampled. Preparation of the Scottish length data for 2005 was delayed owing to difficulties in the implementation of a new database system. The data for 2005 may be subject to some minor revision at the 2007 meeting of WGNSDS.

13.2.6.6.2 Effort

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

13.2.6.6.3 Discards

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.

13.2.6.6.4 Surveys

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 have remained relatively stable throughout the time period, although greater sampling was possible in 2001. Confidence intervals around the abundance estimates are greater than during the late 1990’s, when abundance estimates were lower, but have remained similar since 2002. More general uncertainties relating to underwater TV surveys for *Nephrops* include the extent to which the area of coverage of the survey reflects the distribution of the stock and fishery, and the sensitivity of the outcome to potential differences in the size composition of the fisheries (used to provide a mean weight) and the size compositions implied by the size range of burrows actually counted. For the North Minch, the time series of surveys examined do not include stations within sealoch areas, and these are therefore excluded from the overall population estimate. Sea loch surveys have been conducted in the last few years and attempts will be made to complete analysis of this dataset (albeit limited) for the 2007 WGNSDS. The area of mud is likely to be underestimated.

13.2.6.6.5 Model Formulation

The levels of discard and landings sampling are appropriate for this stock, but concerns over the landings and effort statistics, the length slicing and the appropriateness of dynamic pool models for *Nephrops* have led the WG to the conclusion that catch at age analyses should not presently be presented for *Nephrops* stocks. Advice is therefore provided on the basis of the Scottish underwater TV surveys. This applies to each of the main *Nephrops* stocks in Management Area C. Ongoing developments in size based and spatially disaggregated assessment methodologies (reported at WKNEPH, 2006) will continue and hopefully be applied in due course. Most of these methods will rely on improved biological data, particularly on growth rate.

13.3 South Minch

Prior to 2005, WGNEPH conducted a variety of analyses on the *Nephrops* data for this stock, including analytical assessments and a review of a number of stock indicators. Owing to serious concerns about the quality of landings statistics and uncertainty about model assumptions, the 2005 meeting of WGNSDS did not base its advice on XSA assessments but used underwater television survey information instead. This approach was continued at the 2006 meeting

13.3.1 The Fishery

General information on the fishery can be found in the Stock Annex (A.2).

13.3.1.1 ICES advice applicable to 2005 and 2006

ICES advice for this stock is included in advice for Management Area C as a whole, and is described in 13.1.1.

13.3.1.2 Management applicable in 2005 and 2006

Management applicable to this stock is included in management for Management Area C as a whole, and is described in 13.1.2.

13.3.1.3 The fishery in 2005

Two distinct fleets continued to operate in the South Minch during 2005. Inshore, a large fleet of smaller vessels including creel boats operated throughout the year. Most of the trawlers in this fleet are under 15m in length and use 70mm mesh nets. Trips were typically of 1-3 days usually operating within about 3 hours steaming distance. In recent years, small boats from the east coast and Firth of Clyde have visited the South Minch but in 2005 very few boats came round. Between July and November local inshore boats moved round to the Moray Firth for the seasonal squid fishery. During the winter months fishing activity is severely reduced in the South Minch due to the weather and small boats are often restricted to fishing in the sheltered sea-lochs. This was reflected in the reported seasonal pattern of effort which showed a peak in the 2nd and third quarters.

Reports suggest that a smaller number of larger offshore vessels operating from the two main ports of Mallaig and Oban accounted for the largest proportion of the landings. Working 4-6 day trips, these boats were more nomadic, making regular forays into the North Minch and North Sea depending on fishing opportunities. Most of these boats are in excess of 15m and operated twin-rig mesh nets with larger meshes. These boats took the usual range of marketable fish by-catch (mainly monkfish, haddock, whiting, cod, flatfish, skates and rays, dogfish) especially when operating offshore at Stanton Bank. During the 2005 season, a customary late winter visit by large east coast boats did not place (owing to good fishing in the

North Sea). In some years a few of the locals boast also fish for sprats in November/December, although the number of boats taking part in this fishery was not significant in 2005.

Reported Nephrops trawl effort was slightly down compared to 2004.

13.3.1.4 Official Catch Statistics

Catch statistics reported to ICES are shown in Table 13.2; these relate to the whole of VIa of which the South Minch is a part. Official catch statistics for FU 12 provided through national laboratories are presented in Table 13.9 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 1990's, and low levels more recently reported for Ireland. Total international reported landings in 2005 was 3 841 tonnes, consisting of 2 856 tonnes landed by trawlers and 953 tonnes landed by creel vessels. These estimates for total landings show an overall slight decline since 1999 (from 4 051 tonnes). Landings from creel vessels continue to increase steadily, and in 2005 contributed almost 25% of the total landings. Reported effort by Scottish *Nephrops* trawlers has shown a long term decline since 1990, (Figure 13.8 and Table 13.9) although the reliability of these data is questionable since the logsheet recording of 'hours fished' is known to have become more erratic. Scottish *Nephrops* trawler LPUE remained stable between 1998 and 2001, but has shown a slight increase in more recent years.

13.3.1.5 Revisions to Catch data

The last assessment of Management Area C *Nephrops* stocks was conducted by WGNSDS in 2005. Some minor revisions have been made to 2004 catch data.

13.3.1.6 Quality of the Catch data

See section 13.2.2.3.

13.3.2 Commercial catch-effort data and research vessel surveys

13.3.2.1 Commercial catch effort

Males contribute more to the landings and the LPUEs than females, although the proportion of females tends to increase in years when the effort distribution between the 2nd and 3rd quarter is more evenly spread (Figure 13.9). Effort is normally highest in the 2nd quarter in this fishery, and generally lowest in the 4th quarters. Male LPUE showed an increase in 1995, declined to a relatively stable level between 1996 and 2001, but has increased steadily to 2005.

Discarding of undersize and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discarding rates averaged over the period 2003 to 2005 for this stock were 26% by number. This represents a small increase on the 2002 to 2004 period. An indication of the size distribution of discards compared to landings is provided in Figure 13.10. CPUE data for each sex, for *Nephrops* above and below 35 mm CL, are shown in Figure 13.11. This size was chosen for all the Scottish stocks examined as the general size limit above which the effects of discarding practices and the addition of recruits were likely to be small. The data show a peak in CPUE for smaller individuals in 1995, with values declining to the longer term average after this, and a second rise in 2001 which has continued upward to 2005. The higher values are particularly evident for males in the 1st and 4th quarters. The CPUE for larger males increased in 1994, and also shows a similar increase to the smaller size category in the most recent years. CPUE for the larger females appears to have fluctuated without trend since 2001.

See also Section 13.2.2.1

13.3.2.2 Research vessel surveys

Underwater TV surveys are available for this stock since 1995. Figure 13.12 shows the distribution of stations in TV surveys, with the size of the symbol reflecting the *Nephrops* burrow density. Figure 13.13 shows the time series estimated abundance for the TV surveys, with 95% confidence intervals on annual estimates.

13.3.3 Size composition, age composition and mean weights-at-age

Quarterly landings and discard at length data were available from Scotland. The sampling levels are shown in table 2.3. The sampling, raising and collation procedures for length-compositions are described in the Stock Annex (Sections B.1 and B.2).

A summary of mean size information is given in Table 13.11. Mean size of all categories appears to have been relatively stable since 1996 although in the <35mm catch category there is some evidence of a reduction in 2001 and in the most recent 2 years. Examination of the CPUE data in conjunction with the changes in mean size of the two size categories (Figure 13.8), leads to the suggestion that the increase in CPUE observed since 2001 is associated with a drop in mean size in the < 35 mm CL category in 2001, implying an increase in recruitment. The increase in CPUE of larger males lags slightly behind that of the smaller category, although the mean size of the larger individuals also fell in 2001.

Length composition data for 2003-2005 were used to generate LCA male and female input data files to provide a recent average length composition for use in the TV survey predicted catch calculations (Figure 13.10 – the data have been added to the stock files)

In previous years when XSA has been performed, length compositions of combined landings and dead discards were raised to annual values of removals and sliced using the WGNEPH program L2AGE into numbers at nominal age and weights at age. These were not prepared in 2006.

13.3.4 Natural mortality, maturity at age and other biological parameters

Input parameter values for this stock are poorly known. WKNEPH (2006) has drawn attention to the need to update and improve basic data, especially growth rates, for most *Nephrops* stocks. A summary of values is provided in the Stock Annex (Sections B1 and B2).

13.3.5 Catch-at-age-analyses

This method was not conducted at this year’s WG meeting.

13.3.5.1 Data screening and exploratory runs

13.3.5.1.1 Commercial catch data

See section 13.2.6.1.1.

13.3.5.1.2 Survey data

See section 13.2.6.1.2. The numbers of valid stations used in the final analysis in each year are shown in Table 13.13.

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2004 TV survey							
M	303	3	0.53	0.02	162	604	0.011
SM	2741	19	0.56	0.12	1533	48089	0.921
MS	2028	16	0.42	0.01	848	3512	0.067
Total	5072	38			2543	52206	1
2005 TV survey							
M	303	2	0.69	0.04	208	1674	0.015
SM	2741	17	0.55	0.24	1504	106640	0.732
MS	2028	14	0.40	0.13	816	37418	0.257
Total	5072	33			2528	145732	1

Table 13.On average, 34.5 stations have been considered valid each year, and then raised to a stock area of 5071.3 km^2. Greater sampling levels were possible in 2001 as poor weather meant the vessel was unable to work elsewhere. In 2003 sampling was lower owing to poor weather.

13.3.5.1.3 Exploratory assessment runs

XSA

The XSA method was not applied at this meeting.

Underwater TV Survey

The approach used to provide a stock abundance estimate from the TV survey is outlined in section 13.2.6.1.2. Scrutiny of the 37 video recordings of the 2005 survey showed that 4 stations could not be used through problems of poor visibility or location at the margins of the *Nephrops* ground on coarse sediment. Most of the 33 stations included in the final analysis at the South Minch had densities in the range 0.4 to 0.6 per m^2.

13.3.5.1.4 Final assessment run

Underwater TV Survey

The underwater TV survey is presented as the best available information on the South Minch *Nephrops* stock. This survey provides a fishery independent estimate of *Nephrops* abundance. The details of the 2005 survey is shown in Table 13. compared with the 2004 outcome. At present it is not possible to extract any length or age structure information from the survey, and it therefore only provides information on absolute abundance over the area of the survey.

13.3.5.1.5 Comparison with last years assessment

The new TV survey data presented at the meeting extends the time series by 1 year and has not changed overall perceptions of the state of this stock. Table 13.12provides a comparison with the previous year’s outcome. The abundance estimate for 2005 was very similar to that of 2004.

13.3.5.2 Long-term trends in biomass, fishing mortality and recruitment

Details of the 11 year span covered by TV surveys in the South Minch are provided in Table 13.13. The TV survey estimate of abundance for *Nephrops* in the South Minch suggests that the population fluctuated without trend between 1995 and 2000, but appears to have remained more stable and at a slightly higher level from 2001 to 2003. The survey suggests that this higher abundance was maintained through to 2005. The increase to the more stable level of abundance observed after 2001 coincides with the increase in CPUE and reduction in mean size observed in the catch data, particularly for the smaller size category, interpreted as increase in recruitment.

13.3.5.3 Medium-term projections

See section 13.2.6.3.

13.3.5.4 Yield and biomass per recruit

See section 13.2.6.4

13.3.5.5 Reference points

No precautionary approach reference points have been determined for *Nephrops* stocks.

13.3.5.6 Quality of assessment

13.3.5.6.1 Landings

There are concerns over the accuracy of landings data and because of this the final assessment adopted is independent of Official statistics. The length and sex composition of the landings data is considered to be well sampled. Preparation of the Scottish length data for 2005 was delayed owing to difficulties in the implementation of a new database system. The data for 2005 may be subject to some minor revision at the 2007 meeting of WGNSDS.

13.3.5.6.2 Effort

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

13.3.5.6.3 Discards

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.

13.3.5.6.4 Surveys

An uninterrupted series of annual underwater TV surveys are available since 1995 for this stock. The number of valid stations in the survey has remained relatively stable throughout the time period, although greater sampling was possible in 2001, and sampling was lower in 2003. Confidence intervals around the abundance estimates are generally greater than during the late 1990’s, when abundance estimates were lower. Sampling level in relation to the area of the stock is lower for the South Minch than other west of Scotland *Nephrops* stocks, and 95% confidence limits are broader. Generic TV survey issues are discussed in Section 13.2.6.6.4. The time series of surveys examined do not include stations within sealoch areas, and these are therefore excluded from the overall population estimate. Sea loch surveys have been conducted in the last few years and attempts will be made to complete analysis of this dataset (albeit limited) for the 2007 WGNSDS. The area of mud is likely to be underestimated.

13.3.5.6.5 Model Formulation

See section 13.2.6.6.5.

13.4 Clyde

Prior to 2005, WGNEPH conducted a variety of analyses on the *Nephrops* data for this stock, including analytical assessments and a review of a number of stock indicators. Owing to serious concerns about the quality of landings statistics and uncertainty about model assumptions, the 2005 meeting of WGNSDS did not base its advice on XSA assessments but used underwater television survey information instead. This approach was continued at the 2006 meeting

13.4.1 The Fishery

General information on the fishery can be found in the Stock Annex (A.2).

13.4.1.1 ICES advice applicable to 2005 and 2006

ICES advice for this stock is included in advice for Management Area C as a whole, and is described in 13.1.1.

13.4.1.2 Management applicable in 2005 and 2006

Management applicable to this stock is included in management for Management Area C as a whole, and is described in 13.1.2.

13.4.1.3 The fishery in 2005

Around 35 Trawlers ranging from 9.9m to 20m operated in the Clyde during 2005. Most operated single rig 70mm gears with a few boats working 80mm twin-rig. 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 Nephrop fleet fish daily trips. Fishing in the Clyde was generally steady through the year although there is a dip in catches during April and May. Most of the Clyde fleet stayed in the area during the whole of 2005 and overall effort was little changed from 2004. In common with other years a small by-catch of fish was taken in the Clyde consisting mainly of cod, hake and whiting

A few Northern Irish boats fish the Clyde at varying times of the year fishing mainly for tails, these boats land mainly into Campbelltown though often make landings into Troon depending on where the boats are fishing

Mobile gear is banned in the Inshore Clyde from Friday night to Sunday night as are vessels greater than 21m in length. An increasing number of creel boats operate in the Clyde (70 registered in 2005). Creeling activity often takes place during the weekend when the trawlers cannot fish due to the ban. Only about a third of creelers operated throughout the year, the rest prosecuted a summer fishery. There was considerable gear conflict in 2005.

13.4.2 Catch data

13.4.2.1 Official Catch Statistics

Catch statistics reported to ICES are shown in table 13.2; these relate to the whole of VIa of which the Firth of Clyde is a part. Official catch statistics for FU 13 provided through national laboratories are presented in Table 13.14 broken down by country and by gear type. Landings from this fishery are predominantly reported from Scotland, although the remainder of the UK also contributes, and landings from Northern Ireland form the main part of this. Landings from England, Wales and Northern Ireland contributed about 9% of the total in 2004. Total international reported landings in 2004 was 3423 tonnes, consisting of 3180 tonnes landed by trawlers and 95 tonnes landed by creel vessels. Creel landings have increased in recent years but remain at a low level. The Clyde FU comprises two distinct *Nephrops* fisheries in the Firth of Clyde and the Sound of Jura, to the east and west of the Mull of Kintyre (Figure 13.1). UK landings are broken down between these sub-areas for recent years in Table 13.15 which shows that the contribution from the Sound of Jura has declined in recent years. Landings and effort have declined from high levels in the mid 1990's, and Scottish *Nephrops* trawler LPUE has increased markedly since 2001(Figure 13.14, Table 13.16). The reliability of these data is questionable since the logsheet recording of 'hours fished' is known to have become more erratic.

13.4.2.2 Revisions to Catch data

The last assessment of Management Area C *Nephrops* stocks was conducted by WGNSDS in 2005. Some minor revisions have been made to 2004 catch data.

13.4.2.3 Quality of the Catch data

See section 13.2.2.3.

13.4.3 Commercial catch-effort data and research vessel surveys

13.4.3.1 Commercial catch effort

Sampling data are not as extensive in the Sound of Jura as in the Firth of Clyde, and discard data are only available for the later area. More detailed analysis of the catches and landings are only available for the Firth of Clyde.

Males contribute more to the landings and the LPUEs than females, although the proportion of females tends to increase in years with considerably more effort in the 3rd quarter than the second (ie 1994; Figure 13.15). Effort has previously been highest in the 3rd quarter in this fishery, but has become far more even through the year as the overall level of effort has declined. Male LPUE showed an increase in 1995, to a relatively stable level, and then a further increase between 2001 and 2003; it remains high in 2005 particularly in the first and fourth quarters. Female LPUE is lower than that for males, but shows similar increases after 1995 and 2001, highest rates are obtained in the second and third quarters.

Discarding of undersize and unwanted *Nephrops* occurs in this fishery, and quarterly discard sampling has been conducted on the Scottish *Nephrops* trawler fleet since 1990. Discarding rates averaged over the period 2003 to 2005 for this stock were particularly high at 35% by number. This represents a decrease in discarding rate compared to the 2002 to 2004 period. An indication of the size distribution of discards compared to landings is provided in Figure 13.16. CPUE data for each sex, for *Nephrops* above and below 35 mm CL, are shown in Figure 13.17. This size was chosen for all the Scottish stocks examined as the general size limit above which the effects of discarding practices and the addition of recruits were likely to be small. For both sexes the data show a series of increases in CPUE for smaller individuals in 1995, 1998 and 2003. In small males this rate did not increase further in 2005 but in females there was further rise. The CPUE for larger males remained relatively stable prior to 1997, fell to a slightly lower stable level until 2002, and then increased markedly in 2003 – it remained high in 2005. CPUE for the larger females shows a similar pattern in the early part of the time series but there has not been a noticeable increase recently.

See also Section 13.2.3.1

13.4.3.2 Research vessel surveys

Underwater TV surveys are available since 1995 for the two sub- areas contained in FU13. Figure 13.18 shows the distribution of stations in TV surveys for the Firth of Clyde, with the size of the symbol reflecting the Nephrops burrow density.

Figure 13.19 Nephrops, Firth of Clyde (FU13), Time series of TV survey abundance estimates, with 95% confidence intervals, 1995 – 2005.

Figure 13.19 shows the time series of estimated abundance for the Firth of Clyde TV surveys, with 95% confidence intervals on annual estimates. Figure 13.20 shows the time series of estimated abundance for the Sound of Jura TV surveys, with 95% confidence intervals on annual estimates.

13.4.4 Age composition and mean weights- at- age

Quarterly landings and discard at length data were available from Scotland. The sampling levels are shown in XXXX. The sampling, raising and collation procedures for length-compositions are described in the Stock Annex (Sections B.1 and B.2).

A summary of mean size information is given in Table 13.17. Mean size of all categories appears to have been relatively stable although small changes are apparent. Examination of the CPUE data in conjunction with the changes in mean size of the two size categories (Figure 13.14), leads to the suggestion that the increases in CPUE observed in 1995, 1998 and 2003 were all associated with drops in mean size in the < 35 mm CL category, implying increases in recruitment. Mean sizes in the larger category of both males and females have shown a very gradual decline.

Length composition data for 2003-2005 were used to generate LCA male and female input data files to provide a recent average length composition for use in the TV survey predicted catch calculations (Figure 13.16 – the data have been added to the stock files)

In previous years when XSA has been performed, length compositions of combined landings and dead discards were raised to annual values of removals and sliced using the WGNEPH program L2AGE into numbers at nominal age and weights at age. These were not prepared in 2006.

13.4.5 Natural mortality, maturity at age and other biological parameters

Input parameter values for this stock are poorly known. WKNEPH (2006) has drawn attention to the need to update and improve basic data, especially growth rates, for most *Nephrops* stocks. A summary of input values is given in the Stock Annex (Section B1 and B2).

13.4.6 Catch- at- age- analyses

This method was not conducted at this year’s WG meeting.

13.4.6.1 Data screening and exploratory runs

13.4.6.1.1 Commercial catch data

See section 13.2.6.1.1.

13.4.6.1.2 Survey data

See section 13.2.6.1.2. The numbers of valid stations used in the final analysis in each year are shown for the Firth of Clyde in Table 13.19 and for the Sound of Jura in Table 13.20. An average of 36.6 stations have been sampled in each year, and then raised to a stock area of 2062.2 km^2 for the Firth of Clyde, and 10.3 stations have been considered valid each year for the Sound of Jura.

13.4.6.1.3 Exploratory assessment runs

XSA

The XSA method was not applied at this meeting.

Underwater TV Survey

The approach used to provide a stock abundance estimate from the TV survey is outlined in section 13.2.6.1.2. Scrutiny of the 44 Clyde video recordings of the 2005 survey showed that all were suitable for inclusion in the assessment. Most of the stations included in the Clyde analysis had densities in the range 0.8 to 1.4 per m^2. All 11 stations in the Sound of Jura were suitable for analysis and densities there ranged from 0.6 to 1.8 per m^2.

13.4.6.1.4 Final assessment run

Underwater TV Survey

The underwater TV survey is presented as the best available information on the stocks of *Nephrops* in FU13. The survey in the Clyde component provides a fishery independent estimate of *Nephrops* abundance. The details of the 2005 survey is shown in Table 13.18 compared with the 2004 outcome. At present it is not possible to extract any length or age structure information from the survey, and it therefore only provides information on absolute abundance over the area of the survey. Details of the 2005 data for the more intermittent Sound of Jura survey is given in Table 13.20.

13.4.6.1.5 Comparison with last years assessment

The new TV survey data presented at the meeting extends the Firth of Clyde time series by 1 year and does not change the recent perception of the state of this stock. Table 13.18provides a comparison with the previous year’s outcome. The abundance estimate for 2005 was slightly above that of 2004, but not significantly so.

The data for 2005 continues the previously observed trend of increasing abundance (Figure 13.19). There was no survey in the Sound of Jura in 2004 with which to make comparison.

13.4.6.2 Long-term trends in biomass, fishing mortality and recruitment

The TV survey estimate of abundance for *Nephrops* in the Firth of Clyde suggests that the population has increased steadily since 1999. The data for 2005 appear to suggest a continuation of the previously observed high abundance in recent years (Figure 13.19)

Reductions in the mean size in catches coincident with increases in CPUE The increase to the more stable level of abundance observed after 2001 coincides with the increase in CPUE suggest strong recruitments in 1995, 1998 and 2003. A series of good recruitments would be consistent with the increase in abundance observed from the TV surveys. The higher levels of discarding observed in recent years are associated with the increase in CPUE of smaller individuals.

The TV survey estimate of abundance for *Nephrops* in the Sound of Jura suggest that the population increased between the mid 1990's and 2002 (although there is a gap in the survey time series), but appears to have declined from the high 2002 figure in 2003. No survey was available in 2004 but in 2005 the abundance was similar to 2003.

13.4.6.3 Medium-term projections

See section 13.2.6.3.

13.4.6.4 Yield and biomass per recruit

See section 13.2.6.4

13.4.6.5 Reference points

No precautionary approach reference points have been determined for *Nephrops* stocks.

13.4.6.6 Quality of assessment

13.4.6.6.1 Landings

There are concerns over the accuracy of landings data and because of this the final assessment adopted is independent of Official statistics. The length and sex composition of the landings data is considered to be well sampled. Preparation of the Scottish length data for 2005 was delayed owing to difficulties in the implementation of a new database system. The data for 2005 may be subject to some minor revision at the 2007 meeting of WGNSDS.

13.4.6.6.2 Effort

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

13.4.6.6.3 Discards

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.

13.4.6.6.4 Surveys

An uninterrupted series of annual underwater TV surveys are available since 1995 for the Firth of Clyde. The number of valid stations in the survey have remained relatively stable throughout the time period. Confidence intervals around the abundance estimates have remained relatively stable through the time period. The TV survey for the Sound of Jura was not conducted from 1997 to 2000, and also in 2004. Such large gaps in the series make interpretation of any trends from the data difficult. Generic TV survey issues are discussed in Section 13.2.6.6.4.

13.4.6.6.5 Model Formulation

See section 13.2.6.6.5.

13.5 Other Nephrops Stocks

Nephrops fisheries also take place outside the Functional Units in Management Area C, although they only represent about 3% of the reported landings (Table 13.3). The main areas of activity are the Stanton Bank (to the west of the South Minch; Figure 13.1) and areas of suitable sediment along the shelf edge and slope to the west of the Hebrides.

13.5.1 Stanton Bank

Underwater TV surveys have been conducted at the Stanton Bank ground when time allows on the annual west of Scotland survey. Figure 13.21 shows the time series of estimated abundance for the Stanton Bank TV surveys, with 95% confidence intervals on annual estimates, (details are shown in Table 13.22 and Table 13.23). An average of 8.2 stations have been sampled in each year, and then raised to a stock area of 287.5 km^2. Surveys conducted in 1995 and 1997 were stratified in a slightly different way to those after 2001, and have broader confidence intervals. Surveys between 2001 and 2003 indicate a general increase in abundance, although the annual confidence intervals overlap. No survey was conducted in 2004. In 2005 a new survey suggested a further increase in abundance but again, the confidence intervals overlap with previous years.

13.5.2 Shelf edge west of Scotland

FRS has taken the opportunity of using the Scotia deepwater surveys conducted in 2000, 2002 and 2004 to conduct preliminary underwater TVwork 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 635m, 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.

13.6 Management Area C Overview and management Considerations

13.6.1 Summary and discussion of assessments

Underwater TV surveys of the *Nephrops* stocks in the Management Area C Functional Units indicate a continuation of the general upward trend in abundance over recent years (Figure 13.22). Overall increases in abundance for the 3 Functional Units are quite substantial, with average abundance for the 2002-2005 period 52% greater than the period up to 2001. Results are corroborated by increases in commercial catch rates and there appears to have been good recruitment in recent years. Examination of trends in the mean size of larger animals (>35mm) shows little evidence of significant declines and the stocks appear to be sustainable at current effort levels.

The Underwater Television technique for counting burrows and assessing abundance continues to be developed and it is recognised that further progress can be made and that a number of issues need to be addressed. A key area is the consistency of counting and building in quality control measures. The Working Group discussed the marked differences in the densities between the of West of Scotland counts and the those from the Irish Sea. This is further discussed in Section 14. It is important to point out, however, that a wide range of densities are obtained across the various Scottish grounds surveyed (these are shown in Figure 14.8) and for these, the same TV equipment, counters and protocol are used on the different grounds. It is clear that that stock density can vary from place to place and this probably reflects the different physical nature of the grounds and the population dynamics of Nephrops associated with them. This observation continues to give support to the long held ICES Working Group and ACFM view that Nephrops stocks should be managed at a smaller scale. This was reiterated by STECF 2005.

Use of the technique to estimate abundance raised to the areas of suitable Nephrops ground depends on as accurate an estimation of mud sediment distribution and area as possible. In

ICES Area VIa the mud areas are derived from British Geological Survey data. This is consdered to give good coverage in the Firth of Clyde area (where extensive maritime activity and resource use led to intensive sampling) but was less extensive in the Minches. It is increasingly clear that the estimates used for FUs 11 and 12 give underestimates of mud area. Figure 13.23 illustrates areas in the North Minch requiring attention and notable, well known Nephrops areas exploited mainly by creel vessels include the Torridon, Summer Isles and inshore Hebrides areas. In the South Minch, Figure 13.24 shows that there are weaknesses in the data around the Sound of Sleet and Tiree and Colonsay areas. There is also a need improve the estimate at Stanton Bank. Under-estimates of area mean that the abundance estimates should be considered minimum values.

13.6.2 Sustainable harvest rates

In order to be able to provide advice on suitable levels of landings for management purposes, an exploitation or harvest rate needs to be applied to the abundance estimate. Difficulties have been experienced in the use of advice for Nephrops based on average historic landings, particularly where the spatial extent of the fishery has expanded. This has led to mis-reporting in some of theses fisheries. Continuation with the reliance on landings to provide a reliable harvest rate for these stocks is likely to exacerbate the problem. Indeed the application of an unrealistically low TAC implies that effort would be cut at a time when there are clear indications that the stocks are healthy and have increased in size.

At its 2005 autumn meeting STECF concluded that the use of a harvest rate based on $F_{0.1}$ derived from yield per recruit offers a sustainable approach providing that effort is controlled and providing that stocks are managed at the Functional Unit level. Icelandic stocks of Nephrops have, for some time been managed in line with an $F_{0.1}$ target mortality (ICES, 1992) and a number of other sessile shellfish species are dealt with in the same way (Cryer,1998; Morrison and Cryer, 1999)

Combined sex Y/R plots are shown in Figure 13.25 for each of the Functional Units based on average length compositions of removals for 2003-2005. The text table below shows the $F_{0.1}$ and F_{max} obtained from these yield curves. These estimates are very similar between stocks, driven by the input parameters (see Stock Annex) which are similar for these stocks. Undue emphasis should probably not be placed on the estimated current F from these calculations owing to the tendancy for length cohort analysis to overestimate F. Current F is on the flat topped part of the curves and fairly close to F_{max}.

FUNCTIONAL UNIT	$F_{0.1}$	F_{MAX}
North Minch	0.23	0.39
South Minch	0.23	0.41
Firth of Clyde	0.23	0.38

The estimates of $F_{0.1}$ and F_{max} have been used in the next section. There is a need to improve the basis of the combined sex yield approach (see section 13.6.5), in particular developing an approach which allows for the different seasonal fishing patterns in different Functional Units (and the resultant potential for different exploitation patterns on the two sexes).

13.6.3 Predicted landings in 2007

The approach used to calculate predicted landings nunder a range of different harvest rates is shown in Figure 13.26. In addition to the harvest rates discussed above, predicted landings for arbitrary values of 15%, 20% and 25% have also been computed. Average TV derived abundance values for 2003-2005 and the average length compositions used in the Y/R were used in the calculations. Summaries of the calculations for each Functional Unit is given in Table 13.24, Table 13.25 and Table 13.26. The following text table provides an overall total (all tonnes) for the 3 Functional Units:

HARVEST RATE	NORTH MINCH	SOUTH MINCH	FIRTH OF CLYDE	TOTAL
15%	3213	7226	3765	14204
20%	4284	9634	5020	18938
21% (= F0.1 =0.23)	4498	10116	5271	19885
25%	5355	12043	6275	23673
34% (=Fmax=0.39)	6855	16378	8032	31265

These calculations take no account of the known Nephrops areas which are less well surveyed or do not have adequate sediment distribution information to include in the main areas shown above. Three areas in particular should not be overlooked, the sea loch areas where most creeling for Nephrops takes place, the Sound of Jura area and the other, more offshore areas such as Stanton Bank and the shelf edge where Irish fishermen frequently operate. To provide some guidance on appropriate landings for these areas, the use of average landings for the last 3 years could be considered (subject to review as new, more reliable data, become available):

Creeling areas: average creel landings 2003-2005 = 1673 tonnes

Sound of Jura: average landings 2003-2005 = 35 tonnes

Other areas in Management Area C: 2003-2005 = 363

The Working Group discussed the potential sensitivity of the calculations method to several inputs, most notably the choice of input length composition. Inappropriate choice of this could lead to under or overestimates of the amount of future landings. There was concern that using the catch composition from the commercial fleet might not be representative of the size composition in the population. In section 14, survey catches obtained from smaller mesh nets were used. In the West Coast of Scotland Functional Units , preliminary calculations to investigate the potential effect of the selectivity of the commercial Nephrops gear itself were carried out using Nephrops gear selectivity parameters as follows: mesh size =70mm, Selection Factor =0.4, Selection Range = 13mm . These calculations showed that the predicted landings (under any of the harvest rates) were reduced by between 22 and 29%. Further sensitivity studies are required which look more closely at using appropriate population structures for the length composition. More important, however, is the need to establish exactly what the smallest size of animal (burrow size equivalent) observed during the surveys is. It is quite possible that burrows belonging to the smaller animals in the captured length composition are not being counted in which case the reductions discussed above would be too large. During the earlier stages of life juvenile Nephrops frequently occupy adult burrows and take some time to construct recognisable burrows.

At its meeting earlier in the year WKNEPH concluded that notwithstanding the need for further developmental work, the approach described offers a useful way forward. This WG considers that while not perfect, this approach provides an improved basis for advice than previously adopted for *Nephrops* stocks.

13.6.4 Management considerations

Indications from the fisheries suggest recent improved recruitment, and although the increase in abundance will not be totally reflected in increased biomass, higher catch rates would be expected, leading to increased catches for the same effort. Increased discarding rates of smaller individuals have been observed in recent years, and these cohorts will now be reaching marketable size. There are concerns over the accuracy of official landing statistics for these stocks, leading to uncertainty as to the current and historic landings. Such uncertainty means that harvest rates based around historic landings cannot be taken as a proxy for current effort.

Previous ACFM advice states that “the effort in this fishery should not be allowed to increase and the fishery must be accompanied by mandatory programmes to collect catch and effort data on both target and by-catch species”. Results from the yield analysis, albeit preliminary, suggests that a harvest rate based around $F_{0.1}$ would not be inconsistent with the first part of this advice. Furthermore, Section 17 of this report indicates the marked reductions in effort in KWdays across Area VIa have reduced some of the potential for movement of effort into this fishery. There is a need for management measures to be put in place to ensure that expansion of effort is restricted.

The Table presented in the section above provides a range of potential future landings. A catch option based on an $F_{0.1}$ is believed unlikely to lead to increased effort and predicts a catch of around 22000 (including an allowance for the areas not covered by the survey). Taking into account the possibility that a length composition not truly representative of the population has been used and reducing the estimate of the surveyed component by 25% reduces the predicted catch to just under 17000 tonnes. This is very similar to the TAC in place for 2006 (17650 tonnes).

It is expected that the quality of fishery data available for these stocks will improve the increased 2006 TAC and the Registration of buyers and sellers are expected to lead to more accurate landings information from these stocks in the future. Monitoring continues and enhanced work on observer trips onboard commercial vessels should furnish additional data.

Mixed fishery aspects

A recent investigation (SGRST 2004) suggests by-catches of cod are generally low in Management Area C *Nephrops* fisheries. Nevertheless, young cod frequently occur in inshore areas and any emerging year classes should not be subject to mortality as bycatch in smaller mesh fisheries. The use of 70mm mesh continues in a number of the VI Nephrops fisheries and every effort should be made to improve the selectivity of these gears.

13.6.5 Future developments in approach

It is recognised that a number of key issues require further work and this is planned as follows: i) Attempts will be made to provide a more accurate estimation of the entire mud area in each of the three FUs; ii) improving Y/R estimation using a modelling approach incorporating seasonal availability of the two sexes will be attempted; iii) there is an urgent need for a more thorough sensitivity analysis of the approach. iv) it is hoped that new improvements in software available for analysis of the video image will facilitate methodological development to establish the size range of animals from the size range of burrows observed and also to permit partition of the abundance estimate into ‘recruit sizes’ and ‘older’ Nephrops.

It is expected that some of this work will be reported at a meeting of WKNEPH proposed for 2007. In the meantime a generic Working Paper (applicable to both North Sea Nephrops stocks and those in ICES VIa) addressing some of the modelling issues is planned for WGNSSK 2006.

Table 13.1 Nephrops Functional Units and descriptions by statistical rectangle.

FUNCTIONAL UNIT	STOCK	DIVISION	ICES RECTANGLES	MANAGEMENT AREA
11	North Minch	VIa	44-46 E3-E4	C
12	South Minch	VIa	41-43 E2-E4	C
13	Clyde	VIa	39-40 E4-E5	C
14	Irish Sea East	VIIa	35-38E6; 38E5	J
15	Irish Sea West	VIIa	36E3; 35-37 E4-E5; 38E4	J

Table 13.2 Nominal catch (tonnes) of Nephrops in Division VIa and VIb, 1986 – 2005, as officially reported to ICES. There are no Functional Units in ICES Division VIb but occasional small landings are made.

Division VIa	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
France	8	6	1	0	0	0	0	0	3	4	0	0	0	0	1	9	0	0	0	na
Ireland	20	128	11	9	10	1	10	7	6	9	8	5	25	136	130	115	117	145	150	na
Spain	5	11	7	2	4	0	0	0	0	3	1	15	18	40	69	30	18	12	6	na
UK - Eng+Wales+N.Irl.	0	12	44	25	35	37	56	191	290	346	176	133	202	256	137	139	152	81	10208	10258
UK – Scotland	11,283	11,203	12,649	10,949	10,042	10,458	10,783	11,178	11,047	12,527	10,929	11,104	10,949	11,078	10,667	10,568	10,225	10,450		
TOTAL	11,316	11,360	12,712	10,985	10,091	10,496	10,849	11,376	11,346	12,889	11,114	11,257	11,194	11,510	11,004	10,861	10,512	10,688	10364	10258
Unallocated	-20	-122	-10	-11	-23	31	0	-44	-245	-104	51	-4	-23	-18	35	0	13	63	67	244
WG TOTAL	11296	11238	12702	10974	10068	10527	10849	11332	11101	12785	11165	11253	11171	11492	11039	10861	10525	10751	10431	10502

Division VIb	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
France	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	1	1	0	0	3
Germany	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	na
Ireland	0	0	0	0	0	0	0	0	0	0	0	1	1	0	8	1	0	1	0	na
Spain	8	18	27	14	10	30	2	2	5	2	5	3	6	5	3	14	7	5	2	na
UK - Eng+Wales+N.Irl.	0	11	4	0	1	0	4	6	16	26	65	88	46	2	4	2	3	6	20	14
UK – Scotland	0	0	0	0	0	0	1	9	5	1	5	23	7	5	4	7	7	18		
TOTAL	8	29	31	14	11	30	7	17	26	30	81	115	60	12	21	25	18	30	22	17
Unallocated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WG TOTAL	8	29	31	14	11	30	7	17	26	30	81	115	60	12	21	25	18	30	22	17

Combined UK data provided for 2004

Table 13.3 Nephrops, Management Area C: Total Nephrops landings (tonnes) by Functional Unit plus Other rectangles, 1981-2005.

Year	FU 11	FU 12	FU 13	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	*11253*
1998	2441	3730	4843	157	*11171*
1999	3257	4051	3746	438	*11492*
2000	3246	3952	3420	421	*11039*
2001	3259	3992	3190	420	*10861*
2002	3440	3305	3383	397	*10525*
2003	3268	3879	3171	433	*10751*
2004	3135	3868	3025	403	*10431*
2005*	2984	3841	3423	254	*10502*

* provisional

Table 13.4 Nephrops, North Minch (FU11), Nominal Landings of Nephrops, 1981-2005, as officially reported.

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

* provisional   na = not available

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

Table 13.5 Nephrops, North Minch (FU 11): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish Nephrops trawlers, 1981-2005 (data for all Nephrops gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	2320	78.5	29.6	2320	78.5	29.6	na	na	na
1982	2323	82.4	28.2	2323	82.4	28.2	na	na	na
1983	2784	64.9	42.9	2784	64.9	42.9	na	na	na
1984	3449	79.3	43.5	3449	79.3	43.5	na	na	na
1985	3236	96.8	33.4	3236	96.8	33.4	na	na	na
1986	2642	93.2	28.4	2642	93.2	28.4	na	na	na
1987	3458	121.2	28.5	3458	121.2	28.5	na	na	na
1988	3449	115.0	30.0	3449	115.0	30.0	na	na	na
1989	2603	87.9	29.6	2603	87.9	29.6	na	na	na
1990	1941	79.8	24.3	1941	79.8	24.3	na	na	na
1991	2228	93.4	23.9	2123	90.5	23.5	105	2.9	36.7
1992	2978	99.4	30.0	2810	95.7	29.4	168	3.7	45.4
1993	2699	105.4	25.6	2657	104.4	25.4	42	1.0	43.4
1994	2916	100.8	28.9	2916	100.8	28.9	0	0.0	0.0
1995	2940	94.2	31.2	2937	94.1	31.2	3	0.1	60.0
1996	2355	78.0	30.2	2354	78.0	30.2	1	0.0	0.0
1997	2553	90.0	28.4	2510	88.8	28.3	43	1.2	35.8
1998	2023	84.9	23.8	1973	83.4	23.7	50	1.5	33.3
1999	2791	96.7	28.9	2750	95.5	28.8	41	1.2	34.2
2000	2695	92.6	29.1	2675	92.2	29.0	21	0.4	52.5
2001	2651	82.1	32.3	2599	80.9	32.1	51	1.2	43.3
2002	2775	79.3	35.0	2684	76.5	35.1	91	2.8	32.5
2003	2607	74.1	35.2	2589	73.9	35.0	17	0.2	85.0
2004	2400	69.7	34.4	2377	69.0	34.4	23	0.2	99.6
2005*	2267	58.0	39.1	2241	57.7	38.8	26	0.2	114.5

Table 13.6 Nephrops, North Minch (FU 11): Mean sizes (CL mm) above and below 35 mm of male and female Nephrops in Scottish catches and landings, 1981-2005.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	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

* provisional   na = not available

Table 13.7 Nephrops, North Minch (FU11) North Minch (FU 11): Results by stratum of the 2004 and 2005 TV surveys. Note that stratification was based on a series of arbitrary rectangles.

Stratum	Area (km²)	Number of Stations	Mean burrow density (no./m²)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2004 TV survey							
U	656	15	0.71	0.07	464	2148	0.315
V	425	9	0.57	0.05	240	1031	0.151
W	563	10	0.57	0.09	319	2849	0.418
X	131	4	0.64	0.18	84	786	0.115
Total	1775	38			1107	6813	1
2005 TV survey							
U	656	14	0.80	0.10	521	3780	0.540
V	425	10	0.54	0.05	228	863	0.120
W	563	11	0.49	0.07	274	2053	0.290
X	131	6	0.91	0.12	119	359	0.050
Total	1775	41			1142	7055	1

Table 13.8 Nephrops, North Minch (FU 11): Results of the 1994-2005 TV surveys.

Year	Station Number	Mean density	Abundance	95% confidence interval	Biomass
		burrows/m²	millions	millions	'000 tonnes
1994	41	0.38	665	99	12.5-16.9
1995	No survey				
1996	38	0.25	439	62	8.3-11.1
1997	No survey				
1998	38	0.41	728	103	13.8-18.4
1999	36	0.32	565	104	10.2-14.8
2000	39	0.41	725	80	14.2-17.8
2001	56	0.39	691	75	13.6-16.9
2002	37	0.49	876	149	16.1-22.6
2003	41	0.64	1131	209	20.4-29.6
2004	38	0.62	1107	165	20.8-28.1
2005	41	0.64	1142	168	21.5-28.9

Table 13.9 Nephrops, South Minch (FU12), Nominal Landings of Nephrops, 1981-2005, as officially reported

Year	UK Scotland				Other UK	Ireland	Total
	Nephrops trawl	Other trawl	Creel	Sub-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

* provisional na = not available

Table 13.10 Nephrops, South Minch (FU 12): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish Nephrops trawlers, 1981-2005 (data for all Nephrops gears combined, and for single and multirigs separately).

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	2965	81.6	36.4	2965	81.6	36.4	na	na	na
1982	2925	93.1	31.4	2925	93.1	31.4	na	na	na
1983	2595	77.9	33.3	2595	77.9	33.3	na	na	na
1984	3228	93.4	34.6	3228	93.4	34.6	na	na	na
1985	3096	130.3	23.8	3096	130.3	23.8	na	na	na
1986	2694	105.8	25.5	2694	105.8	25.5	na	na	na
1987	2927	126.3	23.2	2927	126.3	23.2	na	na	na
1988	3544	120.9	29.3	3544	120.9	29.3	na	na	na
1989	3846	138.3	27.8	3846	138.3	27.8	na	na	na
1990	3732	153.5	24.3	3732	153.5	24.3	na	na	na
1991	3597	150.5	23.9	3109	134.6	23.1	488	15.8	30.8
1992	3479	127.3	27.3	3092	115.0	26.9	387	12.3	31.5
1993	3608	126.5	28.5	3441	122.5	28.1	167	4.0	41.5
1994	3743	144.4	25.9	3650	141.4	25.8	93	3.0	31.3
1995	3442	100.4	34.3	3407	99.6	34.2	35	0.9	39.8
1996	3108	106.4	29.2	3036	104.1	29.2	71	2.4	30.1
1997	3519	117.5	29.9	3345	112.1	29.8	174	5.4	32.0
1998	2851	101.4	28.1	2792	99.5	28.1	59	1.9	30.4
1999	3165	111.5	28.4	3111	109.3	28.5	54	2.2	24.6
2000	2939	106.2	27.7	2819	102.1	27.6	121	4.1	29.7
2001	2823	101.7	27.8	2764	99.8	27.7	59	1.9	30.8
2002	2234	75.7	29.5	2210	75.1	29.4	25	0.6	38.9
2003	2812	94.3	29.8	2716	93.5	29.0	96	0.8	113.9
2004	2865	89.8	31.9	2598	84.7	30.7	267	5.1	52.0
2005*	2810	82.5	31.9	2566	79.3	32.4	244	3.2	76.8

Table 13.11 Nephrops, South Minch (FU 12): Mean sizes (CL mm) above and below 35 mm of male and female Nephrops in Scottish catches and landings, 1981-2005.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	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

* provisional na = not available

Table 13.12 South Minch (FU12). Results by stratum of the 2004 and 2005 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
2004 TV survey							
M	303	3	0.53	0.02	162	604	0.011
SM	2741	19	0.56	0.12	1533	48089	0.921
MS	2028	16	0.42	0.01	848	3512	0.067
Total	5072	38			2543	52206	1
2005 TV survey							
M	303	2	0.69	0.04	208	1674	0.015
SM	2741	17	0.55	0.24	1504	106640	0.732
MS	2028	14	0.40	0.13	816	37418	0.257
Total	5072	33			2528	145732	1

Table 13.13 Nephrops, South Minch (FU 12): Results of the 1995-2004 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval	Biomass
		burrows/m²	millions	millions	'000 tonnes
1995	33	0.30	1520	331	25.8-40.2
1996	21	0.38	1945	700	27.1-57.5
1997	36	0.28	1434	244	25.8-36.5
1998	38	0.38	1916	306	35.0-48.3
1999	37	0.23	1146	275	18.9-30.9
2000	41	0.37	1851	332	33.0-47.5
2001	47	0.44	2228	512	37.9-60.5
2002	31	0.42	2114	671	31.9-61.5
2003	25	0.42	2121	721	30.9-62.8
2004	38	0.50	2543	457	46.1-66.3
2005	33	0.50	2529	763	38.9-72.7

Biomass estimated on basis of constant mean size (originally estimated from trawl catches and therefore dependent on trawl selectivity) throughout series.

Table 13.14 Nephrops, Clyde (FU13), Nominal Landings of Nephrops, 1981-2005, as officially reported

Year	UK Scotland				Other UK	Total **
	Nephrops trawl	Other trawl	Creel	Sub-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

* provisional   ** Total also includes Rep. of Ireland

Table 13.15 Nephrops, Clyde (FU13): Breakdown of UK Nominal Landings of Nephrops, 1981-2005 into Clyde sub area, Firth of Clyde and Sound of Jura.

Year	UK		
	Firth of Clyde	Sound of Jura	All sub-areas
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	3148	18	3166
2004	2975	50	3025
2005*	3387	36	3423

* provisional   na = not available

Table 13.16 Nephrops, Clyde (FU 13): Landings (tonnes), effort ('000 hours trawling) and LPUE (kg/hour trawling) of Scottish Nephrops trawlers, 1981-2005 (data for all Nephrops gears combined, and for single and multirigs separately). Results for Firth of Clyde component and Sound of jura component shown separately.

Firth of Clyde

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	1861	108.8	17.1	1861	70.5	26.4	na	na	na
1982	1798	93.1	19.3	1798	148.0	12.1	na	na	na
1983	3258	131.9	24.7	3258	108.8	29.9	na	na	na
1984	2433	122.5	19.9	2433	93.1	26.1	na	na	na
1985	3154	131.6	24.0	3154	131.9	23.9	na	na	na
1986	2745	141.5	19.4	2745	122.5	22.4	na	na	na
1987	2126	126.8	16.8	2126	131.6	16.2	na	na	na
1988	3190	141.6	22.5	3190	141.5	22.5	na	na	na
1989	2393	144.3	16.6	2393	126.8	18.9	na	na	na
1990	2435	142.8	17.0	2435	141.6	17.2	na	na	na
1991	2489	152.9	16.3	1594	144.3	11.0	895	39.5	22.7
1992	2091	144.6	14.5	1316	142.8	9.2	775	42.4	18.3
1993	2650	156.8	16.9	1771	113.5	15.6	879	43.1	20.4
1994	1996	118.0	16.9	1484	102.2	14.5	512	27.6	18.6
1995	3501	133.8	26.2	2583	113.7	22.7	918	31.5	29.1
1996	3530	150.1	23.5	2474	90.4	27.4	1048	38.1	27.5
1997	3020	131.9	22.9	2158	98.0	22.0	861	33.9	25.4
1998	4107	150.8	27.2	2964	110.2	26.9	1142	40.5	28.2
1999	3175	117.2	27.1	2322	86.3	26.9	853	30.9	27.6
2000	2980	124.4	24.0	2100	90.9	23.1	880	33.5	26.3
2001	2711	111.6	24.3	2445	100.2	24.4	266	11.4	23.3
2002	3043	99.6	30.6	2896	94.0	30.8	147	5.6	26.3
2003	2937	84.2	34.9	2839	81.2	35.0	97	3.0	32.3
2004	2611	72.3	36.1	2531	69.6	36.4	80	2.7	29.6
2005*	3133	79.8	39.3	3108	78.7	39.5	25	1.1	23.8

* provisional   na = not available, landings not recorded to Multirig trawl before 1991.

Table 13.16 Cont.

Sound of Jura

Year	All *Nephrops* gears combined			Single rig			Multirig		
	Landings	Effort	LPUE	Landings	Effort	LPUE	Landings	Effort	LPUE
1981	na	na	na	na	na	na	na	na	na
1982	na	na	na	na	na	na	na	na	na
1983	na	na	na	na	na	na	na	na	na
1984	na	na	na	na	na	na	na	na	na
1985	na	na	na	na	na	na	na	na	na
1986	na	na	na	na	na	na	na	na	na
1987	na	na	na	na	na	na	na	na	na
1988	na	na	na	na	na	na	na	na	na
1989	184	5.7	32.2	na	na	na	na	na	na
1990	297	10.7	27.7	na	na	na	na	na	na
1991	355	13.1	27.2	191	7.6	25.1	164	5.5	30
1992	380	14.3	26.6	210	8.7	24.1	169	5.5	30.6
1993	557	15.2	36.7	331	10.2	32.6	226	5	44.8
1994	505	15.4	32.8	270	8.6	31.4	235	6.9	34.1
1995	266	8.6	30.9	161	5.5	29.3	105	3.1	33.9
1996	351	10.0	35.1	204	6.2	33.7	147	3.7	39.7
1997	466	15.0	31.1	190	6.9	27.3	276	8.1	34.1
1998	433	13.6	31.9	195	6.7	29.1	238	6.9	35.3
1999	300	10.0	30.0	128	4.4	28.8	172	5.5	31.0
2000	163	6.4	25.5	71	3.2	22.2	92	3.1	29.7
2001	179	7.6	23.6	143	6.7	21.3	36	0.9	40.0
2002	31	1.5	20.7	30	1.5	20.0	1	0.0	33.3
2003	17	1.0	17.0	16	1.0	16.0	1	0.0	33.3
2004	48	0.3	171.4	48	0.3	171.4	0	0.0	0.0
2005*	33	0.4	94.3	32	0.3	103.2	1	0.0	25.0

* provisional na = not available, landings not recorded to Multirig trawl before 1991.

Table 13.17 Nephrops, Clyde (FU 13): Mean sizes (CL mm) above and below 35 mm of male and female Nephrops in Scottish catches and landings, 1981-2005.

Year	Catches		Landings			
	< 35 mm CL		< 35 mm CL		> 35 mm CL	
	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

* provisional   na = not available

Table 13.18 Nephrops, Firth of Clyde (part of FU 13): Results by stratum of the 2004 and 2005 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
2004 TV survey							
M	717	10	0.87	0.10	621	4990	0.276
SM(N)	316	8	0.73	0.10	229	1280	0.071
SM(S)	366	4	1.20	0.03	437	1142	0.063
MS	665	10	0.88	0.24	582	10649	0.590
Total	2063	32			1869	18060	1
2005 TV survey							
M	717	19	0.96	0.17	688	4618	0.296
SM(N)	316	4	0.93	0.01	294	271	0.017
SM(S)	366	7	1.45	0.22	530	4124	0.264
MS	665	14	0.70	0.21	464	6564	0.461
Total	2063	44			1975	15576	1

Table 13.19 Nephrops, Firth of Clyde (FU 13): Results of the 1995-2005 TV surveys.

Year	Stations	Mean density	Abundance	95% confidence interval	Biomass
		burrows/m²	millions	millions	'000 tonnes
1995	29	0.33	671		
1996	38	0.56	1156	248	20.0-31.0
1997	31	0.66	1365	266	24.2-36.0
1998	38	0.67	1384	232	25.4-35.7
1999	39	0.44	907	215	15.2-24.7
2000	40	0.62	1270	188	23.8-32.1
2001	39	0.65	1339	209	24.9-34.2
2002	36	0.73	1499	287	26.7-39.4
2003	37	0.82	1682	233	32.0-42.2
2004	32	0.91	1869	269	35.3-47.2
2005	44	0.96	1975	250	38.1-49.1

Table 13.20 Nephrops, Sound of Jura (Part of FU 13): Results by stratum of the 2003 and 2005 TV surveys (most recent). Note that stratification was based on a series of sediment strata.

Stratum	Area (km^2)	Number of Stations	Mean burrow density ($no./m^2$)	Observed variance	Abundance (millions)	Stratum variance	Proportion of total variance
2003 TV survey							
M	90	5	0.81	0.05	73	82	0.050
SM	150	4	0.71	0.02	106	107	0.065
MS	142	3	0.92	0.21	131	1432	0.883
Total	382	12			309	1621	1
2005 TV survey							
M	90	4	0.94	0.05	84	106	0.042
SM	150	4	0.65	0.00	98	9	0.004
MS	142	3	1.26	0.36	178	2404	0.954
Total	382	11			360	2519	1

Table 13.21 Nephrops, Sound of Jura (Part of FU 13): Results of the 1995-2005 TV surveys.,

Year	Stations	Mean density	Abundance	95% confidence interval
		burrows/m^2	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

Table 13.22 Nephrops, Stanton Banks: Results by stratum of the 2003 and 2005 TV surveys (most recent). 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
2003 TV survey							
SM	26.5	2	0.30	0.00	8	1	0.99
MS	261	6	0.32	0.01	82	151	0.01
Total	288	8			90	152	1.00
2005 TV survey							
SM	26.5	2	0.44	0.05	12	18	0.11
MS	261	5	0.32	0.01	83	144	0.89
Total	288	7			95		1.00

Table 13.23 Nephrops, Stanton Bank: Results of the 1995-2005 TV surveys.

Year	Station number	Mean density	Abundance	95% confidence interval	
		burrows/m²	millions	millions	
1995	9	0.22	64	35	
1996		no survey			
1997	9	0.28	80	31	
1998		no surveys			
1999					
2000					
2001	8	0.24	68	25	
2002	8	0.27	78	21	
2003	8	0.31	90	25	
2004		no survey			
2005	7	0.33	95	26	

Table 13.24 Nephrops, North Minch (FU11): Predicted landings potential based on abundance estimates using TV surveys, current landings and discard length distributions for the North Minch, and various harvest ratio% based on Y/R reference points and arbitrary percentages

Males			Females	
Weight = a*CL^b	a =	0.00028	a =	0.00085
	b =	3.24	b =	2.91

CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)	CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)
11	0.0	0.0	0.0	0.88	0.00	11	0.0	11.5	8.6	1.17	0.00
13	0.0	0.0	0.0	1.45	0.00	13	0.0	9.7	7.3	1.84	0.00
15	1.1	29.1	22.9	2.23	2.45	15	1.8	116.2	89.0	2.71	4.88
17	17.6	194.0	163.1	3.27	57.51	17	7.5	144.3	115.7	3.82	28.66
19	73.4	625.0	542.2	4.60	337.44	19	63.7	624.7	532.2	5.19	330.79
21	471.4	1917.5	1909.5	6.26	2951.19	21	462.3	2007.0	1967.6	6.85	3168.06
23	1548.5	3505.1	4177.3	8.30	12851.50	23	1742.3	3875.1	4648.6	8.83	15380.01
25	3881.7	4443.2	7214.1	10.76	41753.57	25	4736.2	5554.1	8901.8	11.14	52774.17
27	6829.5	3756.4	9646.8	13.68	93398.30	27	8469.8	4170.8	11597.9	13.82	117090.58
29	8639.8	1308.0	9620.8	17.10	147752.41	29	9581.4	920.3	10271.6	16.90	161908.91
31	9079.9	335.8	9331.8	21.08	191392.55	31	7999.4	157.7	8117.7	20.39	163103.31
33	8727.6	59.1	8771.9	25.65	223895.08	33	5301.2	31.4	5324.8	24.32	128942.70
35	6948.7	43.0	6981.0	30.87	214526.87	35	2871.6	2.5	2873.5	28.72	82486.55
37	4930.1	13.4	4940.2	36.78	181347.93	37	1691.2	0.0	1691.2	33.62	56857.03
39	3044.8	13.8	3055.2	43.43	132248.63	39	831.5	0.0	831.5	39.03	32454.56
41	2286.6	15.8	2298.5	50.87	116325.77	41	477.3	0.0	477.3	44.99	21471.67
43	1500.1	9.9	1507.5	59.15	88728.86	43	199.5	0.0	199.5	51.51	10275.65
45	937.5	0.0	937.5	68.31	64041.97	45	83.6	0.0	83.6	58.62	4900.61
47	536.9	2.0	538.4	78.41	42099.12	47	35.5	0.0	35.5	66.35	2355.37
49	313.7	2.0	315.2	89.50	28076.01	49	18.9	0.0	18.9	74.72	1412.16
51	169.7	4.0	172.7	101.63	17246.09	51	2.8	0.0	2.8	83.75	234.50
53	80.3	0.0	80.3	114.85	9222.09	53	0.9	0.0	0.9	93.47	84.13
55	37.6	0.0	37.6	129.21	4858.20	55	0.5	0.0	0.5	103.91	51.95
57	19.6	0.0	19.6	144.77	2837.40	57	0.0	0.0	0.0	115.08	0.00
59	7.3	0.0	7.3	161.57	1179.48	59	0.0	0.0	0.0	127.01	0.00
61	3.3	0.0	3.3	179.68	592.95	61	0.0	0.0	0.0	139.73	0.00
63	0.6	0.0	0.6	199.15	119.49	63	0.0	0.0	0.0	153.25	0.00
65	0.7	0.0	0.7	220.03	154.02	65	0.0	0.0	0.0	167.61	0.00
67	0.1	0.0	0.1	242.37	24.24	67	0.0	0.0	0.0	182.82	0.00
69	0.0	0.0	0.0	266.24	0.00	69	0.0	0.0	0.0	198.91	0.00

Total	72295.93	1618.02	57797.88	855.32
Total (Males + Females)	130093.80	2473.34		
TV abundance (thousands)	1126718.8			
Landings with harvest ratio eq. Fmax (0.39)		6854.76		
Landings with harvest ratio eq. to F0.1 (0.23)		4498.44		

Landings potential = Raised landings * TV abundance * Harvest Ratio / Raised removals

Landings potential with 25% removals	5355.28
Landings potential with 20% removals	4284.23
Landings potential with 15% removals	3213.17

Table 13.25 Nephrops, South Minch (FU12): Predicted landings potential based on abundance estimates using TV surveys, current landings and discard length distributions for the North Minch, and various harvest ratio% based on Y/R reference points and arbitrary percentages

Males — Weight = a*CL^b; a = 0.00028; b = 3.24

Females — a = 0.00089; b = 2.91

CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)	CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)
11	0.0	0.0	0.0	0.88	0.00	11	0.0	0.0	0.0	1.23	0.00
13	0.0	7.2	5.4	1.45	0.00	13	0.0	22.4	16.8	1.93	0.00
15	3.8	15.8	15.7	2.23	8.48	15	1.0	46.3	35.7	2.84	2.84
17	49.2	280.6	259.7	3.27	160.77	17	22.5	253.4	212.6	4.00	90.04
19	174.7	1185.0	1063.5	4.60	803.13	19	111.9	1067.5	912.5	5.44	608.44
21	771.6	3322.8	3263.7	6.26	4830.59	21	649.4	3043.2	2931.8	7.18	4659.64
23	1861.2	4876.3	5518.4	8.30	15446.69	23	2114.8	5442.7	6196.8	9.24	19546.73
25	4307.2	5643.2	8539.6	10.76	46330.47	25	4823.2	6698.2	9846.9	11.67	56272.70
27	6692.0	3568.5	9368.4	13.68	91517.89	27	7801.9	4169.1	10928.7	14.48	112932.84
29	10041.9	1287.7	11007.7	17.10	171730.24	29	9667.2	1405.5	10721.3	17.69	171046.25
31	10707.5	403.4	11010.1	21.08	225700.25	31	8000.3	258.4	8194.1	21.35	170797.97
33	10003.0	99.9	10077.9	25.65	256613.79	33	5282.3	37.7	5310.6	25.47	134529.25
35	8952.1	15.3	8963.6	30.87	276377.74	35	3115.1	3.6	3117.8	30.08	93691.95
37	7124.2	7.2	7129.6	36.78	262055.32	37	2103.6	0.0	2103.6	35.20	74049.72
39	4856.9	0.0	4856.9	43.43	210955.85	39	1362.8	0.0	1362.8	40.87	55695.06
41	3155.6	0.0	3155.6	50.87	160534.24	41	709.7	0.0	709.7	47.10	33428.76
43	1715.7	0.0	1715.7	59.15	101481.31	43	314.0	0.0	314.0	53.93	16934.29
45	1077.9	0.0	1077.9	68.31	73632.90	45	216.6	0.0	216.6	61.38	13294.55
47	788.7	0.0	788.7	78.41	61843.13	47	98.7	0.0	98.7	69.47	6856.76
49	526.5	0.0	526.5	89.50	47121.51	49	50.7	0.0	50.7	78.23	3966.44
51	319.8	0.0	319.8	101.63	32500.30	51	19.3	0.0	19.3	87.69	1692.45
53	175.8	0.0	175.8	114.85	20189.83	53	4.8	0.0	4.8	97.87	469.78
55	99.5	0.0	99.5	129.21	12856.13	55	5.0	0.0	5.0	108.80	543.99
57	60.6	0.0	60.6	144.77	8772.78	57	1.4	0.0	1.4	120.49	168.69
59	25.8	0.0	25.8	161.57	4168.58	59	0.5	0.0	0.5	132.99	66.49
61	15.2	0.0	15.2	179.68	2731.18	61	0.1	0.0	0.1	146.30	14.63
63	4.4	0.0	4.4	199.15	876.26	63	0.0	0.0	0.0	160.46	0.00
65	2.8	0.0	2.8	220.03	616.08	65	0.0	0.0	0.0	175.49	0.00
67	0.4	0.0	0.4	242.37	96.95	67	0.0	0.0	0.0	191.42	0.00
69	0.1	0.0	0.1	266.24	26.62	69	0.0	0.0	0.0	208.27	0.00
Total			89048.78		2089.98				63312.80		971.36

Total (Males + Females)	152361.58	3061.34
TV abundance (thousands)	2397432.4	
Landings with harvest ratio eq. Fmax (0.41)		16378.02
Landings with harvest ratio eq. to F0.1 (0.23)		10115.83

Landings potential = Raised landings * TV abundance * Harvest Ratio / Raised removals

Landings potential with 25% removals	12042.66
Landings potential with 20% removals	9634.13
Landings potential with 15% removals	7225.60

Table 13.26 Nephrops, Firth of Clyde (FU13): Predicted landings potential based on abundance estimates using TV surveys, current landings and discard length distributions for the North Minch, and various harvest ratio% based on Y/R reference points and arbitrary percentages

Males — Weight = a*CL^b — a = 0.00028, b = 3.24

Females — a = 0.00085, b = 2.91

CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)	CL	Landings ('000)	Discards ('000)	Removals ('000)	wt (g)	Landings (t)
11	0.0	0.0	0.0	0.88	0.00	11	0.0	16.5	12.4	1.17	0.00
13	0.0	8.1	6.1	1.45	0.00	13	0.0	34.9	26.2	1.84	0.00
15	52.8	478.8	411.9	2.23	117.80	15	25.7	526.7	420.7	2.71	69.72
17	413.9	914.1	1099.5	3.27	1352.50	17	347.2	1336.5	1349.6	3.82	1326.91
19	1039.1	2745.6	3098.3	4.60	4776.97	19	1801.1	4358.2	5069.8	5.19	9353.07
21	3274.8	6097.4	7847.9	6.26	20501.81	21	3946.7	8290.5	10164.6	6.85	27046.00
23	6349.0	10844.7	14482.5	8.30	52692.38	23	8248.1	11716.4	17035.4	8.83	72809.42
25	9996.7	10727.6	18042.4	10.76	107529.68	25	11411.1	8980.5	18146.5	11.14	127150.74
27	12290.0	5532.6	16439.5	13.68	168074.54	27	11222.2	4609.8	14679.6	13.82	155141.08
29	13972.1	1492.0	15091.1	17.10	238942.05	29	11053.5	2134.5	12654.4	16.90	186784.83
31	13471.4	500.9	13847.1	21.08	283959.69	31	8129.0	695.6	8650.7	20.39	165745.78
33	10389.3	203.9	10542.2	25.65	266523.81	33	5059.3	237.0	5237.1	24.32	123058.89
35	7105.1	86.5	7170.0	30.87	219355.40	35	2549.6	42.8	2581.7	28.72	73237.12
37	4233.9	4.3	4237.1	36.78	155739.04	37	1414.8	1.1	1415.6	33.62	47564.64
39	2634.4	6.7	2639.4	43.43	114423.21	39	787.4	1.6	788.6	39.03	30733.28
41	1678.7	0.0	1678.7	50.87	85400.19	41	419.1	0.5	419.5	44.99	18853.50
43	903.4	0.0	903.4	59.15	53434.87	43	272.0	0.0	272.0	51.51	14009.90
45	585.8	0.5	586.2	68.31	40016.84	45	144.7	0.0	144.7	58.62	8482.28
47	352.4	0.0	352.4	78.41	27632.20	47	95.3	0.0	95.3	66.35	6323.01
49	212.9	0.0	212.9	89.50	19054.45	49	80.3	0.0	80.3	74.72	5999.81
51	138.6	0.0	138.6	101.63	14085.49	51	38.0	0.0	38.0	83.75	3182.53
53	75.0	0.0	75.0	114.85	8613.41	53	28.9	0.0	28.9	93.47	2701.36
55	43.5	0.0	43.5	129.21	5620.52	55	13.2	0.0	13.2	103.91	1371.58
57	19.3	0.0	19.3	144.77	2793.97	57	7.0	0.0	7.0	115.08	805.55
59	6.0	0.0	6.0	161.57	969.44	59	3.5	0.0	3.5	127.01	444.54
61	2.8	0.0	2.8	179.68	503.11	61	0.4	0.0	0.4	139.73	55.89
63	0.6	0.0	0.6	199.15	119.49	63	0.3	0.0	0.3	153.25	45.98
65	1.0	0.0	1.0	220.03	220.03	65	1.1	0.0	1.1	167.61	184.37
67	0.0	0.0	0.0	242.37	0.00	67	0.2	0.0	0.2	182.82	36.56
69	0.0	0.0	0.0	266.24	0.00	69	0.0	0.0	0.0	198.91	0.00
Total			118975.28		1892.45				99337.03		1082.52

Total (Males + Females) 218312.30 2974.97

TV abundance (thousands) 1841940.4

Landings with harvest ratio eq. Fmax (0.38) 8032.12

Landings with harvest ratio eq. to F0.1 (0.23) 5271.08

Landings potential = Raised landings * TV abundance * Harvest Ratio / Raised removals

Landings potential with 25% removals 6275.09
Landings potential with 20% removals 5020.07
Landings potential with 15% removals 3765.06

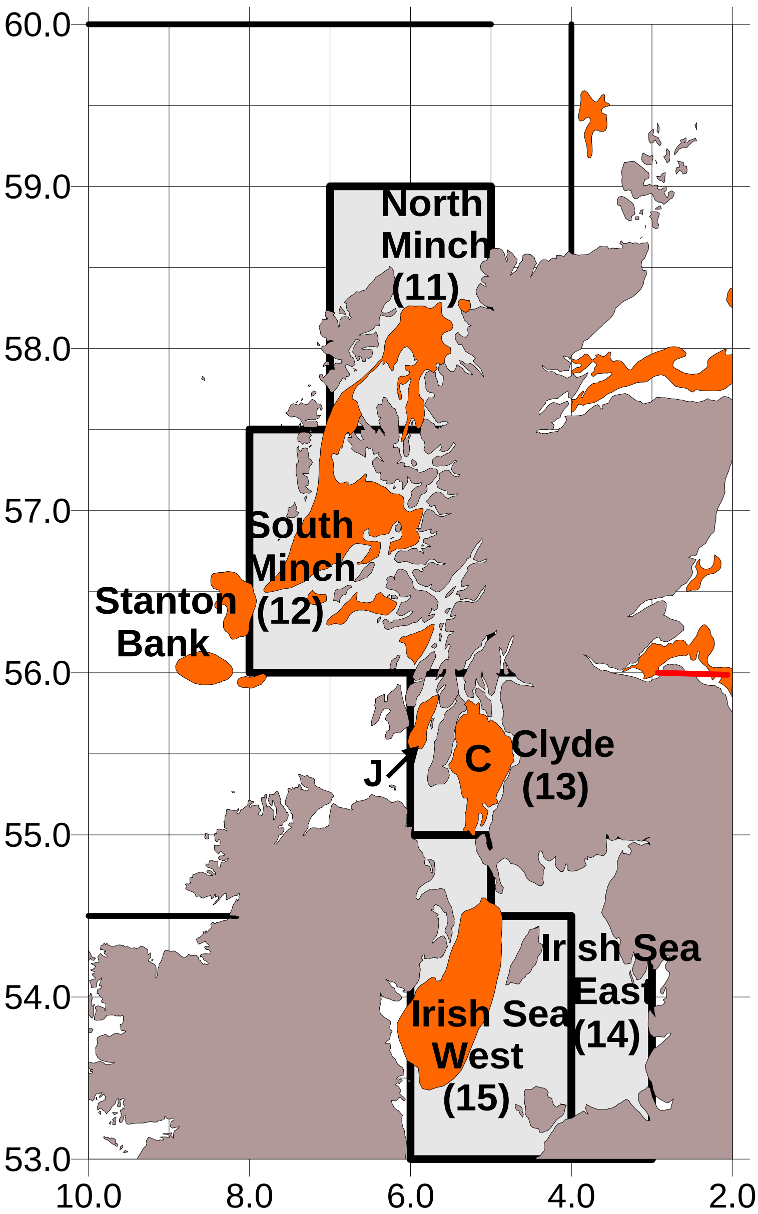


Figure 13.1 Nephrops Functional Units in VIa and VIIa. Bold lines show boundaries of FUs, shaded regions within FUs indicate mud distribution. Within the Clyde FU, C denotes Firth of Clyde and J denotes Sound of Jura

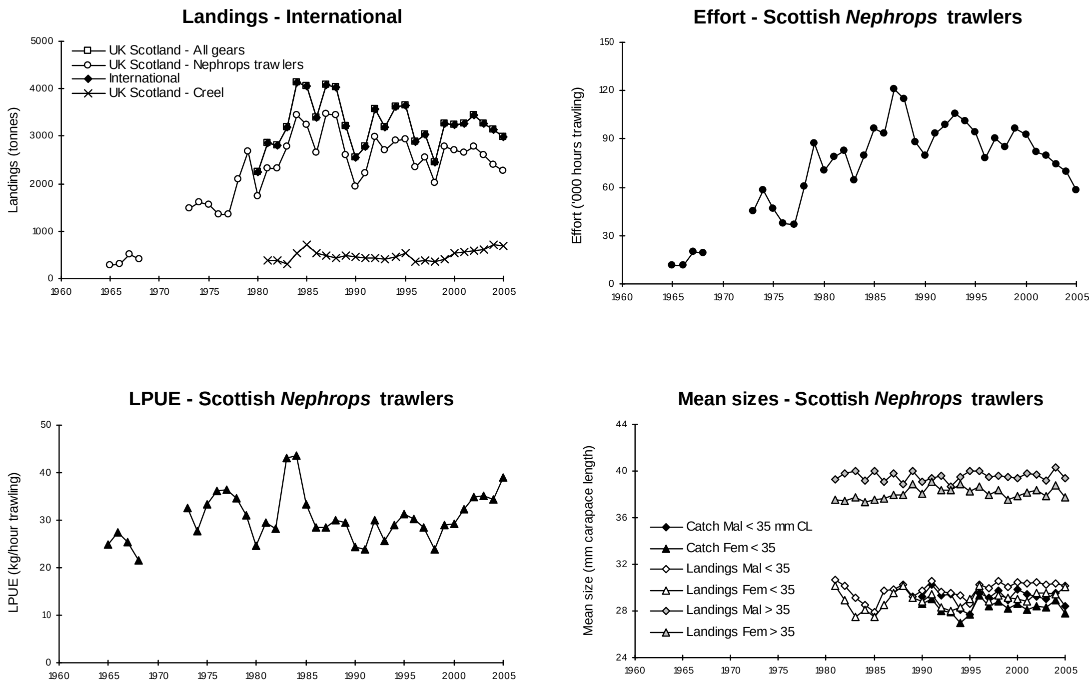


Figure 13.2 Nephrops, North Minch (FU11), Long term landings, effort, LPUE and mean sizes.

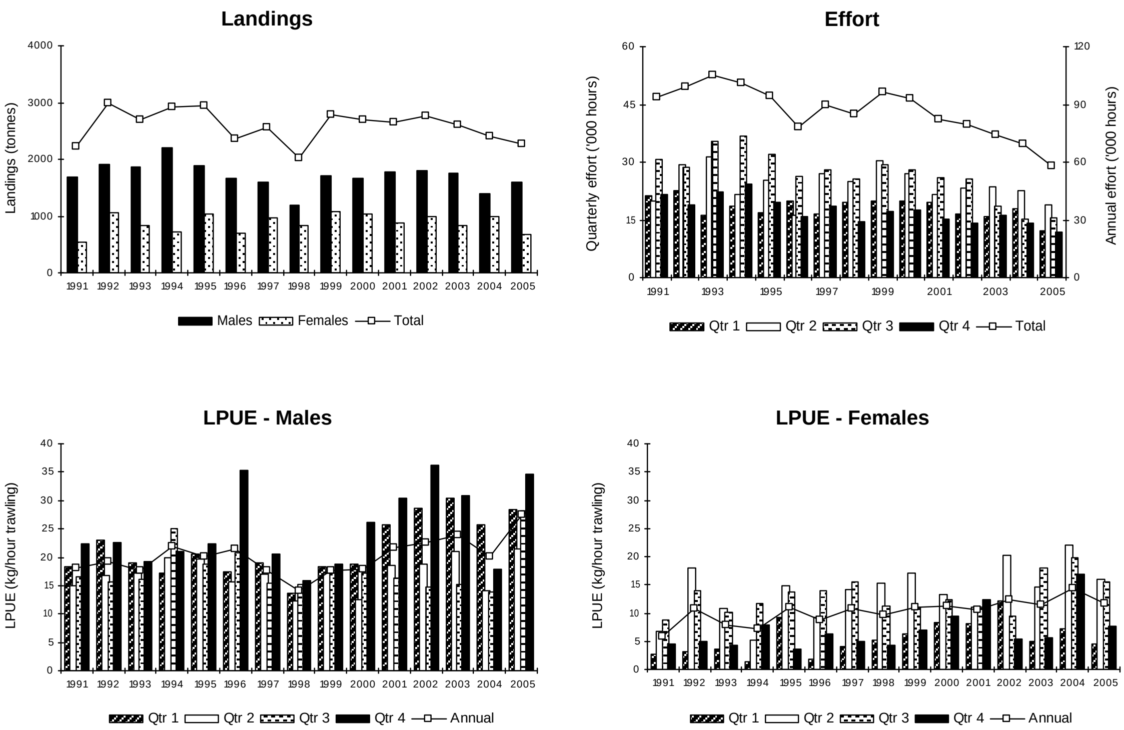


Figure 13.3 Nephrops, North Minch (FU11), Landings, effort and LPUEs by quarter and sex from Scottish Nephrops trawlers.

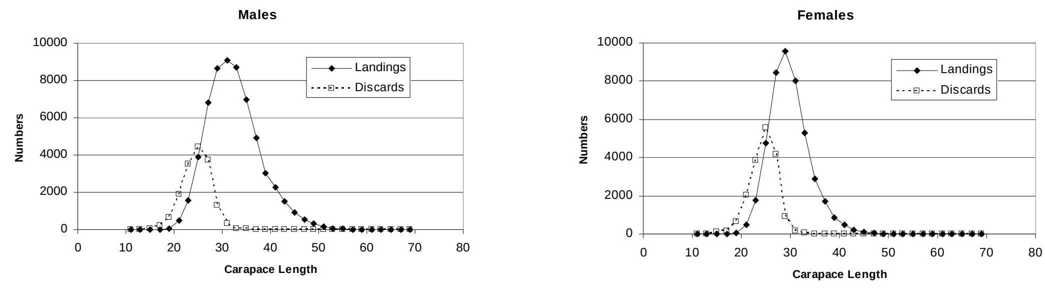


Figure 13.4 Nephrops, North Minch (FU11), Length frequency distributions of male and female landings and discards, averaged over 2003 – 2005.

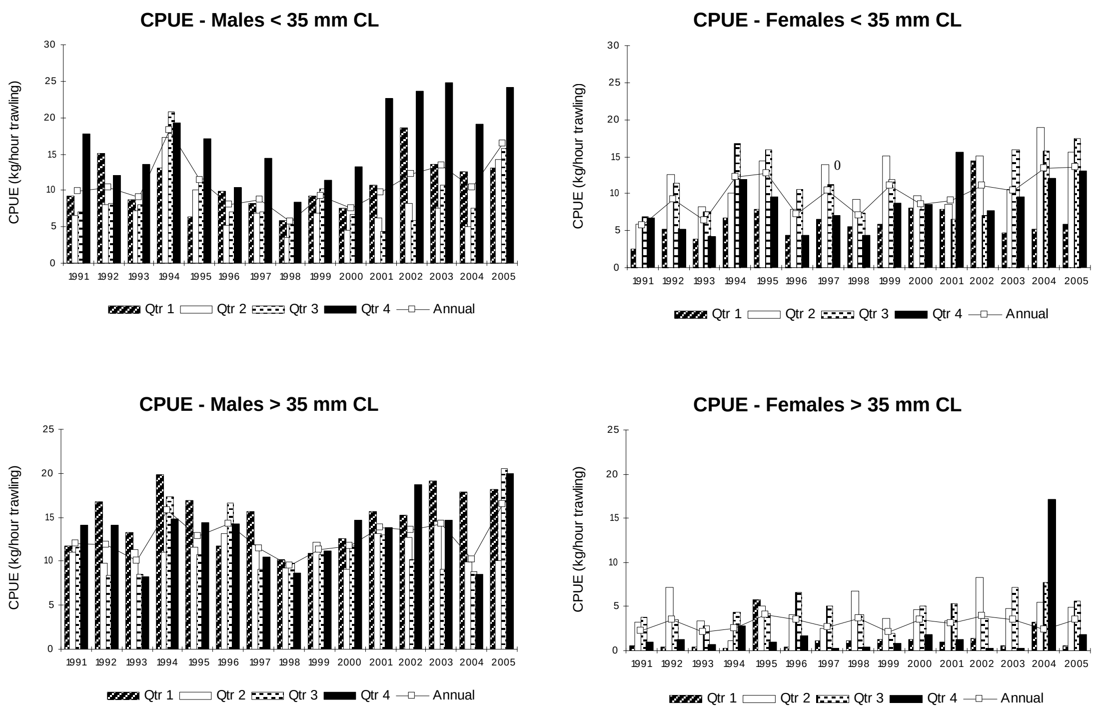


Figure 13.5 Nephrops, North Minch (FU11), CPUEs by sex and quarter for selected size groups, Scottish Nephrops trawlers.

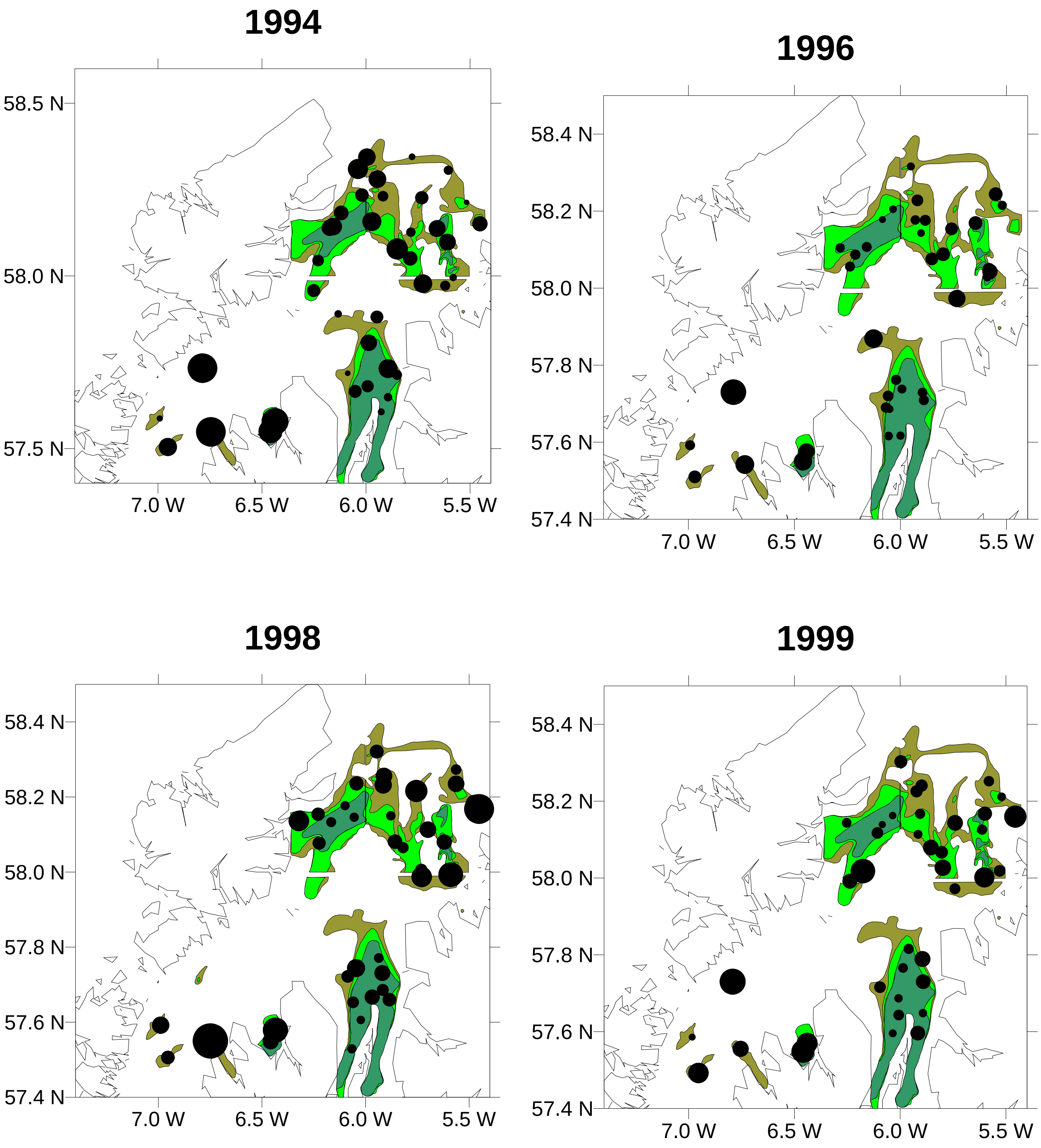


Figure 13.6 Nephrops, North Minch (FU11), TV survey station distribution and relative density, 1994 – 1999. Shaded green and brown areas represent areas of suitable sediment for Nephrops. Bubbles in this figure are all scaled the same.

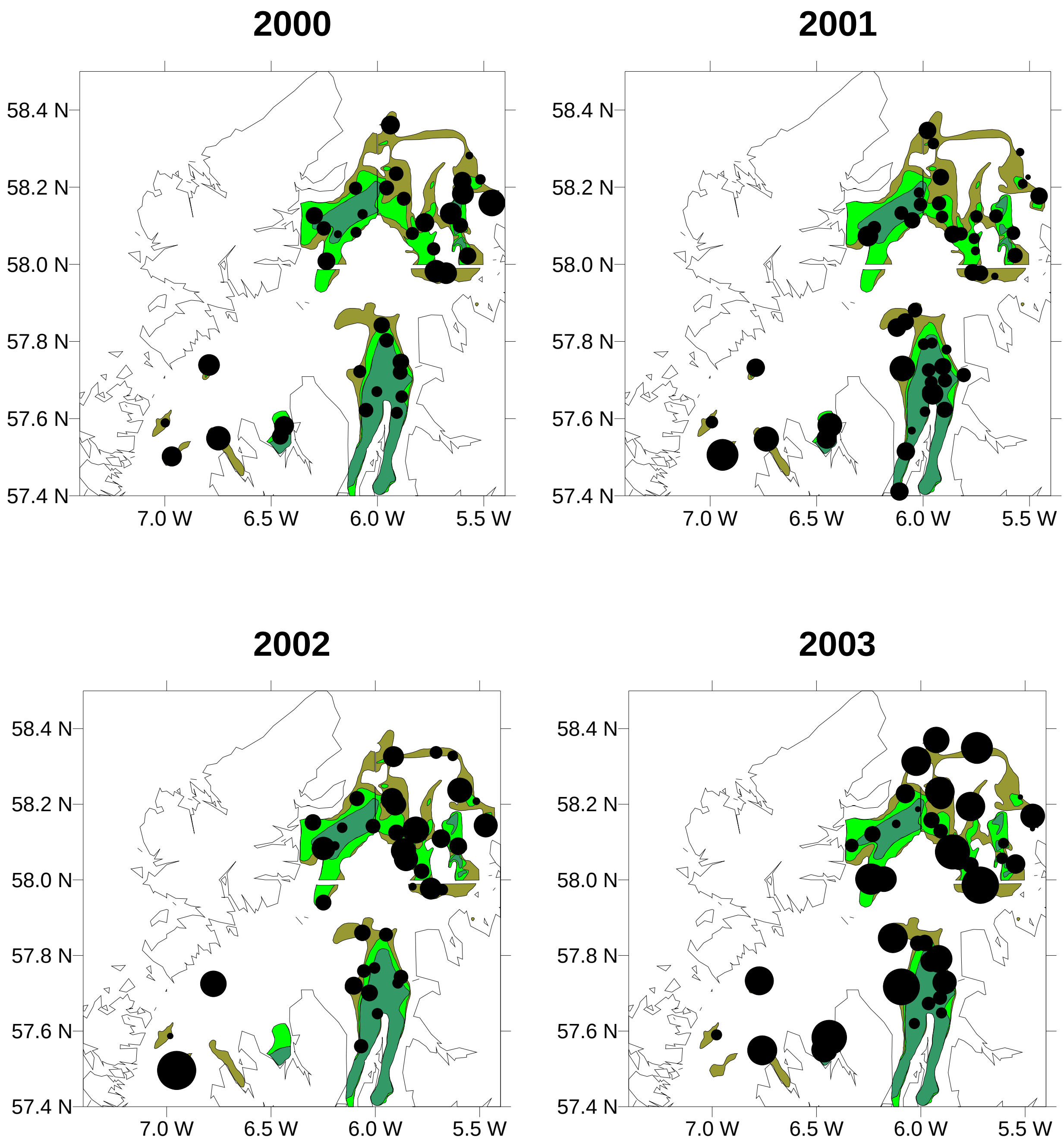


Figure 13.6 Nephrops, North Minch (FU11),cont 2000-2003

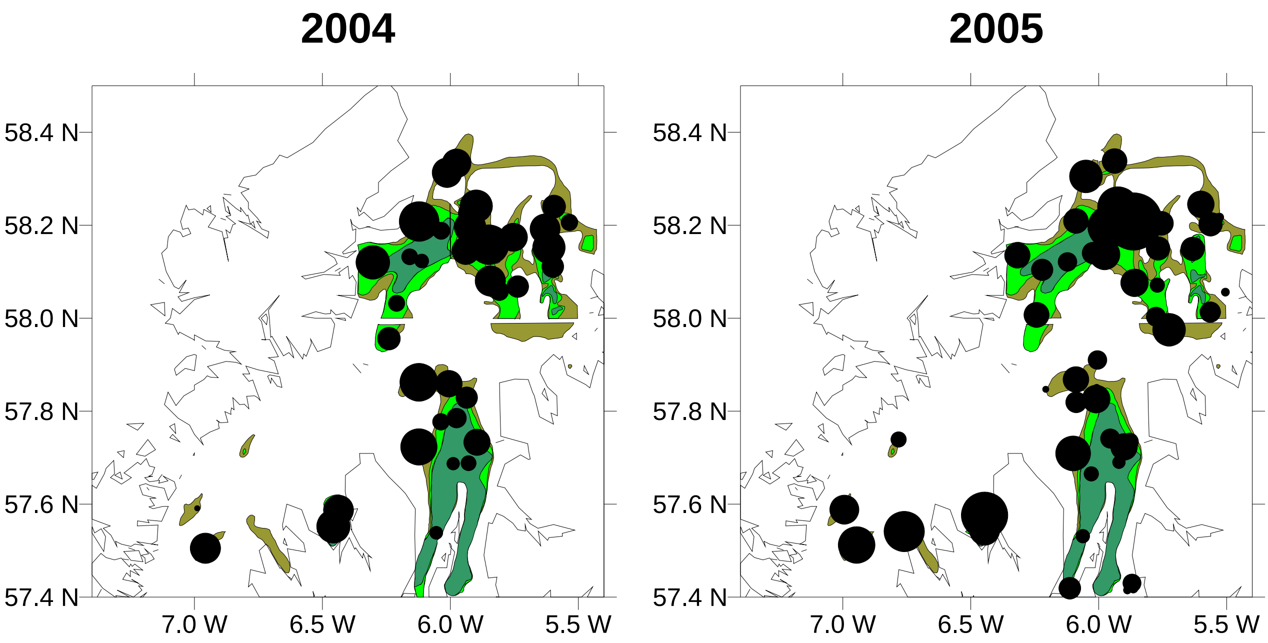


Figure 13.6 Nephrops, North Minch (FU11),cont 2004 and 2005

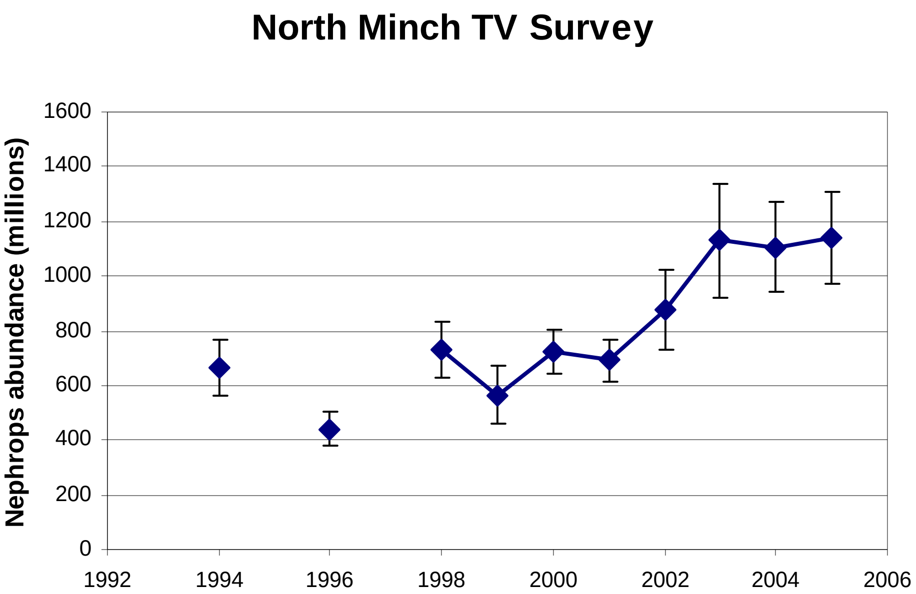


Figure 13.7 Nephrops, North Minch (FU11), Time series of TV survey abundance estimates, with 95% confidence intervals, 1994 – 2005.

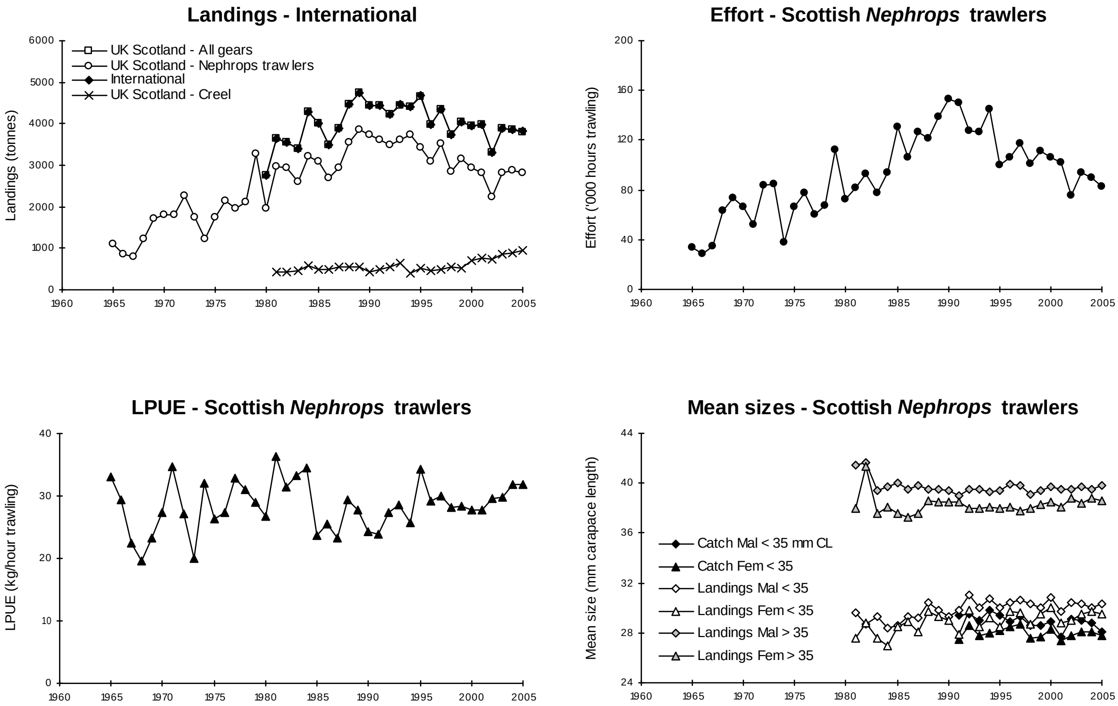


Figure 13.8 Nephrops, South Minch (FU12), Long term landings, effort, LPUE and mean sizes.

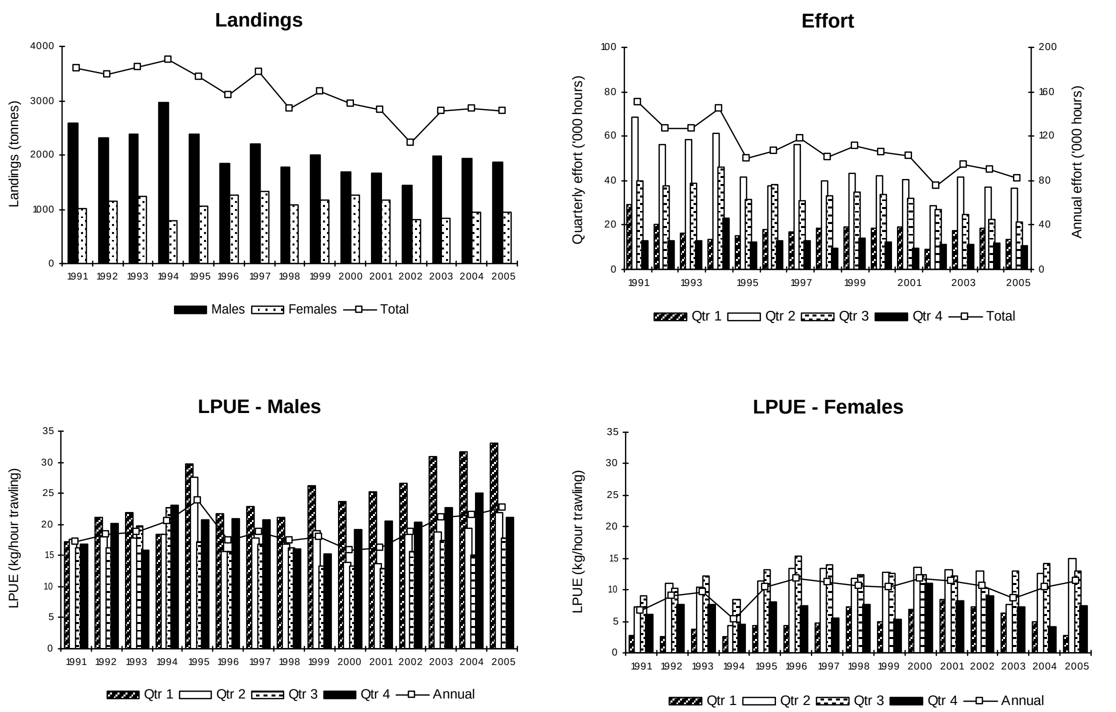


Figure 13.9 Nephrops, South Minch (FU12), Landings, effort and LPUEs by quarter and sex from Scottish Nephrops trawlers.

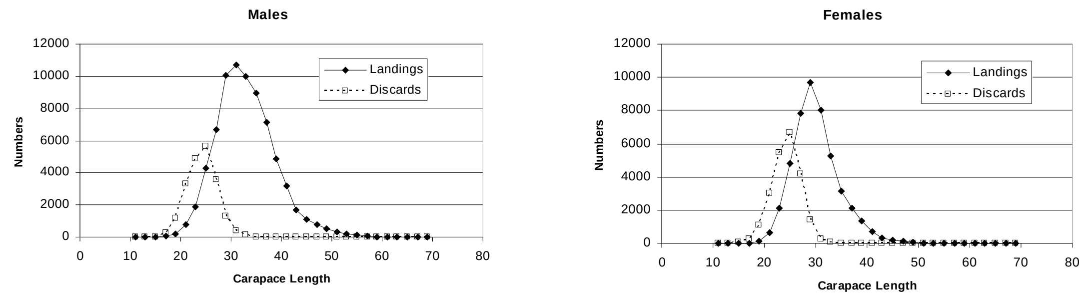


Figure 13.10 Nephrops, South Minch (FU12), Length frequency distributions of male and female landings and discards, averaged over 2003 – 2005

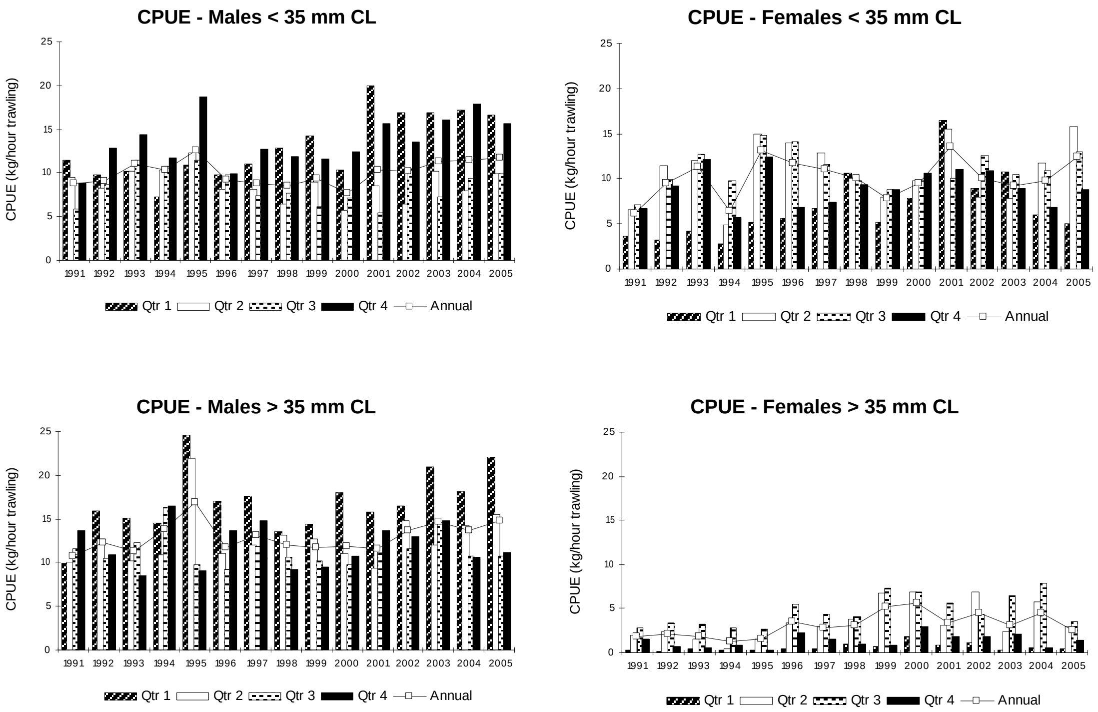


Figure 13.11 Nephrops, South Minch (FU12), CPUEs by sex and quarter for selected size groups, Scottish Nephrops trawlers.

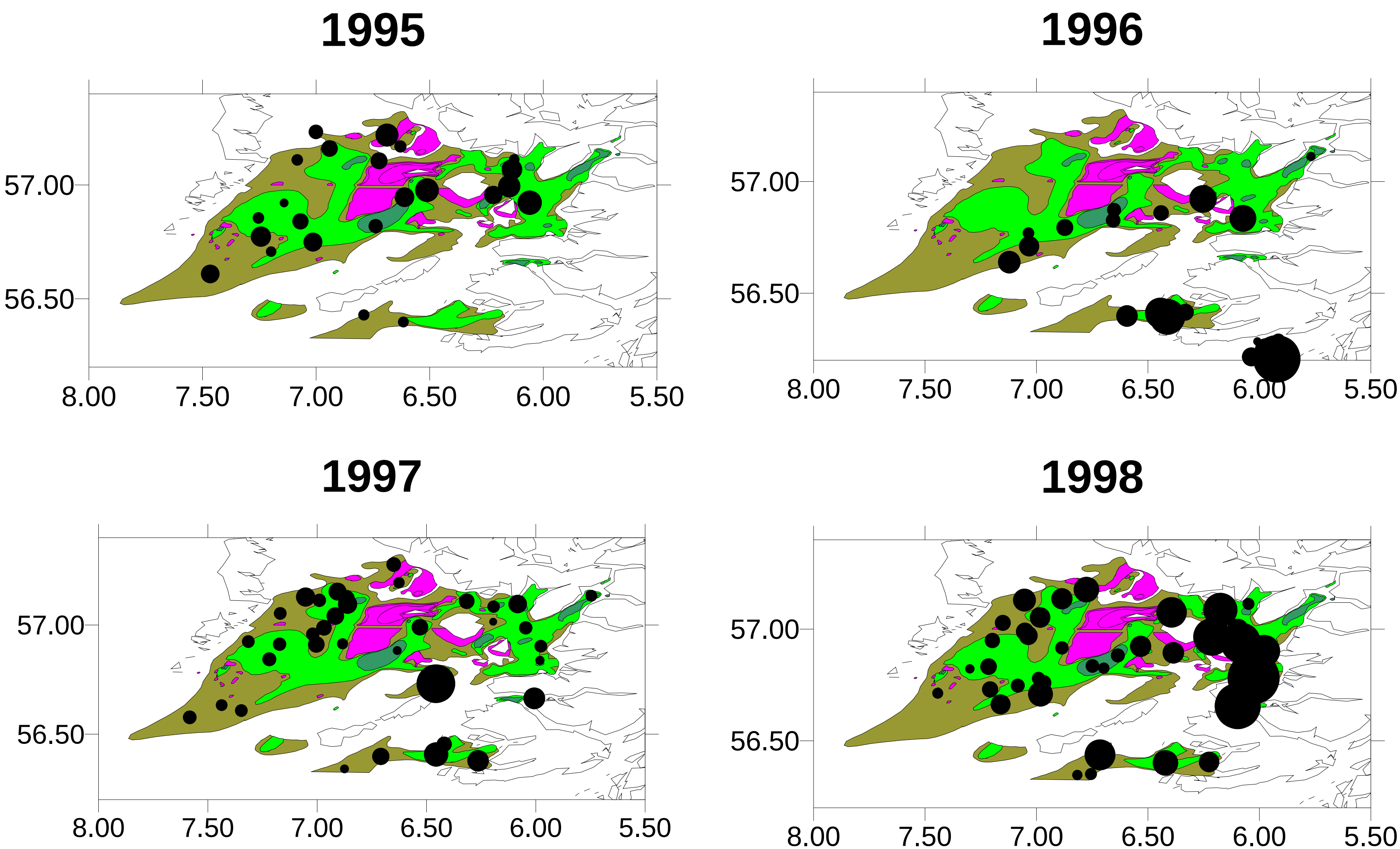


Figure 13.12 Nephrops, South Minch (FU12), TV survey station distribution and relative density, 1995 – 1998. Shaded reen and brown areas represent areas of suitable sediment for Nephrops. Bubbles in this figure are all scaled the same.

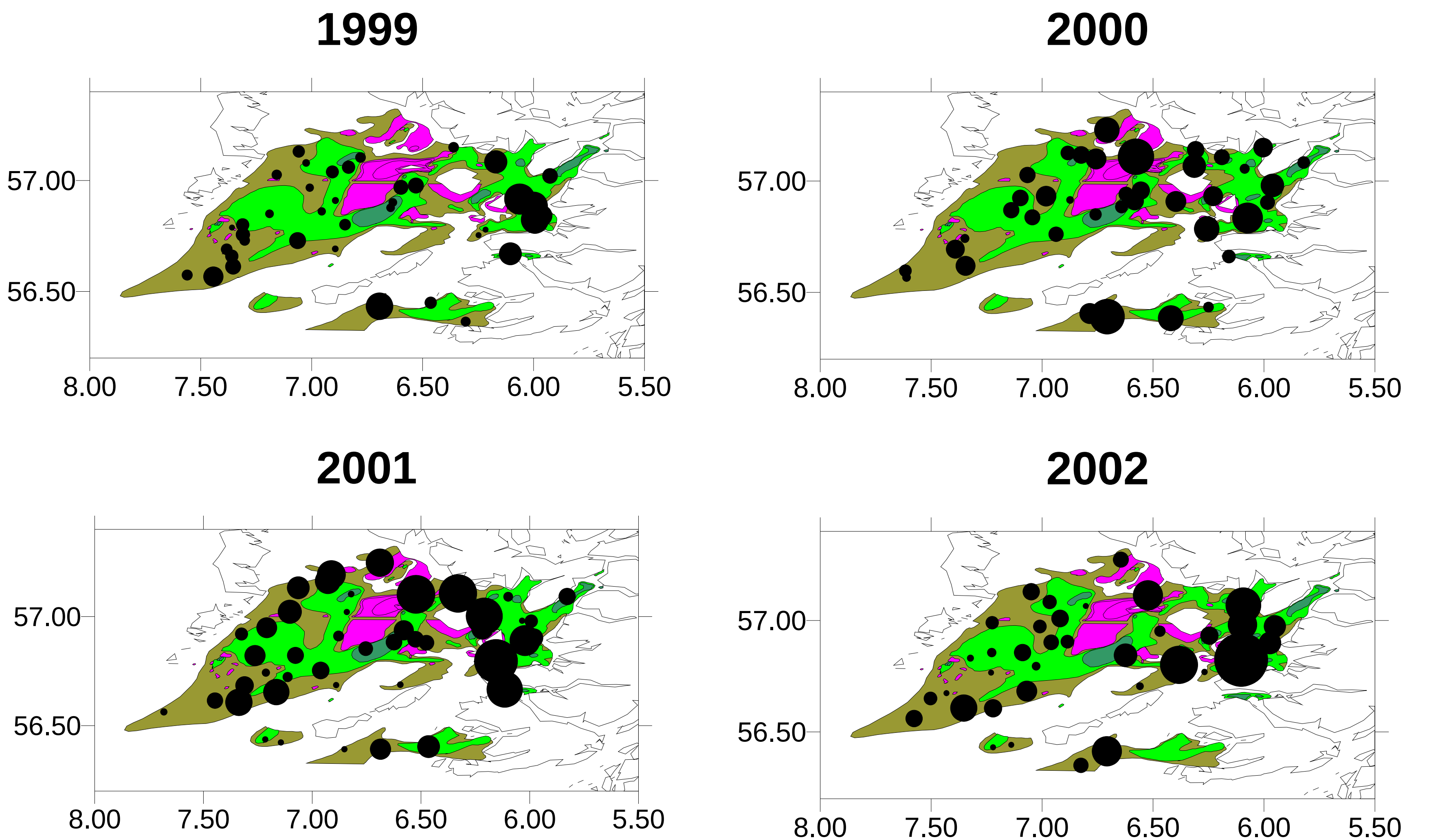


Figure 13.12 Nephrops, South Minch (FU12) cont 1999-2002

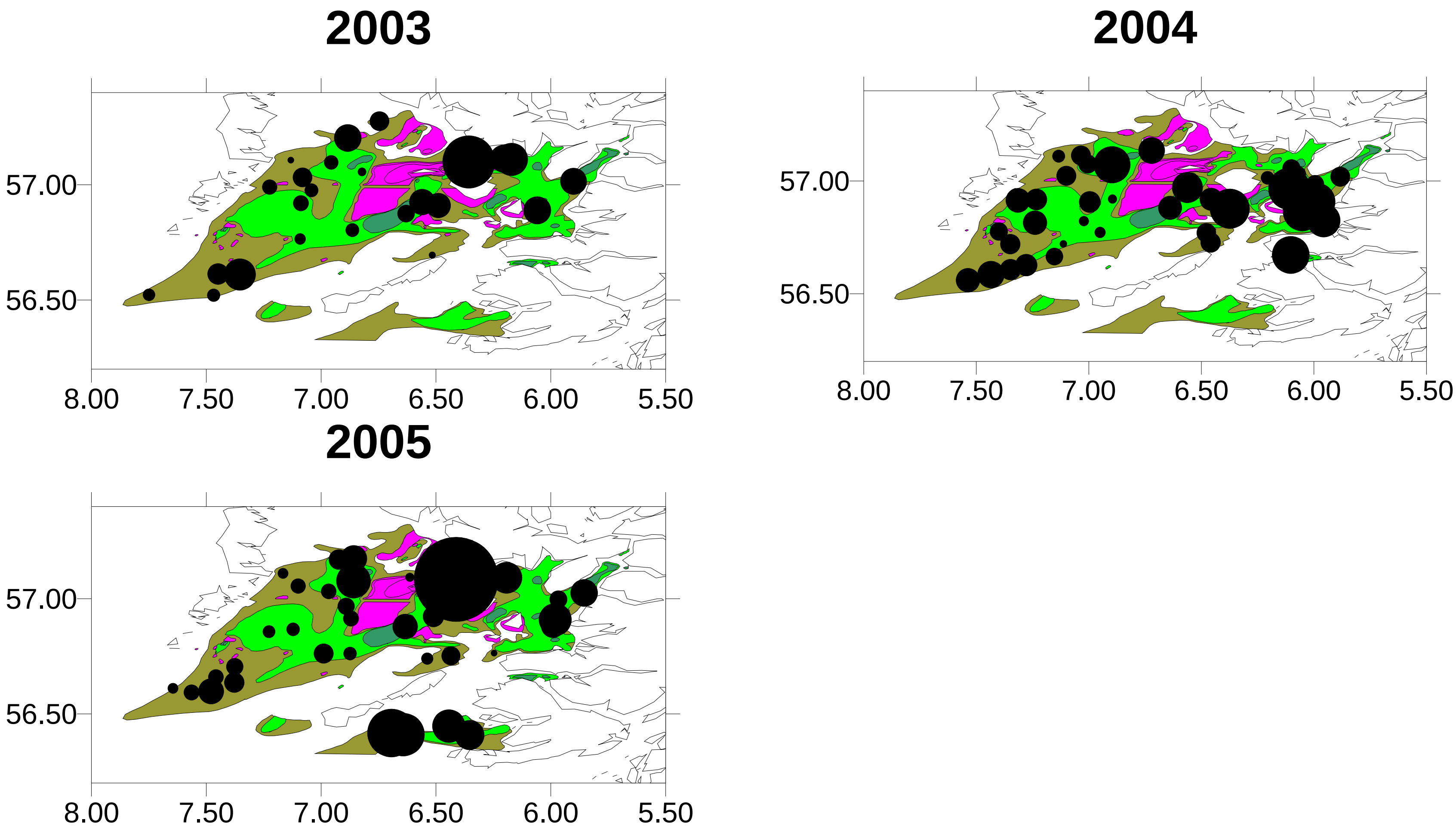


Figure 13.12 Nephrops, South Minch (FU12) cont 2003-2005

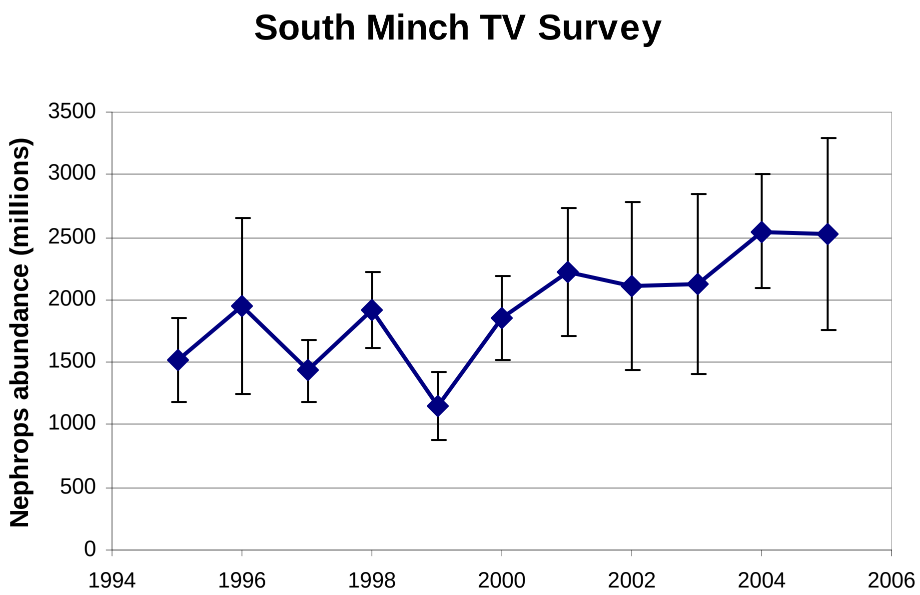


Figure 13.13 Nephrops, South Minch (FU12), Time series of TV survey abundance estimates, with 95% confidence intervals, 1995 – 2005.

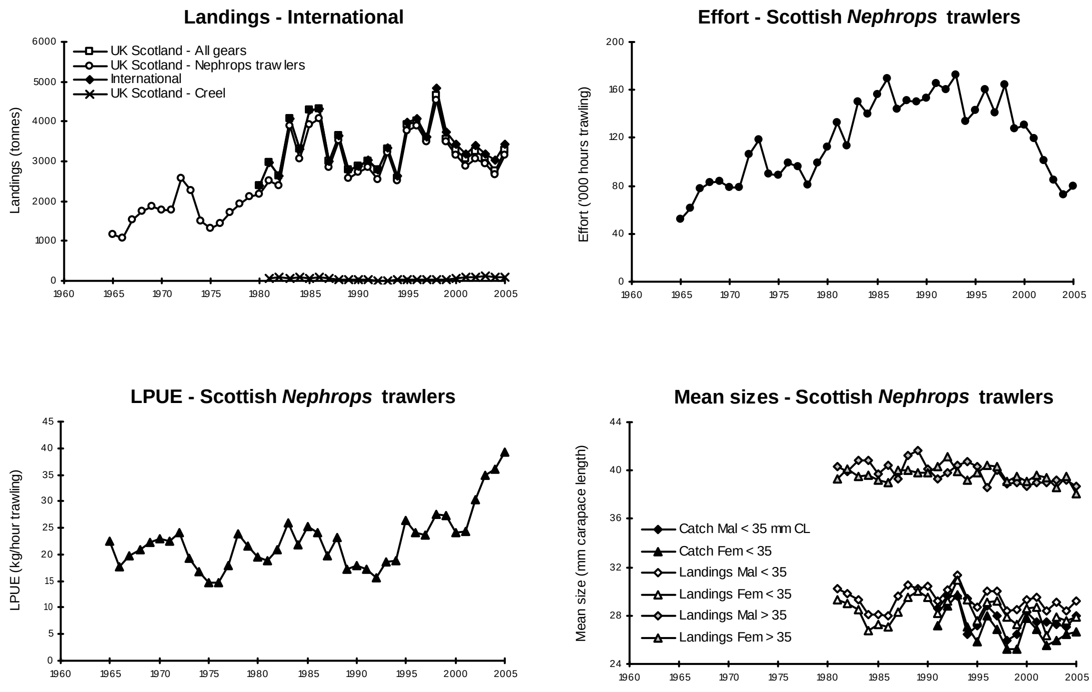


Figure 13.14 Nephrops, Clyde (FU13), Long term landings, effort, LPUE and mean sizes.

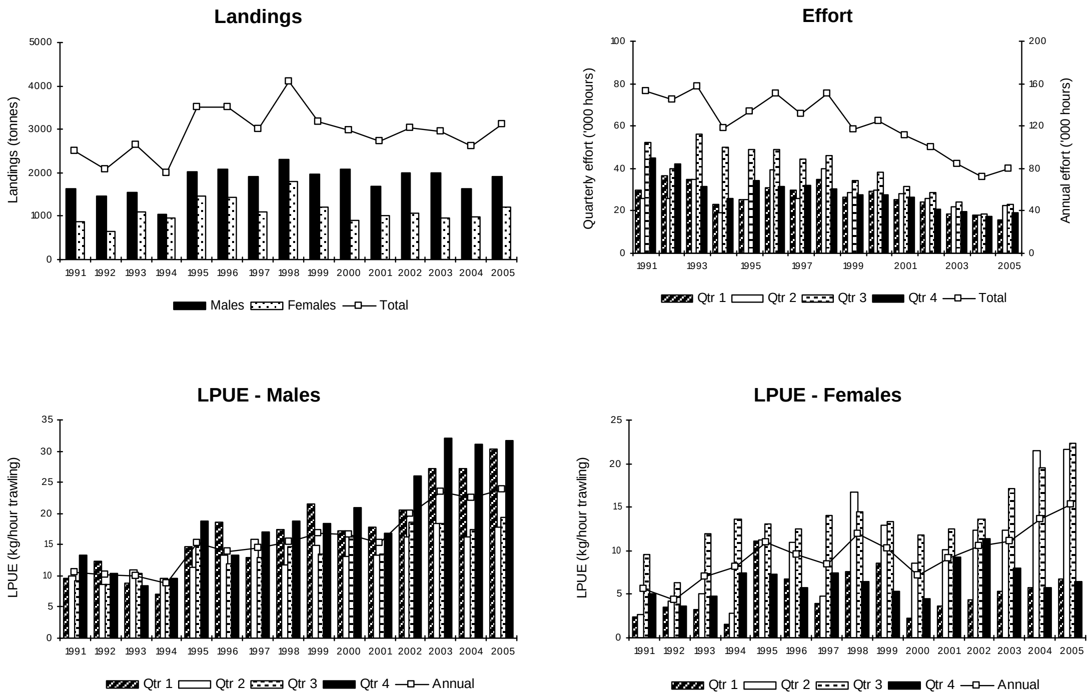


Figure 13.15 Nephrops, Firth of Clyde (FU13), Landings, effort and LPUEs by quarter and sex from Scottish Nephrops trawlers.

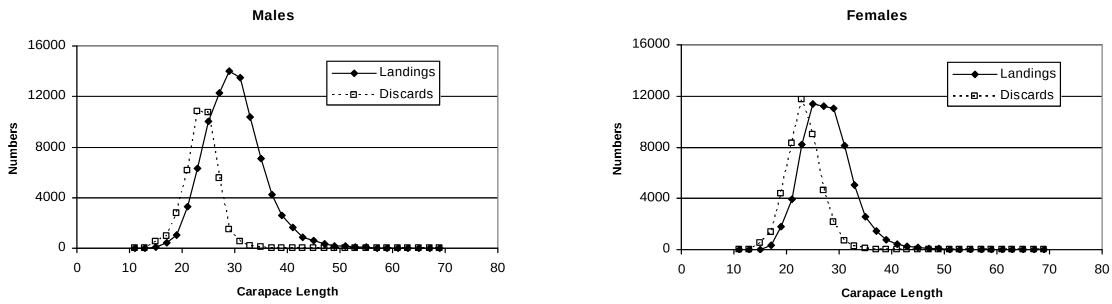


Figure 13.16 Nephrops, Firth of Clyde (FU13), Length frequency distributions of male and female landings and discards, averaged over 2002 – 2004

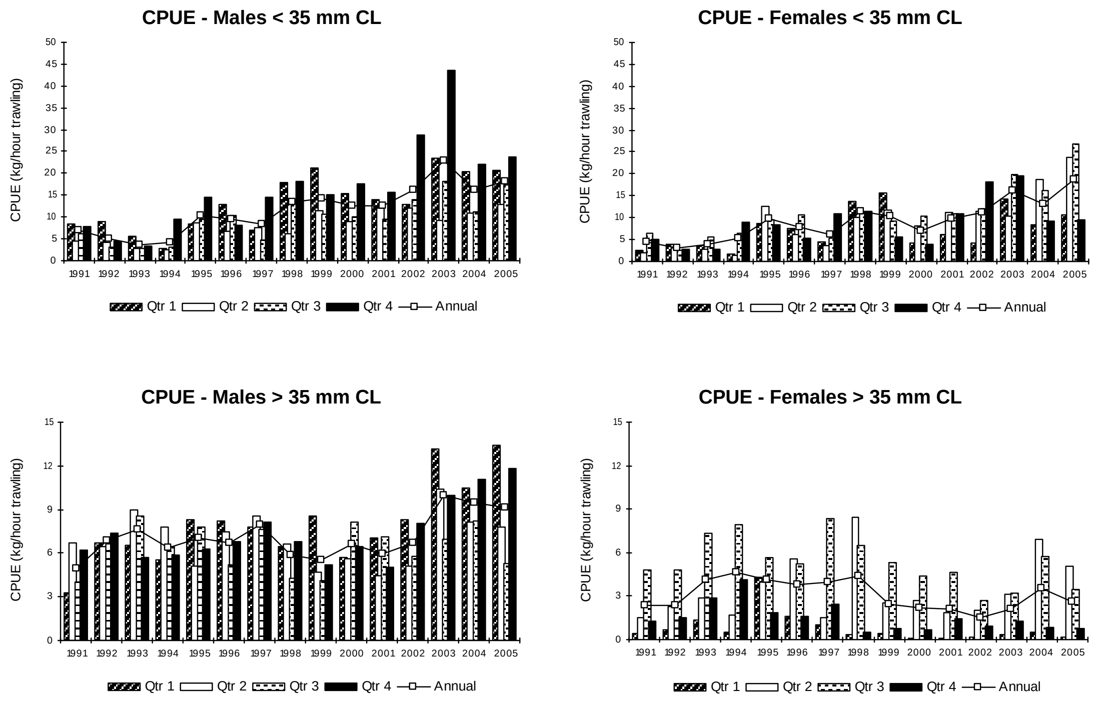


Figure 13.17 Nephrops, Firth of Clyde (FU13), CPUEs by sex and quarter for selected size groups, Scottish Nephrops trawlers.

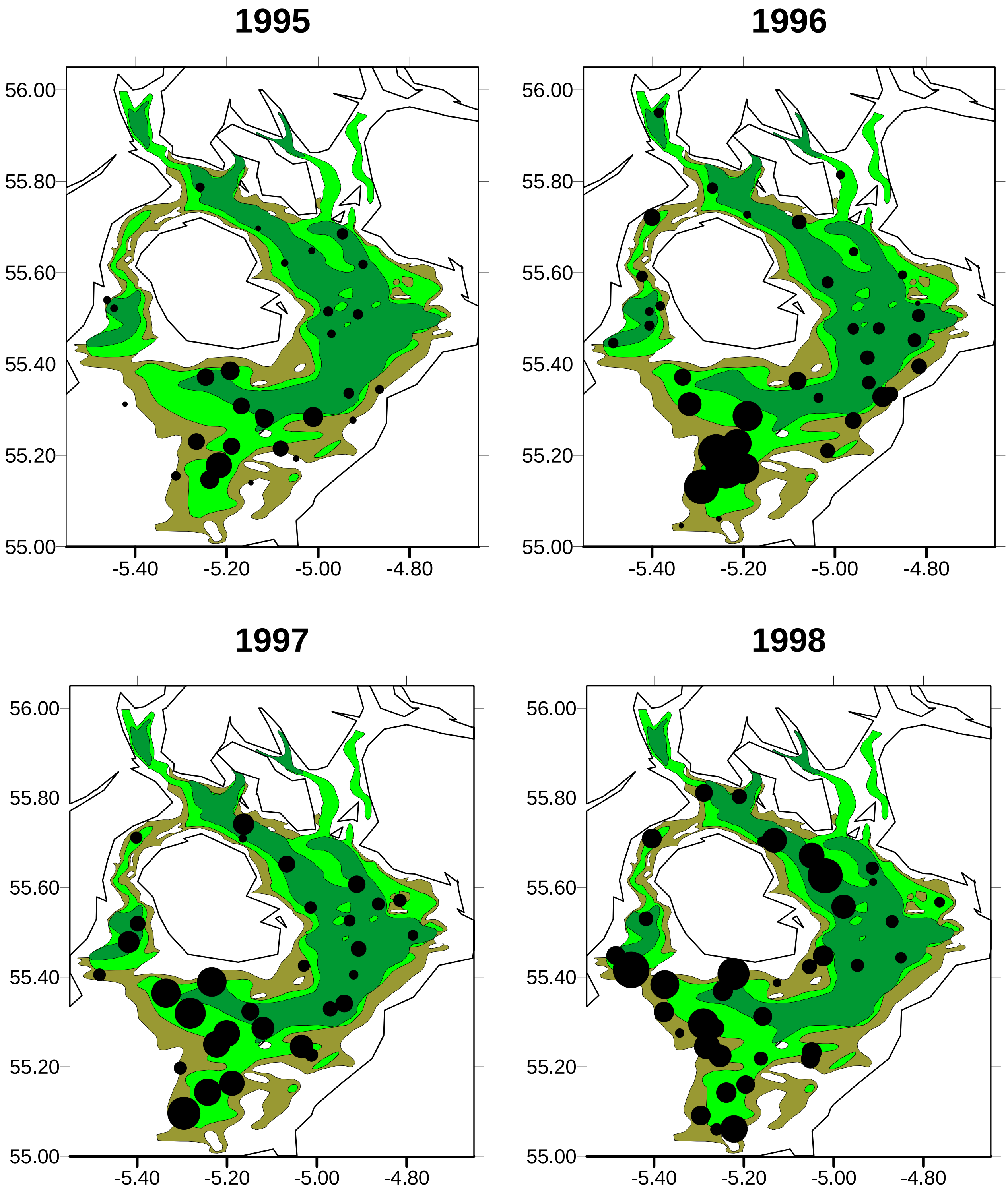


Figure 13.18 Nephrops, Firth of Clyde (FU13), TV survey station distribution and relative density, 1995 – 2004. Shaded green and brown areas represent areas of suitable sediment for Nephrops. Bubbles scaled the same.

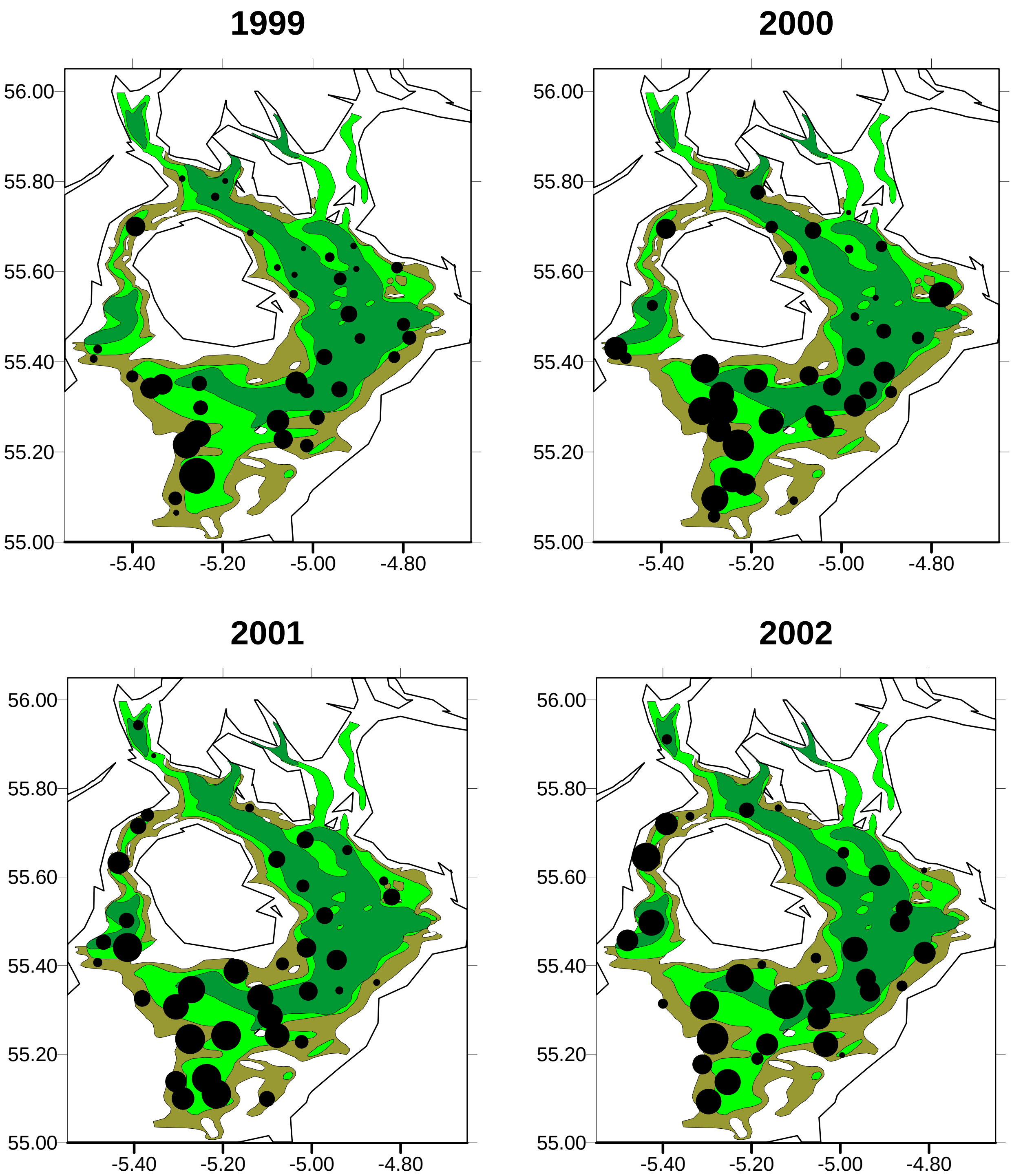


Figure 13.18 Nephrops, Firth of Clyde (FU13) cont 1999-2002

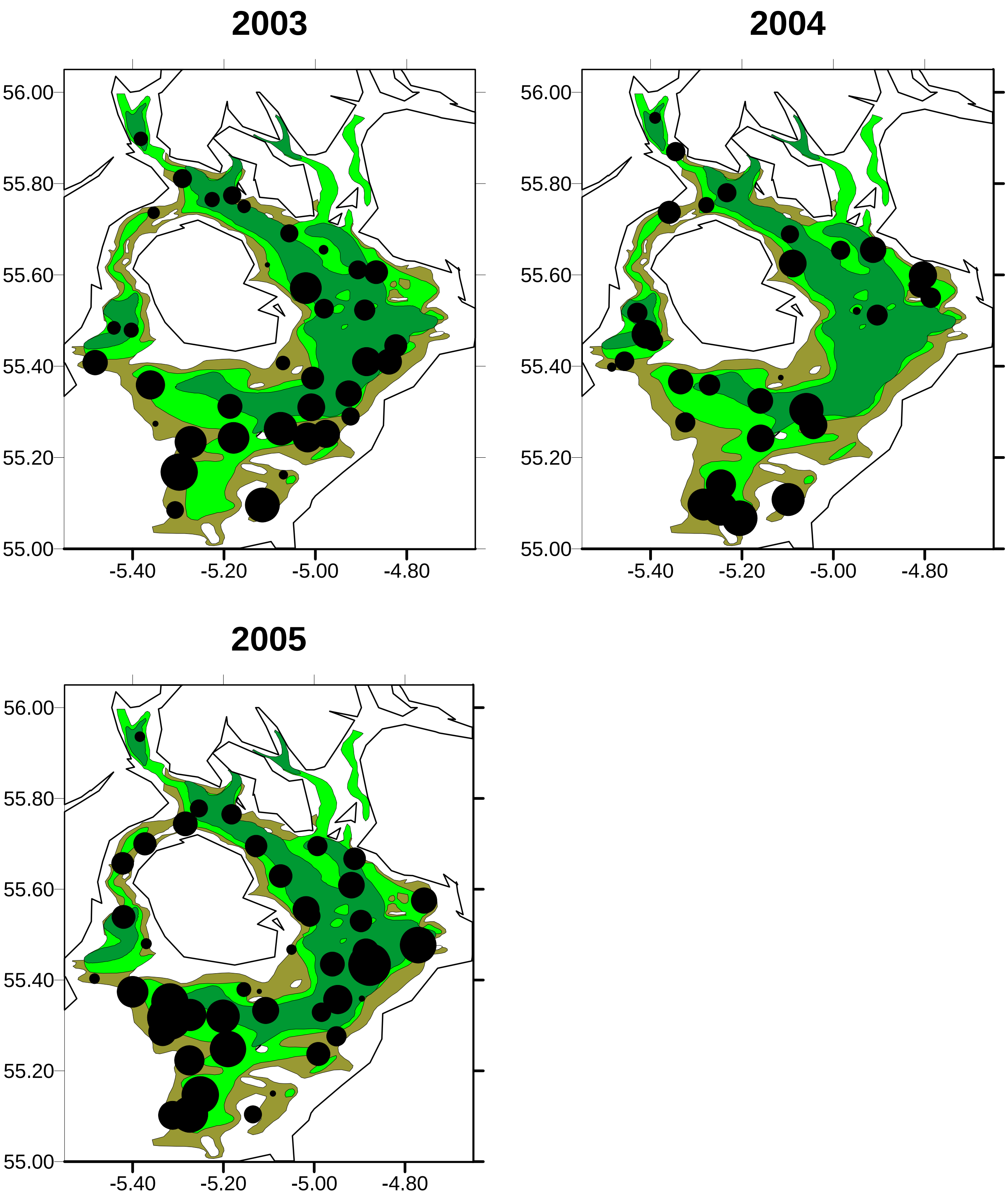


Figure 13.18 Nephrops, Firth of Clyde (FU13) cont 2003-2005

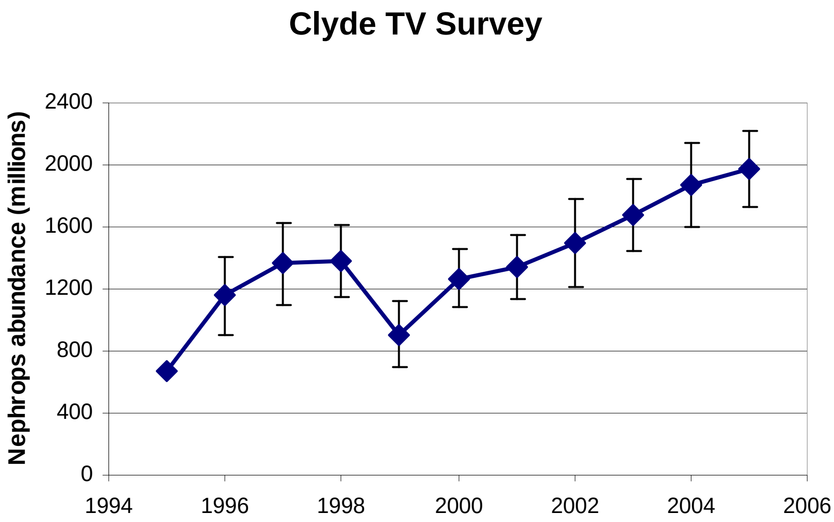


Figure 13.19 Nephrops, Firth of Clyde (FU13), Time series of TV survey abundance estimates, with 95% confidence intervals, 1995 – 2005.

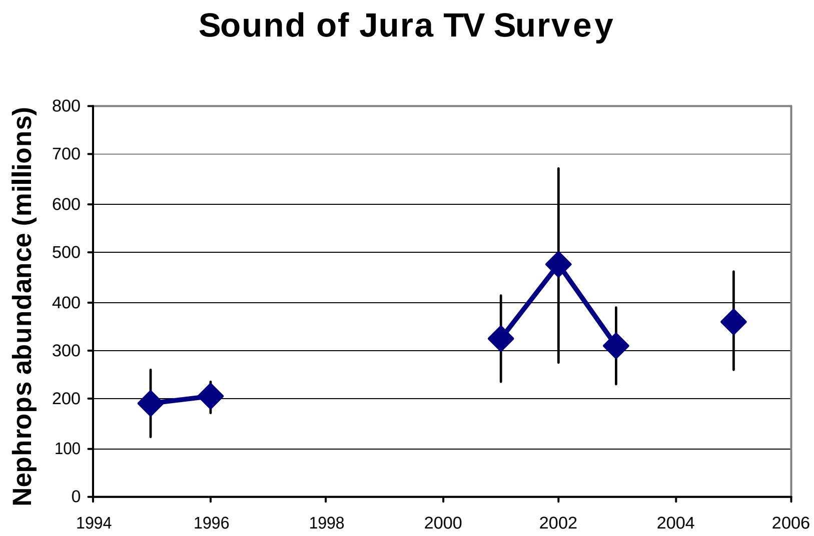


Figure 13.20 Nephrops, Sound of Jura (FU13), Time series of TV survey abundance estimates, with 95% confidence intervals, 1995 – 2005.

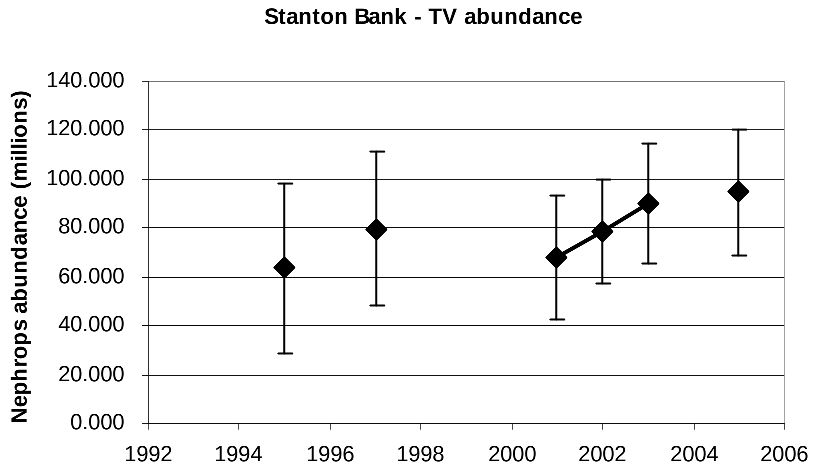


Figure 13.21 Nephrops, Stanton Bank, Time series of TV survey abundance estimates, with 95% confidence intervals, 1995 – 2005.

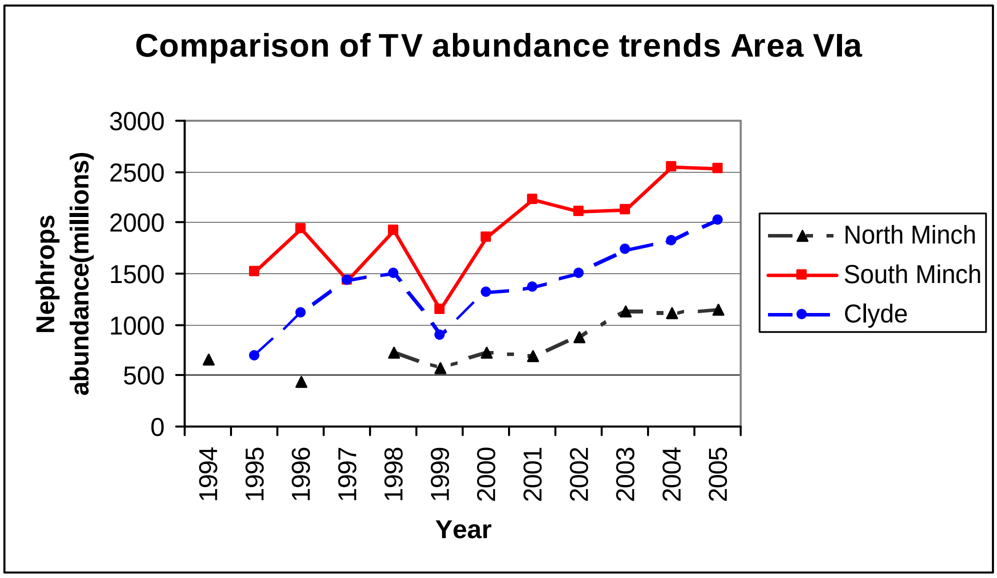


Figure 13.22- Nephrops, Comparison of TV abundance trends in the three FUs making up Management Area C – ICES area VIa

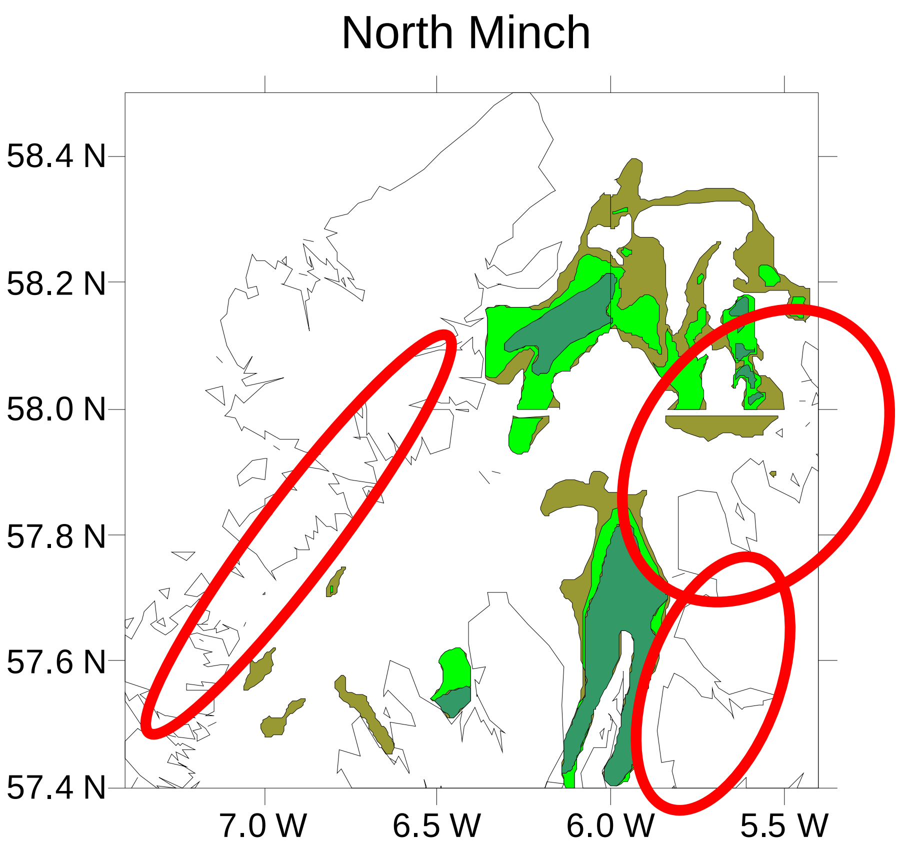


Figure 13.23Nephrops, , North Minch, Diagram to show particular areas (circled) where Nephrops are known to occur but where sediment data are not mapped or the distribution is poorly described by BGS sampling.

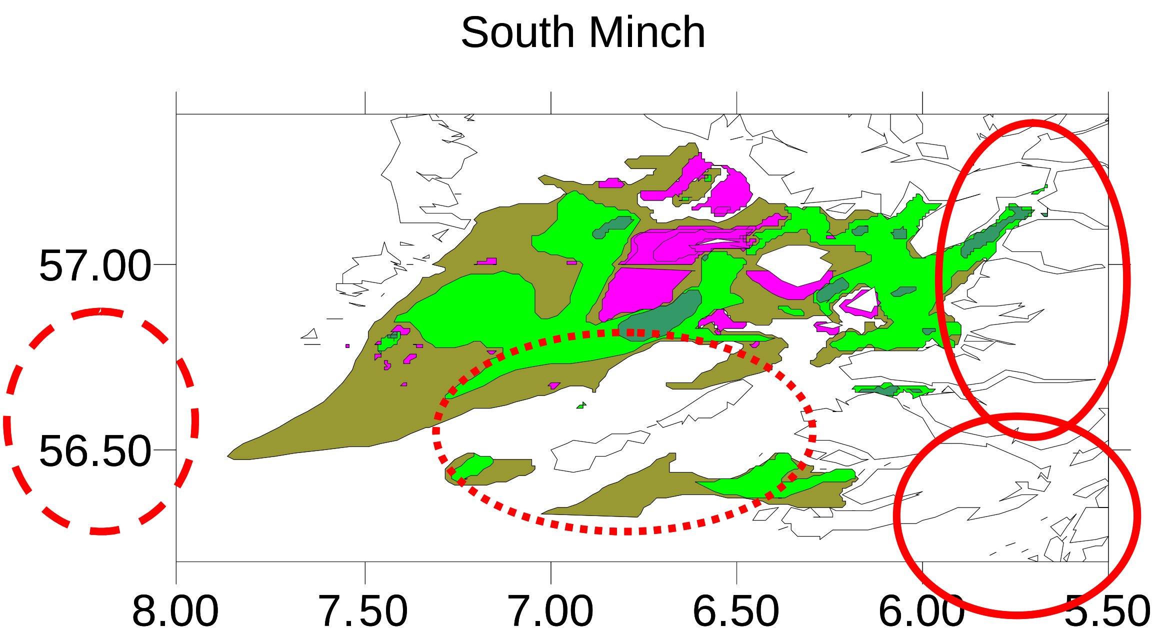


Figure 13.24 Nephrops, , South Minch, Diagram to show particular areas where Nephrops are known to occur but where sediment data are not mapped (circled) or the distribution is poorly described by BGS sampling (dashed line ellipses) . Area to the west relates to the Stanton Bank

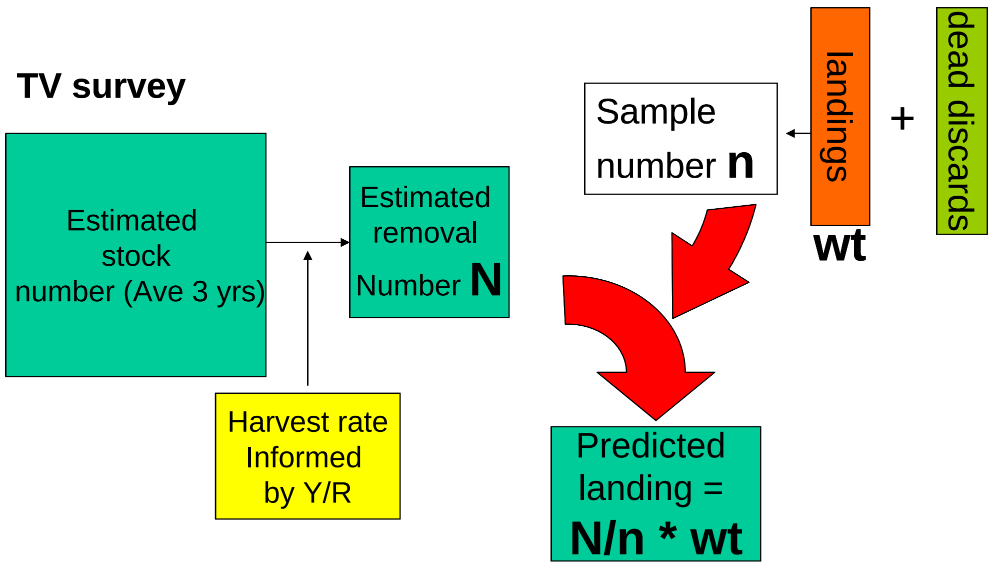
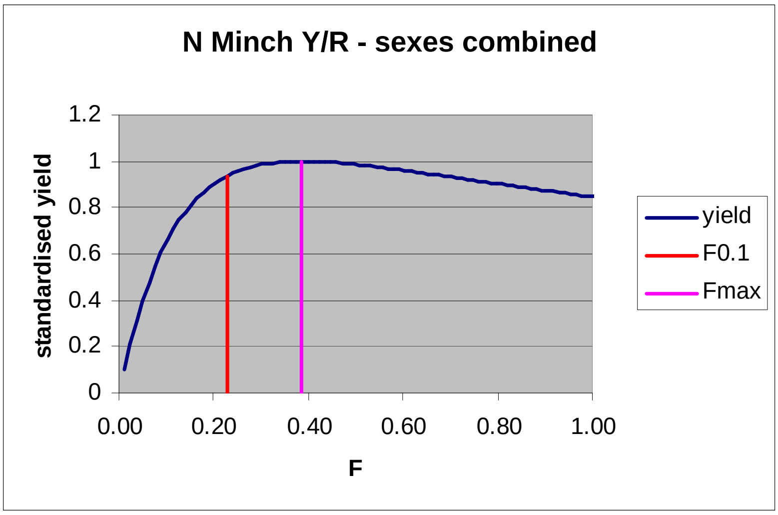
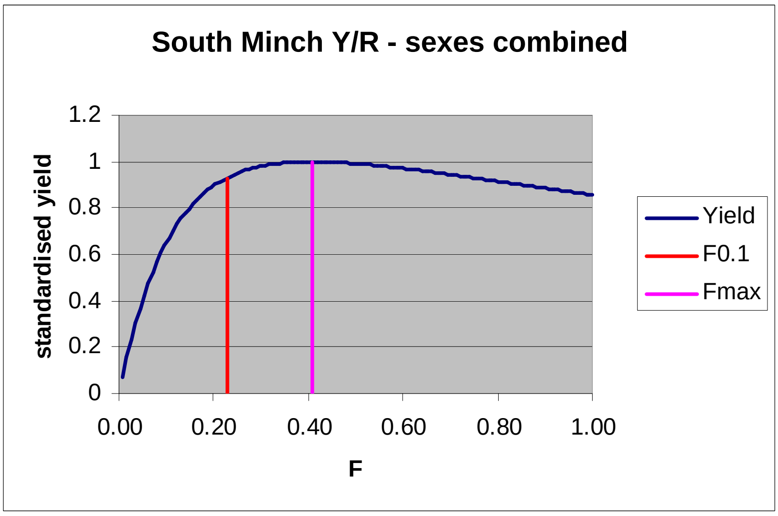


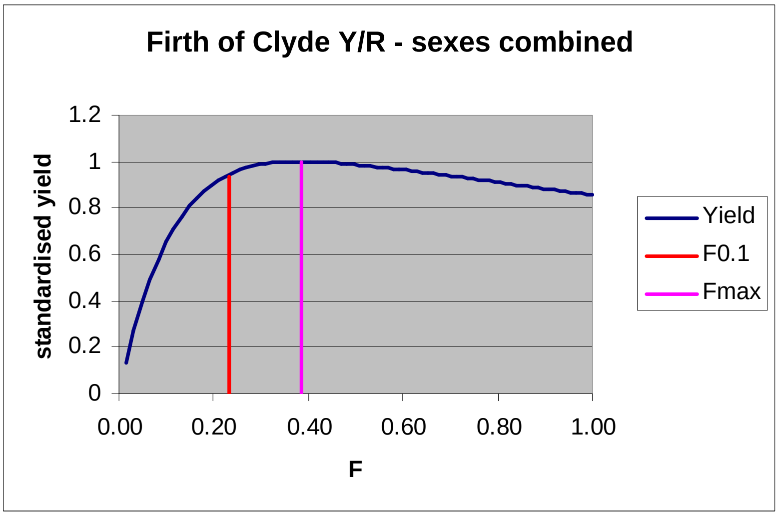
Figure 13.25 Nephrops, Diagram to illustrate the process of calculating a predicted landing from TV survey abundance estimates.



Fbar = 0.49



Fbar = 0.32



Fbar = 0.57

Figure 13.26 Nephrops, Combined sex Y/R curves for the three Functional Units in Management Area C

14 NEPHROPS IN DIVISION VIIa

14.1 Nephrops in Management Area J

Division VIIa *Nephrops* stocks from FU 14 were assigned a 'monitoring stock' and those from FU 15 as an 'experimental assessment' status. Prior to 2005 *Nephrops* were assessed 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 14.1 and Figure 13.1. 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 analytical assessments.

Nephrops from the north of 53^{o}N of Division VIIa form two Functional Units, Irish Sea East (FU14) and Irish Sea West (FU15). These Functional Units are combined to form Management Area J. The TAC area as defined by ICES comprises of an aggregation of Management Units M, A & J (ICES area VII). This stock was last assessed by WGNSDS05.

14.1.1 The Fishery

14.1.1.1 ICES advice applicable to 2005 and 2006

ICES advice for 2005

There is no basis to revise the advice given previously of a TAC from this Management Area in 2005 be kept at the level recommended in 2002 and 2003, i.e. 9 550 t. Advice on the exploitation of this stock in 2005 is presented in the context of mixed fisheries and is found in section 3.7.1.

ICES also notes that this Management Area is within a much larger TAC area (Sub area VII), and that a single TAC set for the whole Sub area will not result in balanced exploitation. In an attempt to resolve this problem, ICES suggests a separate *Nephrops* TAC for Division VIIa, as is done for several finfish stocks (such as cod, whiting, plaice, and sole).

ICES advice for 2006

The *Nephrops* trawl fisheries take considerable bycatches of other species. The management of these fisheries should be seen in the context of mixed fisheries. Evidence of under-reporting of landings creates problems with using commercial data for analytical assessments and in TAC recommendations. Despite evidence of under reporting, the *Nephrops* fisheries in Division VIIa have been sustained for over 20 years with similar high levels of fishing effort. Because of some uncertainty regarding the accuracy of recent landings the advice for these FUs (14 & 15) is based on effort, whereas the advice for other *Nephrops* stocks within the TAC area is based on recent average landings (2000-2002). There is no information on the accuracy of landings for these other *Nephrops* stocks.

14.1.1.2 Management applicable in 2006

"Management area J" falls within a larger TAC area for management purposes. The table below gives the ICES advice and basis as provided for each "Management Area" in the TAC area as a whole in 2005.The table also gives the TACs in 2005 and 2006 for all of VII. The TAC was increased by 12% for 2005 and by a further 10% for 2006 but this was not based on scientific recommendations.

Management Area	Functional Units	ICES advice for MA in VII	Basis of ICES advice in 2003	TAC 2005	TAC 2006
WG-MA J	14, 15	9,440	Effort maintained at recent levels		
WG-MA L	16, 17, 18,19	3,300	Restrict landings to average landings of recent years		
WG-MA M	20-22	4,600	Average landings 1993-2002		
Sub-Area VII	**14 to 22**	**17,450**		**19,544**	**21,498**

In 2005 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 Section 1.7.

These regulations incorporate 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). In addition to *Nephrops* measures the cod spawning areas of the Irish Sea are closed to whitefish directed vessels from 14 February to 30 April as part of the Irish Sea cod recovery plan. There is derogation for *Nephrops* vessels during this closure.

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).

Official declared landings from Division VIIa are presented in Table 14.2, Table 14.3 and Table 14.4

14.2 Irish Sea East (FU14)

14.2.1 The fishery in 2005

This was designated a monitoring stock by the 2005 Review Group. 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. In 2005 the size of this fleet increased by 9 new vessels to the fishery. Currently, around 25 of these vessels, between 9 and 21m in length, have their ‘home’ ports in Whitehaven, Maryport and Fleetwood, England. The rest of the fleet is made up of generally larger vessels from Kilkeel, Northern Ireland. In 2005 about 70% of the landings from this fishery were made to Whitehaven and about 20% to Kilkeel. The decline in the English and Welsh fleet has had little affect on the average vessel size and gear make up overall. However the changes to the fleets at individual ports has been far more significant. Technical conservation and cod recovery measures have affected mesh sizes and fishing patterns.

14.2.2 Catch data

14.2.2.1 Official Catch Statistics

Official landings as reported to ICES from Management Area J are presented in Table 14.5 and are incomplete for 2005

14.2.2.2 Revision to catch data

The last assessment of Management Area J *Nephrops* stocks was conducted by WGNSDS in 2005.

14.2.2.3 Quality of the Catch data

The TAC for Division VIIa *Nephrops* forms part of the larger TAC Area VII, which has remained between 17,790 and 23,000 tonnes since 1992. This advice was provided on the basis of historical landings owing to the inability to conduct appropriate catch predictions. Individual vessel quotas have become restrictive leading to under reporting of landings.

14.2.3 Commercial catch-effort data and research vessel surveys

Over the past 19 years, landings from FU 14 have been relatively stable, fluctuating around a long-term average (1991-2005) of about 543 t (Figure 14.1). Landings in 2005 have returned to average levels after landings dropped in 2003 to their lowest point since 1974. Over the last 10 years UK vessels landed most of the international landings (up to 97%) although Irish vessels increased their share of the landings to a peak level of 35% in 2002 (Table 14.5). In 2005, most of the landings were made into England with a high proportion of these landings (66 % of the directed landings) being made by visiting Northern Irish vessels. UK *Nephrops* directed effort has fluctuated around a downward trend since 1978 reaching a minimum in 2004: effort in 2005 increased by 14% on the 2004 level. Quarterly effort plots show a predominance of effort in the 2^{nd} and 3^{rd} quarters (Figure 14.2). In 2005, 3^{rd} quarter effort was at its lowest level since 1998 and partly explains the high male:female sex ratio observed for 2005. The overall increase in total annual effort in 2005 was mainly driven by effort in the 2^{nd} quarter.

The UK LPUE series is based on a combination of directed *Nephrops* voyages by English and Welsh 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 vessels which target *Nephrops*. The combined LPUE has fluctuated between 17 and 29 kg/hour trawling in the last 10 years with the lowest and the highest LPUE figure occurring in 2003 and 2005 respectively. A particular feature of the recent LPUE is the dramatic increase observed in 2004, which is mainly driven by the Northern Irish fleet. Such a pattern has been seen before (1989-1990) and is therefore not unique, it might reflect a change in reporting or a change in targeted effort rather than biological phenomena. LPUEs for males and females < 35 mm CL (Figure 14.3) appear to exhibit the same general trends fluctuating around averages of 5.5 and 4.5 kg/hour trawling respectively with minima in 2003. The LPUE of the larger males (>35mm) has been increasing since 2002. For females >35mm, the quarterly pattern of availability to the fishery means that meaningful statistics for this portion of the population are highly dependent upon the level of fishing/sampling effort deployed in the 3^{rd} quarter. There are no recent research vessel survey data for this Functional Unit.

14.2.4 Length at Age composition and mean weights-at-age

Landings, effort and length compositions of landings were available from UK England and Wales sampling for 1992-2005. Although the UK Fisheries Inspectorate attempts to census the landings and effort of all vessels landing in the UK, there has been some concern and anecdotal evidence that actual landings are higher than reported. The number of landings samples improved between 1999 and 2004 when between 13 and 25 landings were sampled annually. The situation deteriorated in 2005 where only 8 landings were sampled. In 1999, a catch sampling programme was set up to address the lack of discard samples since 1994. Although only 5 samples were collected in 2003, between 12 and 26 catch samples were taken annually since 2000.

14.2.5 Natural mortality and maturity at age

Biological input parameters are given in the Stock Annex

14.2.6 Catch-at-age-analyses

No age-based assessment is presented this year.

14.2.6.1 Data screening and exploratory runs

Although an exploratory age-based assessment was performed this is not presented in view of the serious uncertainties associated with declared landings data.

14.2.6.1.1 Commercial catch data Survey data

Although levels of market and discard sampling in the Irish Sea East were sustained during 2005 concerns have been raised at both WGNEPH and WGNSDS about the implications of the use of the knife edge slicing technique for catch at age analysis of the resulting year classes. The increase in variability in length at age for older individuals may lead to a number of “real” ages being included within a sliced age, leading to an overestimation of F.

14.2.6.1.2 Survey data

There were no fishery independent survey data available for this Functional Unit.

14.2.6.1.3 Exploratory assessment runs

XSA

A trial single fleet assessment was carried out, using UK data from 1992-2005. The Lowestoft VPA program was run on 'age groups' generated by slicing the length distributions with the L2AGE program. Tuning of the VPA was carried out with Inputs are detailed in and the VPA was tuned with the available commercial CPUE series for the UK English, Welsh and Northern Ireland *Nephrops* directed trawl effort data adjusted to international landings. After exploratory runs optimal settings were chosen and a final run completed. The results of this assessment together with the XSA diagnostics are provided in the stock files. Given the concerns of the WG on the appropriateness of the commercial CPUE tuning fleet, the Official landings and effort data, the implications of the slicing procedure and the validity of a dynamic pool model for *Nephrops*, it was decided not to present an XSA assessment.

14.2.6.1.4 Final assessment run

An LCA was carried out on both male and female data to provide a comparison with the analysis performed for Irish Sea west (FU15) which was subsequently used to generate a harvest ratio to be applied to an UWTV generated stock abundance estimate.

A reference period of the three years 2002, 2004 and 2005 was chosen and excluded 2003 data which were from too few catch samples to be reliable. The year’s chosen provided a period of relatively stable length distributions in catch, landings and discards along with relatively stable effort. Given uncertainty over the fate of discards in the Irish Sea East *Nephrops* fishery, discard survival rate was set to zero.

The Y/R curves from this analysis (Figure 14.5) suggest the fishery is sustaining current levels of exploitation. For females current F is slightly above F_{max} (0.23) on the long-term yield per recruit curve and for males it is at F_{max} (0.33) and long-term gains in from reducing effort would be negligible.

14.2.6.2 Reference points

No reference points have been determined for this *Nephrops* stocks.

14.2.6.2.1 Management considerations

This stock appears to be sustaining current levels of effort. However anecdotal evidence of under reporting makes it difficult to determine what current landings actually are. Management considerations are discussed in section 14.4 in relation to Management Area J

14.3 Irish Sea West (FU15)

14.3.1 The Fishery

General information on the fishery can be found in section 1.52 and in the stock files.

14.3.2 Catch data

Total declared international *Nephrops* landings reported from FU 15 in 2005 was 6603 t (Table 14.9 and Figure 14.5). Reported Republic of Ireland landings peaked at 4582 t in 1999 and dropped to a provisional 2106 t in 2005. Officially reported landings by UK vessels from this FU were 4497 t, which is 68% of the international landings. Northern Ireland landings represented 96 % of the total UK landings from this FU.

14.3.2.1 Revision to catch data

The last assessment of Management Area J *Nephrops* stocks was conducted by WGNSDS in 2005

14.3.2.2 Quality of Catch data

The TAC for Division VIIa *Nephrops* forms part of the larger TAC Area VII, which has remained between 17790 and 23000 tonnes since 1992. This advice was provided on the basis of historical landings owing to the inability to conduct appropriate catch predictions. There is evidence of significant under reporting in this fishery and individual vessel quotas have been restrictive.

14.3.3 Commercial catch-effort data and research vessel surveys

CPUEs and LPUEs for the Northern Ireland fleet have remained relatively constant since 1995 with a drop in 2000 and an increase since then (Table 14.10 and Figure 14.5). Republic of Ireland CPUE data available for *Nephrops* from 1995 peaked in 2003 and declined in 2004 and 2005. (Table 14.11 and Figure 14.5). The mean sizes of *Nephrops* in the catches of both the Northern Ireland and the Republic of Ireland fisheries have fluctuated without obvious trend for many years (1984-2000). Data from recent years (2001-2005) suggests a slight increase in mean size. (Table 14.12, Table 14.13 and Figure 14.5).

Since 2003 Ireland and Northern Ireland have jointly carried out and underwater television surveys of the main *Nephrops* grounds in the western Irish Sea. These surveys were based on a randomised fixed grid design. The methods used during the survey were similar to those employed for UWTV surveys of *Nephrops* stocks around Scotland and elsewhere (See Chapter 13 and Section 2.5.1).

Northern Ireland have also carried out a spring (April) and summer (August) *Nephrops* trawl surveys since 1994. These surveys provide data on catch rates and LFDs from of stations throughout in the western Irish Sea (Figure 14.6).

14.3.4 Length at Age composition and mean weights-at-age

Quarterly length frequency data were available for Republic of Ireland landings and discards up to 2005. These data were raised to the reported international catch to perform LCA and Yield Per Recruit analysis.

14.3.5 Natural mortality and maturity at age

Biological input parameters are given in the Stock Annex

14.3.6 Catch-at-age-analyses

No age-based assessment was performed in 2005

14.3.6.1 Data screening and exploratory runs

14.3.6.1.1 Commercial catch data

Although catch at length and effort data were available for a sub-set of Irish *Nephrops* trawlers (1995-2005) and for the Northern Ireland fleet (1986-2002) both WGNEPH and WGNSDS have expressed concern about the implications of using a knife edge slicing technique for catch at age analysis of resulting year classes. Evidence of under reporting of landings discussed elsewhere in this report also creates problems with raised data. The CPUE and LPUE data will also be affected by under reporting and by changes in catchability over the time series due to changes in efficiency and structure of the fleets.

14.3.6.1.2 Survey data

The underwater TV surveys performed in 2003, 2004 and 2005 are presented as the best available information on the Western Irish Sea *Nephrops* stock. These surveys provide a fishery independent estimate of *Nephrops* abundance. Plots of the standardised burrow densities (numbers/m2) are shown for each survey in Figure 14.8. The highest modal density was in 2004. The results indicate that very high burrow densities are widespread throughout the survey area. The densities observed are one of the highest observed by UWTV surveys (Figure 14.8). Although the spatial patterns were similar the 2003 survey showed highest densities in the southwestern corner of the grounds, whereas in 2004 highest densities were found in the northern part of the ground. In 2005 highest densities occurred at central and eastern stations. Relevant metadata and results for the three surveys are summarised in Table 14.14. Although the mean burrow densities are precisely estimated with CVs <5% this may under estimate the true uncertainty because of discrepancies between the burrow estimates of the individual counters (especially in 2005) and the spatial characteristics of the densities. These issues have not as yet been addressed, though likely to be an agenda item for an ICES Study Group dedicated to UWTV surveys in 2007.

Nephrops UWTV surveys have various important assumptions and methodological uncertainties, which should be considered. All burrow complexes passing off the bottom of the screen are counted and may result in a slightly larger effective field of view and an overestimate in the burrow counts. The assumptions are very important when considering the results of the survey in absolute terms, but are not as important when using the survey as a relative indicator.. A further joint NI/ROI UWTV survey is planned for August 2006.

Northern Ireland trawl surveys performed during spring (April) and summer of each year (August) demonstrate a stable situation with no trend in mean size, catch rate, sex ratio or recruitment as indicated from the number of animals <20mm CL and there is no change in sex ratio during summer surveys (Figure 14.9).

14.3.6.1.3 Exploratory assessment runs

An age-base assessment was not performed in 2006.

14.3.6.1.4 Final assessment run

A Length Cohort Analysis (LCA) was carried out on male and female *Nephrops* combined, using commercial Republic of Ireland landed and discard length frequency data averaged over the period 2003-2005 (Figure 14.10). Growth parameters and the length-weight relationship were as detailed in the data appendix. Natural mortality by sex was assumed to be in line with other stocks and discard survival (25%) was in line with that used for Scottish stocks.

14.3.6.1.5 Comparison of Results with last years assessment

There was no analytical assessment presented in 2005

14.3.6.2 Reference points and Results

In view of uncertainties associated with total abundance estimates a mean of all three surveys was used to estimate total stock biomass. A fixed area estimate of 5,790 km^2 was used to calculate the raised numbers in the population, assuming 100% burrow occupancy. A mean *Nephrops* weight was calculated from the length frequencies (Figure 14.10) of male and female *Nephrops* combined, caught during DARD summer trawl surveys during 2003-2005 of 11.18 g. This value was raised to the mean density estimate from the three surveys of 8.422 x 10^9 to provide an estimate of stock biomass of 94,156 t.

The yield per recruit analysis from the LCA was used to generate fishing mortality reference points (Figure 14.11). These were $F_{0.1}$ = 0.24 and F_{max} = 0.36. Reference points derived from LCAs are calculated from the shape of the exploitation pattern, and should be relatively independent of commercial landings. The reference point of $F_{0.1}$ recommended by STECF as an appropriate exploitation level was converted to a harvest ratio and applied to the camera survey biomass estimate averaged over the period 2003-2005 (Table 14.15). This was considered to be the most appropriate approach in view of the discrepancies between burrow estimates of the individual counters and the spatial characteristics of the densities as discussed above.

14.3.6.2.1 Management considerations

For an $F_{0.1}$ the equivalent harvest ratio is 20%, which would provide potential removals (landings plus dead discards) of 18,834 and landings of 15,424 t. The text table below shows catch options for a range of harvest ratios.

HARVEST RATIO	REMOVALS	LANDINGS
25%	23,542	19,280
20% ($F_{0.1}$)	18,834	15,424
15%	14,125	11,568

14.4 Management Area J Management Considerations

Serious concerns about under reporting of landings creates problems with using commercial data for analytical assessments and in TAC recommendations. Despite evidence of under reporting the VIIa *Nephrops* fisheries have been sustained for over 20 years with high levels of fishing effort. There is no evidence from trends in population data (eg mean size and sex ratio) for either Functional Unit (FU14 and (FU15) that there is a problem in this Management Area. This is reinforced by data generated from trawl surveys. This fishery appears to be sustaining current exploitation levels.

The previous ICES practice of basing TAC recommendations on reported landings where there is evidence of under-reported landings is not appropriate, as these stocks appear to be sustainable with higher catch rates, though the exact magnitude of these is unknown. This is further discussed in Section 13.6 in relation to Area VIa stocks. In view of the apparent stability of this stock and the very high densities identified by UWTV surveys the WG recommend a catch for 2007 based upon the fisheries independent assessment aligned with an exploitation level at, or near to $F_{0.1}$ by applying a harvest ratio of 20% to the estimated stock biomass giving a recommended landing of 15,424 t.

Table 14.1. - Nephrops Functional Units and descriptions by statistical rectangle.

Functional Unit	Stock	ICES Rectangles	Management Area
14	Irish Sea East	35-38E6; 38E5	J
15	Irish Sea West	36E3; 35-37E4-E5; 38E4	J

Table 14.2. - Official catch data Nephrops VIIa as reported to ICES

Country	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Belgium	0	0	0	0	0	0	0	0	0	2
France	91	55	62	3,539	3,797	2,977	8	8	16	6
Ireland	4,682	4,639	3,201	2,840	2,000	3,200	2,370	2,614	2,337	3,303
Isle of Man	7	18	39	8	25	61	14	32	14	29
UK - Eng+Wales+N.Irl.	0	0	0	6,002	6,155	6,805	5,572	5,900	6,300	5,944
UK - England & Wales	693	474	693	0	0	0	0	0	0	0
UK - N. Ireland	5,188	5,091	5,255	0	0	0	0	0	0	0
UK – Scotland	32	29	16	43	24	59	29	17	18	63
Total	10693	10306	9266	12432	12001	13102	7993	8571	8685	9347

Country	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005*
Belgium	1	1	0	0	1	0	1	1	1	2
France	1	1	0	0	1	0	0	1	0	
Ireland	2,156	3,695	2,754	4,698	3,621	2,892	2,403	2,846	2896	na
Isle of Man	20	24	17	10	3	2	0	1	13	
UK - Eng+Wales+N.Irl.	6,103	7,163	6,316	6,514	5,328	5,213	4,841	4,621	4,899	5,051
UK - England & Wales	0	0	0	0	0	0	0	0	0	0
UK - N. Ireland	0	0	0	0	0	0	0	0	0	0
UK – Scotland	14	17	74	38	31	34	90	27	55	0
Total	8295	10901	9161	11260	8985	8141	7335	7497	7,864	4,954

*Preliminary

na not available

Table 14.3. - Management Area J (Vlla, North of 53° N): Total Nephrops landings (tonnes) by Functional Unit plus Other rectangles, 1996-2005.

Year	FU 14	FU 15	Other	Total
1996	511	7257	6	7774
1997	597	9979	44	10620
1998	389	9145	4	9538
1999	625	10786	2	11412
2000	567	8370	0	8937
2001	532	7441	1	7974
2002	577	6793	0	7370
2003	377	7052	2	7431
2004	472	7398	11	7881
2005*	567	6603	33	7202

*** provisional**

Table 14.4. - Management Area J (Vlla, North of 53° N): Total Nephrops landings (tonnes) by country, 1996-2005.

Year	Belgium	France	Rep. of Ireland	Isle of Man	UK	Other Rectangles	Total
1996	1	2	1638	10	6118	6	7774
1997	2	0	3365	7	7202	44	10620
1998	1	0	3126	17	6389	4	9537
1999	0	0	4735	6	6669	2	11412
2000	2	0	3547	0	5388	0	8937
2001	0	0	2715	3	5255	1	7974
2002	1	0	2494	0	4875	0	7370
2003	0	0	2766	4	4658	2	7430
2004	0	0	2844	13	5011	11	7880
2005*	0	0	2138	0	5032	33	7202

* provisional

Table 14.5. - Irish Sea East (FU 14): Landings (tonnes) by country, 1996-2005.

Year	Rep. of Ireland	UK	Other countries **	Total
1996	64	444	3	511
1997	16	580	1	597
1998	26	362	1	389
1999	153	471	0	625
2000	114	451	2	567
2001	26	506	0	532
2002	203	373	1	577
2003	70	306	1	377
2004	62	409	1*	472
2005*	32	535*	0*	567

* provisional   na = not available

** Other countries includes Belgium and Isle of Man

Table 14.6. - Irish Sea East (FU 14): Effort (‘000 hours trawling) and LPUE (kg/hour trawling) of Nephrops directed voyages by UK trawlers, 1996-2005.

Year	Effort	LPUE
1996	17.2	22.2
1997	16.6	25.3
1998	13.7	19.6
1999	18.4	19.8
2000	17.9	21.2
2001	20.3	20.7
2002	14.7	20.1
2003	14.1	16.7
2004	12.1	27.5
2005*	13.8	28.5

* provisional   na = not available

Table 14.7. - Irish Sea East (FU 14): Effort ('000 hours trawling) and LPUE (kg/hour trawling) of Nephrops directed voyages by Republic of Ireland trawlers, 1996-2005.

Year	Effort	LPUE
1996	1.5	39.7
1997	0.3	46.6
1998	0.6	33.2
1999	2.3	55.4
2000	2.5	43.6
2001	0.6	42.5
2002	3.3	57.1
2003	1.1	37.6
2004	1.4	41.2
2005*	0.7	41.9

* provisional   na = not available

Table 14.8. - Irish Sea East (FU 14): Mean sizes (mm CL) of male and female Nephrops from UK vessels landing in England and Wales, 1996-2005.

Year	**Catch**		**Landings**	
	Males	Females	Males	Females
1996	na	na	34.1	32.6
1997	na	na	34.0	31.3
1998	na	na	31.7	28.6
1999	na	na	35.5	32.5
2000	29.2	28.3	33.7	32.3
2001	31.6	29.2	34.2	32.5
2002	32.0	29.2	35.1	32.0
2003	36.4	30.7	38.4	34.5
2004	32.0	29.3	35.2	33.1
2005*	32.4	29.5	34.6	32.3

* provisional   na = not available

Table 14.9. - Irish Sea West (FU 15): Landings (tonnes) by country, 1996-2005.

Year	Rep. of Ireland	Isle of Man	UK	Other countries **	Total
1996	1574	8	5673	2	7257
1997	3349	7	6622	1	9979
1998	3101	17	6027	0	9145
1999	4582	6	6198	0	10786
2000	3433	0	4937	0	8370
2001	2689	3	4749	0	7441
2002	2291	1	4501	0	6793
2003	2696	4	4352	0	7052
2004	2782	13	4602	0	7398
2005*	2106	0	4497	0	6603

* provisional

Table 14.10. - Irish Sea West (FU 15): Catches and landings (tonnes), effort (‘000 hours trawling), CPUE and LPUE (kg/hour trawling) of Northern Ireland Nephrops trawlers, 1996-2005.

Year	Catches	Landings	Effort	CPUE	LPUE
1996	6323	5574	164	38.5	33.9
1997	7070	6415	175	40.3	36.6
1998	6603	5842	171	38.7	34.2
1999	6974	6032	172	40.6	35.1
2000	5929	4758	169	35.1	28.2
2001	5769	4587	164	35.2	28.0
2002	5168	4495	131	39.5	34.4
2003	-	4146	141	-	29.4
2004	-	4302	141	-	30.5
2005*	-	4280	140	-	30.6

* provisional

Table 14.11. - Irish Sea West (FU 15): Catches and landings (tonnes), effort (‘000 hours trawling), CPUE and LPUE (kg/hour trawling) Nephrops Directed Trawlers 1995-2005.

Year	Effort	Landings	LPUE
1996	32987	1410.6	42.76
1997	63134	2832.5	44.87
1998	53916	2654.1	49.23
1999	74560	4010.7	53.79
2000	61160	3159.6	51.66
2001	52548	2474.8	47.10
2002	48979	2237.9	45.69
2003	46110	2621.7	56.86
2004	53887	2646.5	49.11
2005*	48074	2044.0	42.52

Table 14.12. - Irish Sea West (FU 15): Mean sizes (mm CL) of male and female Nephrops in Northern Ireland catches, landings and discards, 1996-2005.

Year	**Catches**		**Landings**		**Discards**	
	Males	Females	Males	Females	Males	Females
1996	28.5	25.9	29.9	27.0	22.3	22.0
1997	26.1	24.3	27.2	25.7	19.9	20.1
1998	27.5	25.0	28.7	26.4	21.6	21.6
1999	27.7	24.5	29.1	26.1	22.0	21.7
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

* provisional   na = not available

Table 14.13. - Irish Sea West (FU 15): Mean sizes (mm CL) of male and female Nephrops in Republic of Ireland catches, landings and discards, 1996-2005.

Year	Catches		Landings		Discards	
	Males	Females	Males	Females	Males	Females
1996	26.8	24.7	28.5	26.2	22.7	22.5
1997	26.8	26.1	28.3	27.7	na	na
1998	26.3	25.2	28.4	27.6	na	na
1999	26.4	24.9	28.7	27.1	23.3	22.8
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

* provisional   na = not available (Qtr 3 & Qtr 4 missing)

Table 14.14. - Irish Sea West (FU 15): Results from NI/ROI collaborative UWTV surveys of *Nephrops* grounds in 2003, 2004 and 2005

Year	Number of stations	Area Surveyed (M2)	Mean Density (No./M2)	+/- 95% Confidence Intervals on mean	St Error	Stdev	CV	Variance	Burrow count	Raised abundance estimate ($X10^9$)
2003	166	27566	1.66	0.14	0.07	0.87	4.34%	0.76	42493	9.617
2004	147	23214	1.43	0.13	0.07	0.75	4.59%	0.57	38484	8.291
2005	144	21415	1.27	0.12	0.06	0.69	4.74%	0.42	22100	7.359

Table 14.15 *Nephrops* , Irish Sea West (FU15): Predicted landings potential based on abundance estimates using TV surveys, current landings and discard length distributions for Irish Sea West and various harvest ratio% based on Y/R reference points and arbitrary percentages

Males

Weight = a*CLb — a = 0.00032; b = 3.21

Females

a = 0.00068; b = 2.96

CL	Males Landings ('000)	Males Discards ('000)	Males Removals ('000)	Males Wt (g)	Males Landings (t)	Females Landings ('000)	Females Discards ('000)	Females Removals ('000)	Females Wt (g)	Females Landings (t)
10.5	0	6	5	3	0.00	0	0	0	0	0.00
11.5	0	0	0	0	0.00	0	2	2	1	0.00
12.5	0	0	0	0	0.00	0	0	0	0	0.00
13.5	0	0	0	0	0.00	0	98	73	111	0.00
14.5	0	310	233	398	0.00	0	433	325	606	0.00
15.5	0	162	121	257	0.00	0	252	189	429	0.00
16.5	2	721	543	1406	0.01	0	954	715	1954	0.00
17.5	39	1650	1277	3995	0.12	71	2799	2170	7054	0.23
18.5	180	3848	3066	11465	0.67	307	5287	4272	16366	1.18
19.5	609	8311	6842	30292	2.69	678	9509	7810	34969	3.04
20.5	1344	14646	12328	64090	6.99	1571	16614	14031	72843	8.15
21.5	3411	19766	18235	110455	20.66	4542	27062	24839	148478	27.15
22.5	7665	25851	27054	189621	53.73	9376	32529	33773	230960	64.12
23.5	14424	31828	38295	308617	116.24	15688	36293	42907	333735	122.02
24.5	23160	33928	48605	447771	213.36	22944	35903	49871	438824	201.89
25.5	33493	29886	55907	585617	350.83	30228	31102	53554	530472	299.42
26.5	39921	24533	58321	691187	473.12	35123	24445	53457	593365	389.86
27.5	49885	17830	63258	844349	665.85	37105	15124	48448	600082	459.59
28.5	52864	12691	62382	933822	791.34	34359	7857	40252	554164	473.04
29.5	58382	8108	64463	1077928	976.24	30435	4279	33644	512971	464.04
30.5	52973	5043	56756	1056238	985.85	23516	2162	25137	423009	395.72
31.5	44010	2867	46160	952777	908.40	16287	1269	17239	319162	301.54
32.5	37040	1651	38278	873468	845.22	12229	601	12680	257520	248.36
33.5	30945	766	31520	792739	778.29	9252	316	9488	210784	205.52
34.5	26610	0	26610	735507	735.51	7137	0	7137	172970	172.97
35.5	19845	0	19845	601216	601.22	4985	0	4985	131473	131.47
36.5	15447	0	15447	511628	511.63	3500	0	3500	100225	100.23
37.5	11393	0	11393	411561	411.56	2359	0	2359	73187	73.19
38.5	10186	0	10186	400374	400.37	1946	0	1946	65245	65.24
39.5	6923	0	6923	295482	295.48	1923	0	1923	69564	69.56
40.5	4334	0	4334	200428	200.43	1095	0	1095	42644	42.64
41.5	3112	0	3112	155659	155.66	960	0	960	40189	40.19
42.5	1931	0	1931	104250	104.25	514	0	514	23072	23.07
43.5	1197	0	1197	69647	69.65	745	0	745	35879	35.88
44.5	1182	0	1182	73959	73.96	363	0	363	18674	18.67
45.5	461	0	461	30975	30.97	267	0	267	14700	14.70
46.5	531	0	531	38245	38.25	279	0	279	16371	16.37
47.5	314	0	314	24212	24.21	136	0	136	8475	8.48
48.5	222	0	222	18295	18.29	115	0	115	7661	7.66
49.5	231	0	231	20352	20.35	0	0	0	0	0.00
50.5	273	0	273	25641	25.64	43	0	43	3203	3.20
51.5	82	0	82	8151	8.15	39	0	39	3071	3.07
52.5	83	0	83	8784	8.78	30	0	30	2533	2.53
53.5	0	0	0	0	0.00	67	0	67	5971	5.97
Total				12,710,862	10,924				6,122,966	4,500

Total (Males + Females)	18,834	15,424
TV abundance (thousands)	8,423,000	
Biomass (tonnes)	94,169	

	Removals	landings
landings potential with 25% removals	23,542	19,280
landings potential with 20% removals	18,834	15,424
landings potential with 15% removals	14,125	11,568

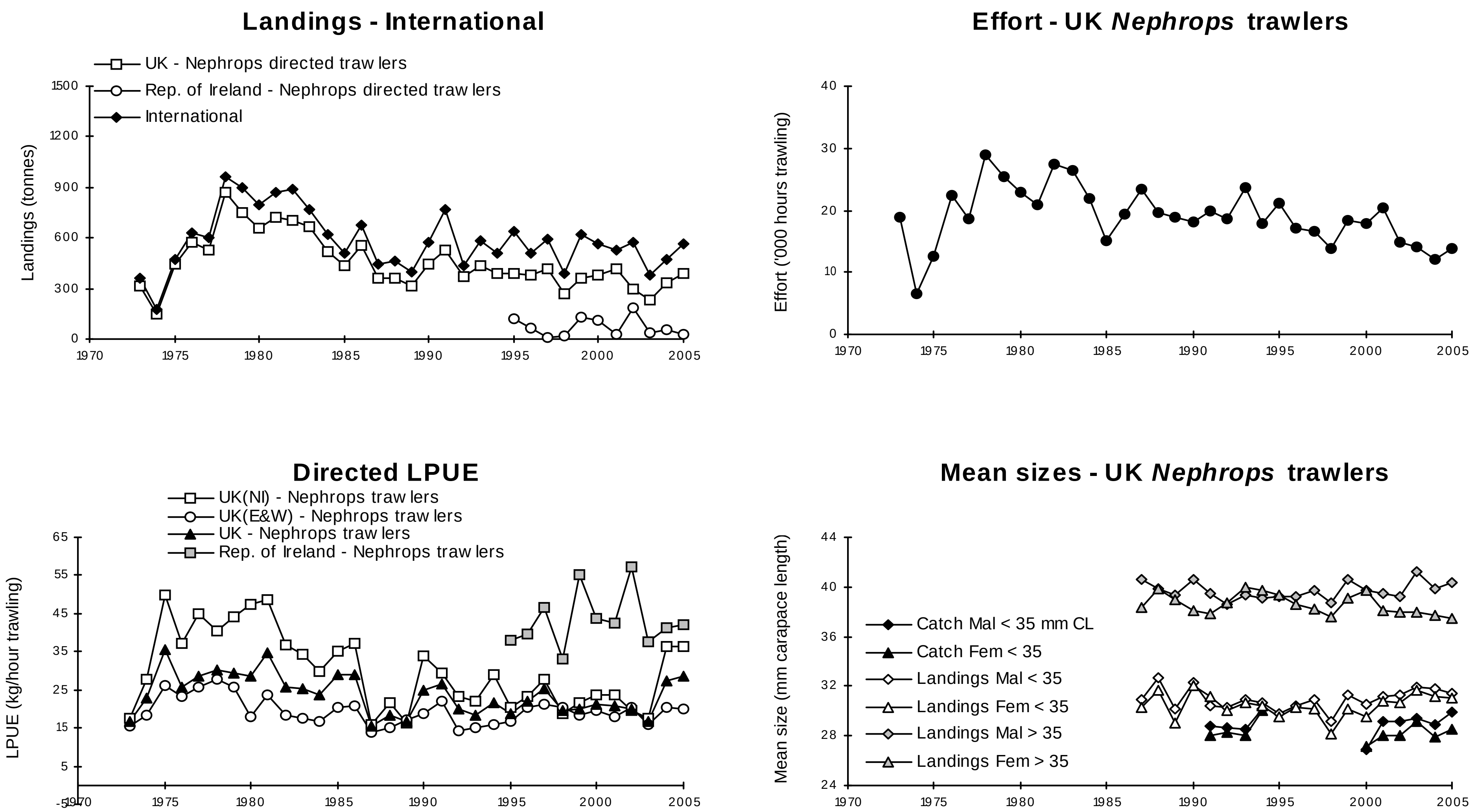


Figure 14.1. - Irish Sea East (FU 14): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of Nephrops.

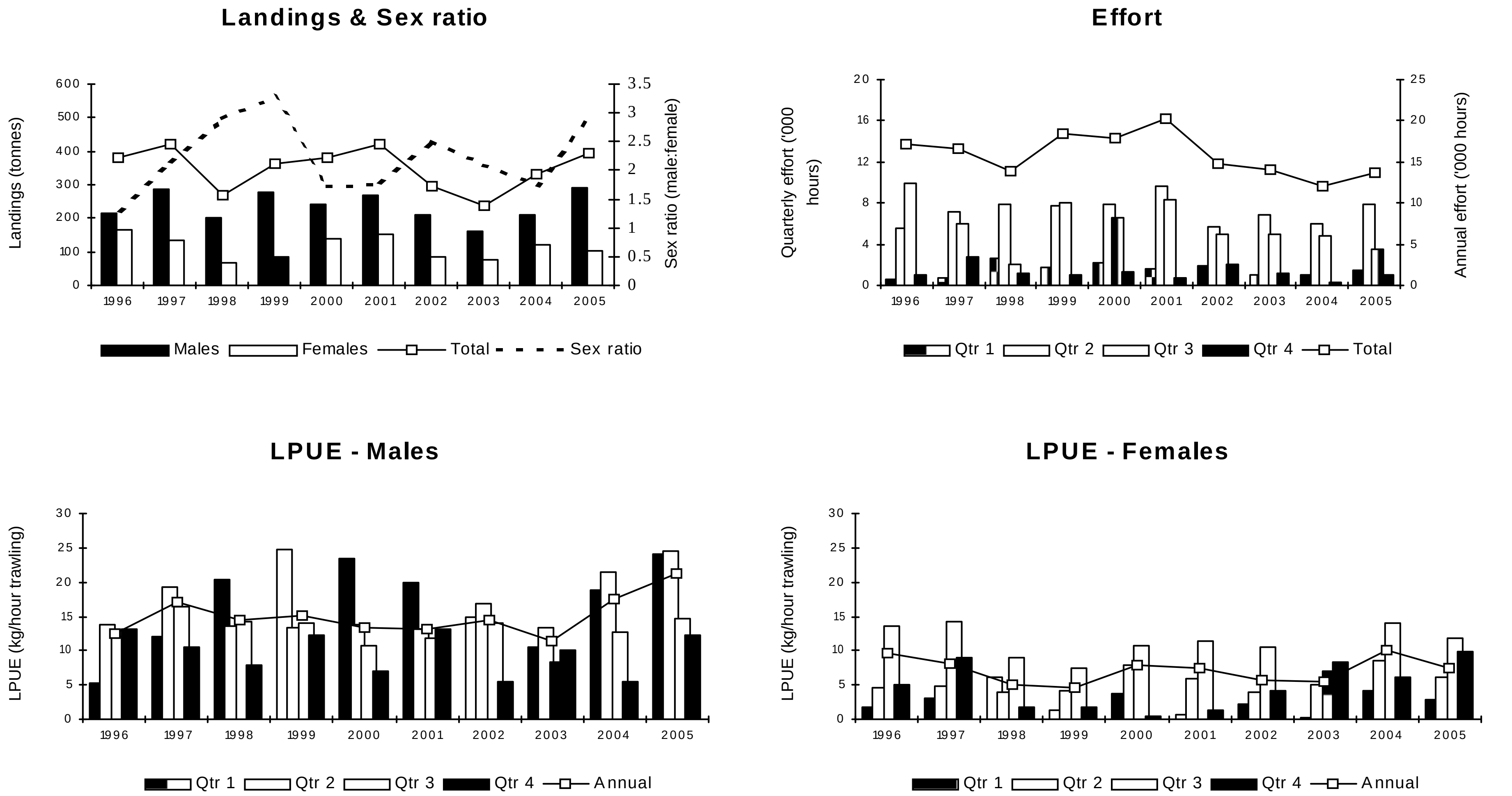


Figure 14.2. - Irish Sea East (FU 14): Landings, effort and LPUEs by quarter and sex from UK Nephrops directed trawlers.

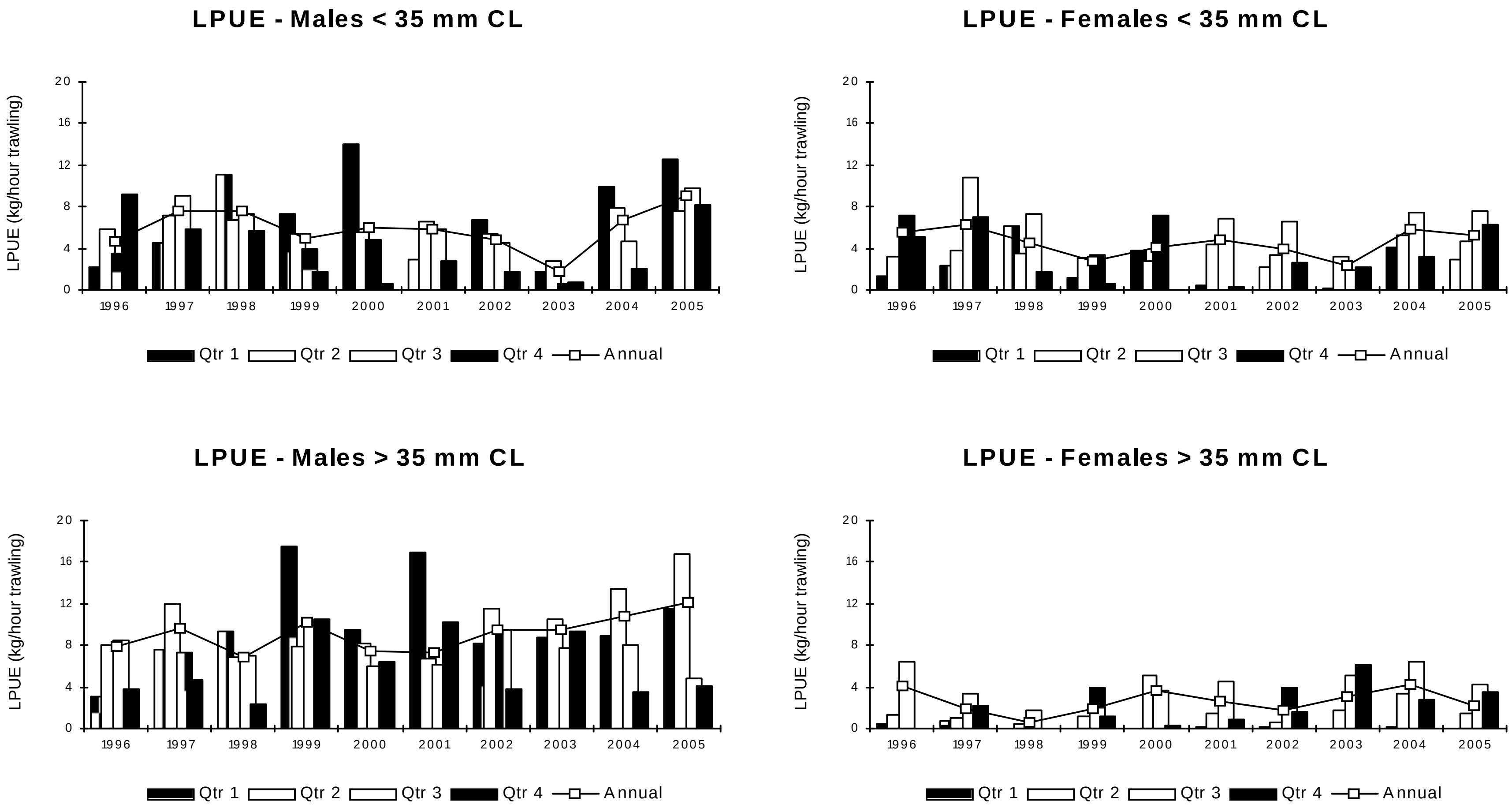
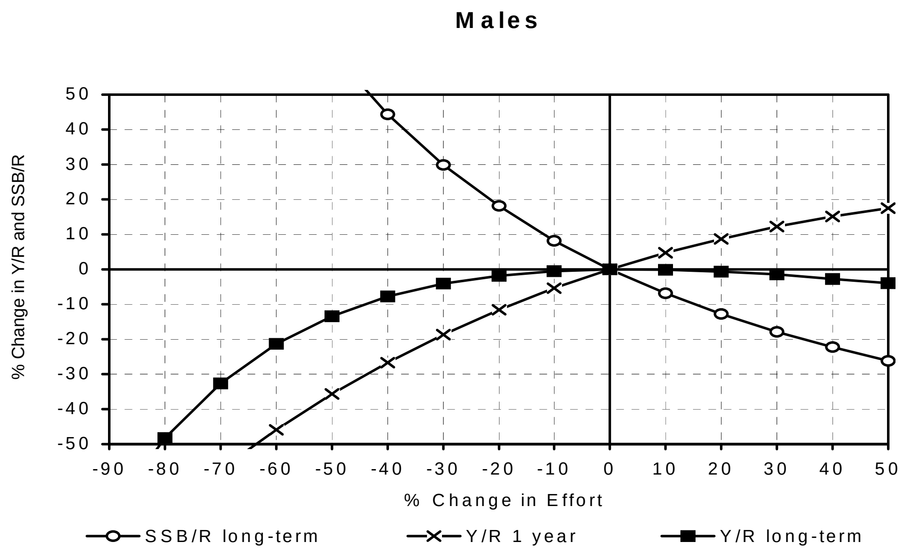


Figure 14.3. - Irish Sea East (FU 14): LPUEs by sex and quarter for selected size groups, UK Nephrops directed trawlers.



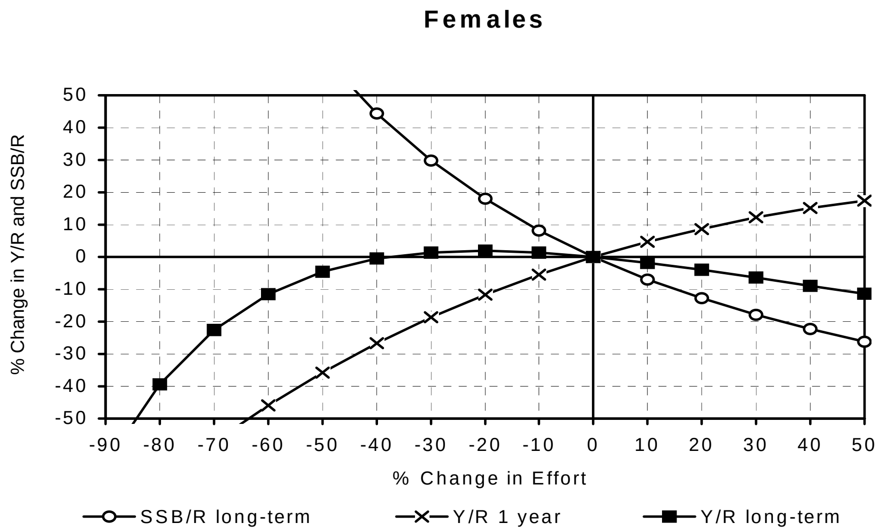


Figure 14.4. Irish Sea East (FU 14): Relative changes in short term Y/R (ie after 1yr), long term Y/R and long term B/R upon relative changes in effort. Males and females shown separately

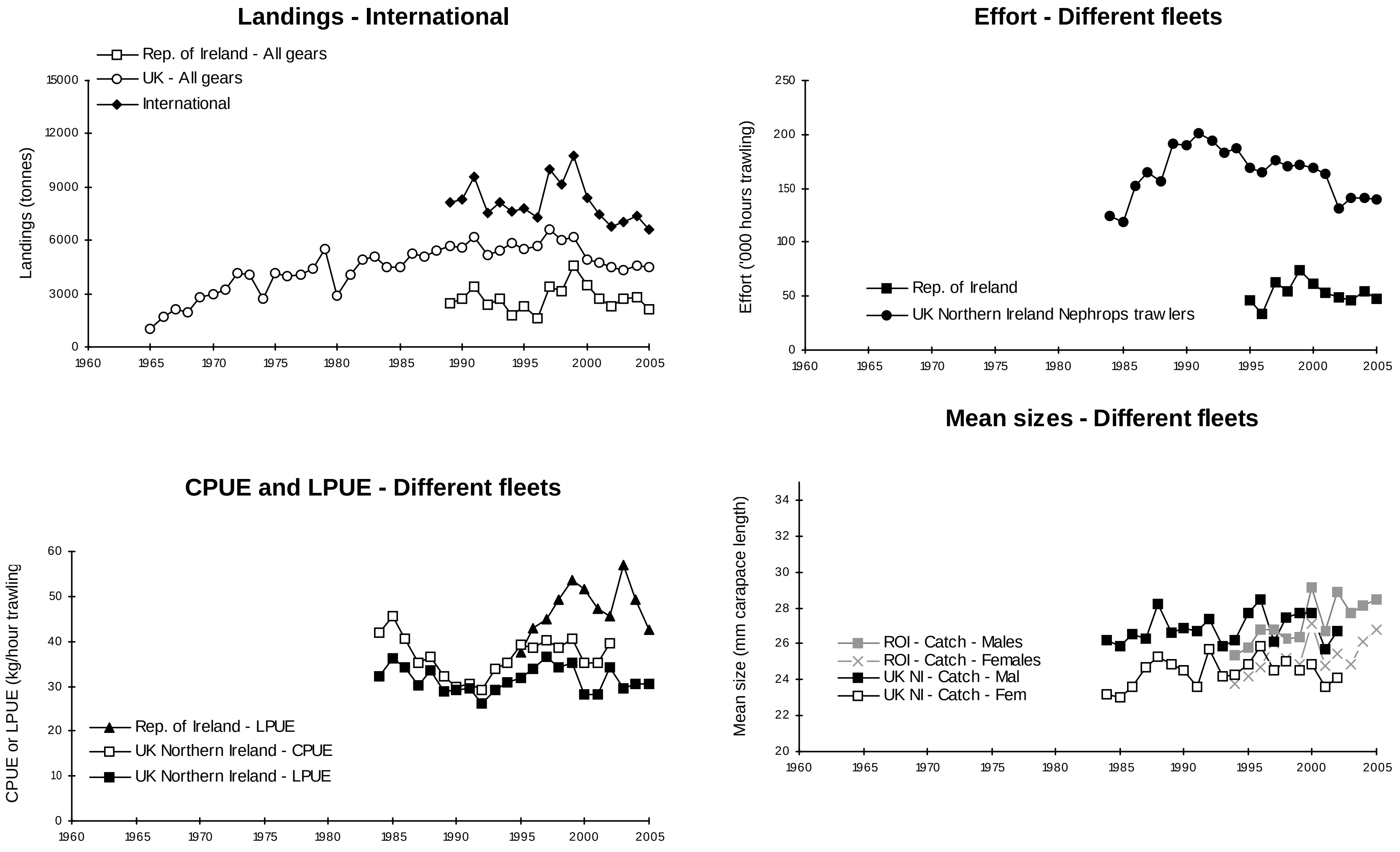


Figure 14.5. - Irish Sea West (FU 15): Long-term trends in landings, effort, CPUEs and/or LPUEs, and mean sizes of Nephrops.

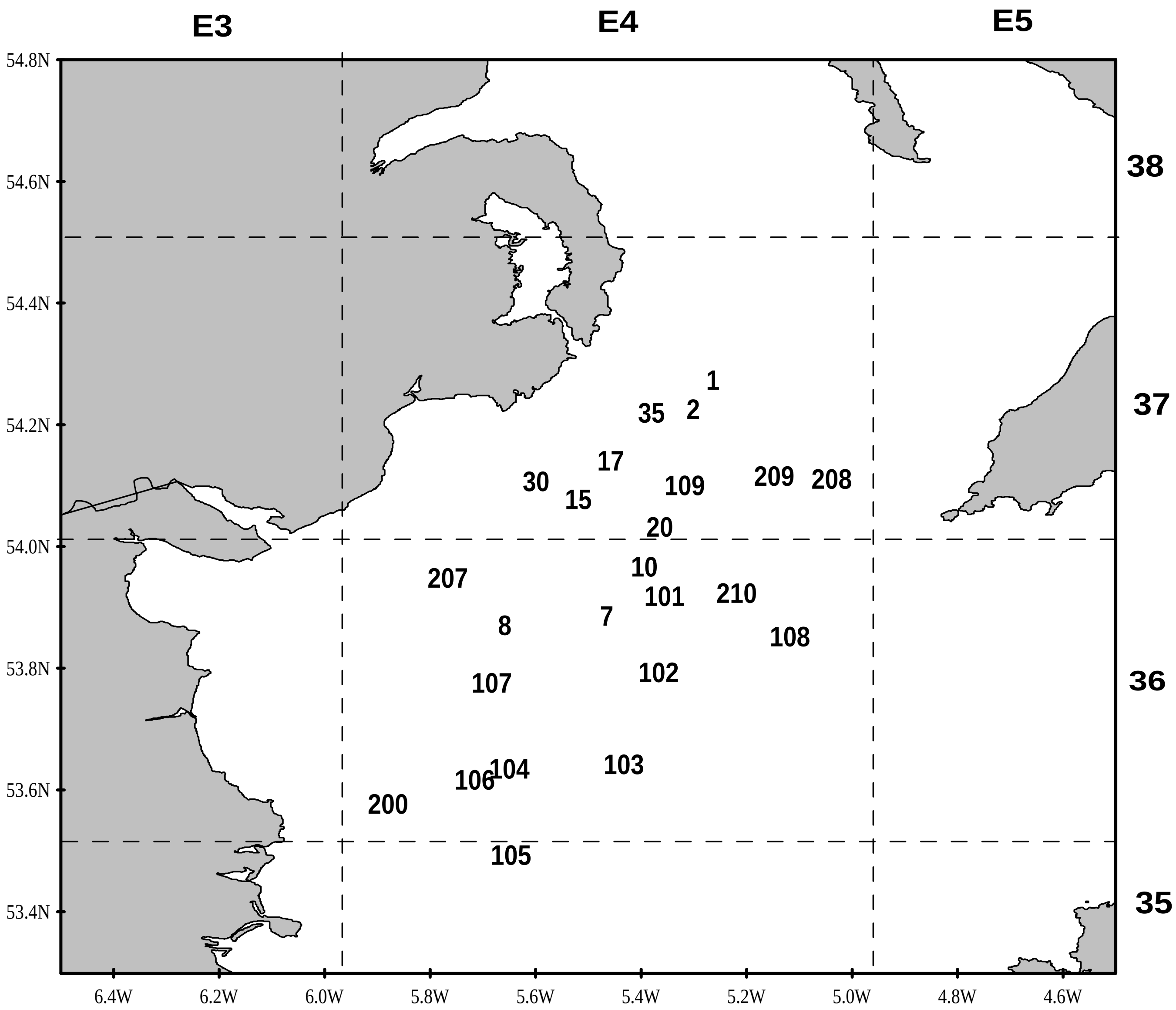


Figure 14.6. - Irish Sea West (FU 15): – NI Trawl survey stations

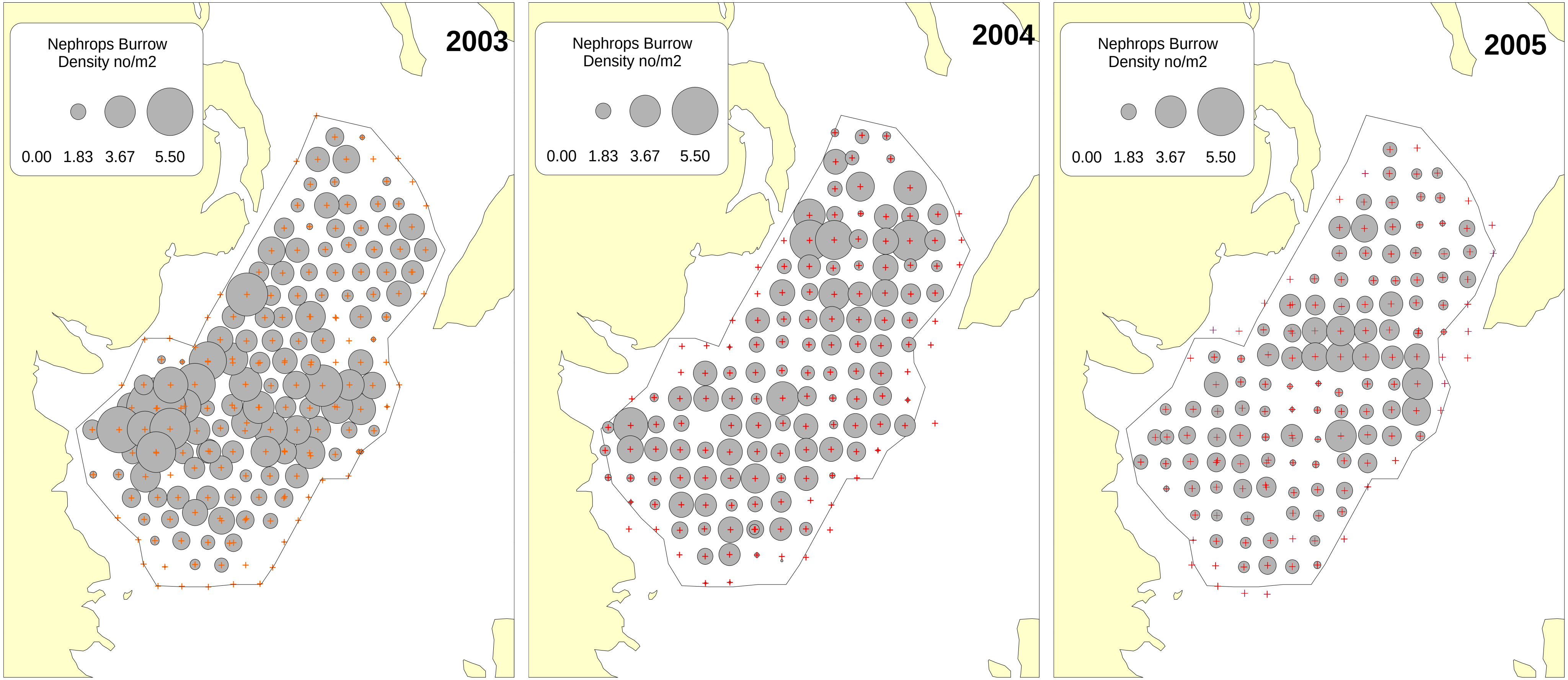


Figure 14.7. – Irish Sea West (FU 15): Bubble plot of Nephrops burrow densities estimated during NI/ROI UTV surveys Station positions

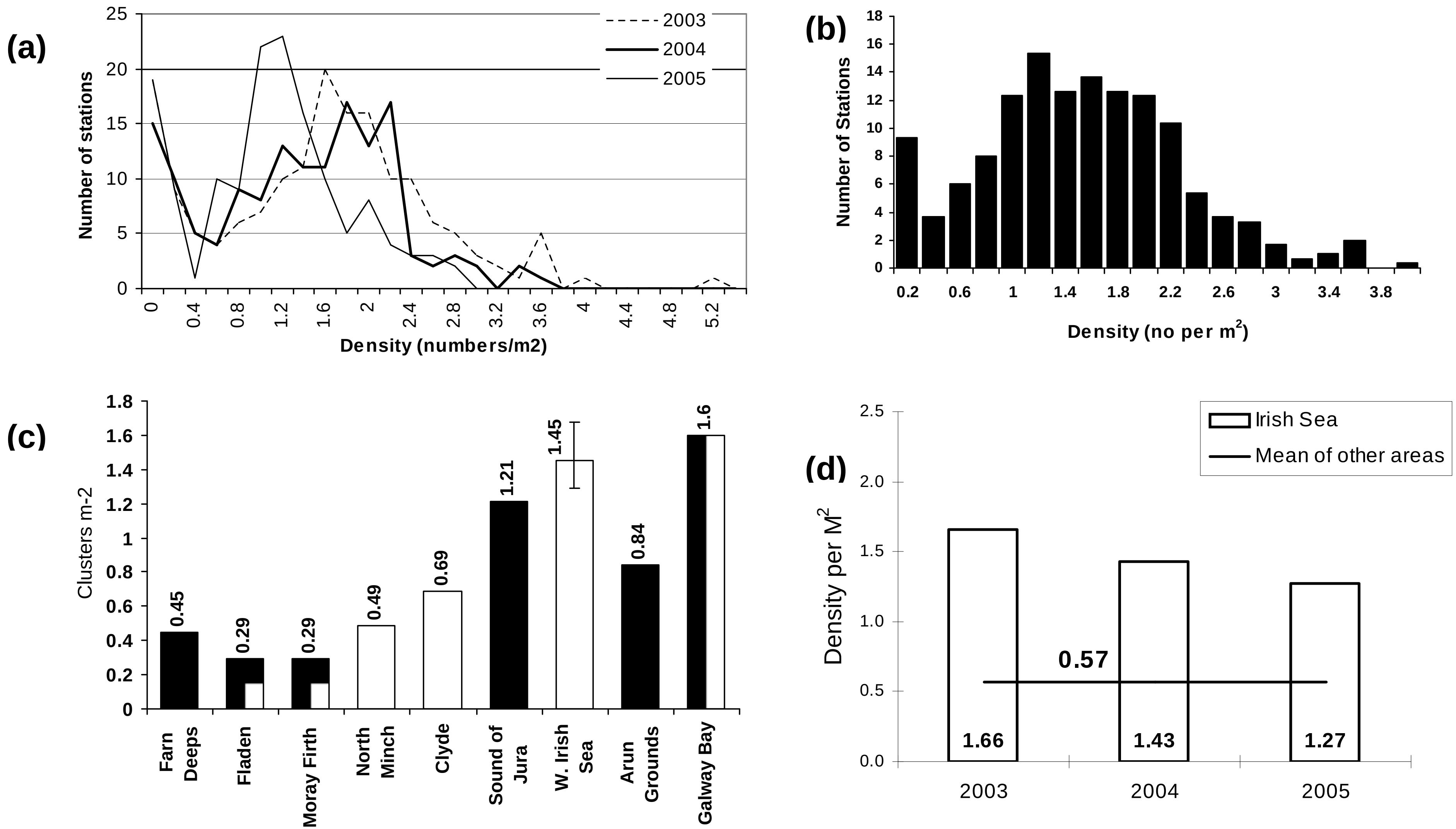


Figure 14.8. – Irish Sea West (FU15): (a) Standardised burrow densities (numbers/m2) for each survey (b) Mean burrow density from all three NI/ROI surveys performed. (c) Burrow densities for different Nephrops stocks (d) Burrow densities for each Irish Sea survey compared with average density for other stocks for which camera surveys have been performed.

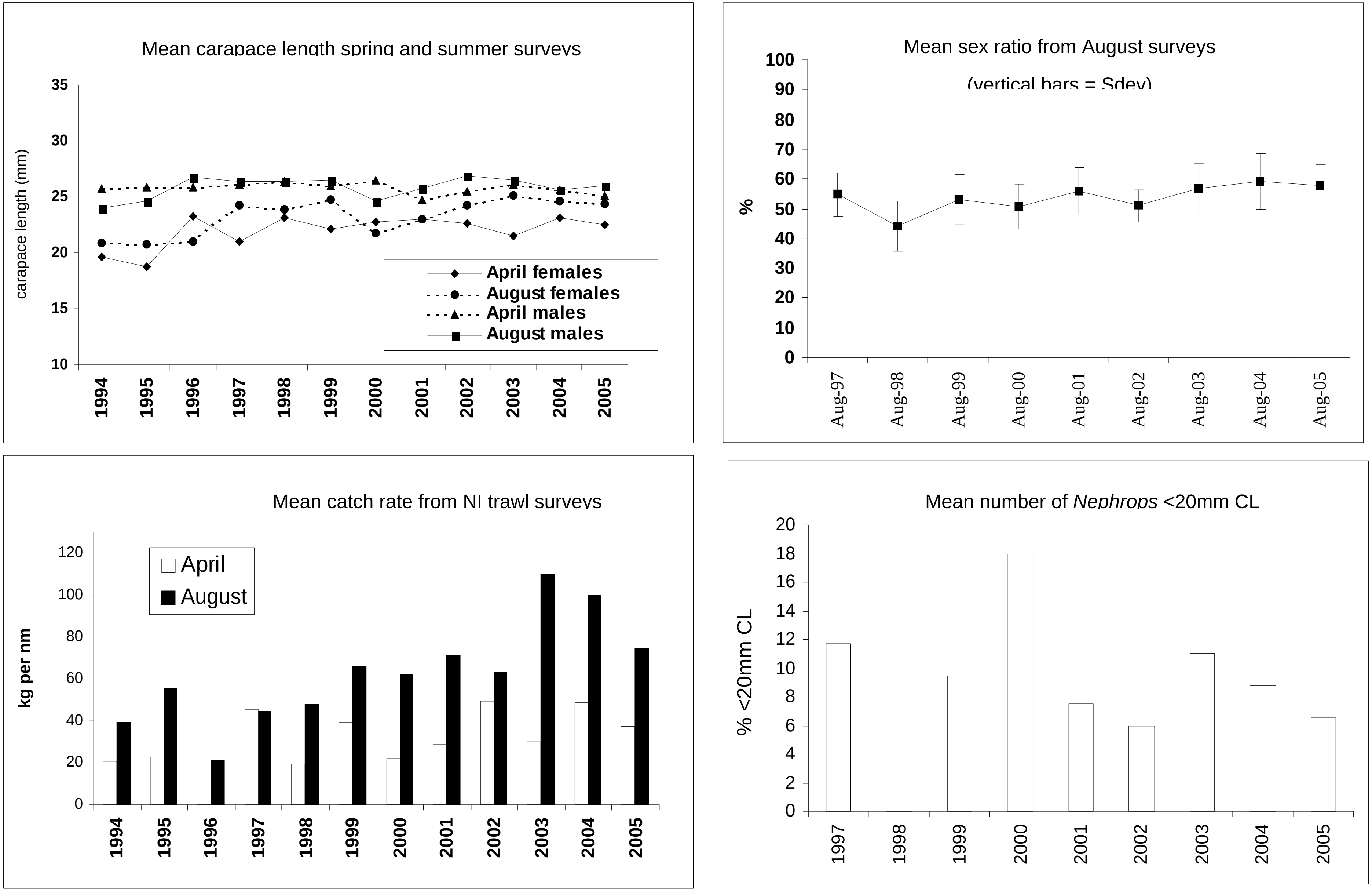
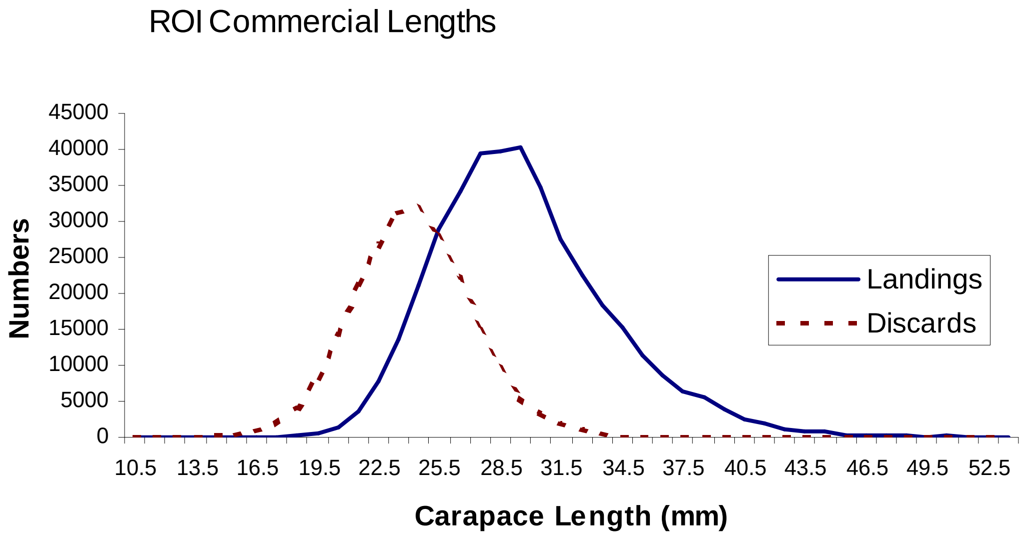
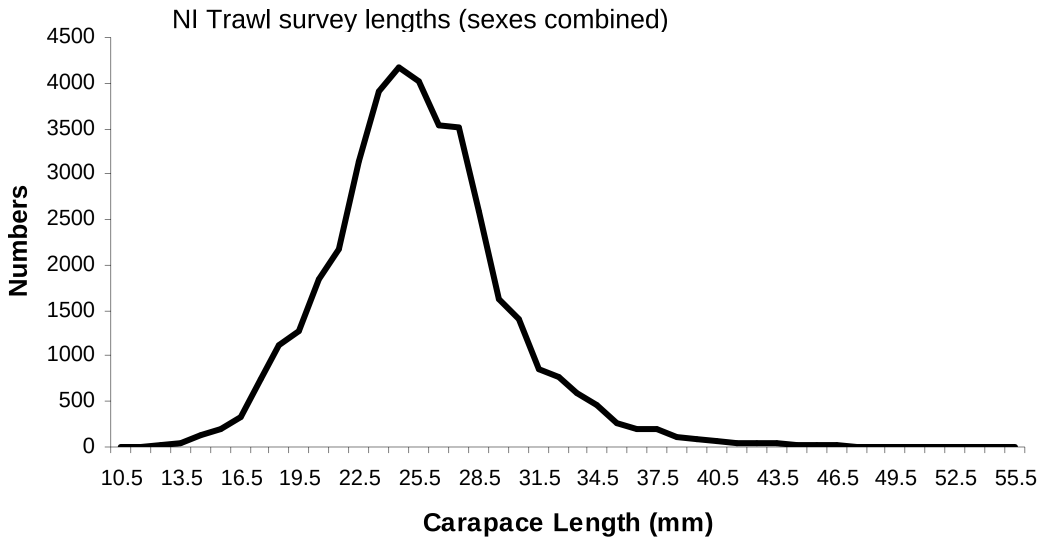


Figure 14.9. – Irish Sea West (FU 15): Trends in mean size, catches, sex ratio and recruitment (<20mm CL) from NI trawl surveys





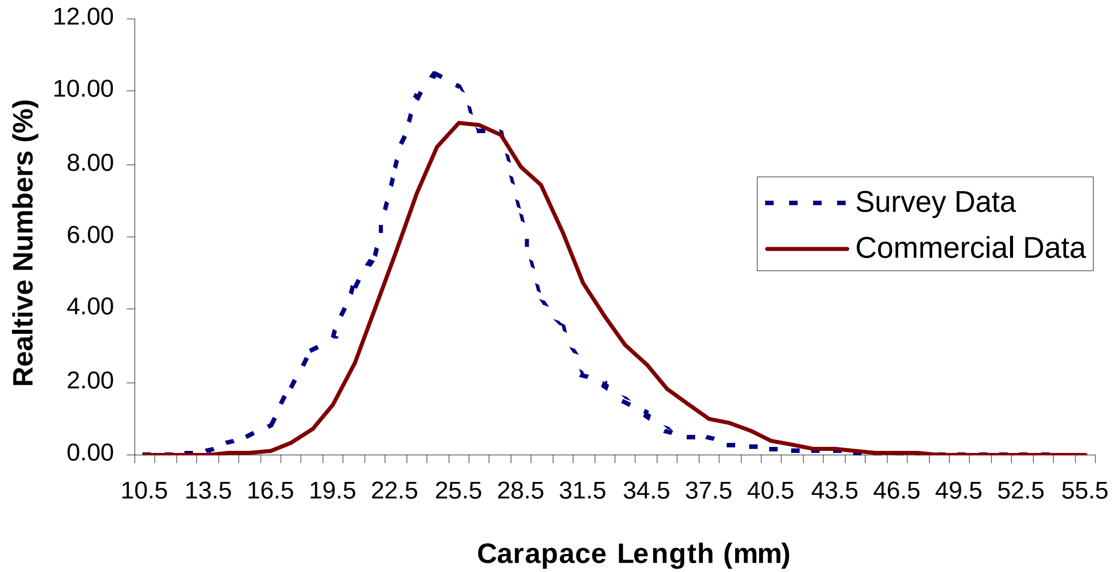


Figure 14.10. – Irish Sea West (FU 15): Commercially caught and survey caught length frequency distributions and comparison of relative lengths

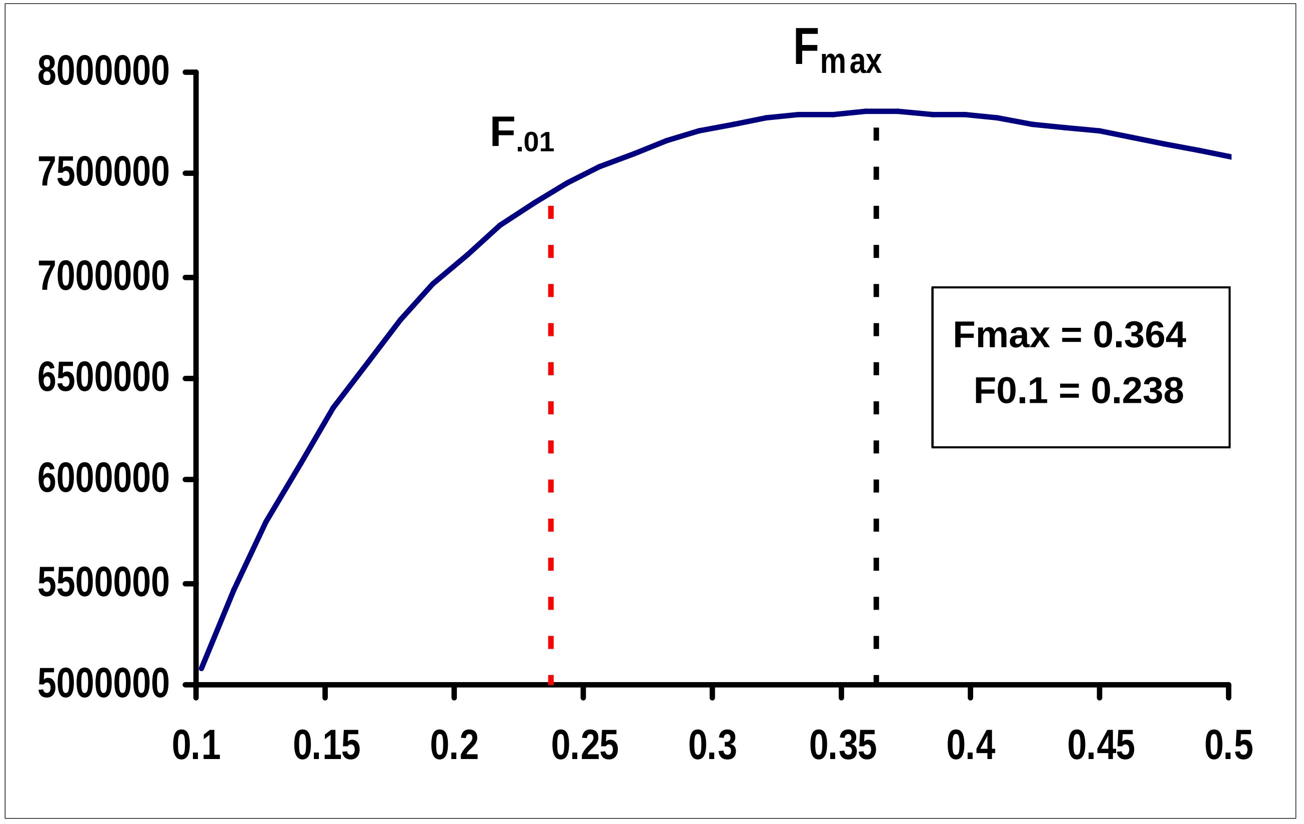


Figure 14.11. – Irish Sea West (FU15): Yield per recruit curve from Length Cohort Analysis for male and female Nephrops combined

15 Cod management plan evaluation

15.1 Introduction

Term of reference d) requested that the working group:

Evaluate existing management plans to the extent that they have not yet been evaluated. Develop options for management strategies including target reference points if management has not already agreed strategies or target reference points (or HCRs) and where it is considered relevant review limit reference points (and come forward with new ones where none exist) – following the guidelines from SGMAS (2005, 2006), AGLTA (2005) and AMAWGC (2004, 2005, and 2006); If mixed fisheries are considered important consider the consistence of options for target reference points and management strategies. If the WG is not in a position to perform this evaluation then identify the problems involved and suggest and initiate a process to perform the management evaluation.

The potential effectiveness of the VIa and VIIa cod recovery plans are assessed by running full feedback management evaluation simulations for the years 2006 to 2020. The simulation framework includes a biological model of the stock, used to represent the "true" state of the stock, and simulated fishing activity through a model fleet object and stock assessment process. The activity of the fleet is set using the harvest control rule (HCR). The HCR uses the perceived stock data, derived through sampling of the fleet object, to calculate the effort required by the fleet to reach the desired TAC. This effort is then used to control the future activity of the fleet.

To assess the robustness of the recovery plans to uncertainty, stochastic simulations are run. The perceived stock is not estimated using a particular method of stock assessment (e.g. XSA). Instead, to represent the inaccuracies of performing a stock assessment, the perceived stock is taken to be the same as the stock from the biological model but with noise added to it. In this way the behaviour of the modelled system is not influenced by the behaviour of a particular assessment method and the results are more general. Stochasticity is also applied to the recruitment level of the biological stock. The fishing effort that is actually implemented may also be subject to a predetermined level of bias. In this way, the effects of bias and noise on stock estimation and management plan implementation are investigated. Three different uncertainty schedules (with combinations of different stock assessment noise and effort bias) were investigated.

By replicating the stochastic simulations, the potential effectiveness of the recovery plan can be assessed by analysing the probability distributions of important measures such as SSB and catch. The simulations are carried out in R using the software library Fisheries Library in R (FLR).

It is important to note that the results of the simulation are not predictions of the future and should not be interpreted as such. They can only be used as a guide to the possible outcome of following a specific set of rules.

15.2 The data

The recovery plan was assessed for two stocks: cod VIa and cod VIIa.

15.3 The harvest control rule

The harvest control implements regulations given by the European Comission in Council Regulation EC No. 423/2004.

"*For stocks above $\boldsymbol{B}_{lim}$ the harvest control rule (HCR) requires:*

6. *setting a TAC that achieves a 30% increase in the SSB from one year to the next,*
7. *limiting annual changes in TAC to $^{+}_{-}$ 15% (except in the first year of application), and,*
8. *a rate of fishing mortality that does not exceed F_{pa}.*

For stocks below $\boldsymbol{B}_{lim}$ the Regulation specifies that:

9. *conditions 1-3 will apply when they are expected to result in an increase in SSB above $\boldsymbol{B}_{lim}$ in the year of application,*
10. *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 $\boldsymbol{B}_{lim}$ in the year of application.*"

The TAC is set two years in advance. Details on the implementation of the HCR are given below.

15.4 Software

The simulations were implemented using FLR (Fisheries Library in R) (see http://www.flr-project.org/doku.php?id=team:paperflcore). R is a computer language and environment for statistical computing and graphics which is highly extensible and open-source. FLR is a library of methods that have been developed specifically for conducting management strategy evaluations. It takes advantage of all the main features of R and extends it to fisheries modelling. Using an object-oriented approach, different elements of fisheries systems (stocks, fleets, assessment methods etc.) are represented as predefined classes. Objects of these classes can then be linked together to run management simulation models. FLR has been used for this purpose in several European projects including FEMS, EFIMAS, COMMIT and FISBOAT. The simulations run here were conducted using the FLR packages FLCore 1.3 and an amended version of FLSTF.

15.5 Simulation outline

The simulation framework can be seen in Figure 1. The framework is broadly split into two sections: the "true" system and the management procedure.

15.5.1 The "true" system

The "true" system represents the biological processes and fishing activity of the real world. The population biology of the stock is represented by an FLR object of type *FLBiol*. This contains information about the "real" stock, including numbers at age and natural mortality. The stock-recruitment relationship is contained in an object of type *FLSR*. A Ricker stock-relationship is used. The *FLSR* object is also used to estimate recruitment during the simulation using the stock numbers contained in the *FLBiol* object and the previously fitted relationship. Lognormal noise is applied to the recruitment estimate by multiplying it by lognormally distributed noise with a mean of 1 and a standard deviation given by the fit of the stock-recruitment relationship (Table 1). The estimated recruitment is then passed to the *FLBiol* object.

The fishing fleet is represented by an FLR object of type *FLFleet*. This contains information on the state of the fleet including catch numbers, effort and selection patterns. The fleet object interacts with the "true" stock object to generate catch numbers and to simulate the effects of fishing on the stock. Depending on the uncertainty schedule, a bias is applied to the fishing effort of the fleet. This is to simulate the effects of the results of the HCR not being implemented as desired. If a bias was implemented the effort exerted by the fleet was always 25% greater than that specified by the HCR.

15.5.2 The management procedure

The management procedure simulates the attempts of stock managers to estimate the state of the real stock and to manage the activity of the fleet through a harvest control rule.

The perceived state of the stock, that is the state of the stock as perceived by managers, is represented by an FLR object of type *FLStock*. The catch numbers are taken from fleet object, and the discards and landings set appropriately. The perceived harvest rates of the perceived stock are set to the fishing rates if an unbiased effort was used, that is they represent the level of fishing that occurs if the effort calculated by the HCR is implemented exactly.

The stock numbers of the perceived stock are taken from the "true" biological model but with lognormally distributed noise. Two levels of noise are used. The abundance of each age group is multiplied by lognormal noise with a mean of 1 and a standard deviation of 0.1 or 0.5, depending on the uncertainty schedule. This approach simulates the problems of inaccurate stock assessment without actually using a particular stock assessment method (e.g. ICA). The results are therefore more general than if one particular method had been used.

A harvest control rule is then applied, using the perceived stock, to calculate effort for two years after the current year.

15.5.3 Implementing the HCR

Implementing the HCR requires careful consideration of timing. The TAC is set for two years after the current simulation year. This means that the earliest that the SSB desired by the HCR can be achieved is at the start of the third year after the current year. For example, when the HCR is applied at the end of 2005, it sets the TAC for 2007 and the resulting SSB from this TAC is realised at the start of 2008. The HCR is implemented by finding the fishing effort multiplier (*fmult*) that, when applied to the fishing effort two years after the current year, results in the total catch weight meeting the required TAC two years after the current year. Hence the desired SSB is achieved (if possible) at the start of the third year after the current year. The value of *fmult* in the first year after the current year also affects the SSB and the TAC. This value has already been set from implementing the HCR at the end of the previous simulation year.

When the SSB in the current year is above $\mathbf{B}_{\mathrm{lim}}$ the HCR requires a 30% increase in SSB from one year to the next. However, as mentioned above, the HCR sets the effort and TAC two years in advance. This means that it is necessary to project forward, using the fishing effort and selectivity for the following year, and estimate the SSB two years after the current year. The desired SSB three years after the current year is then a 30% increase on this. To calculate the *fmult* that results in the desired SSB a short-term forecast is run for three years. The details of the short-term forecast are given below. The R optimising function, *optimise()*, is used with the short-term forecast to find the value of *fmult* two years after the current year that results in the desired SSB being achieved three years after the current year. The HCR also specifies that the TAC may not change by more 15%. If the change in the total catch weight estimated from the first and second years of the short term forecast exceeds 15%, it is assumed that the SSB desired three years afters the current year can only be met if the 15% constraint is broken. In this case the total catch weight two years after the current year is set to the limit of the constraint i.e. either 1.15 or 0.85 times the total catch estimated one year after the current year. The value for *fmult* two years after the current year required to achieve the constrained total catch weight is then estimated using *optimise()*.

When the SSB in the current year is below $\mathbf{B}_{lim}$ the HCR is more complicated. It is necessary to check if a 30% increase in the projected SSB two years after the current year will exceed $\mathbf{B}_{lim}$. If so, the same process of finding the desired value for *fmult* and checking that the catch constraint is not broken also applies. However, if the catch constraint is broken and the TAC is subsequently set to a maximum 15% change, the resulting SSB may then not exceed $\mathbf{B}_{lim}$. In this case conditions 6-8 above are assumed not to apply, the catch constraint is ignored and the desired SSB set to $\mathbf{B}_{lim}$. If a 30% increase in the projected SSB two years after the current year does not exceed **B**lim then the desired SSB three years after the current year is set to $\mathbf{B}_{lim}$ and the catch constraint does not apply. If the catch constraint does not apply, the fishing effort can be set to anything, including 0. This may result in 1 or more years where the fishery is effectively closed.

The $\mathbf{F}_{pa}$ constraint is not checked during the simulation. Instead, the results of the simulations are examined to see how often the $\mathbf{F}_{pa}$ constraint is broken (see condition 8, or 3, of the HCR).

The value of *fmult* that is estimated by the HCR is used to modify the fishing effort of the fleet two years after the current year.

15.5.4 The short-term forecast

The short term forecast is used to estimate the state of the stock and the catch numbers three years in the future without using a full simulation model. The stock weights and natural mortality for all forecast years were set to the mean of the last three data years. Stock maturity for all forecast years was set as the maturity in the last data year.

During each simulation year a Ricker stock-recruitment relationship was fitted using all years of the perceived stock data, including the simulation years. The predicted recruitment given by the fitted relationship for the following year was then used for all three years of the forecast.

The fishing rates were set as the mean of the harvest rates of the last three years, multiplied by the value of *fmult* for that forecast year. However, when the projected SSB is below $\mathbf{B}_{lim}$ the HCR allows the effort, and hence the harvest rates, to be set to 0. When this happens the projected harvest rates used in the forecast will be strongly affected by any previous harvest rate (or rates) of 0 in the last three years. To avoid this, the means of the last three non-zero harvest rates are used. This may mean that the harvest rates used in the forecast are overestimated and this serves to further test the robustness of the recovery plan .

The forecast stock and catch numbers are calculated using the estimated natural mortality and fishing rates and recruitment.

Before the optimising function is used checks are made to see if it possible to get a value for *fmult*. If a specific SSB is desired, a check is made to see if the desired SSB is less than the maximum possible SSB. The maximum SSB is found by setting *fmult* in the second year of the forecast (i.e. the one that a value will be found for) to 0 to simulate the effects of stopping all fishing. If the SSB in the following year is less than the desired SSB then it is clear the desired SSB cannot be achieved by reducing the effort. In this case the HCR is assumed to have broken and the simulation stopped. This event is only found to occur when the SSB is above $\mathbf{B}_{pa}$ and growing strongly.

If a specific catch is desired, a check is made to see if the desired catch is greater than the maximum catch. The maximum catch is found by setting *fmult* in the second year of the forecast to an unrealistically high value (1000 is used). If the resulting catch is less than the desired catch then it is assumed that the desired catch is impossible to obtain without set an unrealistically high value of effort. Again, in this case the HCR is assumed to have broken and the simulation stopped. This event was not found to occur in any of the simulations.

15.6 Simulation initialisation and assumptions

Before the simulations can be run various parameters need to be initialised and several assumptions made.

The values for $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ are 6000 and 10000 tonnes respectively for cod VIIa and 14000 and 22000 tonnes for VIa cod. For cod VIIa the discards are assumed to be zero for all years. For cod VIa a discard ratio per age is calculated as the mean ratio of the catch-at-age to the discards-at-age of the last three years of the original data (2003 to 2005). This ratio is then used through the simulations to calculate the proportions of the catch that are landed and discarded.

The natural mortality for the "true" and perceived stocks during the simulation years is set to the natural mortality of the last original data year (2005). For cod VIa and VIIa this value is 0.2 for all ages. The stock weights, fecundity and natural mortality for the original data years of the biological model and the perceived stock are set to those of the original data set (1968 to 2005 for cod VIIa and 1978 to 2005 for cod VIa). For the simulation years (2006 to 2020) they are set to the means of the last three original data years. The initial stock numbers of the biological model are the same as the original data.

A Ricker model, fitted using all original data years, was used for the stock-recruitment relationship for the "true" stock. The relationships were fitted using an FLR object of type *FLSR*. The stock-recruitment model parameters can be seen in Table 1 and analysis of the fit in Figures 2 and 3.

The fishing effort of the fleet for the original data years is set to the mean harvest rates of ages 2 to 4. The effort in the first year after the last original data year (2006) is set to the same level as the last original data year. The fishing effort for all other simulation years is initially set to 1. Through the simulations this fishing effort is adjusted by multiplying it by the fishing effort multiplier (*fmult*) that is generated by the HCR (see section 15.5.3). The selectivity of the fleet for the original data years is set to the harvest rates scaled by the largest rate of that year. For all of the simulation years the selectivity is set to the selectivity of the last original data year. The catchability is set to 1 for all ages and years for the original years and the simulation years.

Three uncertainty schedules (combinations of different stock assessment noise and implemented effort bias) are used (Table 2). This enables the cod recovery plan to be assessed under a range of different uncertainty assumptions.

15.7 Results

300 simulations for each noise schedule were carried out for both cod stocks. As mentioned above, the last data year is 2005 and the fishing effort in 2006 is assumed to be the same as the effort in 2005. The earliest year that the HCR can set the TAC is therefore 2007 and the corresponding affect of this TAC will be not seen in the stock numbers until 2008. Consequently, at the start of the simulation, there is a lag of 3 years before the effects of the HCR are visible in the stock numbers. The stock numbers in 2006 and 2007 have been effectively predetermined by the prior fishing efforts and are not under the control of the HCR.

15.7.1 Cod VIIA

From 2008, the "true" SSB continually increases through time (Figure 6). The distribution of results suggests that this recovery is robust, even with high assessment noise and error implementation bias. As mentioned above, the short-term forecast initially checks that the desired SSB is less than the maximum SSB (to see if the desired SSB is possible). If the desired SSB is not possible, the HCR is assumed to have broken and the simulation stopped. The probability of this happening increases rapidly from 2011 and is more likely to occur when the SSB is very high. For example, over half of the simulations have stopped by 2016. This isn’t to say that the HCR has failed to recover the stock because it is clear from Figure 8 that the “true” SSB is increasing, only that the desired 30% year on year increase in stock cannot be met, even by decreasing the effort to 0. Due to the fall off in the number of simulations through time, only the results until 2015 are considered. By 2015 the SSB for all uncertainty schedules is well above $\mathbf{B}_{pa}$.

In 2005 the stock is below $\mathbf{B}_{lim}$ and consequently the HCR sets the TAC in 2007 that should result in an SSB is greater than $\mathbf{B}_{lim}$ in 2008. The “true” SSB for almost 100% of the simulations for all three uncertainty schedules reaches $\mathbf{B}_{lim}$ by 2008 (Figure 4). Considering the probability of the “true” SSB being greater than $\mathbf{B}_{pa}$, the probability starts increasing in 2009 (Figure 5). By 2011 the “true” SSBs for almost all simulations for all uncertainty schedules is greater than $\mathbf{B}_{pa}$.

There is only a small difference between the behaviour of the uncertainty schedules. Essentially, high stock assessment noise and no bias results in slightly broader range of “true” SSBs. Including the effort bias slightly decreases the probabilities of SSB exceeding $\mathbf{B}_{lim}$ or $\mathbf{B}_{pa}$.

The perceived stock numbers are essentially the same as the “true” stock numbers, but with the addition of lognormally distributed noise. This means that the SSB of the perceived stock tracks that of the “true” stock. Due to the stochastic nature of the perceived stock, the probability that the SSB of the perceived stock is greater than $\mathbf{B}_{im}$ or $\mathbf{B}_{pa}$ tends to be higher than the probability for the “true” stock when the probability for the true stock is less than 0.5 and vice versa. This is most clearly seen when the stock assessment noise is high and the effort is biased (Figure 5c).

The fishery was closed for all simulations in 2007 (the first year for which the HCR can set the TAC) to allow the SSB in 2008 to reach $\mathbf{B}_{lim}$. After this the total catch shows an increase through the years for all three uncertainty schedules, with the schedules with high stock assessment noise having the widest distribution (Figure 7). The continual increase in SSB means that the effort decreases through the years to catch the required TAC (Figure 8).

15.7.2 Cod VIa

The results for cod VIa are similar to those for cod VIIa (Figures 8, 10, 11, 12 and 13. To enable a reasonable scale, only results until 2017 are shown.). The initial SSB in 2005 is very low compared to $\mathbf{B}_{lim}$ (2685 tonnes compared to 14000 tonnes). Therefore to get the “true” SSB above $\mathbf{B}_{lim}$ the fishery is shut for all nearly simulations in 2007, 2008 and 2009 (Figure 12). This means that the probabilities of the SSB being greater than $\mathbf{B}_{lim}$ and $\mathbf{B}_{pa}$ start to increase later than for cod VIIa (Figures 9 and 10). By 2015 the SSB in almost all the simulations has reached $\mathbf{B}_{pa}$. After 2007, the “true” SSB continues to increase and after the fisheries reopen in most of the simulations (from 2010) there is a steady increase in catch.

Even though by 2010 the probability that the SSB has recovered above $\mathbf{B}_{lim}$ is low, the fishery reopens for nearly all the simulations. This suggests that the projected SSB used in the HCR is overly optimistic. However, despite this is apparently too early return to fishing, the SSB still increases strongly suggesting that the cod recovery plan is robust to inaccuracies in the SSB projection and HCR.

Unlike with cod VIIa the HCR seldom breaks and all but about a quarter of the simulations reach 2020. This does not mean that the cod recovery plan is more effective for cod VIa because by the time the HCR breaks with VIIa the SSB is well above $\mathbf{B}_{pa}$.

15.8 Conclusions

The cod recovery plan was evaluated for cod VIIa and cod VIa using management evaluation simulations. The main findings are:

- Both stocks were found to recover and there was a high probability that SSB would exceed $\mathbf{B}_{pa}$ by 2011 for VIIa and 2015 for VIa for all three uncertainty schedules.
- To allow the stock to recover, it is likely that the fisheries will need to be closed for at least one year. For VIIa a closure of 1 year (in 2007), and for VIa a closure of three years (2007 to 2009) is likely. Future simulations could investigate the effect of applying the change in catch constraint when SSB is also below $\mathbf{B}_{lim}$.

15.9 References

R Development Core Team (2006). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org.

Table 15.1. Stock-recruitment parameters using a Ricker relationship.

STOCK	ALPHA	BETA	STANDARD DEVIATION OF LOG RESIDUALS
Cod VIa	0.69	4.7e-6	0.52
Cod VIIa	0.93	5.1e-5	0.63

Table 15.2. Uncertainty schedules for the simulations

UNCERTAINTY SCHEDULE	STANDARD DEVIATION OF LOGNORMAL STOCK ASSESSMENT NOISE	APPLIED EFFORT BIAS
1	0.1	0
2	0.5	0
3	0.5	25 %
Lognormal noise was also applied to the recruits, the standard deviation given by the fits of the stock-recruitment relationship (Table 1), i.e. 0.52 for cod VIa and 0.63 for cod VIIa. The recruitment noise was the same for all noise schedules.		

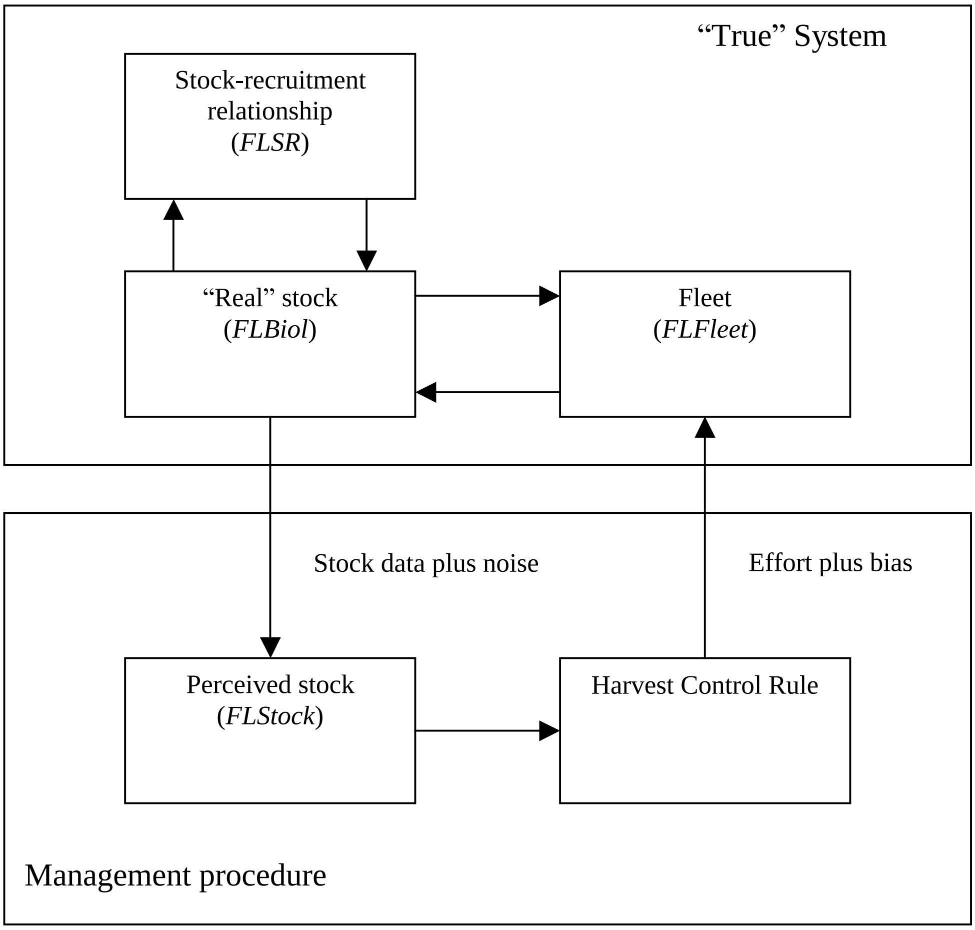


Figure 15.1. framework for the management evaluation

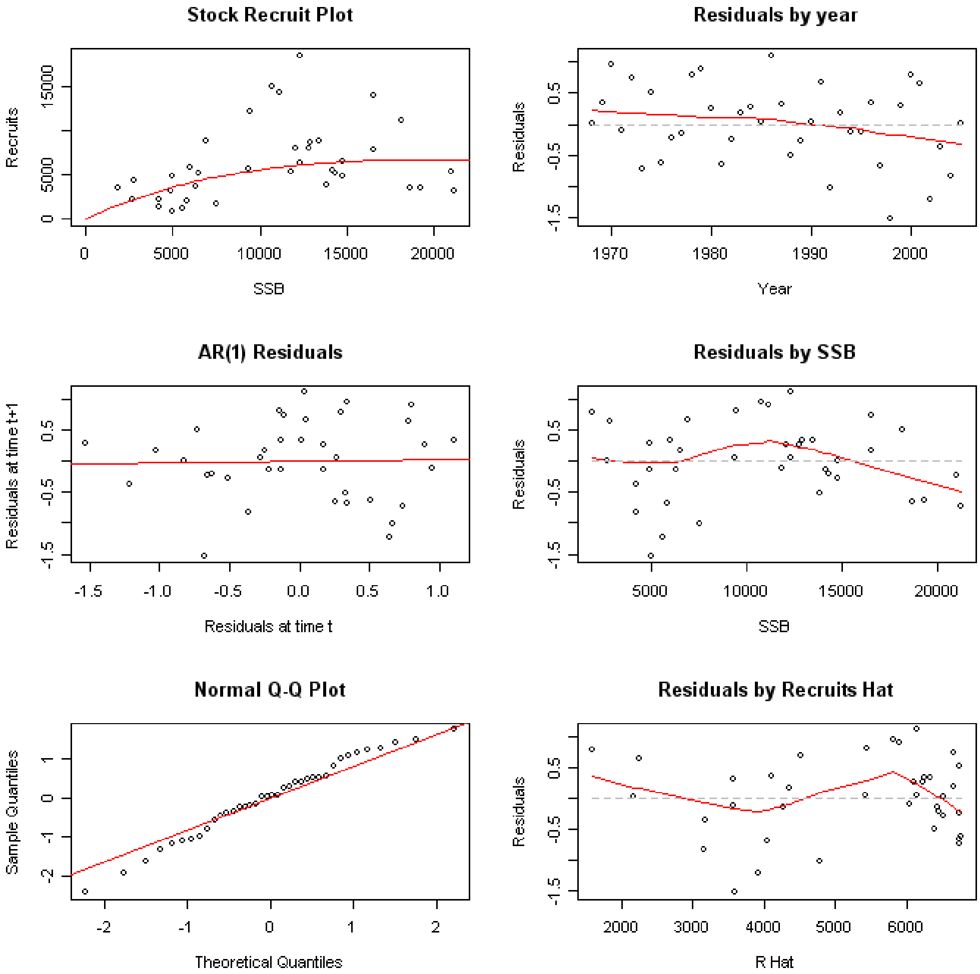


Figure 15.2. Ricker stock-recruitment function fit for cod VIIa, using years 1968 to 2005.

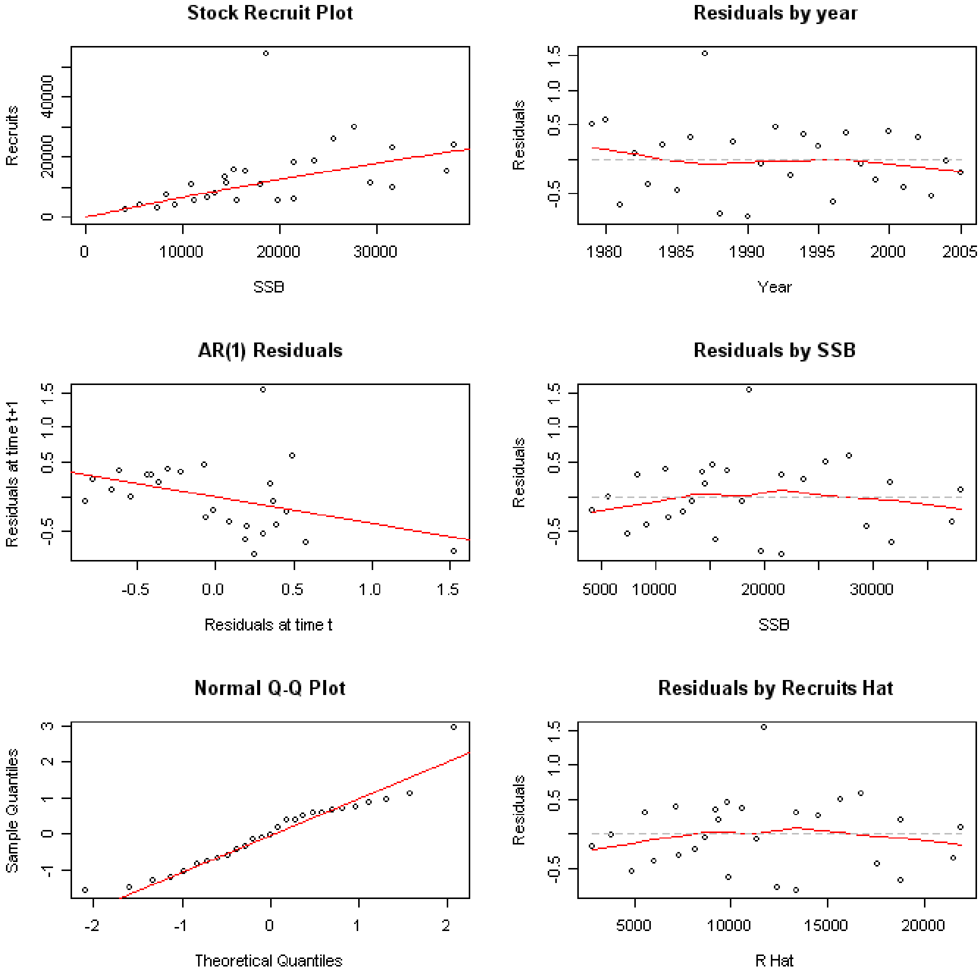


Figure 15.3. Ricker stock-recruitment function fit for cod VIa, using years 1978 to 2005.

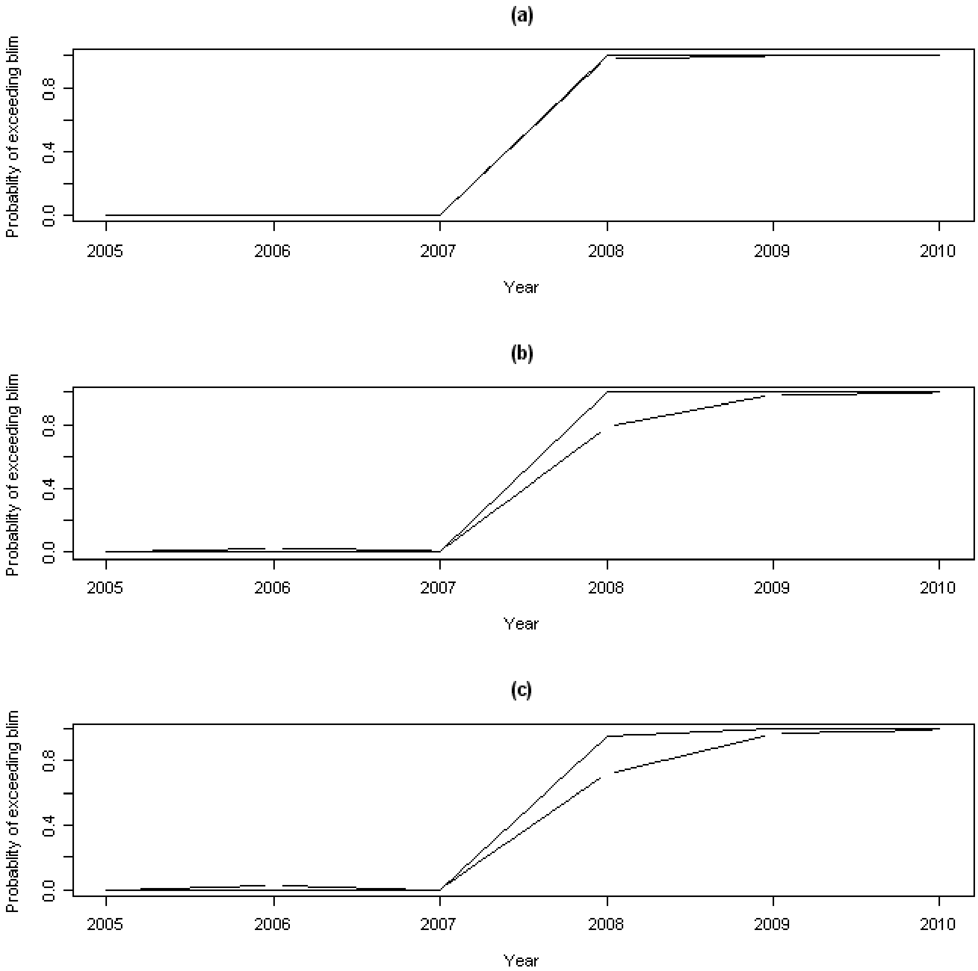


Figure 15.4. Probability that the SSB is greater than b_{lim} (6000 tonnes) for cod VIIa. (a) low stock assessment noise and no effort bias; (b) high stock assessment noise and no effort bias; (c) high stock assessment noise and effort bias. Solid line is the "true" stock, dashed line is the perceived stock.

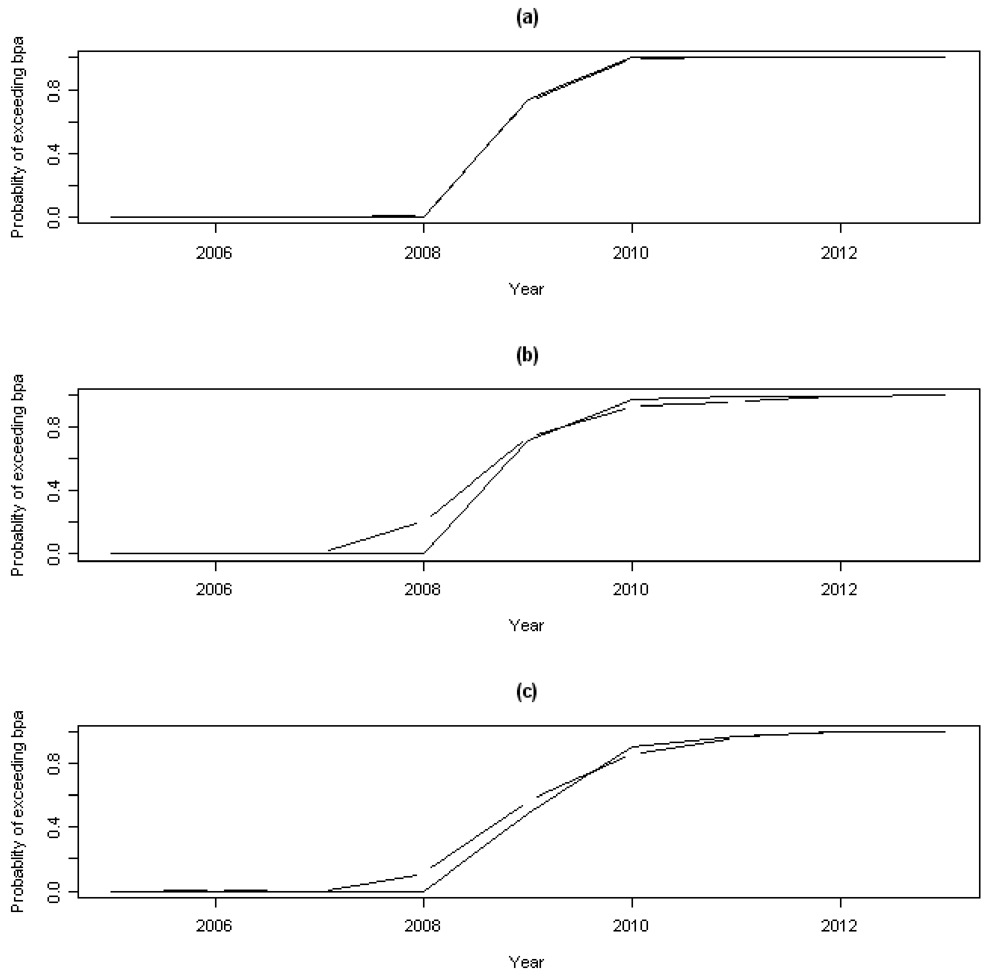


Figure 15.5. Probability that the SSB is greater than b_{pa} (10000 tonnes) for cod VIIa. (a) low stock assessment noise and no effort bias; (b) high stock assessment noise and no effort bias; (c) high stock assessment noise and effort bias. Solid line is the “true” stock, dashed line is the perceived stock.

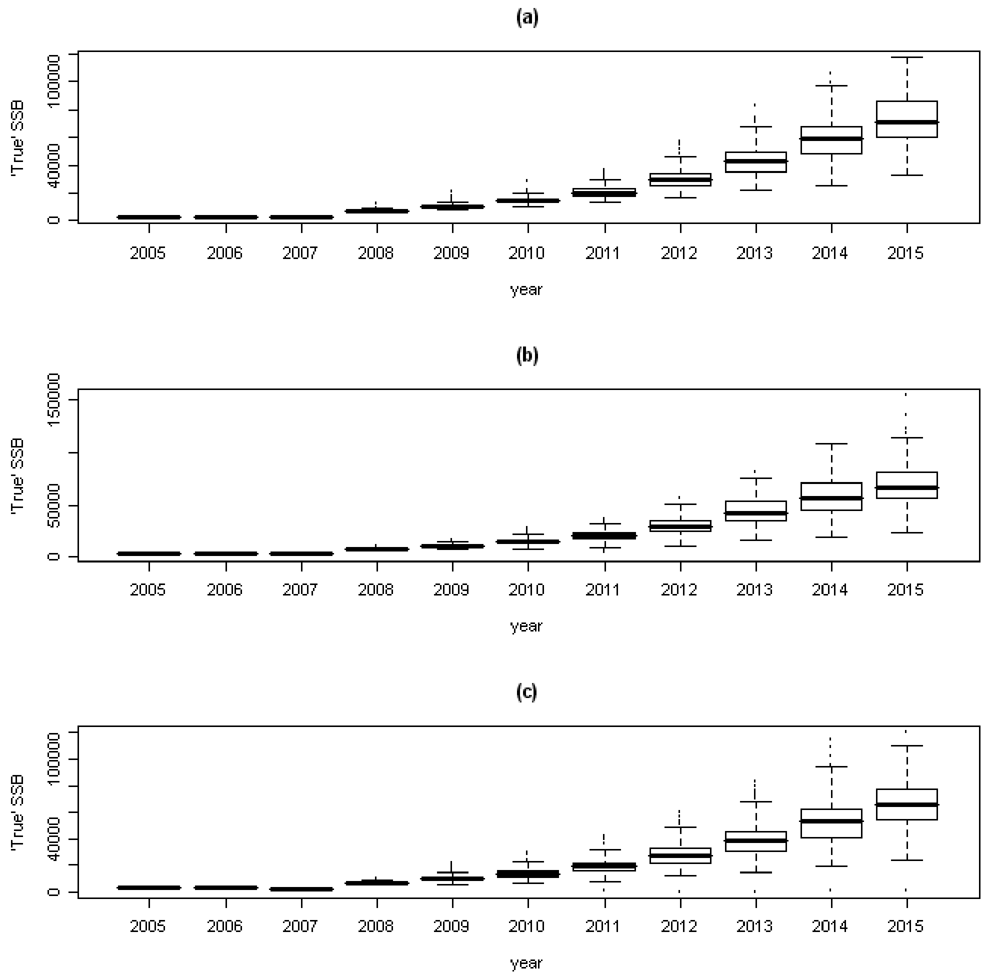


Figure 15.6. Box plot of the "true" SSB for cod VIIa. (a) low stock assessment noise and no effort bias; (b) high stock assessment noise and no effort bias; (c) high stock assessment noise and effort bias.

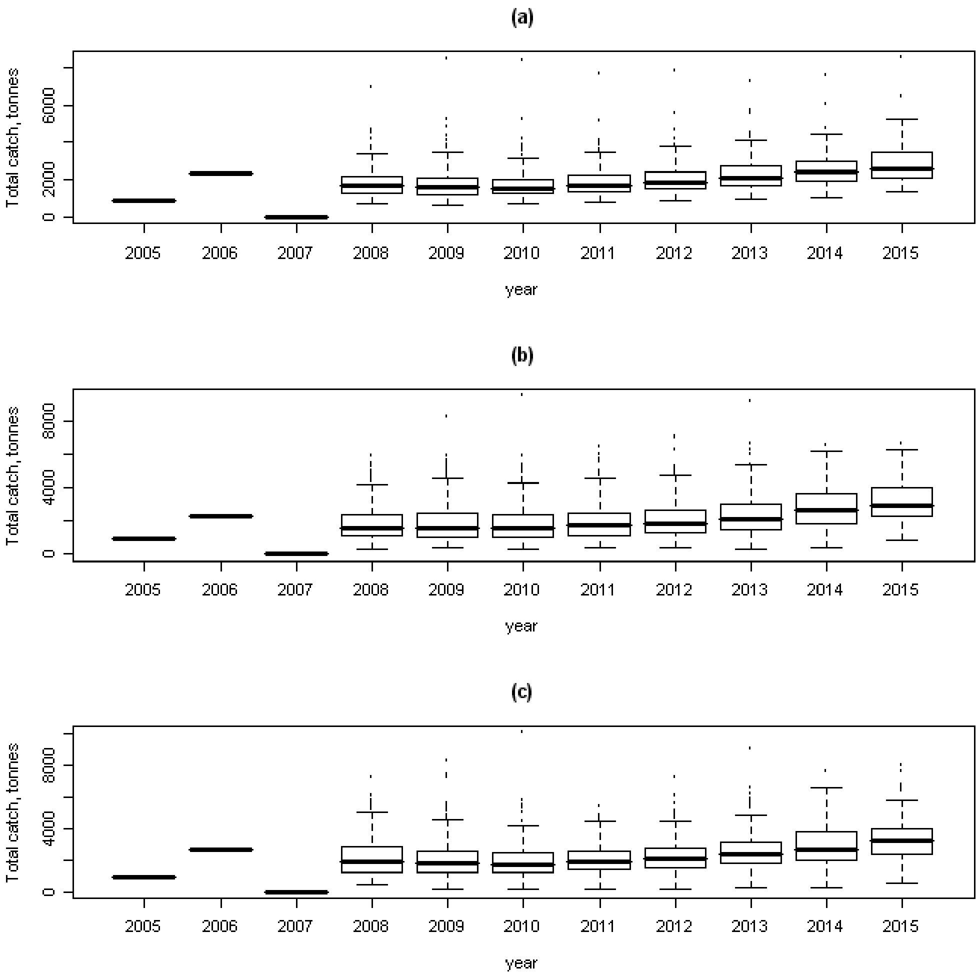


Figure 15.7. Box plot of the total catch for cod VIIa. (a) low stock assessment noise and no effort bias; (b) high stock assessment noise and no effort bias; (c) high stock assessment noise and effort bias.

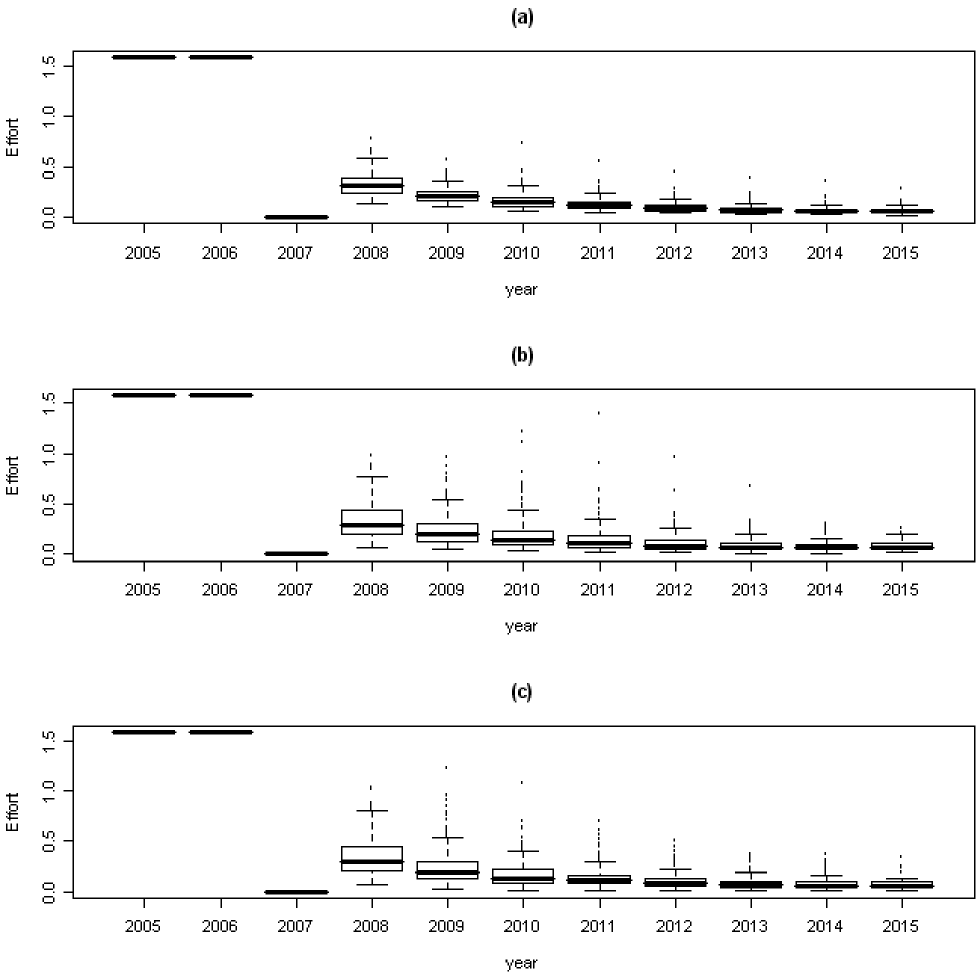


Figure 15.8. Box plot of the fishing effort for cod VIIa. (a) low stock assessment noise and no effort bias; (b) high stock assessment noise and no effort bias; (c) high stock assessment noise and effort bias.

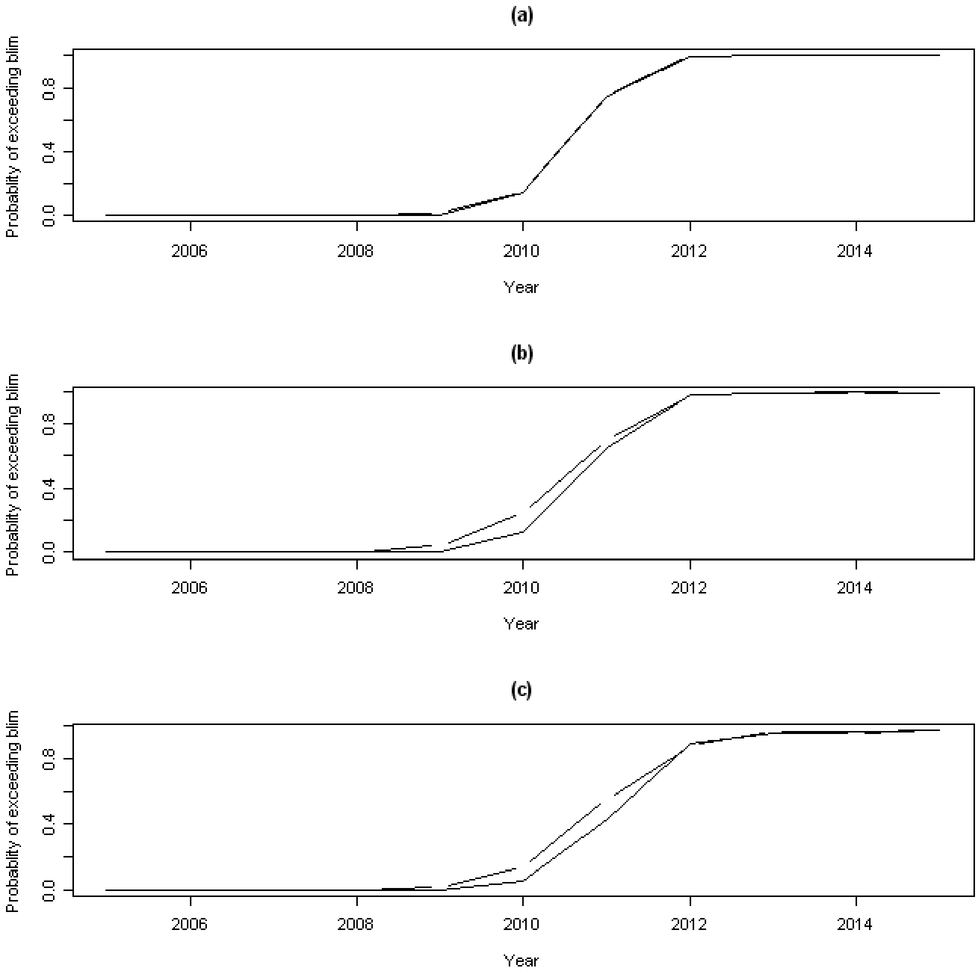


Figure 15.9. Probability that the SSB is greater than B_{lim} (14000 tonnes) for cod VIa. (a) low stock assessment noise and no effort bias; (b) high stock assessment noise and no effort bias; (c) high stock assessment noise and effort bias. Solid line is the "true" stock, dashed line is the perceived stock.

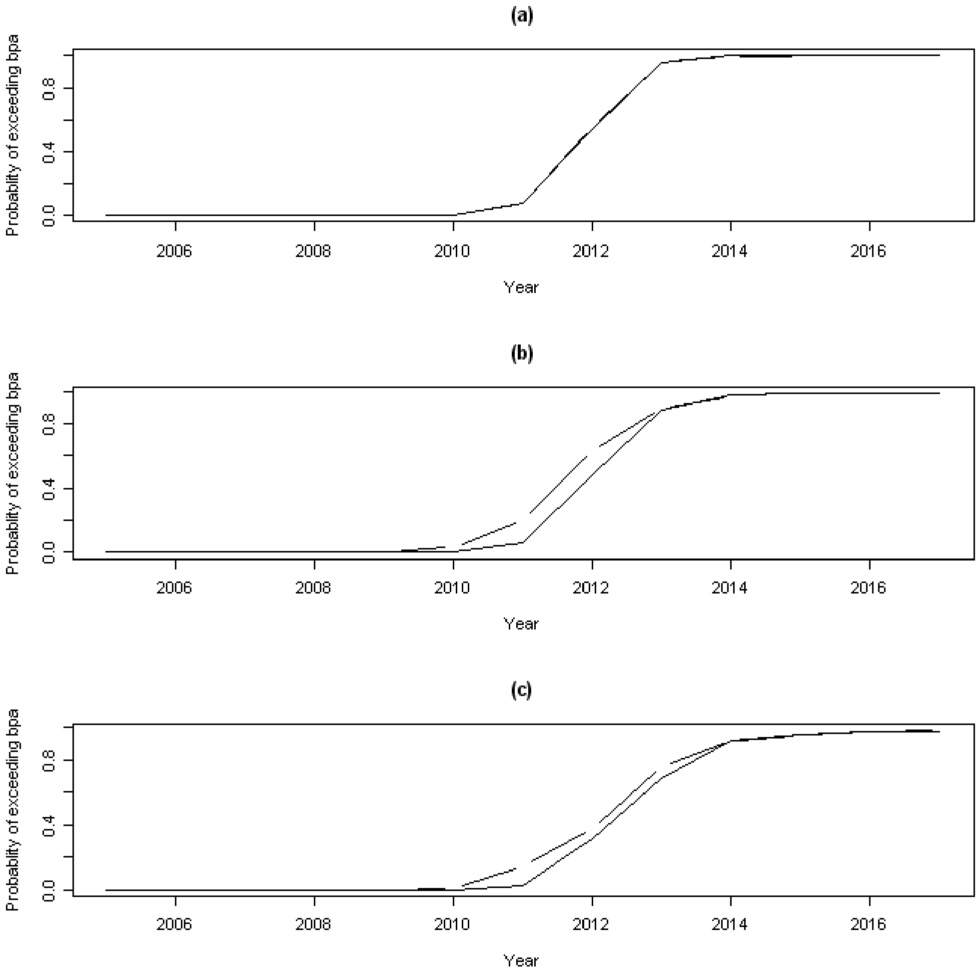


Figure 15.10. Probability that the SSB is greater than B_{pa} (22000 tonnes) for cod VIa. (a) low stock assessment noise and no effort bias; (b) high stock assessment noise and no effort bias; (c) high stock assessment noise and effort bias. Solid line is the "true" stock, dashed line is the perceived stock.

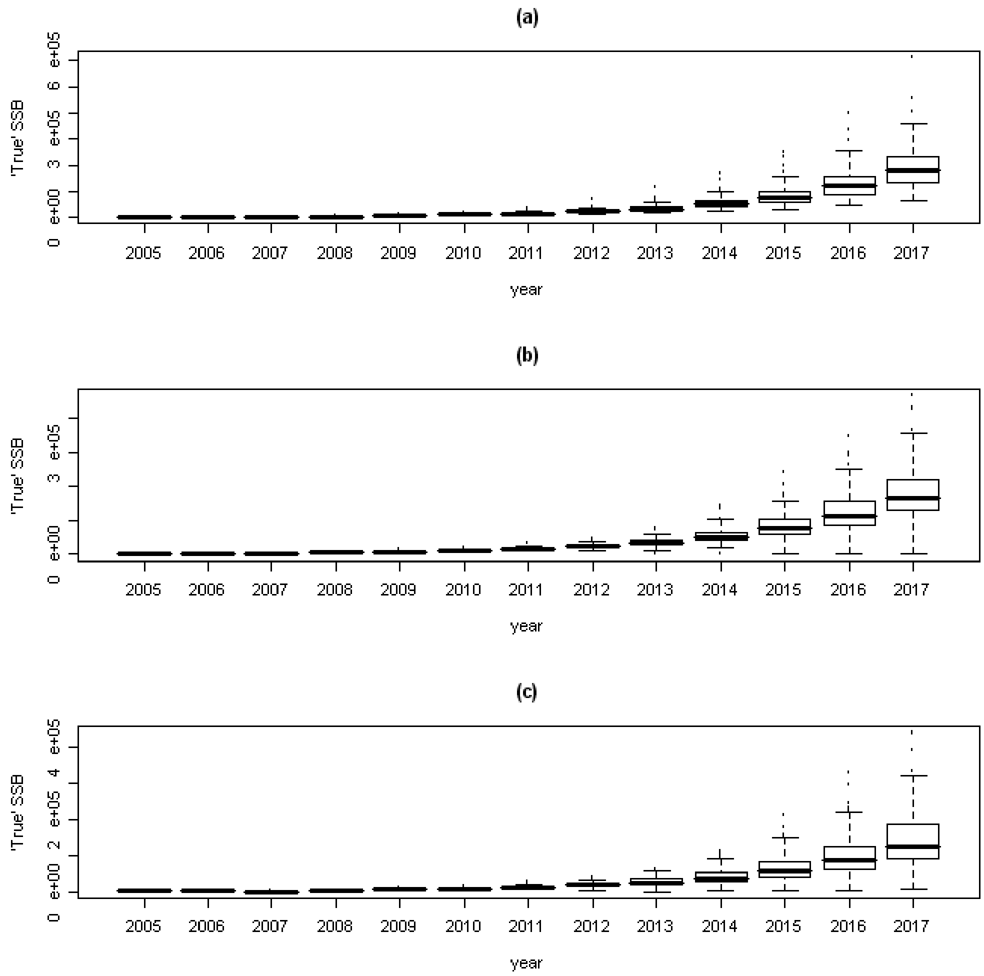


Figure 15.11. Box plot of the "true" SSB for cod VIa. (a) low stock assessment noise and no effort bias; (b) high stock assessment noise and no effort bias; (c) high stock assessment noise and effort bias.

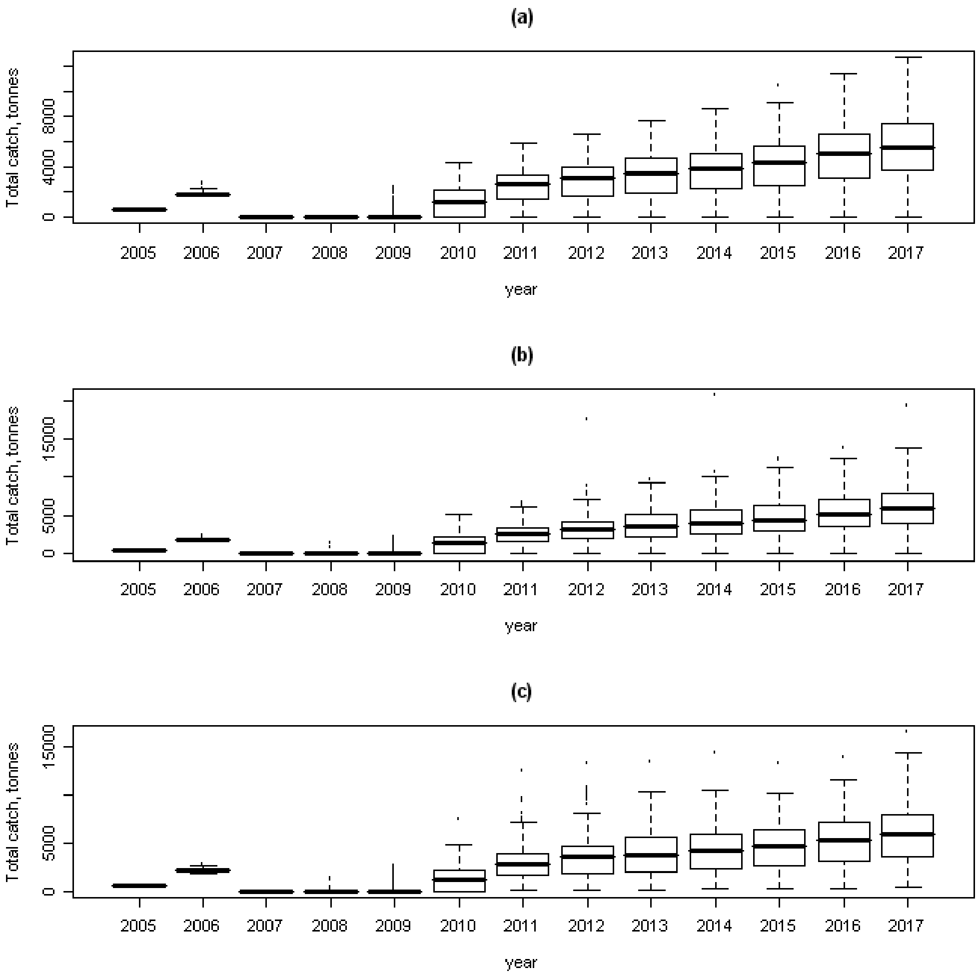


Figure 15.12. Box plot of the total catch for cod VIa. (a) low stock assessment noise and no effort bias; (b) high stock assessment noise and no effort bias; (c) high stock assessment noise and effort bias.

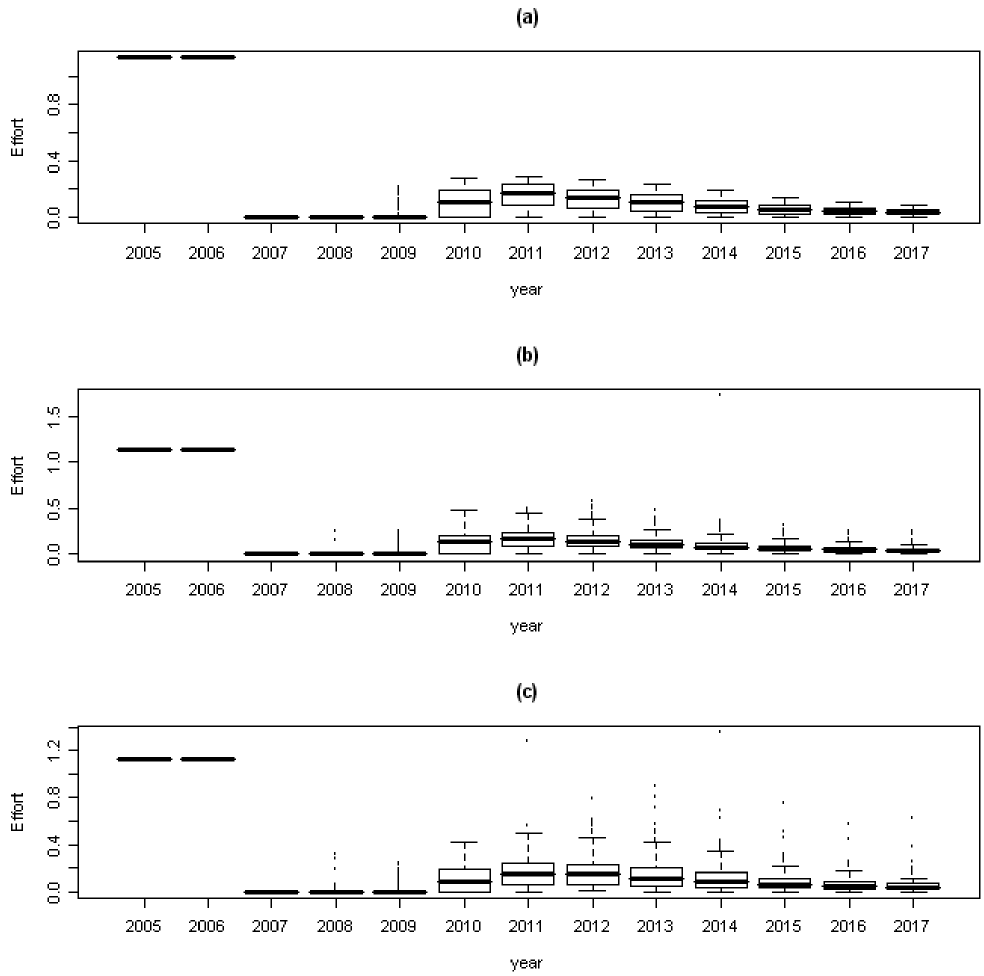


Figure 15.13. Box plot of the fishing effort for cod VIa. (a) low stock assessment noise and no effort bias; (b) high stock assessment noise and no effort bias; (c) high stock assessment noise and effort bias.

16 The effect of the Rockall Box

The NEAFC Commission requests ICES to provide information on the effect of the Rockall box:

Point no.	Latitude	Longitude
1	57° 000 N	15° 000 W
2	57° 000 N	14° 700 W
3	56° 575 N	14° 327 W
4	56° 500 N	14° 450 W
5	56° 500 N	15° 000 W

in protecting juvenile haddock and possible revisions of the boundary of the box.

The Working Group discussed how an evaluation of the effect of the Rockall box described above could be made given that no specific programme of monitoring designed to provide this information had been established. A general concern with the application of closed area management is the potential for displacement of effort from the closed area into areas where its effects may negate the benefits conferred by the closure. An effective evaluation of this kind was precluded by the lack of information on the distribution and level of international effort prior to and following the introduction of the closure. The difficulty of making this sort of evaluation is further compounded by the fact that the closed area described above (effective from 2001) represents one part of a closed area in which the other, EU waters, component came into effect in 2002. A time series of disaggregated data for International and EU waters components were not available at the meeting

A Working Document (WD 8) presented by Vladimir Khlivnoy included considerable detail on size compositions and distributional detail from sampling commercial boats and various surveys by Scotland and Russia. Proposals on alteration of the box boundaries were presented. Summary results from a preliminary VPA were also included. There was, however, no evaluation of the distribution of fishing effort associated with the box or information on subsequent changes in distribution in fishing effort

Based on the preliminary assessment, the Working Document text attributed a drop in fishing mortality on age 1 and 2 year old haddock to the closure. The more comprehensive assessment (Section 4.2) conducted at the meeting, however, shows similarly low fishing mortality rates in earlier years (1993-1995 and 1997), значительно увеличилась в 1999-2001 гг. and also that F on these ages rose again in 2003 *after* the introduction of the closed area.

The full assessment in Section 4.2 also shows that overall mean F has fluctuated and in recent years has continued to do so despite the presence of the closed area. A fall in F in 2001 was followed by an increase up to 2004. The fishing mortality in the final year, 2005, appears to have dropped to its lowest level in the series. While the terminal F figure has a relatively high uncertainty associated with it, the marked downward movement nevertheless coincides with a major drop in effort by UK trawlers in the VIb area as a whole (see Section 17).

It is unfortunate that spatially disaggregated international catch and effort datasets were not available to explore the extent to which the closure altered fishing patterns. More detailed analysis of the UK effort data presented in Section 17 was, however possible. Figure 16.1 shows the time series of effort by *all* gears except long-lines for three subsets of the UK VIb data as follows i) the statistical rectangle (42D5) in which the closure area is located; ii) other statistical rectangles (43-44, D5-D6) covering the remainder of the shallow Rockall bank area and iii) the remainder of statistical rectangles in VIb. However, it is unknown what proportion of effort was applied directly to the haddock fishery.

Effort in the rectangle containing the closure declined following the legislation coming into effect in 2001. There was also a decline in UK effort across the Rockall bank as a whole at this time but an increase across the remaining VIb rectangles. The magnitude of effort and scale of changes in the rectangle with the closure were relatively small compared to events taking place in other parts of VIb and based on this data set, at least, it seems that events in wider areas are likely to have had a more significant influence on the haddock stock. It is difficult to conclude what contribution the closure may have made.

From the Working paper (WD8) it generally appears that the bank is an area where juvenile fish are frequently located, although the limited sampling from depths greater than 200m means that firm conclusions about population structure in these areas cannot readily be made. The presentation of percentage length composition also made difficult the interpretation of the importance of the bank for larger fish. From year to year the centres of abundance in distribution of fish smaller than 25cm varied and the distribution was patchy with some areas of the bank exhibiting very low abundance.

The most recent assessment of the Rockall haddock stock suggests some upturn in the size of the biomass. Based, however, on the various pieces of information available, it is difficult to say what contribution has been made by the attempts to protect juveniles in the closed area. It is possible that the most recent reductions in mean F have arisen from more general reductions in the overall levels of effort. Provision of a more complete effort dataset and some further analysis is required before firm conclusions can be drawn about the effectiveness of the existing closure and recommendations made about its size and shape.

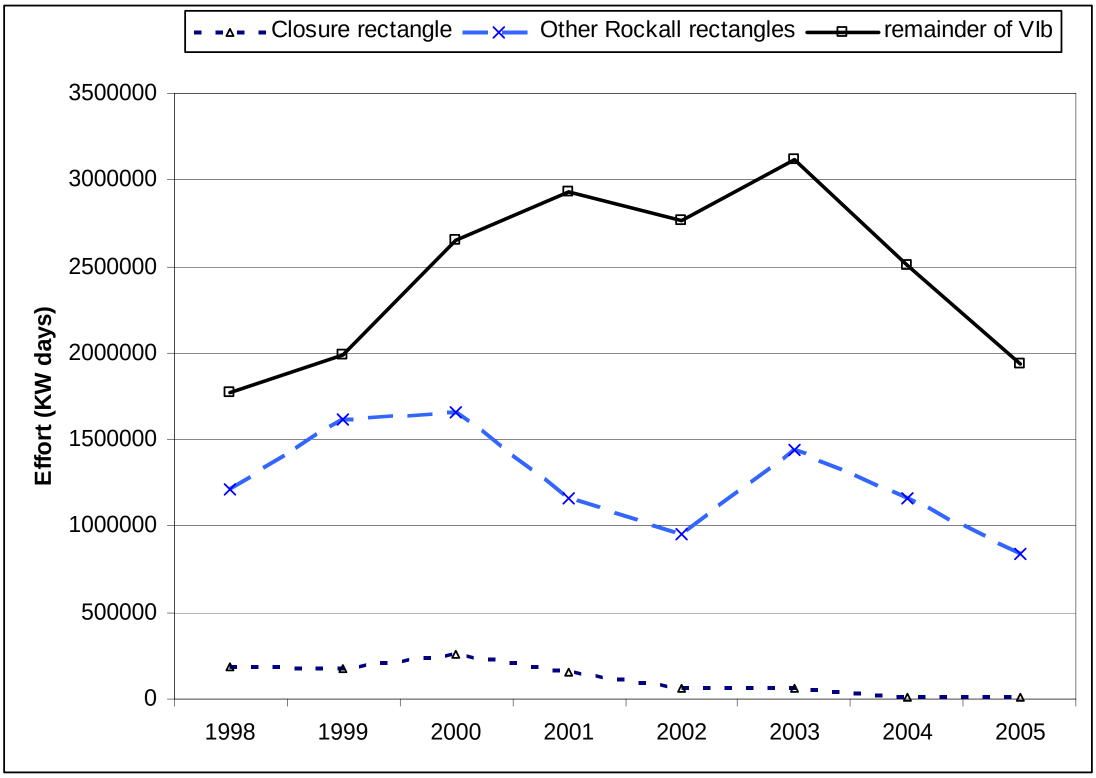


Figure 16.1 UK effort (KW days) for all gears except long lines. Separate lines show three subsets of the UK VIb data as follows i) the statistical rectangle (42D5) in which the closure area is located; ii) other statistical rectangles (43-44, D5-D6) covering the remainder of the shallow Rockall bank area and iii) the remainder of statistical rectangles in VIb.

17 Fishing effort trends

Fishing effort data are reported on fishermen's log sheets according to the nature of the fishing operation. Measures of effort directly related to the fishing operation, such as hours spent trawling, or total length of gill-nets multiplied by soak time, provide the most useful statistic for stock assessment purposes. However, not all effort records are mandatory, and WGNSDS has noted for several stocks that trends in hours-fished for some fleets may be biased by variable effort reporting over time. Information on time spent at sea is more accurately recorded, and the implementation of effort limitation schemes in recent years has required accurate records of days at sea. The STECF Sub-group SGRST has compiled data on fishing effort of effort-regulated and unregulated fleets, by gear type and mesh band, using kW*days as a measure of nominal effort. Appendix 4 of the SGRST report on Evaluation of the Cod recovery Plan (STECF, 2005) contains kW-days data for international fleets in area VI and Division VIIa from 2000 – 2004. Updates were available to WGNSDS including data for 2005, and the UK data were also provided for a greater range of gear types within the categories 4A and 4C regulated gears. The recent trends in effort based on these data are presented below. Longer-term trends in fishing effort for fleets relevant for specific assessments are given in individual stock sections. These are also described in more detail in Section 1.6 of WGNSDS (2006).

17.1 Area VIa and VIb

The extraction specification used to produce landings and efforts records for Area VIIa (see Section 17.2) was repeated for Areas VI. Almost 50,000 records over the period 1998 to 2005 were grouped into a series of 9 gear categories shown in Figures 17.1.1 and 17.1.2. Note that only over 10m vessels are included here and that gears such as pots etc are excluded. No attempt was made to compile an international data set since effort information from countries potentially making a significant contribution (such as France and Spain) were not available to the group. Despite the incomplete nature of the data, the trends recorded for UK vessels (one of the main countries fishing in the area) provide useful indications of recent effort patterns.

Figure 17.1.1 shows that larger meshed whitefish demersal trawls were the most important gears in VIa prior to 2002 but that since then there has been a marked decline in KW days by this category. This is principally explained by the recent, significant decommissioning schemes in the UK. Single rig Nephrops trawls in the 70-99mm mesh category are the other major gears in use and effort by these seems to have been maintained at a fairly stable level throughout the time series. Numerous other gears make generally small contributions to the overall effort and the pattern in most of these has either been a downward trend (eg seine nets and midwater trawls) or fluctuation without trend (eg fixed nets). Taken together the picture suggests that overall, effort has declined in recent years in Area VIa and that declines in particular categories have not been compensated for by rises in other categories.

Figure 17.1.2 shows the results for VIb, again only for UK vessels. The effort (KWdays) figures are smaller in this area (mostly reflecting fishing at Rockall) and fewer gears are used extensively. Most gears are only recorded sporadically and some (eg Nephrops trawls and Nephrops twin trawls) are essentially not used in this area at all. Whitefish demersal trawls are the most important gears in use, particularly larger mesh ones and the pattern of these in recent years has been a slight rise followed by a decline since 2003. Fixed nets and longlines are the other significant category and the trend in these has been downward.

17.2 Irish Sea Division VIIa

Within categories 4A (trawls, seines etc., ≥ 100mm) and 4E (trawls, seines etc., 70-99mm) gears in the Irish Sea, there is a range of fishing gears of quite different design. Demersal trawls in the 4A category include a variety of single and multiple rig otter trawls used for gadoids, rays and other demersal fish, and semi-pelagic (mid-water) trawls that have been used extensively in the deeper waters of the Irish Sea to target hake, whiting, cod and haddock since the 1980s. Category 4E includes single-rig and multiple-rig *Nephrops* trawls, and whitefish trawls targeting species such as plaice and whiting where catch composition rules permit this mesh size. The change in mesh size regulations in 2000, requiring the use of 100mm mesh for vessels targeting species such as cod, resulted in a change in the distribution of effort between mesh bands.

The nominal effort trends in kW-days for VIIa given by STECF-SGRST (2005) for 2000-2004 are reproduced in Table 17.2.1, to allow comparison with up-dated values given in Table 17.2.2. The data are split by more gear-types in Table 17.2.2 than were given by STECF. In the case of UK vessels, the figures for the gear types sum to the aggregated STECF figures for 2000-2004. Figures for Belgium have been revised slightly. Major revisions were supplied by Ireland. Specifically, effort data by mesh band for Ireland were not available for 2000-2002, and the figures given by STECF for these years may not be accurate or complete.

The majority of nominal effort is in the gear grouping for otter trawls with mesh sizes between 70-99 mm. Most of the effort in this mesh band is attributable to *Nephrops* trawlers, but includes vessels targeting plaice, whiting or other species where the catch-composition rules permit 70-99mm trawls. These are included in the “whitefish otter trawl” category, although the distinction between *Nephrops* trawls and whitefish trawls using 70-99mm mesh is blurred because many vessels use gears optimised to catch *Nephrops* with a whitefish by-catch. The more restricted days-at-sea allowances for 4A (100mm+) otter trawls has resulted in some vessels returning to 70-99mm trawls to obtain more days per month. A number of UK(NI) vessels switch between semi-pelagic trawls and twin-rig *Nephrops* trawls according to fishing opportunities including access to the cod spawning closure where there is a derogation for *Nephrops* vessels. The effort of the two series tends to vary in opposite directions.

The fishing effort for UK 4A gear types has declined in the last few years in VIIa. Specifically, fishing effort of midwater whitefish trawlers has declined by 50% between 2003 and 2005, and effort of Irish otter trawlers (100mm+) has declined by over 80% in the same period (Figs. 17.2.1). Single-rig Nephrops effort has declined by 33% since 2001. The combined effort of towed gears and static gears (gillnets and longlines) has declined by 33% since 2001 (Fig. 17.2.2).

Taking Irish and Belgian fleets into account, an almost 3-fold decline international effort of 100mm+ demersal trawls is evident between 2003 and 2005, whilst otter trawls in the 70-99mm mesh band have slightly increased their effort over this period (Fig. 17.2.3). Beam trawl effort declined slightly between 2000 and 2002, and gillnet effort has halved over these three years.

Although the trends in kW-days are indicative of recent trends in fleet activities in recent years, the relationship with fishing mortality will be affected by changes in the amount of fishing per day at sea, technological improvements, and changes in species targeting and fishing practices resulting from management restrictions and changing fish availability. An analysis of catchability (F generated per unit of effort) will require more highly resolved data, (both spatially and temporally), accurate catch and effort data for suitably disaggregated fleet/gear combinations, and sufficiently accurate assessment estimates of F. Recent trends in F are very poorly determined for most of the stocks assessed by WGNSDS. However, very large apparent changes in mortality (e.g. the large decline in estimates of F in VIa haddock, mirroring a similar large decline in F estimates for North Sea haddock stock in recent years), should be reflected in recent trends in kW-days in fleets targeting the species.

Table 17.2.1. Fishing effort in kW-days for different national fleets as tabulated by STECF Sub-group SGRST (2005)

		2000	2001	2002	2003	2004
Beam>=80	BEL	1004688	1486557	1760619	1517628	1118670
Beam>=80	UK	127815	216216	138474	213235	110838
Beam>=80	IRL	609304	505776	608444	671754	407656
Beam>=80	NED	181060		1895		
Dem Trawl >=100	UK	1692759	2093165	2224980	2535771	1376026
Dem Trawl 70-99	UK	4411335	4265769	3198881	3651695	3577440
longline	IRL					300
longline	UK		7872		3608	
static gears	UK	24572	15157	16321	14873	14711
static gears	IRL	8554	20942	42724	59967	50152
static gears	NED					
Other gears	BEL		4416		518	8107
Other gears	UK	14110	17018	8248	7422	2042
Other gears	NED	12485				
Other gears	IRL	2067939	1836000	1720667	1708992	1784795

Table 17.2.2 Fishing effort of national fleets by gear type and mesh band, in kW-days. Includes revisions to STECF-SGRST data for Ireland and Belgium in Table 17.2.1. UK data for different gear types in 2000-2004 sum to the aggregated figures in Table 17.2.1

			1998	1999	2000	2001	2002	2003	2004	2005
Beam trawl	Beam>=80	BEL	n/a	n/a	982855	1484122	1759801	1541794	1140300	1251345
Beam trawl	Beam>=80	UK	283705	276217	127813	216216	138473	213234	110839	165015
Beam trawl	Beam (all meshes)	IRL	n/a	n/a	n/a	n/a	n/a	917379	661852	602439
Beam trawl	Beam>=80	NED	n/a	n/a	181060		1895			n/a
Dem Trawl >=100	whitefish otter trawls>=100	UK	239935	103007	251045	419976	366994	428708	177883	100117
Dem Trawl >=100	twin trawls >=100	UK	1265	34147	4065	5480	22323	77098	40091	5183
Dem Trawl >=100	seine nets >=100	UK	32108	24597	161552	97435	60073	126488	67594	27984
Dem Trawl >=100	Nephrops otter>=100	UK	0	0	0	0	1788	209	0	288
Dem Trawl >=100	otter trawl >=100	IRL	n/a	n/a	n/a	n/a	n/a	448335	161981	76845
Dem Trawl >=100	semi-pelagic >=100	UK	2952	885	1171304	1395746	1625759	1757119	1050681	827758
Dem Trawl	semi-pelagic 70-99	UK	1520802	1842037	81331	13621	5398	0	12983	0
Dem Trawl 70-99	whitefish otter 70-99	UK	922300	830738	627184	564833	382865	408090	684043	582907
Dem Trawl 70-99	twin otter 70-99	UK	0	0	6197	0	0	9204	78411	32922
Dem Trawl 70-99	Nephrops single 70-99	UK	2545381	2494306	2342478	2522752	1960901	2143790	1722762	1682888
Dem Trawl 70-99	Twin Nephrops 70-99	UK	859307	926249	1308012	1140422	830739	1064004	1052313	1226483
Dem Trawl 70-99	Seine nets 70-99	UK	41158	120545	18175	777	333	666	222	0
Dem Trawl 70-99	Nephrops trawl 70-99	IRL	n/a	n/a	n/a	n/a	n/a	1274785	1445775	1628742
Trawls unspecified	Trawls excl beam	IRL	n/a	n/a	n/a	n/a	n/a	27451	128981	615
Trawls unspecified	Trawls excl beam	BEL				4416			8107	17800
longlines	longlines	UK	147137	205998	163686	164490	83240	33340	23814	31605
static gears	gillnets	UK	25128	23128	23990	15157	16766	14873	12547	10012
static gears	gillnets	IRL	n/a	n/a	n/a	n/a	n/a	139841	82951	50841
static gears	static gears	NED	n/a	n/a						
Other gears	Other gears	BEL	n/a	n/a						5621
Other gears	Other gears	UK	186669	148658	71239	170880	158810	163603	72997	98954
Other gears	Other gears	NED	n/a	n/a	12485					
Other gears	Pelagic	IRL	n/a	n/a	n/a	n/a	n/a	447582	426370	217550

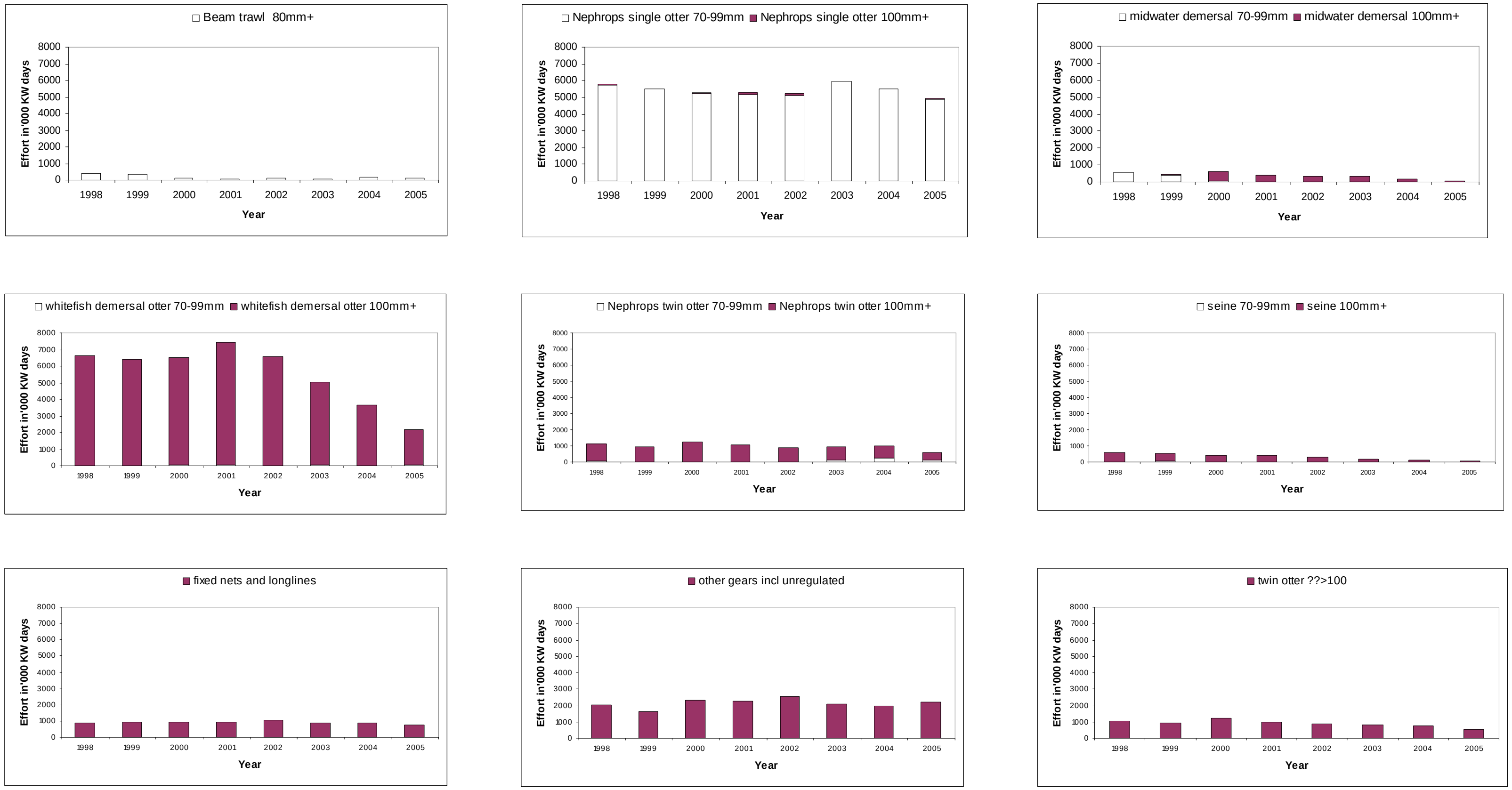


Figure 17.1.1 Fishing Effort (KW days) by UK vessels from ICES Area VIa between 1998 and 2005 for various categories of fishing gear. All scaled to maximum of 8000 kwdays. Open bars indicate 70-99mm mesh gears , filled bars indicate 100+mm mesh gears

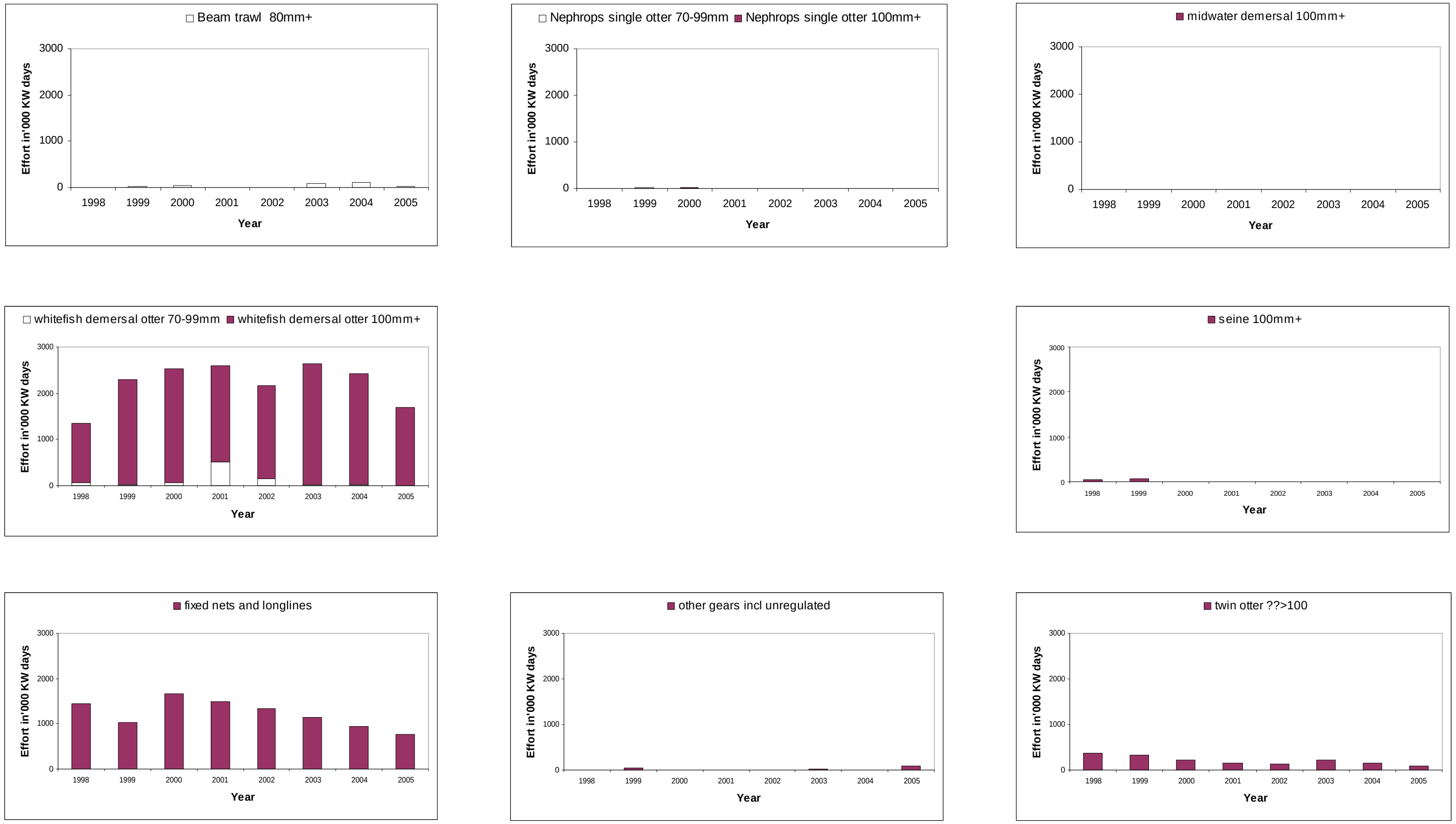


Figure 17.1.2 Fishing Effort (KW days) by UK vessels from ICES Area VIb between 1998 and 2005 for various categories of fishing gear. All scaled to maximum of 8000 kwdays. Open bars indicate 70-99mm mesh gears , filled bars indicate 100+mm mesh gears

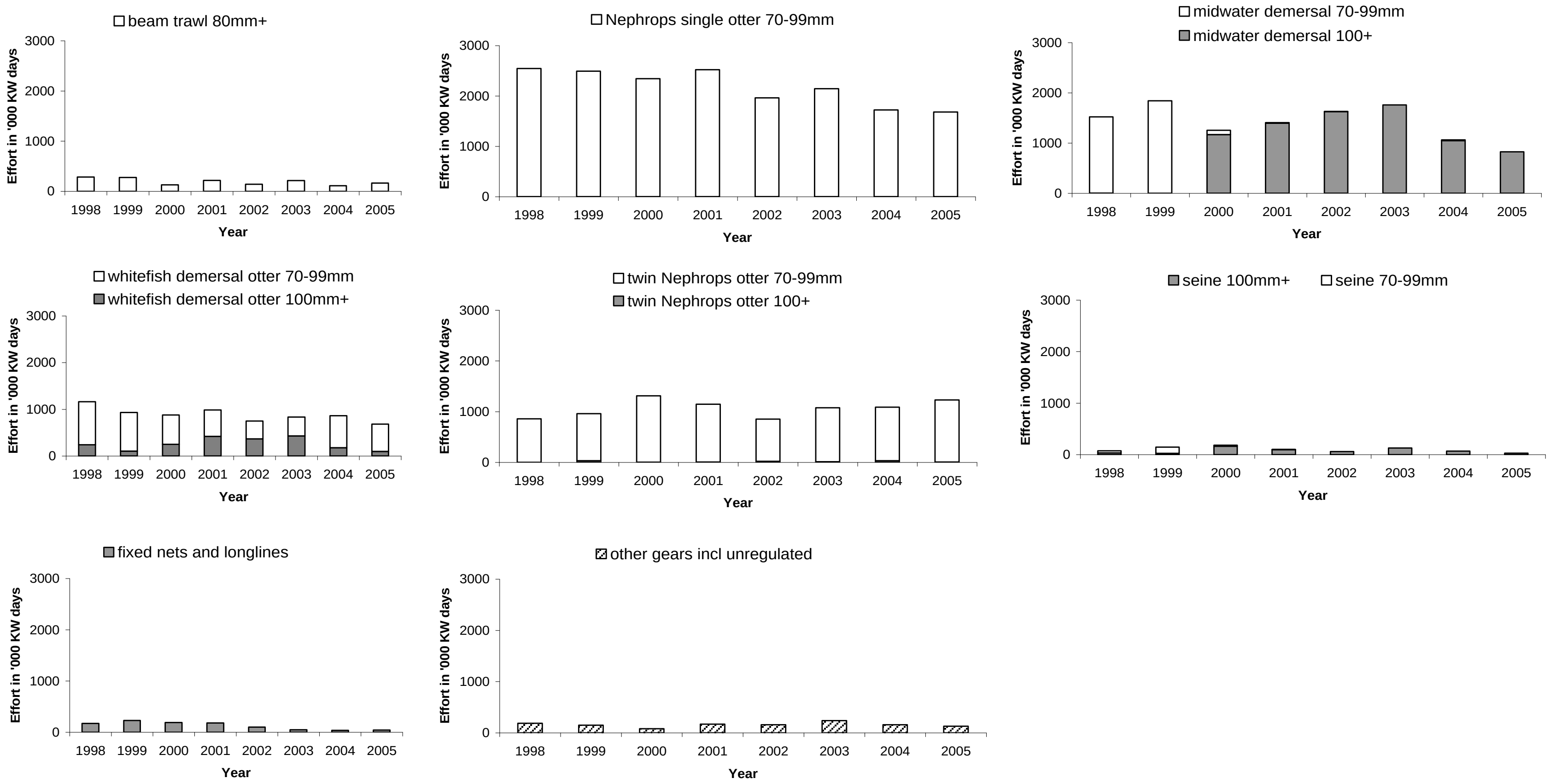


Fig. 17.2.1. Trends in UK fishing effort (kW-days) for different gear types and mesh bands, from 1998-2005.

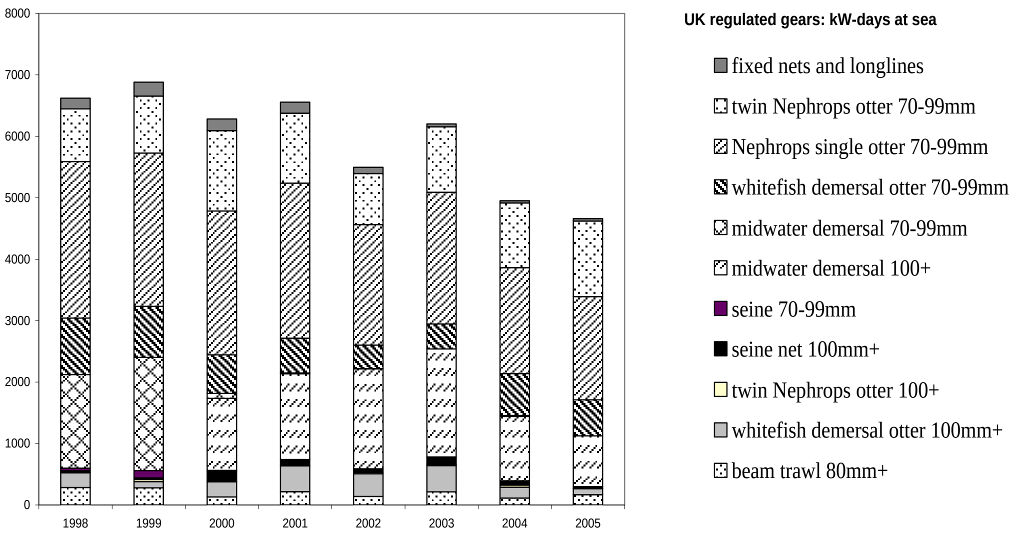


Fig. 17.2.2. Trends in fishing effort (kW-days) for UK regulated gears, 1998 – 2005.

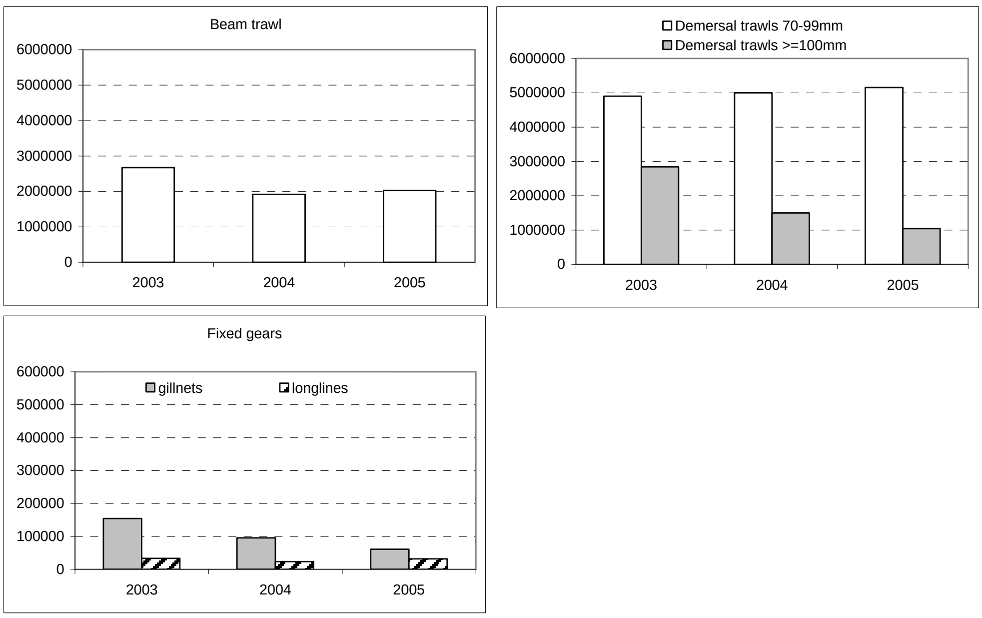


Fig. 17.2.3. Trends in international fishing effort (kW-days) for different gear types and mesh bands, from 2003-2005, for UK, Ireland, Belgium and Netherlands. No data from France were provided.

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Annex 1: Participants list

Working Group on the Assessment of Northern Shelf Demersal Stocks

ICES, Headquarters, 9 – 18 May 2006

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Annex 2: Fleet definitions templates

Copy the following fleet definition table template for each fleet.

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	**Description of characteristic**	**Codes to use or explanation**
Name and email of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	VIIa cod (cod-iris) VIIa haddock (had-iris) VIIa whiting (whg-iris) FU 11-15 *Nephrops* (nep-via and nep-7a)	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	OTB_NEP_S	
Description (*Mandatory*)	*Nephrops* otter trawl, single trawl	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	- Unspecified fleet - Human consumption - Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	70-99	In mm
Vessel tonnage range		Weight range in tonnes
Vessel length range		Length range in meters
Engine size range		Range in kW
[Add more if needed]		

Please filled in the form for each fleet and email them to Henrik Kjems-Nielsen, ICES Secretariat, email: Henrikkn@ices.dk

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	**Description of characteristic**	**Codes to use or explanation**
Name and email of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	VIIa cod (cod-iris) VIIa haddock (had-iris) VIIa whiting (whg-iris) FU 11-15 *Nephrops* (nep-via and nep-7a)	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	OTB_NEP_M	
Description (*Mandatory*)	*Nephrops* otter trawl, multiple nets	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	- Unspecified fleet - Human consumption - Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	70-99	In mm
Vessel tonnage range		Weight range in tonnes
Vessel length range		Length range in meters
Engine size range		Range in kW
[Add more if needed]		

Please filled in the form for each fleet and email them to Henrik Kjems-Nielsen, ICES Secretariat, email: Henrikkn@ices.dk

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	**Description of characteristic**	**Codes to use or explanation**
Name and email of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	FU 11-15 *Nephrops* (nep-via and nep-7a)	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	CREEL	
Description (*Mandatory*)	*Nephrops* creels	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	- Unspecified fleet - Human consumption - Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range		In mm
Vessel tonnage range		Weight range in tonnes
Vessel length range		Length range in meters
Engine size range		Range in kW
[Add more if needed]		

Please filled in the form for each fleet and email them to Henrik Kjems-Nielsen, ICES Secretariat, email: Henrikkn@ices.dk

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	**Description of characteristic**	**Codes to use or explanation**
Name and email of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	VIIa cod (cod-iris) VIIa haddock (had-iris) VIIa whiting (whg-iris)	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	PT	
Description (*Mandatory*)	Pelagic trawl	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	- Unspecified fleet - Human consumption - Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	?	In mm
Vessel tonnage range		Weight range in tonnes
Vessel length range		Length range in meters
Engine size range		Range in kW
[Add more if needed]		

Please filled in the form for each fleet and email them to Henrik Kjems-Nielsen, ICES Secretariat, email: Henrikkn@ices.dk

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	**Description of characteristic**	**Codes to use or explanation**
Name and email of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	VIIa cod (cod-iris) VIIa haddock (had-iris) VIIa whiting (whg-iris) VIIa sole (sol-iris) VIIa plaice (ple-iris)	
Used by stock in other WGs (write WG in front of the stock)	(WGNSSK)	
Fleet code/name (*Mandatory*)	BT	
Description (*Mandatory*)	Beam trawl	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	- Unspecified fleet - Human consumption - Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	?	In mm
Vessel tonnage range		Weight range in tonnes
Vessel length range		Length range in meters
Engine size range		Range in kW
[Add more if needed]		

Please filled in the form for each fleet and email them to Henrik Kjems-Nielsen, ICES Secretariat, email: Henrikkn@ices.dk

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	**Description of characteristic**	**Codes to use or explanation**
Name and email of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	Anglerfish, all areas (ang-ivvi and ang-kask)	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	GILLNET	
Description (*Mandatory*)	Directed gillnet fishery for anglerfish	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	- Unspecified fleet - Human consumption - Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	>220	In mm
Vessel tonnage range		Weight range in tonnes
Vessel length range		Length range in meters
Engine size range		Range in kW
[Add more if needed]		

Please filled in the form for each fleet and email them to Henrik Kjems-Nielsen, ICES Secretariat, email: Henrikkn@ices.dk

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	**Description of characteristic**	**Codes to use or explanation**
Name and email of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	Anglerfish IV and VI (ang-ivvi) Cod VIa (cod-scow) Haddock VIa (had-scow) Haddock VIb (had-rock) Whiting VIa (whg-rock) Megrim VI (meg-scrk)	
Used by stock in other WGs (write WG in front of the stock)	WGNSSK	
Fleet code/name (*Mandatory*)	OTB_LIGHT	
Description (*Mandatory*)	Otter trawl, roundfish, light trawlers	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	- Unspecified fleet - Human consumption - Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	>100 ?	In mm
Vessel tonnage range	?	Weight range in tonnes
Vessel length range	?	Length range in meters
Engine size range	?	Range in kW
[Add more if needed]		

Please filled in the form for each fleet and email them to Henrik Kjems-Nielsen, ICES Secretariat, email: Henrikkn@ices.dk

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	**Description of characteristic**	**Codes to use or explanation**
Name and email of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	Anglerfish IV and VI (ang-ivvi) Cod VIa (cod-scow) Haddock VIa (had-scow) Haddock VIb (had-rock) Whiting VIa (whg-rock) Megrim VI (meg-scrk)	
Used by stock in other WGs (write WG in front of the stock)	WGNSSK	
Fleet code/name (*Mandatory*)	OTB_HEAVY	
Description (*Mandatory*)	Otter trawl, roundfish, heavy trawlers	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	- Unspecified fleet - Human consumption - Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	>100 ?	In mm
Vessel tonnage range	?	Weight range in tonnes
Vessel length range	?	Length range in meters
Engine size range	?	Range in kW
[Add more if needed]		

Please filled in the form for each fleet and email them to Henrik Kjems-Nielsen, ICES Secretariat, email: Henrikkn@ices.dk

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	**Description of characteristic**	**Codes to use or explanation**
Name and email of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	Anglerfish all areas (ang-ivvi and ang-kask) Cod VIa (cod-scow) Haddock VIa (had-scow) Haddock VIb (had-rock) Whiting VIa (whg-rock) Megrim VI (meg-scrk)	
Used by stock in other WGs (write WG in front of the stock)	WGNSSK	
Fleet code/name (*Mandatory*)	OTB_OTHER	
Description (*Mandatory*)	Otter trawl, roundfish, other trawlers	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	- Unspecified fleet - Human consumption - Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	?	In mm
Vessel tonnage range	?	Weight range in tonnes
Vessel length range	?	Length range in meters
Engine size range	?	Range in kW
[Add more if needed]		

Please filled in the form for each fleet and email them to Henrik Kjems-Nielsen, ICES Secretariat, email: Henrikkn@ices.dk

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	**Description of characteristic**	**Codes to use or explanation**
Name and email of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	Anglerfish all areas (ang-ivvi and ang-kask) Cod VIa (cod-scow) Haddock VIa (had-scow) Haddock VIb (had-rock) Whiting VIa (whg-rock) Megrim VI (meg-scrk)?	
Used by stock in other WGs (write WG in front of the stock)	WGNSSK	
Fleet code/name (*Mandatory*)	OTB_NEP	
Description (*Mandatory*)	*Nephrops* otter trawl	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	- Unspecified fleet - Human consumption - Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	70-99?	In mm
Vessel tonnage range	?	Weight range in tonnes
Vessel length range	?	Length range in meters
Engine size range	?	Range in kW
[Add more if needed]		

Please filled in the form for each fleet and email them to Henrik Kjems-Nielsen, ICES Secretariat, email: Henrikkn@ices.dk

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	**Description of characteristic**	**Codes to use or explanation**
Name and email of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	Anglerfish all areas (ang-ivvi and ang-kask) Cod VIa (cod-scow) Haddock VIa (had-scow) Haddock VIb (had-rock) Whiting VIa (whg-rock) Megrim VI (meg-scrk)?	
Used by stock in other WGs (write WG in front of the stock)	WGNSSK	
Fleet code/name (*Mandatory*)	DEM_SEINES	
Description (*Mandatory*)	Demersal seines, e.g. Scottish and Danish seines	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	- Unspecified fleet - Human consumption - Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	?	In mm
Vessel tonnage range	?	Weight range in tonnes
Vessel length range	?	Length range in meters
Engine size range	?	Range in kW
[Add more if needed]		

Please filled in the form for each fleet and email them to Henrik Kjems-Nielsen, ICES Secretariat, email: Henrikkn@ices.dk

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	**Description of characteristic**	**Codes to use or explanation**
Name and email of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	Anglerfish all areas (ang-ivvi and ang-kask) Cod VIa (cod-scow) Haddock VIa (had-scow) Haddock VIb (had-rock) Whiting VIa (whg-rock) Megrim VI (meg-scrk)?	
Used by stock in other WGs (write WG in front of the stock)	WGNSSK	
Fleet code/name (*Mandatory*)	DEM_PAIR	
Description (*Mandatory*)	Demersal pair trawls	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Human consumption	- Unspecified fleet - Human consumption - Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range	?	In mm
Vessel tonnage range	?	Weight range in tonnes
Vessel length range	?	Length range in meters
Engine size range	?	Range in kW
[Add more if needed]		

Please filled in the form for each fleet and email them to Henrik Kjems-Nielsen, ICES Secretariat, email: Henrikkn@ices.dk

Fleet characteristic Mandatory characteristic are marked with (*Mandatory*)	**Description of characteristic**	**Codes to use or explanation**
Name and email of responsible person (*Mandatory*)	Otte Bjelland otte@imr.no	
Working Group (*Mandatory*)	WGNSDS	
Used by stock in this WG (*Mandatory*)	All stocks	
Used by stock in other WGs (write WG in front of the stock)		
Fleet code/name (*Mandatory*)	OTHER	
Description (*Mandatory*)	Other gears	
Unit for Effort (*Mandatory*)	kWD	kW*days at sea
Fleet type (*Mandatory*)	Unspecified fleet	- Unspecified fleet - Human consumption - Industrial
Vessel type		See Appendix A. Write new if not already in the list
Gear		
Mesh size range		In mm
Vessel tonnage range		Weight range in tonnes
Vessel length range		Length range in meters
Engine size range		Range in kW
[Add more if needed]		

Please filled in the form for each fleet and email them to Henrik Kjems-Nielsen, ICES Secretariat, email: Henrikkn@ices.dk

Annex 3: Quality Handbook: WGNSDS- North Minch Nephrops (FU11)

Stock specific documentation of standard assessment procedures used by ICES.

Stock: North Minch Nephrops (FU11)

Working Group: Assessment of Northern Shelf Demersal Stocks

Date: May 2005

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 North Minch area the Nephrops stock inhabits two generally continuous areas of muddy sediment extending from the Ullapool/Loch Inver area to Lewis, and between Skye and the mainland, with other smaller isolated patches.

A.2. The fishery

The North Minch Nephrops fishery is predominantly exploited by Nephrops trawlers using single rig gear with a 70 mm mesh, although about 20 % of landings are made by creel vessels. About 15 % of the trawl landings are made with a 100 mm mesh, and only 1 % of landings appear to be made by twin-rig vessels.

All the creel vessels are local, and roughly three quarters of the trawl landings are made by vessels based between Mallaig and Kinlochbervie on the mainland, and Stornoway on the Isle of Lewis. In all, about 135 trawlers contribute to the landings, 75 % of which are local. Most of the local trawlers exploiting the North Minch are based around Stornoway and Mallaig, although the vessels from Gairloch and Ullapool also contribute significantly. Mean engine power is 206 kW, and mean vessel length 15.5 m. Most vessels were built between the 1960s and 1980s. The major landing ports are Ullapool, Gairloch and Stornoway.

The minimum landing size for Nephrops in the North Minch is 20 mm CL, and less than 0.5 % of the animals are landed under size. Discarding takes place at sea, and landings are made by category for whole animals (small, medium and large) and as tails. The main by-catch species is haddock, although whiting and Norway pout also feature significantly in discards.

The fishery is exploited throughout the year, with the highest landings usually made in the spring and summer. Vessels usually have a trip duration of one day in the winter, but up to six days in the summer.

The current legislation governing Nephrops trawl fisheries on the West coast of Scotland was laid down by the North Sea and West of Scotland cod recovery plan (EC 2056/2001), which established measures additional to EC 850/98. This regulation was amended in 2003 by Annex XVII of EC 2341/2002, which establishes fishing effort and additional conditions for monitoring, inspection and surveillance for the recovery of certain cod stocks. This regulation effectively limits vessels targeting Nephrops with 70-99mm mesh size to 25 days at sea per month. The use of square mesh and headline panels are compulsory in this fishery.

Additional Scottish legislation (SSI No 2000/226) applies to twin trawlers operating North of 56^0N, A mesh size of 100mm or above must be used without a lifting bag and with not more than 100 meshes round the circumference but with up to 5mm double twine. By comparison, vessels using a single trawl may use 70-89mm mesh with a lifting bag and 120 meshes round the cod-end but with 4mm single twine.

A.3. Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

B. Data

B.1. Commercial catch

Length and sex compositions of Nephrops landed from the North Minch are estimated from port sampling in Scotland. Length data from Scottish sampling are applied to all catches and raised to total international landings. Rates of discarding by length class are estimated for Scottish fleets by on-board sampling, and extrapolated to all other fleets. The proportion of discarded to landed Nephrops changes with year, often determined by strong year classes. Discard sampling started in 1990, and for years prior to this estimates have been made based on later data. Landings and discards at length are combined (assuming a discard survival rate of 25%) to removals. The differences in catchability between sexes have lead to the two sexes being assessed separately. And hence removals are raised separately for each sex.

Trawl and creel fisheries are sampled separately.

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 is implemented in the L2AGE programme which automatically generates 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 ensures comparability of ‘age’ classes across stocks.

B.2. Biological

Growth : males Linfinity = 70mm, k=0.16:

Immature Females Linfinity = 70mm k= 0.16; mature females Linfinity =60mm, k=0.06: size maturity =27mm

Mean weights-at-age for this stock are estimated from fixed Scottish weight-length relationships (Howard et al 1988 – citation required).

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

Abundance indices are available from the following research-vessel surveys:

- Underwater TV survey: years 1995 – present. The survey usually occurs in June. The burrowing nature of Nephrops, and variable emergence rates mean that trawl catch rates may bear little resemblance to population abundance. An underwater TV survey has been developed, estimating Nephrops population abundance form burrow density raised to stock area. A random stratified sampling design is used, on the basis of a regular grid. The survey provides a total abundance estimate, and is not age or length structured.

- B.4. Commercial CPUE

Catch-per-unit-effort time-series are available from the following fleets:

- Scottish Nephrops trawl gears. Landings at age and effort data for Scottish Nephrops trawl gears are used to generate an CPUE index. Catch at age are estimated from raising length sampling of discards and landings to Officially recorded landings (Nephrops single trawl, multiple Nephrops trawl, Light trawl and multiple demersal trawl), 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 single trawl and multiple Nephrops trawl is raised to landings reported by the four gears listed above. Discard sampling commenced in 1990 for this fishery, and for years prior to this, an average of the 1990 and 1991 values is applied. There is no account taken of any technological creep in the fleet.

B.5. Other relevant data

None.

C. Historical Stock Development

This section is in the Working Group report.

D. Short-Term Projection

This section is in the Working Group report.

E. Medium-Term Projections

This section is in the Working Group report.

F. Yield and Biomass per Recruit / Long-Term Projections

This section is in the Working Group report.

G. Biological Reference Points

This section is in the Working Group report.

H. Other Issues

None.

I. References

Refer to References section in Working Group report

Annex 4: Quality Handbook: WGNSDS- South Minch Nephrops (FU12)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	South Minch Nephrops (FU12)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Date:	May 2005

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 South Minch area the Nephrops stock inhabits a generally continuous area of muddy sediment extending from the south of Skye to the Stanton Bank, to the south of the Outer Hebrides.

A.2. The fishery

The South Minch Nephrops fishery is predominantly exploited by Nephrops trawlers, although about 10 % of landings are made by creel vessels. About 90 % of trawler landings are made by vessels targeting Nephrops, and only 1 % of landings are made by twin-rig vessels. Of the Nephrops trawlers, about 80 % of landings are made with a 70 mm mesh.

All the creel vessels are local, and roughly half of the trawl landings are made by vessels based between Mallaig and Campbeltown. Visiting vessels originate from the North Minch (8 % of landings) and the Scottish East coast. The East coast vessels tend to be larger than the local ones, and carry out longer trips. Mean engine power of the local vessels is 200 kW, and their mean length 15.0 m. Most vessels were built between the 1960s and the 1980s. The major landing ports are Oban and Mallaig. The smaller vessels usually have a trip duration of 1-3 days, while larger boats may stay out for 5-6 days.

The minimum landing size for Nephrops in the South Minch is 20 mm CL and less than 0.5 % of animals are landed under size. Discarding takes place at sea and landings are made by category for whole animals (small and large) and as tails. The main by-catch species are whiting and haddock, with whiting in particular featuring heavily in discards. Of the non-commercial species caught, poor cod, Norway pout and long rough dab contribute significantly to the discards.

The fishery is exploited throughout the year, with the highest landings usually being made in the spring and summer. A seasonal sprat fishery often develops in November and December, which is targeted by vessels of all sizes (including those that usually target Nephrops). Some vessels also turn to scallop dredging when Nephrops catches or prices drop, although the scope for this has been limited in recent years with ASP and PSP closures of the scallop fishery in some areas.

The current legislation governing Nephrops trawl fisheries on the West coast of Scotland was laid down by the North Sea and West of Scotland cod recovery plan (EC 2056/2001), which established measures additional to EC 850/98. This regulation was amended in 2003 by Annex

XVII of EC 2341/2002, which establishes fishing effort and additional conditions for monitoring, inspection and surveillance for the recovery of certain cod stocks. This regulation effectively limits vessels targeting Nephrops with 70-99mm mesh size to 25 days at sea per month. The use of square mesh and headline panels are compulsory in this fishery.

Additional Scottish legislation (SSI No 2000/226) applies to twin trawlers operating North of 56^0N, A mesh size of 100mm or above must be used without a lifting bag and with not more than 100 meshes round the circumference but with up to 5mm double twine. By comparison, vessels using a single trawl may use 70-89mm mesh with a lifting bag and 120 meshes round the cod-end but with 4mm single twine.

A.3. Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

B. Data

B.1. Commercial catch

Length and sex compositions of Nephrops landed from the South Minch are estimated from port sampling in Scotland. Length data from Scottish sampling are applied to all catches and raised to total international landings. Rates of discarding by length class are estimated for Scottish fleets by on-board sampling, and extrapolated to all other fleets. The proportion of discarded to landed Nephrops changes with year, often determined by strong year classes. Discard sampling started in 1990, and for years prior to this estimates have been made based on later data. Landings and discards at length are combined (assuming a discard survival rate of 25%) to removals. The differences in catchability between sexes have lead to the two sexes being assessed separately. And hence removals are raised separately for each sex.

Trawl and creel fisheries are sampled separately.

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 is implemented in the L2AGE programme which automatically generates 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 ensures comparability of ‘age’ classes across stocks.

B.2. Biological

Growth : males Linfinity = 68mm, k=0.161:

Immature Females Linfinity = 68mm k= 0.161; mature females Linfinity =59mm, k=0.06: size maturity =25mm

Mean weights-at-age for this stock are estimated from fixed Scottish weight-length relationships (Howard et al 1988 – citation required).

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

Abundance indices are available from the following research-vessel surveys:

- Underwater TV survey: years 1995 – present. The survey usually occurs in June. The burrowing nature of Nephrops, and variable emergence rates mean that trawl catch rates may bear little resemblance to population abundance. An underwater TV survey has been developed, estimating Nephrops population abundance form burrow density raised to stock area. A random stratified sampling design is used, on the basis of British Geological Survey sediment strata. The survey provides a total abundance estimate, and is not age or length structured.

- B.4. Commercial CPUE

Landings-per-unit-effort time-series are available from the following fleets:

- Scottish Nephrops trawl gears. Landings at age and effort data for Scottish Nephrops trawl gears are used to generate an CPUE index. Catch at age are estimated from raising length sampling of discards and landings to Officially recorded landings (Nephrops single trawl, multiple Nephrops trawl, Light trawl and multiple demersal trawl), 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 single trawl and multiple Nephrops trawl is raised to landings reported by the four gears listed above. Discard sampling commenced in 1990 for this fishery, and for years prior to this, an average of the 1990 and 1991 values is applied. There is no account taken of any technological creep in the fleet.

B.5. Other relevant data

None.

C. Historical Stock Development

This section is in the Working Group report.

D. Short-Term Projection

This section is in the Working Group report.

E. Medium-Term Projections

This section is in the Working Group report.

F. Yield and Biomass per Recruit / Long-Term Projections

This section is in the Working Group report.

G. Biological Reference Points

This section is in the Working Group report.

H. Other Issues

None.

I. References

Refer to References section in Working Group report

Annex 5: Quality Handbook: WGNSDS- Clyde Nephrops (FU13)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Clyde Nephrops (FU13)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Date:	May 2005

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 Clyde area the Nephrops stock inhabits an area of muddy sediment extending throughout the Firth of Clyde, and another smaller area in the Sound of Jura. The two areas are separated by a large area of sandy gravely sediment around the Mull of Kintyre, and are treated as separate populations since they have differing population characteristics.

A.2. The fishery

Firth of Clyde

The Firth of Clyde Nephrops fishery is predominantly exploited by a dedicated Nephrops trawler fleet of approximately 120 vessels, with less than 2-3 % of the landings made by creel vessels. The 90 resident Clyde trawlers make about 90 % of the Nephrops landings. Under the Scottish 'Inshore Fishing Order' of 1989 (Prohibition of Fishing and Fishing Methods), fishing with mobile gear is prohibited within the Firth of Clyde over weekends, and with vessels > 70 feet (about 21 m) in length.

The trawler fleet that fishes the Firth of Clyde mostly consists of vessels between 10 and 20 m in length (mean overall length 14 m), with a mean engine power of 185 kW. Almost half the fleet was built during the 1960s, with less than 20 % built after 1979. Most vessels use single otter trawls with a 70 mm mesh codend, but just under a third of Nephrops landings are taken by vessels using twin-rig trawls with an 80 mm mesh codend. Vessels employing twin-rig gear are generally slightly more powerful than the single rig vessels (mean power 214 kW compared to 176 kW).

The regular fleet is comprised of Scottish vessels, but some catches are taken by Northern Ireland and Republic of Ireland vessels. The major landing ports are Troon, Campbeltown, Girvan and Tarbert, but smaller landings are also made at Carradale, Largs and Rothsay.

The minimum landing size for Nephrops in the Clyde is 20 mm CL. Compliance with the minimum landing size is good, with samples suggesting only a very small undersized component in the landings (< 0.5 %).

Nephrops growth varies within the area, with low density animals growing to large sizes in the North, and with higher density animals reaching smaller sizes in the South. Far more Nephrops material (undersized individuals and 'heads' from tailed animals) is discarded in the

South. Discarding usually takes place at sea and landings are made by category for whole animals (small, medium and large) and as tails. In poor weather or for the last haul of the day, discarding may take place within the harbour, thus increasing discard mortality.

Only a small fish by-catch is made in the Firth of Clyde, with whiting and cod being the most important species. The composition of the by-catch and discards varies within the Firth of Clyde, with more flatfish (common and long rough dab), echinoderms and crustaceans (other than Nephrops) caught in the North, while more roundfish (particularly whiting) are caught in the South. These differences reflect the different habitats and fish communities in the area.

The fishery is exploited throughout the year, with highest landings usually made between July and September. Vessels usually have a trip duration of one day, sailing to shoot before dawn, and carrying out 3-4 hauls of 4 hours per day.

Sound of Jura

The fishery for Nephrops in the Sound of Jura constitutes part of the Clyde FU, but is examined separately from the fishery within the Firth of Clyde, because of differences in the biological parameters of the Nephrops populations.

The fleet exploiting the Sound of Jura is also different to the Firth of Clyde, with vessels tending to be slightly smaller but more powerful. In 1999, the vast majority of landings were made by 30 trawlers specifically targeting Nephrops, with a small number of creel vessels also active. Most landings are taken by Scottish vessels (which are virtually all local to the area), with a very small proportion taken by boats from the rest of the UK. The local trawler fleet consists of vessels between 9 and 16 m in length, and with a mean engine power of 185 kW.

Just over half the landings are made by twin-rig Nephrops trawlers using 80 mm meshes, with most of the remainder landed by single rig vessels using 70 mm meshes. Vessels employing twin-rig gear are generally larger and more powerful than those using single rig trawls (15 m and 220 kW compared to 13 m and 160 kW). The main landing ports are Port Askaig, West Loch Tarbert and Crinan.

The minimum landing size for Nephrops in the Sound of Jura is 20 mm CL. Nephrops are found in high densities in this stock, but only grow to relatively small sizes. Discarding takes place at sea (this can be a high proportion of the catch by number, because of the small mean size of the animals caught), and landings are made by category for whole animals (small, medium and large) and as tails.

Catches of fish in the Sound of Jura area are generally poor, and Nephrops is by far the target species, with only small by-catches of whitefish and flatfish.

The fishery is exploited throughout the year, with highest landings usually made between April and June. Vessels usually have a trip duration of one day, with 3-4 hauls per day.

For both areas the current legislation governing Nephrops trawl fisheries on the West coast of Scotland was laid down by the North Sea and West of Scotland cod recovery plan (EC 2056/2001), which established measures additional to EC 850/98. This regulation was amended in 2003 by Annex XVII of EC 2341/2002, which establishes fishing effort and additional conditions for monitoring, inspection and surveillance for the recovery of certain cod stocks. This regulation effectively limits vessels targeting Nephrops with 70-99mm mesh size to 25 days at sea per month. The use of square mesh and headline panels are compulsory in this fishery. Additional UK legislation has also been applied in the southern areas of the Firth of Clyde in recent years, aimed at protecting the aggregating cod in the south of the Clyde during February, March and April.

A.3. Ecosystem aspects

No information on the ecosystem aspects of this stock has been collated by the Working Group.

B. Data

B.1. Commercial catch

Length and sex compositions of Nephrops landed from the Firth of Clyde are estimated from port sampling in Scotland. Length data from Scottish sampling are applied to all catches and raised to total international landings. Rates of discarding by length class are estimated for Scottish fleets by on-board sampling, and extrapolated to all other fleets. The proportion of discarded to landed Nephrops changes with year, often determined by strong year classes. Discard sampling started in 1990, and for years prior to this estimates have been made based on later data. Landings and discards at length are combined (assuming a discard survival rate of 25%) to removals. The differences in catchability between sexes have lead to the two sexes being assessed separately. And hence removals are raised separately for each sex.

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 is implemented in the L2AGE programme which automatically generates 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 ensures comparability of 'age' classes across stocks.

B.2. Biological

Growth : males Linfinity = 73mm, k=0.16:

Immature Females Linfinity = 73mm k= 0.16; mature females Linfinity =62mm, k=0.06: size maturity =27mm

Mean weights-at-age for this stock are estimated from fixed Scottish weight-length relationships (Howard et al 1988 – citation required).

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

Abundance indices are available from the following research-vessel surveys:

- Underwater TV survey of the Firth of Clyde: years 1995 – present. The survey usually occurs in June. The burrowing nature of Nephrops, and variable emergence rates mean that trawl catch rates may bear little resemblance to population abundance. An underwater TV survey has been developed, estimating Nephrops population abundance form burrow density raised to stock area. A random stratified sampling design is used, on the basis of British Geological Survey sediment strata and latitude (Tuck et al 1999). The survey provides a total abundance estimate, and is not age or length structured.

- Underwater TV survey of the Sound of Jura: years 1995 – present. This survey is conducted when time allows following completion of the Firth of Clyde survey. The time series is not complete. A random stratified sampling design is used, on the basis of British Geological Survey sediment strata.

- B.4. Commercial CPUE

Landings-per-unit-effort time-series are available from the following fleets:

- Scottish Nephrops trawl gears. Landings at age and effort data for Scottish Nephrops trawl gears are used to generate an CPUE index. Catch at age are estimated from raising length sampling of discards and landings to Officially recorded landings (Nephrops single trawl, multiple Nephrops trawl, Light trawl and multiple demersal trawl), 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 single trawl and multiple Nephrops trawl is raised to landings reported by the four gears listed above. Discard sampling commenced in 1990 for this fishery, and for years prior to this, an average of the 1990 and 1991 values is applied. There is no account taken of any technological creep in the fleet.

B.5. Other relevant data

None.

C. Historical Stock Development

This section is in the Working Group report.

D. Short-Term Projection

This section is in the Working Group report.

E. Medium-Term Projections

This section is in the Working Group report.

F. Yield and Biomass per Recruit / Long-Term Projections

This section is in the Working Group report.

G. Biological Reference Points

This section is in the Working Group report.

H. Other Issues

None.

I. References

Refer to References section in Working Group report

Annex 6: Quality Handbook Annex: WGNSDS- 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 2006

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 it's 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

Over the past 19 years, landings from FU 14 have been relatively stable, fluctuating around a long-term average (1991-2004) of about 540 t. However landings in 2003 were the lowest since 1974 and in 2004 they remained some 13 % below the long-term average. Over the last 10 years UK vessels landed most of the international landings (upto 97%) although Irish vessels increased their share of the landings up to 35% in 2002. In 2004, most of the landings were made into England with a high proportion of these landings (59 % of the directed landings and 52% of the total landings) being made by visiting Northern Irish vessels. UK *Nephrops* directed effort has fluctuated around a downward trend since 1993 and in 2004 was at the lowest level in the series since 1975.

The changes to the structure and landing practices of the Northern Irish fleet (see above) will have had some impact on this data series. In recent years, fewer of the Northern Irish fleet were landing to England. The differences between LPUE figures for individual vessels suggest that earlier years may have included less truly directed effort. Recent reductions in quota between 2002 and 2004 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 directed fishery In 2003 and 2004 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 introduced as part of a revised package of EC Fisheries Technical Conservation measures in 2000 remained during 2004-2005. 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 *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 14 February to 30April 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 catches and raised to total international landings.

The lack of discard data since 1994 is likely to aversely affect the quality of 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. Two more years of catch and landings sampling has provided further catch compositions to add to the data series available for assessments.

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 is implemented in the L2AGE programme which automatically generates 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 ensures 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

There are no documented surveys of this stock.

Landings-per-unit-effort time-series are available from the following fleets:

- 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.

B.5. Other relevant data

None.

C. Historical Stock Development

This section is in the Working Group report.

D. Short-Term Projection

E. Medium-Term Projections

F. Yield and Biomass per Recruit / Long-Term Projections

This section is in the Working Group report.

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	"

Annex 7: Quality Handbook: WGNSDS- Irish Sea West Nephrops (FU15)

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Irish Sea West *Nephrops* (FU15)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Date:	May 2006

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 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 characterised 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.2. The fishery

Northern Ireland

In 1991, the Northern Ireland *Nephrops* fleet operating in the Irish Sea consisted of 230 trawlers of over 10 m length and with an engine power of 200-500 hp. The vessels used single net otter trawls of low headline height (< 1.5 m) and the same mesh size throughout. The minimum mesh size was increased to 70 mm in the mid-1980s, and for single net otter trawls is the optimum mesh size for Irish Sea *Nephrops* (BRIGGS, *et al.*, 1999).
A revised package of EC Fisheries Technical Conservation measures came into force on January 1st, 2000. This new 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 *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).

Over the seven-year period from 1992 to 1998, there have been six decommissioning rounds in Northern Ireland. These removed 56 vessels from the fleet traditionally associated with *Nephrops* fishing, leaving a fleet of 174 vessels at the end of December 1998. Further fleet reductions left 158 vessels >10 m capable of fishing for *Nephrops*, of which up to 47 work twin-trawls for part of the year.

Single trawl vessels normally do 1-2 day trips of 3-4 hour tows, while twin-trawl vessels stay at sea for 3-5 days and do tows of 4-12 hours duration.

Landings are into the three traditional Northern Ireland *Nephrops* ports of Kilkeel, Ardglass and Portavogie. Historically, *Nephrops* were landed into Northern Ireland as tails only and sold to supply the lucrative 'scampi' industry for consumption at home and abroad. The scampi industry requires a sustained supply of small *Nephrops*, which are homogenised and coated in breadcrumbs to produce the popular product. In the last 10-15 years, however, the trend has been towards landing whole large *Nephrops* for the export market. In 2001 and 2002, 35.7 % and 30.9 % of the *Nephrops* were landed whole.

Although the *Nephrops* fishery represents nearly 50 % of the combined value of all Northern Ireland sea fisheries, there is an important by-catch component for a range of species, with haddock, and cod ranking as the most important. Analysis of landings data and observations at sea (BRIGGS, unpublished) have indicated that fish by-catch is a more significant component of catches by twin-trawls than single trawls with no significant difference in *Nephrops* catch per unit effort between the two gear types. This is thought to be mainly due to differences in the species targeted by voyages.

Republic of Ireland

FU 15 contains the largest *Nephrops* fishery in the Republic of Ireland. In 2002 48 vessels reported *Nephrops* landings from this FU of these 42 reported annual landings in excess of 10 t. This *Nephrops* fleet is by far the largest fleet segment in the Irish Sea. The smaller vessels are mainly side trawlers and the larger ones stern trawlers. Engine power ranges from 110-450 kW. Most of the fleet now use twin-rigged trawls. The minimum mesh size and SMP restrictions for the Irish fleet are as described for the NI fleet above. Separator trawls were introduced in the Irish fishery in 2000 in an attempt to reduce cod by-catches. Uptake of separator trawls has increased in recent years to around 80% of vessels in 2002.

Trip duration is 1-5 days, depending on the size of the vessel. The twin-rig boats, which are on average the larger, make 3-4 tows of about 5 hours each during a 3-5 day trip. Single rigged boats, which are generally smaller, make 4-hour tows during 1-3 day trips. The main landing ports are Howth, Clogherhead, Skerries and Balbriggan.

Most of the larger boats move freely between the *Nephrops* fisheries in FUs 15, 14, 20-22 and other areas, depending on the tides and weather in the Irish Sea. Historically the fleet also switched to finfish trawling but due to the poor state of finfish stocks in the Irish Sea most vessels now concentrate on *Nephrops*. The fishery show seasonal patterns with highest catches in the summer months.

In addition to *Nephrops* measures the cod spawning areas of the Irish Sea are closed to whitefish directed vessels from 14 February to 30 April as 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 Ireland and Northern Ireland. A lack of co-operation by the Northern Ireland industry prevented sampling during 2003 and 2004. The Irish LFDs were therefore raised to the Northern Ireland and international catch for these years in the trial assessment performed by WGNSDS05.

Length data from this sampling are applied to catches and raised to total international landings.

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 is implemented in the L2AGE programme which automatically generates 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 ensures comparability of 'age' classes across stocks.

B.2. Biological

Mean weights-at-age for this stock are estimated from studies by Pope and Thomas (1955).

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

Ireland and Northern Ireland jointly carried out underwater television (UWTV) surveys on the main *Nephrops* grounds in the western Irish Sea in 2003, 2004 and 2005. These surveys were based on a randomised fixed grid design. The methods used during the survey were similar to those employed for UWTV surveys of *Nephrops* stocks around Scotland and elsewhere (See Chapter 13 of WGNSDS Report). A harvest ratio was derived from a YPR generated from an LCA performed on ROI catch sample data for 2003-2005. Catch options for $F_{0.1}$ were obtained by applying the harvest ratio to a stock biomass calculated from burrow density and a mean weight from trawl surveys for the period 2003-2005.

Northern Ireland have carried out a spring (April) and summer (August) *Nephrops* trawl surveys since 1994. These surveys provide data on catch rates and LFDs from of stations throughout in the western Irish Sea.

Landings-per-unit-effort time-series are available from the following fleets:

- Northern Ireland Nephrops trawl gears. Landings at age and effort data from this fishery from 1986 are used to generate a CPUE index. There is also a CPUE series from 1995 for a sub-set 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) although the recording of effort is not mandatory.

Combined effort for *Nephrops* trawlers is raised to landings. 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.5. Other relevant data

None.

C. Historical Stock Development

This section is in the Working Group report.

D. Short-Term Projection

E. Medium-Term Projections

F. Yield and Biomass per Recruit / Long-Term Projections

This section is in the Working Group report.

G. Biological Reference Points

H. Other Issues

I. References

Biological Input Parameters

Parameter	Value	Source
Discard Survival	0.10	ICES (1991a)
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	24	Briggs (1988)
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	"

Annex 8: Quality Handbook: WGNSDS- Northern Shelf Anglerfish

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Anglerfish (Northern Shelf – Division IIIa, Sub-area IV & Sub-area VI)
Working Group: Stocks	Assessment of Northern Shelf Demersal
Date:	17 May 2005
Last updated:	17 May 2005

A. General

A.1. Stock definition

Northern Shelf anglerfish occur in a wide range of depths, from quite shallow inshore waters down to at least 1,000 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 anglerfishes 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 behavior, anglerfish eggs and larvae are rarely caught in conventional surveys.

A recent EU-funded research project entitled 'Distribution and biology of anglerfish and megrim in the waters to the West of Scotland' (Anon, 2001) has however, improved 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 (Sub-area VII) may also be part of the same stock.

A.2. Fishery

The fishery for anglerfish in Sub-Area 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.

The Scottish fishery for anglerfish in Division VIa comprises two main fleets targeting mixed round-fish. 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 by-catch 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 round-fish 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.

There is no minimum landing size for anglerfish and discarding is known to occur at low levels in the targeted fishery for anglerfish, but also in other fisheries, for example for scallops. However, discard data are not routinely collated.

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 effected by the recent hake and cod recovery plans.

The Irish fleet otter trawl in Division VIb take anglerfish as a by-catch 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. 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.

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.

Landings of anglerfish from the North Sea show a similar trend to those in Division VIa – a rapid increase in the late 1980s followed by a decline since 1996. Around 90% of the landings are taken in the Northern North Sea and the fishery is dominated by the Scottish fleet which takes around 80% of the total landings in this area. As in Division VIa, the fishery in this region has moved into deeper more offshore areas. 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. The landings from this fishery have comprised around 6% of the total landings from Division IVa since 1999. Danish trawlers, mostly operating east of E 2°, have increased their landings from the area in recent years and were responsible for around 10% of the landings from IVa in 2001-2002. Reports from the Norwegian Coastguard indicate that this fleet increased their focus on anglerfish in succeeding years.

The trend in landings in the total North Sea is very similar to that in the Northern North Sea. This reflects the northerly distribution of the species within the North Sea (Knijn et al, 1993) and the development of a directed fishery in the Northern North Sea since about 1984.

Landings from Division IIIa are extremely low, accounting for less than 5% of the total Northern Shelf landings with Denmark and Norway responsible for the bulk of the landings. Most of the Norwegian landings are taken in the directed gillnet fishery. Until the end of the 1990s the Danish landings were taken mainly as by-catches in fisheries for shrimp (*Pandalus*), lobster (*Nephrops*) and mixed roundfish, but in recent years some Danish demersal trawlers have been targeting Anglerfish.

Since the mid-1990s, a deepwater gill net 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 4 German registered.

A.3. Ecosystem aspects

No information.

B. Data

B.1. Commercial catch

Quarterly length-frequency distribution data were available from Scotland and Ireland for Division VIa and Spain for Sub-area VI. 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.

Year Range	Formula (L – length in cm, W – weight in g)	Source
1992 - 2000	$W=0.01626L^{2.988}$	Coull et al. 1989
2001 onwards	$W=0.0232L^{2.828}$	Scottish Market Sampling

For anglerfish in the North Sea, catch-at-age composition data are available from Scotland for the years 1992 to 2000. 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. 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. Some additional length samples are available from the Danish and Norwegian fisheries since 2002.

Total international catch-at-length distribution data for the whole Northern shelf (Division IIIa, Sub-area IV and Sub-area VI) were 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. Scottish market sampling information from RockallNo market sampling information is available from landings from either Division IIIa or Rockall.

B.2. Biological

Previous assessments of this stock used the natural mortality rate applied to anglerfish in Division VI adopted by an earlier Hake Assessment Working Group of 0.15 yr^{-1}. This value is once more adopted for all ages and lengths in the absence of any direct estimates for this stock.

Traditionally, the catch-at-age analysis of anglerfish in Division VIa has used the same maturity ogive as that applied to anglerfish in Sub-areas VII and VIII by the Working Group on the Assessment of Southern Shelf Demersal Stocks. However, it has always been unknown as to whether this provided a good estimate of the maturity ogive for the VIa stock. 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 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.

B.3. Surveys

As in previous years, the recruitment index used in the assessment is obtained from the Scottish March West Coast survey. The index consists of numbers of anglerfish less than 30 cm caught per hour.

B.4. Commercial CPUE

The present assessment of the stocks does not make use of commercial catch-per-unit effort data, but does 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. The data from recent years have been excluded due to changes in the practices of effort recording for the Scottish Light Trawl in these years. Fishing effort was consistent from 1991-1995, increased in 1996 and declined in 1998. These data are not corrected for fishing power or the proportion of the fleet likely to be targeting anglerfish. Further details of the Scottish fleet effort recording problem can be found in the report of the 2000 WGNSSK (ICES, 2001).

B.5. Other relevant data

None.

C. Historical Stock Development

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

Length-based model.

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}."

H. Other Issues

None.

I. References

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Annex 9: Quality Handbook Annex: WGNSDS- CodVIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock: West of Scotland Cod (Division VIa)

Working Group: Assessment of Northern Shelf Demersal Stocks

Last updated: May 2006

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 by-catches 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 are a by-catch in *Nephrops* and anglerfish fisheries in Division VIa. These fisheries use a smaller mesh size of 80mm, but landings of cod are restricted through by-catch 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 take effect, however east of a line defined in Council Regulation No 51\2006.

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. Most of the cod catch during the closed period is normally taken in the fourth quarter. During 2000-2002 50% of the Irish catch weight of cod in VIa (61% by number) was taken in the fourth quarter. The closure is expected to have reduced the Irish fishing mortality on cod that would otherwise have occurred in 2003 to 2005. As the Greencastle codling fishery is a mixed demersal fishery, any benefits flowing from the closure are likely to extend to other demersal stocks.

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 No. 51/2006 the use of gillnets has been banned outside 200m depth. $WGFTFB_{2006}$ report that this has greatly reduced effort at depths greater than 200m in VIa. The measure was aimed to protect monkfish and deepwater shark and it is unclear what effect it will have on cod.

Technical measures:

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. 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 200m 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 maximise 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 14^{th} February to 30^{th} 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 & 99 mm except beam trawls[1];	25	22	21	127/12
Demersal trawls, seines or similar towed gears of mesh size between 16 mm & 31 mm except beam trawls.	23	20	19	128/12

[1] With mesh size between 80 mm & 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. United Kingdom vessels were granted 4 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 ≥ 100mm, 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 >=100mm if the mesh was >120mm and the net contained a square mesh panel of 140mm mesh size. A total of 148 days in the year was allowed for vessels with mesh between 100 and 120mm if the catch contained < 5% cod in 2002. This allowance rises to 160 days in the year if the same 140mm square mesh panel is used together with a mesh size > 120mm.

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 higher 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 by-catch composition limits after EC Regulation No 850/98.

Council regulation (EC) No 423\2004 sets out a multi-annual recovery plan that constrains effort to specified harvest control rules. For stocks above $\mathbf{B}_{\text{lim}}$, 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 $\mathbf{F}_{\text{pa}}$.

For stocks below $\mathbf{B}_{\text{lim}}$ the Regulation specifies that:

4. conditions 1-3 will apply when they are expected to result in an increase in SSB above $\mathbf{B}_{\text{lim}}$ in the year of application,

5. 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 $\mathbf{B}_{\mathrm{lim}}$ in the year of application.

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 > 10m	298	96	30.2%

A.3. Ecosystem aspects

Geographic location and timing of spawning

Spawning has occurred throughout much of the region in depths < 200m. However, a number of spawning concentrations can be identified from egg surveys in the 1950s, 1992 and from recent surveys of spawning adult distribution. The most commercially important of these range from the Butt of Lewis to Papa Bank. There are also important spawning areas in the Clyde and off Mull. The relative contribution of these areas is not known. Based on recent evidence there are no longer any significant spawning areas in the Minch. Peak spawning appears to be in March, based on egg surveys (Raitt, 1967). Recent sampling suggests that this is still the case.

The main concentrations of juveniles are now found in coastal waters.

Fecundity

Fecundity data are available from West (1970) and Yoneda and Wright (2004). Potential fecundity for a given length is higher than in the northern North Sea but lower than off the Scottish east coast (see Yoneda and Wright, 2004). There was no significant difference in the potential fecundity – length relationship for cod between 1970 (West, 1970) and 2002-2003 (Yoneda and Wright, 2004).

B. Data

B.1. Commercial catch

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 data bases maintained by national Government Departments and research agencies. These figures may be adjusted by national scientists to correct for known or estimated mis-reporting 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 (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. Up to 2003, 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.

The quantity, length and age of cod discarded by Scottish Nephrops trawlers is 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.

Discards from Scottish and Irish boats using several different gear types is currently 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.

AGE	1	2	3	4+
Prop mat	0.0	0.52	0.86	1.0

B.3. Surveys

Four research vessel survey series for cod in VIa were available to the Working Group in 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 1985–2006.

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 0–3, years 1993–2002.

The Irish quarter four survey was a comparatively short series, was discontinued in 2003 and has been replaced, (by the IRGFS).

- Scottish forth-quarter west coast groundfish survey (ScoGFSQ4): ages 0–8, years 1996–2005.

The Scottish quarter four survey was presented to the WG for the first time in 2005.

- Irish forth-quarter west coast groundfish survey (IRGFS); ages 0-3, years 2003-2005.

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 randomised 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.

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).

B.4. Commercial CPUE

Three commercial Scottish CPUE series have been made available in recent years. However, none have been used in the final assessment presented by the WG during any of its last seven meetings, although they 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 mis-reporting 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.

B.5. Other relevant data

None.

C. Historical Stock Development

Models used: XSA (up to 2001 WG); TSA (2002 & 2003 WG); TSA & XSA (2004 WG); SURBA (2005 WG). SURBA & TSA (2006 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	1966 – last data year	1 – 7+	Yes
Canum	Catch at age in numbers	1966 – last data year	1 – 7+	Yes
Weca	Weight at age in the commercial catch	1966 – last data year	1 – 7+	Yes
West	Weight at age of the stock at spawning time.	1968 – 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
Research Vessel Survey			
Tuning fleet 1	ScoGFS-Q1	1985- last data year	1 - 7
Tuning fleet 2	IreGFS-Q4	1993-2002	0-3
Tuning fleet 3	ScoGFS-Q4	1996-last data year	0-8
Tuning fleet 4	IRGFS – Q4	2003-last data year	0-3
Commercial CPUE data			
Tuning fleet 5	Scottish Seiners	1978-last data year	1-6
Tuning fleet 6	Scottish Light Trawlers	1978-last data year	1-6
Tuning fleet 7	Irish Otter Trawlers	1995-last data year	1-7

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

TSA parameter settings for the 2004, 2005 and 2006 analysis.

Parameter	*Setting*	*Justification*
Age of full selection.	$a_m = 4$	Based on inspection of previous XSA runs.
Multipliers on variance matrices of measurements.	$B_{\text{landings}}(a) = 2$ for ages 6, 7+ $B_{\text{survey}}(a) = 2$ for age 1, 5, 6	Allows extra measurement variability for poorly-sampled ages.
Multipliers on variances for fishing mortality estimates.	$H(1) = 4$	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 1994, age 6 in 1995 and 2002, ages 4, 5, 6 in 2001 (the latter are from a single large haul, 24 fish > 75 cm in 30 mins.)	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 2006 were:

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						

This differed from the final run performed in 2005 only in terms of the down weighting of data from 2001 and the values (but not method of determination) of catchabilities at age.

Catchabilities at age are derived by comparing raw survey indices with numbers at age estimates from a TSA run. These ratios were then standardised relative to a given reference age. The justification is that even if there are concerns over mis-reporting 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.

- 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 short-term GM (1992 onwards) 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: average stock weights for last three years. Assumed equal to the catch weight at age.
- Weight at age in the catch: Average weight of the three last years
- Exploitation pattern: Average of the three last years. Discard F's, 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 (last 10 years) geometric mean recruitment at age 1 is used

In 2006 a short term projection was 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. Consideration of the diagnostics lead to the conclusion that mean F 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 were not made at the 2005 & 2006 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. 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 3 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

REFERENCE POINT	TECHNICAL BASIS
B_{pa} = 22,000t	Previously set at 25,000t, which was considered a level at which good recruitment is probable. Since reduced to 22,000t due to an extended period of stock decline
B_{lim} = 14,000t	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 1980's

H. Other Issues

None.

I. References

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Annex 10: Quality Handbook Annex: WGNSDS- CodVIIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock: Irish Sea Cod (Division VIIa)

Working Group: Assessment of Northern Shelf Demersal Stocks

Last updated: May 2005

A. General

A.1. Stock definition

Meristic evidence for stock structure in this area is limited. Brander (1979) derived a general relationship between vertebral number and water temperature for cod from around the North Atlantic. Samples from the Irish Sea did not conform with the relationship with observed water temperatures at the time of spawning. Irish Sea cod had a lower average vertebral count than expected. Since vertebral count is influenced by water temperature during the early life stages, this led to the suggestion that there might be a significant level of immigration of cod into the region that had been spawned in warmer waters to the south.

Agnew (1988) examined length at age data from market sampling data from Northern Irish ports. Landings in the first quarter (at time of spawning) showed evidence for two distinct populations of cod with differing growth rates. This bimodality was not apparent in samples from the other quarters of the year. The maintenance of two distinct populations would however require reproductive isolation for which there is limited evidence.

Evidence for population structuring from genetic studies in this region is limited and equivocal. Glucose phosphate isomerase and lactate dehydrogenase allelle frequencies gave evidence of separate populations based on samples of larvae collected in the eastern (Solway) and western Irish Sea (Child 1988). Similar differences appeared to be present in samples collected the following year but these differences had vanished one year further on. This was interpreted as evidence for movement away from nursery grounds and population mixing of the older fish. However, haemoglobin (Hbl) allelle frequencies collected over a longer time period were for the most part similar all around the British Isles, but with a few unusual samples (Jamieson and Birley 1989). More recent research by Hutchinson et al. (2001) using microsatellite markers did not find evidence for genetic sub-structuring within the Irish Sea and between the Irish and Celtic Seas.

Results of tagging mature fish during the 1970s suggested separation between cod in the eastern and western Irish Sea. Mature fish tagged on spawning grounds in the northeast and northwest Irish Sea (and in the Bristol Channel) were recaptured from the same sites in subsequent spawning seasons but movement of fish from distinct spawning grounds to mixed feeding grounds may occur (Brander 1975).

More recent studies on cod movements in this region by tagging did not provide evidence for large-scale movements of cod between the Celtic and Irish Seas. One problem with interpreting this evidence is that the overall stock sizes in both areas have declined significantly in recent years. There may therefore have been changes in geographic range and movement patterns making comparison of recent results with earlier studies problematic.

Immature cod may disperse over a wide area as demonstrated by fish tagged and released from various parts of the Irish Sea (including Belfast Lough). These showed a substantial migration into the Celtic Sea and round the north and west of Ireland. Once these fish mature however they appear to return to the Irish Sea spawning grounds. Extensive tagging off the West of Scotland produced no recaptures from the Irish Sea. A summary of cod movements between the Irish Sea and Celtic Sea and Bristol Channel is given in Pawson (1995). Although movements in a north-south orientation seem common, very few recaptures of tagged fish that had crossed the deep-water trough separating the eastern and western Irish Sea have been made (Figure 5). A recent tagging program run from 1997-2000, in which over 2,200 cod were tagged using external and data storage tags showed that while there was some movement of cod between the Irish and Celtic Seas, the component of Irish Sea cod in the Celtic Sea was low. Furthermore, no cod tagged in the Celtic Sea were recovered from the Irish Sea (Connolly and Officer 2001).

A.2. Fishery

Irish Sea fisheries for cod have changed considerably over the last four decades: A brief description is given below.

1960s&70s. UK and Irish single otter trawlers targeted spawning cod in spring in both the western and eastern Irish Sea. Fisheries for young cod (codling) took place in autumn and winter. The growing single-rig *Nephrops* fleet took by-catches of cod. Several strong year classes of cod were formed resulting in good catches. Fleets were catching around 40-50% of the stock of adult fish each year.

1980s. Development of mid-water trawls and bottom-trawls capable of fishing on rough grounds opened up opportunities to fish in difficult areas such as the North Channel. “Dual purpose” trawls were developed to optimize catches of *Nephrops* and whitefish. The English beam-trawl fleet grew rapidly in the 1980s, taking a by-catch of cod. The percentage of the stock of adult cod caught each year increased from 50% to 60%. Throughout the 1980s, TACs remained well above scientific advice to avoid triggering of the Hague Preference agreement which would have given Irish fleets a relatively bigger fraction of the TAC.

1990s. Mid-water trawlers developed a summer and autumn fishery for cod. The English otter trawl fleet declined and was reduced to inshore vessels taking mixed demersal fish, including codling. Fishing effort of the English beam-trawl fleet peaked in 1990 and then declined. Twin-rig trawling for *Nephrops* and whitefish grew rapidly in the 1990s. This fleet also took a by-catch of cod. The Irish whitefish fleet moved increasingly to grounds off the south and west coasts, leaving mainly a *Nephrops* fleet and a number of vessels fishing rays, cod and haddock in the Irish Sea. A major change in the 1990s was the growth of the haddock stock. Vessels that would have fished for cod also targeted haddock in the western Irish Sea, although still taking a by-catch of cod in certain areas and time periods.

*2000 onwards***.** Emergency measures were introduced in 2000 to allow the maximum number of cod to spawn. These measures included a closure of the western and eastern Irish Sea spawning grounds from mid February to the end of April, and modifications to trawl gear to improve selectivity. The closure was retained in 2001 - 2005, but only in the western Irish Sea. Derogations were allowed for *Nephrops* fishing in the closure, and experimental fisheries for haddock, flatfish and rays were permitted in some years with observers. Irish scientists successfully tested inclined separator panels in *Nephrops* trawlers, showing large reductions in by-catch of cod. Vessels using such panels have been allowed to fish over a wider area of the closure since 2002. Vessels displaced from the closed area either switched to twin-rigging for *Nephrops*, fished for cod in the North Channel and Clyde, or tied up. From 2001, the Clyde fishing grounds were also closed in spring as part of emergency measures to protect west-of-Scotland cod. TACs for Irish Sea cod from 2000 onwards were reduced substantially.

Technical measures. Vessels operating with 70mm and 80mm 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.

New technical regulations for EU waters came into force on 1 January 2000 (Council Regulation (EC) 850/98 and its amendments). The regulation prescribes the minimum target species' composition for different mesh size ranges. Since 2001, cod in Division VIIa have been a legitimate target species for towed gears with a minimum codend mesh size of 100 mm. The minimum landing size for cod in the Irish Sea is 35 cm.

Emergency measures. Due to the depleted state of the stock and following the advice from ICES, a recovery plan for cod in the Irish Sea was introduced in 2000. Commission regulation (EC) 304/2000 established emergency closed areas to fishing for cod between 14 February and 30 April in the western and eastern Irish Sea to protect spawning adults at spawning time. Council regulation (EC) 2549/2000, which came into force on 1 January 2001, established additional technical measures for the protection of juveniles. The closed area and additional technical regulations were extended to 2001 in Council Regulation (EC) 300/2001 and to 2002 in Council Regulation (EC) 254.2002. The main difference in the recovery measures for 2002, 2003 and 2004 from those of 2001 is that a closed area remained only in the western Irish Sea. Derogations have existed for fleets targeting *Nephrops* in all years.

Decommissioning schemes. There has been some decommissioning of UK vessels in the Irish Sea, most recently at the start of 2002 and during 2003. Whilst few new Irish vessels have joined the fishery, some vessels from County Donegal have reported catches in VIIa. These vessels have been attracted into the Celtic Sea fishery in recent years in response to poor catches in other areas.

A.3. Ecosystem aspects

Geographic location and timing of spawning

Several studies have produced maps of the spawning location for cod in the Irish Sea (Nichols *et al.* 1993; Fox *et al.* 1997; Fox *et al.* 2000; Armstrong 2002). However, these have been based on the assumption that the majority of eggs between 1.25 and 1.75 mm diameter and not possessing oil globules were those of cod. Eggs of other species, particularly haddock overlap this size range and have a similar appearance (Figure 7). Maps for the occurrence of late stage cod eggs and cod larvae broadly match the assumed spawning locations. Currently, biochemical based methods for identifying gadoid eggs are being developed and applied to ichthyoplankton surveys in this region (Mork *et al.* 1983; Armstrong 2002; Taylor *et al.* 2002). DNA probes have recently been developed and applied to eggs collected in the Irish Sea in 2003 (Fox et al. 2005). This indicated that eggs towards the lower end of the 1.25-1.75mm size range do include those of other species including whiting.

Based on the above, and Brander (1975), spawning is concentrated in the western Irish Sea close to the coast (between Carlingford Lough and Dublin) but also occurs in the eastern Irish Sea over a wider area. Estimation of the relative importance of the eastern and western spawning components has previously been hindered by the inability to unambiguously identify cod, haddock and whiting eggs.

Spawning begins in late January and is largely completed by end of May (Nichols *et al.* 1993; Fox *et al.* 1997; Fox *et al.* 2000). According to Brander (1994), the peak of spawning probably occurs in early March in the western Irish Sea and late March in the northeast. Similarly based on more extensive surveys undertaken in 1995, the peak of spawning occurred at the end of March – early April (Fox *et al.* 2000). There is relatively little information regarding inter-annual variability in the timing of spawning as egg surveys have not been conducted on a regular basis in this region.

B. Data

B.1. Commercial catch

B1.1. Landings

The following table gives the source of landings data for Irish Sea 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	X	X	X	X
UK(E&W)	X	X	X		X
UK(Scotland)	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 data bases maintained by national Government Departments and research agencies. These figures may be adjusted by national scientists to correct for known or estimated mis-reporting 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.

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\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. Up to 2003, estimates of discards are available only from limited observer schemes and a self-sampling scheme. Observer data are collected using standard at-sea sampling schemes. Results are reported to ICES.

The quantity of cod discarded from the UK (NI) *Nephrops* fishery from 1996 to 2002 was estimated on a quarterly basis from samples of discards and total catch provided by skippers. The discards samples contain the heads of *Nephrops* tailed at sea. Using a length-weight relationship, the live weight of *Nephrops* that would have been landed as tails only is calculated from the carapace lengths of the discarded heads. The number of cod in the discard samples is summed over all samples in a quarter and expressed as a ratio of the summed live weight of *Nephrops* in the discard samples (i.e those represented as heads only in the samples). The reported live weight of *Nephrops* landed as tails only is then used to estimate the quantity of cod discarded using the cod:*Nephrops* ratio in the discard samples. The length frequency of cod in the discard samples is then raised to the fleet estimate. Age data have not been collected, however the discards are mainly of small cod that can be allocated to ages 0 and 1 based directly on their length. Roughly 40 discard samples are collected annually.

Discards from Irish and UK(E&W) trawlers is currently 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, and was estimated from UK(NI) trawl surveys in March 1992 – 1996.

AGE	1	2	3+
Prop mat	0.0	0.38	1.00

B.3. Surveys

Eight research vessel survey series for cod 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 (UKE&W-BTS): ages 0 and 1, years 1988–2004.

  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 in the eastern Irish Sea, and without accounting for stratification except for ALKs. Numbers of 0-gp and 1-gp cod at age per 100km towed are provided for prime stations only (i.e. those fished in most surveys).

- UK (Northern Ireland) October Groundfish Survey (NIGFS-October): ages 0–3, years 1992–2004.

  The survey series commenced in its present form in 1992. It comprises 45 3-mile tows at fixed station positions in the northern Irish Sea, with an additional 12 1-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. Virtually all cod are aged apart from 0-gp and 1-gp fish when particularly abundant. An ALK for the whole survey is used for filling in for any length groups with no ages at a station. Mean numbers at age 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 cod are described in detail in Armstrong *et al* (2003). From 2002 onwards, all stations in the survey have been reduced to 1 n.mile. A number of comparative 1-mile and 3-mile tows are done during each survey to build up calibration data.

- UK (Northern Ireland) March Groundfish Survey (NIGFS-March): ages 1–5, years 1992–2005.

General description as for NIGFS-October above, except that 3-mile stations have been retained in all strata other than in the St Georges Channel. Since 2005, the RV Lough Foyle used for all surveys since 1992 has been replaced by the larger RV Corystes. The trawl gear and towing practices have remained the same.

- UK (Northern Ireland) Methot-Isaacs Kidd Survey (UKNI-MIK): age 0, years 1993–2004.

  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 ground gear and a 20mm cod-end 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 1996-2005.

  This survey represents an extension of the Scottish West Coast groundfish survey (Area VI), using the research vessel *Scotia*. The survey gear is a GOV trawl, and the design is two fixed-position stations per ICES rectangle from 1997 onwards (17 stations) and one station per rectangle in 1996 (9 stations). The survey extends from the Northern limit of the Irish Sea to around 53^o 30'.

- UK (Scotland) groundfish survey in Autumn (ScoGFS – autumn): ages 0-5, years 1997-2004

  The survey covers a similar area to the ScoGFS in Spring, but has only 11-12 stations.

- Irish groundfish survey (IR GFS - autumn). Ages 0 – 5, years 2003-2004

  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 randomised stations. There were 34 stations in 2003 and 39 in 2004.

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.

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 data series were available to the WG: But have not been used in the assessment for several years.

- Irish otter trawl (IR-OTB): ages 1–6, years 1995–2004.

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 cod stock in the Irish Sea. Hence the catch rates will represent changes in abundance of cod in the western part of VIIa. The use of this fleet as a tuning index would therefore rely on the assumption that trends in abundance in the west of VIIa reflect those of the entire stock. The otter trawl catch-at-age data contained data for landings only.

- UK (Northern Ireland) pelagic trawl: ages 2–6, years 1993–2001.

The pelagic trawl catch-at-age data contained data for landings only. This fleet currently targets haddock and cod in the deeper waters of the western Irish Sea and the North Channel. The fleet is considered unsuitable for indexing cod abundance. A recent survey series of the western Irish Sea using a pelagic trawler from Northern Ireland has commenced as part of the UK Fisheries Science Partnership.

- UK (Northern Ireland) single rig otter trawl: ages 0–6, years 1993–2001.

This fleet operates mainly in the western Irish Sea. The distribution of fishing does not encompass the entire range of the cod stock (which surveys suggest is distributed across the Irish Sea).

- UK (England and Wales) otter trawl: ages 2–6, years 1981–2004.

Estimates up to and including 2004 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 group 1 which may be discarded. This fleet operates mainly in the eastern Irish Sea. The distribution of fishing does not encompass the entire range of the cod stock.

B.5. Other relevant data

None.

C. Historical Stock Development

Models used: XSA (up to 2003 WG); TSA (2004 WG); SURBA (2005 WG).

Software used: Lowestoft VPA suite; Marine Lab Aberdeen TSA and SURBA software.

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 2 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	1968 – last data year	0 – 7+	Yes
Canum	Catch at age in numbers	1968 – last data year	0 – 7+	Yes
Weca	Weight at age in the commercial catch	1968 – last data year	0 – 7+	Yes
West	Weight at age of the stock at spawning time.	1968 – last data year	0 – 7+	Yes:
Mprop	Proportion of natural mortality before spawning	1968 – last data year	0 – 7+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1968 – last data year	0 – 7+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1968 – last data year	0 – 7+	No – the same ogive for all years
Natmor	Natural mortality	1968 – last data year	0 – 7+	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
Tunin fleet 5	NI MIK net		

For analysis of alternative procedures see WG reports from WGNSDS 1997-2003.

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

E. Medium-Term Projections

Medium term projections have been carried out in previous years using the Aberdeen software suite.

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 3 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

Precautionary approach reference points have remained unchanged since 1999.

B_{pa} = 10,000t ; B_{lim} = 6,000t. F_{pa} = 0.72; F_{lim} = 1.0.

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 Assessement of Northern Shelf Demersal Stocks. 33pp.

Annex 11: Quality Handbook Annex: WGNSDS- Irish Sea Plaice

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Plaice (division VIIa)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Date:	4th May 2004
Last updated:	13th May 2004

A. General

A.1 Stock definition

The degree of separation between the stocks of plaice in the Irish Sea and the Celtic Sea is currently unclear. Numerous tagging studies indicate a southerly movement of mature fish from the south east Irish Sea into the Bristol Channel during the spawning season. Whilst some of these fish remain in this area the majority return to summer feeding grounds in the Irish Sea (Dunn and Pawson ,2002). Mixing is also considered to occur between the Celtic Sea and Eastern Channel stocks and time series of recruitment estimates for all three stocks show very similar patterns.

The majority of movements by plaice in the Irish Sea is considered to be in the north-south direction and the level of mixing between the east and west components of the Irish Sea stock is believed to be small. (Dunn and Pawson, 2002). Length at age measurements from research surveys aswell 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 ?; Sideek 1989) and should therefore be considered independently of one another. Morphometric differences have been observed between the east and west components of the stock; a comment in the 1982 WG report states that plaice to the west of the 5°W line are approximately 3cm larger at age (for the most abundant age groups) than those to the east of this line. This however, contradicts the findings of the September beam trawl survey for which plaice caught off the Irish coast are found to be smaller at age than those caught in the eastern Irish Sea.

Recent examination of survey results which contrasted recruitment indices from the east with those from the west showed good levels of correspondence of year class strengths between the two sub-stocks. This would indicate either that the two sub-stocks are subject to similar large-scale environmental forces and respond to similarly to them, or alternatively that they represent two sub-populations of a single stock which share a common spawning.

There are considered to be three principle spawning areas of plaice in the Irish Sea. One off the Irish coast, another between the Isle of Man and the Cumbrian coast and the third off the north Wales coast (Nichols et al 1993; Fox et al 1997). Cardigan Bay has also been identified as a spawning ground for plaice in the Irish Sea (Simpson 1959).

A.2 Fishery

The status and activities of the fishing fleets operating in ICES sub division VIIa are described by Pawson et al (2002) and also by Anon (2002). The majority of vessels operating in the Irish Sea are otter trawlers fishing for cod, haddock, whiting and plaice with by-catches of angler-fish, hake and sole. Since 2001 these trawlers have adopted mesh sizes of 100-120mm and other gear modifications depending on the requirements of recent EU technical conservation regulations and national legislation. Square mesh panels have been mandatory for UK otter trawlers since 1993 and for Irish trawlers since 1994. The number of Irish vessels operating in this area has declined in recent years. Fishing effort in the England and Wales fleet declined rapidly after 1989 and over 1992-1995 was about 40% of the levels reported in the late 1980's.

Although some of the otter trawlers also take part in the fishery for sole, there has been a growing number of beam trawlers, particularly from southern England and Belgium exploiting this stock. This fishery has important by-catches 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 compared with other areas in which the fleet operates.

A fleet of vessels primarily from Ireland and Northern Ireland take part in a targeted nephrops fishery using 70mm mesh nets with 75mm square mesh panels. This fishery takes a substantial by-catch 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 gill nets and tangle nets, 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 19?? To 27cm (Council Regulation (EEC) No ?).

Since 2000 a recovery program 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 north-west 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

B. Data

B.1 Commercial Catch

Landings

International catch at age data based on quarterly market sampling and annual landings figures are available from 1964. Throughout the period 1978 to 2003 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 1978 to 2003.

Up until 1982 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. From 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.

Discards

In 1986 the UK fleet was restricted to a 10% by-catch 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 CPUE values for 1985/86 with those for 1984/85. 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 by-catch 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 is not routinely incorporated into the assessment. A sufficient time series of discard information is not currently available though studies were conducted in 1993/94 and since

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 data set (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 1983weights 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 1990 catch weights were smoothed by eye, from 1991 onwards a smooth curve was fitted using a numerical minimisation routine. Stock weights were derived from the smoothed international catch weights at age curve with values representing 1 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". (*This procedure remains a little opaque*). The same procedure was adopted in 1996 (when stock weights in 1982 and 1983 were also revised so as to be consistent with this methodology) and 1997. In 1988 however, the *Silver Star* survey was discontinued and stock weights at ages 1 to 3 were calculated as means of the 3 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.

Catch weights at the younger ages also show a similar increase coincident with the start of the smoothing process. This apparent increase in the estimated catch weights is not believed to have affected the derivation of catch numbers since smoothing of the catch weights occurs after having determined the catch numbers at age. SOP checks are generally very close to 100%.

The 1982 WG report notes a study by R.Cross (unpublished) stating that there was no evidence for a change in growth rates for the stock nor was there any evidence of density dependent effects on growth.

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.

AGE	1978-82		1983-92	1992-03
	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

B.4 Commercial CPUE

B.5 Other relevant data

C. Historical stock development

The stock of plaice in the Irish Sea has been assessed by ICES since 1977 and has been managed by TAC since 19??.

Commercial Tuning Data
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 standardised international index. The UK(E&W) trawl series was revised in 1986 (not known how) 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 re-calculated using otter trawl age compositions only rather than combined fleet age compositions as previously.

Two newly 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). Whilst 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 under-estimation of vessel effects.

Survey Tuning Indices

In 1993 the UK(E&W) beam trawl survey series which 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. The series was therefore 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.

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 south-east Ireland between Dundalk Bay and Carnsore Point and there was some concern that this localised 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.

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. The XSA settings for each of the assessments since 1992 are detailed in table C1.

Trial runs have, over the years, explored many of the options with regards XSA settings.

- 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.

D. Short term projection

Software: Multi Fleet Deterministic Projection (MFDP)

Age based short term projections are conducted for a 3 year period using initial stock numbers derived from XSA analyses. Numbers at age 1 are considered poorly estimated and are generally overwritten using a geometric mean of past recruitment values. Recent recruitments 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 1989 - present) is used.

The exploitation pattern is typically an un-scaled 3 year arithmetic mean, though alternative options may be used depending on recent F trajectories and the working groups perception of the fishery.

Catch and stock weights at age are generally taken as the mean of the last 3 years. Maturity ogive and natural mortality estimates are those used in the assessment method.

E. Medium term projections

Software: MLA miscellany

Input values to the medium term forecast are the same as those used in the short term forecast. Any stock recruit relationship is poorly defined and whilst a Beverton Holt SRR has been assumed in earlier years, a simple geometric mean may now be considered more appropriate, though it remains unclear whether the full time series or a reduced time series from 1989 should be used.

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.

G. Biological reference points

Biological reference points were proposed for this stock 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}	3,800 t	(on the basis of Bloss and evidence of high recruitments at low SSBs

H. Other Issues

None

I. References

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Sideek (1981) The estimation of natural mortality in Irish Sea plaice (*Pleuronectes platessa* L.) using tagging methods 206pp

Simpson (1959) The spawning of the plaice (*Pleuronectes platessa* L.) in the Irish Sea Fishery Investigations Series II **22** 8 30pp

Table B.1 Data sources and derivation of international landings. % sampled indicates the percentage of the total landings represented by sampling.

YEAR		SOURCE					
of WG	*Data*	*UK*	*Belgium*	*Ireland*	*Netherland*	Derivation of international landings	*% 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
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.	

[1] Assumed – (not explicitly stated in report)

	1991	***1992***	***1993***	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***	***2001***	***2002***	***2003***
Assmnt 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+
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
Assmnt Method	L.S.	L.S.	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA	XSA
Tuning Fleets													
UK trawl yrs ages	81-90 1-8	82-91 1-8	76-92 1-8	76-93 1-8	76-94 1-8								
UK otter yrs ages						86-95 2-8	87-96 2-8	88-97 2-8	89-98 2-8	90-99 2-8	91-00 2-8	87-01 2-8	87-02 2-8
UK beam yrs ages									89-98 2-8	90-99 2-8	91-00 2-8	89-01 2-8	89-02 2-8
Bel Beam yrs ages					85-94 2-8	86-95 3-8	87-96 3-8	88-97 3-8					
IR otter yrs ages												95-01 2-8	95-02 2-8
UKBTS Sept yrs ages			88-92 1-4	88-93 1-4	88-94 1-4	88-95 1-4	89-96 1-4	89-97 1-4	89-98 1-4	90-99 1-4	91-00 1-4	89-01 1-4	89-02 1-4
UKBTS Mar yrs ages								93-97 1-4	93-98 1-4	93-99 1-4	93-99 1-4	93-99 1-4	93-99 1-4
IR-JPS yr agess												91-01 1-6	91-02 1-6
Time taper			20yr tri	20yr tri	20yr tri	No	No	No	No	No	No	No	No
Power model ages			1	0	1	1	1	1	1	0	0	0	0
P shrinkage			True	False	True	True	True	True	True	False	False	False	False
Q plateau age			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
Num yrs			5	5	5	5	5	5	5	5	5	5	5
Num ages			5	5	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

Annex 12: Quality Handbook Annex: WGNSDS- Sole VIIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Irish Sea Sole (Division VIIa)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Last updated:	22 May 2003

A. General

A.1. Stock definition

Sole occur throughout the Irish Sea, but are found more abundant in depth less than 60m.

A.2. The Fishery

There are three main countries fishing for sole in the Irish Sea; Belgium, taking the bulk of the landings (50-75%), and the UK and Ireland, also taking considerable amounts. The Netherlands and France take the remainder. Approximately 25 Belgian beam trawlers are operating in the Irish Sea, targeting sole. The UK trawl fleet operates predominantly in the eastern side of the Irish Sea in Liverpool Bay and Morecambe Bay. Sole catches from Ireland are mainly coming from bycatches in the *Nephrops* fishery (operation in the North West of the Irish Sea).

When fishing in VIIa it is prohibited to use any beam trawl of mesh size range 70-79 mm or 80-90 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 70mm mesh with square mesh panels or more commonly an 80mm mesh. Similarly the Belgian and UK(E&W) beam trawls use 80mm mesh gear. Otter trawlers targeting roundfish have, since 2000, used 100mm mesh gear.

It was concluded at the 2000 working group and confirmed in 2001 that the cod recovery measures first enacted 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.

Discard estimates are estimated to be minor. Preliminary data indicating ranges from 0 to 2 % by weight discarded.

No data are available on the extent of misreporting of landings from this stock. However, the quota in 2003 became restrictive.

A.3. Ecosystem aspects

No information

B. Data

B.1. Commercial catch.

Quarterly age compositions for 2002 were available from UK (E&W), Belgium and Ireland, as well as quarterly landings from France and Northern Ireland. The quarterly UK (E & W) age compositions were raised to total UK landings. A total international age composition was obtained by combining the quarterly age compositions from Belgium, the UK, and Ireland, and raising them to the total international landings.

B.2. Biological

Currently there are no direct (from tagging) or independent (from survey information) estimates of natural mortality. Therefore, as in previous years, annual natural mortality (M) was 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 much reduced rates of growth after reaching maturity, whilst females continue to grow. Given the minimum landing size of 24cm the majority of landings represent mature females.

B.3. Surveys

Two UK(E&W) beam trawl surveys were available to the working group.

Area covered

Irish Sea; 52^0 N to 55^0 N; 3^0 W to 6^0 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

1988-2002: September (continuing).
1993-1999: March.

Gear used

Commercially-rigged 4m steel beam trawl; chain matrix; 40mm cod-end 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. *Corystes* (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 80% of the weighting to the total estimates of the incoming years classes.

B.4. Commercial catch-effort data

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) (Table 12.2.1 and Figure 12.2.1).
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.

Effort from both commercial beam trawl fleets increased from the early seventies until the late eighties. Since then UK beam trawl effort has declined to a minimum in 2000, and has remained at this level up till now. In the nineties, the Belgian beam trawl effort fluctuated around a lower level than the late eighties. Since 2000 the effort has increased substantially with 64% and 27% respectively each year, despite which CPUE has remained stable in this and other fleets.

Indices of abundance derived from the UK September survey (data from 1988 onwards) are shown in Table 12.2.2. High abundance indices for the UK September survey can be seen for year classes 1989, 1995 and 1996. The data series from the UK March beam trawl survey is rather short (from 1993 to 1999), and therefore difficult to interpret.

There has been no March beam trawl survey since 1999. The tuning data available for this assessment comprise the beam trawl survey UK beam trawl survey, September and March cruise series, UK(E&W) beam trawl fleet (UK(E&W)BTF), UK(E&W) otter trawl fleet (UK(E&W)OTF), the Irish juvenile plaice survey (IR-JPS), the Irish Sea Celtic Sea ground fish survey (ISCS-GFS), and Irish otter trawl fleet (IR-OTF). Standardized CPUE for the above fleets are shown in table 11.2.1. Details of surveys and commercial fleet tuning data are given in Appendices 1 and 2 of the 1998 report (ICES CM 1998 : Assess1).

Similarly the Irish otter trawl fleet mainly targets nephrops, however, vessels from this fleet do on occasion move into areas where plaice are abundant. Landings of plaice by this fleet have been approximately 15% of the total international landings and the working group considered that this fleet may provide a reliable index of abundance for plaice.

B.5. Tuning data evaluation

A thorough investigation of the utility of the different tuning indecies available for this stock was conducted by the 2002 working group the reusts of which are summarized below:

Following an initial consideration of the appropriateness of each tuning fleet and its anticipated utility as an index of abundance, the tuning data from both commercial fleets and research surveys were evaluated externally to the assessment program to test for internal and external consistency. These tests comprised plots of the effort corrected - mean standardised indices for each age; tests for cross correlation of ages between fleets and of ages within fleets and the results of single fleet SurBA (WD1) runs.

The working group considered that the Irish ground fish survey would not be appropriate for use in the assessment as it is designed principally for gadoids and would not be expected to provide a reliable index for flatfish stocks. Similarly the Irish otter trawl fleet mainly targets nephrops, however, vessels from this fleet do on occasion move into areas where plaice are abundant. Landings of plaice by this fleet are approximately 15% of the total international landings and the working group considered that this fleet may provide a reliable index of abundance for plaice. For the period 1976 to 1990 the juvenile plaice survey had used a combined ALK. Serious concerns were expressed regarding the quality of the data for this period and it was decided that this series should be truncated to 1991.

The juvenile plaice survey stations are located along the coast of south east Ireland between Dundalk Bay and Carnsore Point and there was some concern that this localised survey series would not be representative of the plaice population over the whole of the Irish Sea. Plots of the effort corrected - mean standardised indices for the juvenile plaice survey and the September beam trawl survey by age showed some correspondance between the two series. It should be noted that recruitment over the past 13 years has been remarkably stable and there is very little contrast in year-class strengths for the period covered by the tuning fleets making cross comparisons difficult. The 1991 year-class is clearly identified by the juvenile plaice survey at ages 1,2,4,5,and 6, suggesting good internal consistency for this fleet. This year-class is also apparent, though to a lesser extent, in the September beam trawl survey series. It was therefore decided that the juvenile plaice survey could be used as an appropriate index for the plaice population in the whole of the Irish Sea

A test for cross correlation between fleets (following a test for auto-correlation) showed significant results for the UK(E&W) beam trawl fleet and the UK(E&W) otter trawl fleet at ages 1 to 4; for the juvenile plaice survey and the UK(E&W) otter trawl fleet at age 6 and for the juvenile plaice survey and the September beam trawl survey at age 5, indicating a consistent signal between these fleets at these ages. The lack of contrast in year-class strengths, mentioned above, and the short time series of some fleets meant that it was difficult to identify consistent signals between fleets and resulted in very few significant tests for cross-correlation.

SurBA runs for the September beam trawl survey, the UK(E&W) beam trawl fleet and the UK(E&W) otter trawl fleet showed fairly consistent results in terms of predicted SSB and mean F. Results for the juvenile plaice survey showed a much noisier pattern but were considered to conform sufficiently to the general trend. Although SurBA has been developed specifically for use with survey data, runs for the two commercial series were considered to be acceptable as the residual patterns over time did not show any apparent trends. This was not the case for the Irish otter trawl fleet and the results of SurBA runs for this fleet were not considered further.

Whilst it was difficult to derive any firm conclusions from individual tests, it was concluded from the overall body of evidence that in addition to the four fleets used last year, the juvenile plaice survey and the Irish otter trawl fleet should be considered as appropriate abundance indices for tuning the assessment.

C. Historical Stock Development

Model used: XSA

Software used: IFAP / Lowestoft VPA suite

Model Options chosen:
No time weighting applied
Catchability independent of stock size for all ages
Catchability independent of age for ages >= 5
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 estimate are shrunk = 1.5
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	1964 – last data year	2 – 9+	Yes
Canum	Catch at age in numbers	1964 – last data year	2 – 9++	Yes
Weca	Weight at age in the commercial catch	1964 – last data year	2 – 9+	Yes/No - constant at age from 1960 - 1979
West	Weight at age of the spawning stock at spawning time.	1964 – last data year	2 – 9+	Yes - but based on back caluclated catch weights
Mprop	Proportion of natural mortality before spawning	1964 – last data year	2 – 9+	No – set to 0 for all ages in all years
Fprop	Proportion of fishing mortality before spawning	1964 – last data year	2 – 9+	No – set to 0 for all ages in all years
Matprop	Proportion mature at age	1964 – last data year	2 – 9+	No – the same ogive for all years
Natmor	Natural mortality	1964 – last data year	2 – 9+	No – set to 0.2 for all ages in all years

Tuning data:

Type	Name	Year range	Age range
Tuning fleet 1	UK beam trawl survey (September)	1989 – last data year	1 – 4
Tuning fleet 2	UK beam trawl survey (March)	1993 – 1999	1 – 4
Tuning fleet 3	Irish Juvenile Plaice Survey	1991 – last data year	1 – 6
Tuning fleet 4	UK(E&W) beam trawl fleet	1989 – last data year	2 – 8
Tuning fleet 5	UK(E&W) otter trawl fleet	1987 – last data year	2 – 8
Tuning fleet 6	Irish otter trawl fleet	1995 – last data year	2 – 8

For analysis of alternative procedures see WG reports from AFWG 1997-2002.

D. Short-Term Projection

Model used: Age structured
Software used: IFAP prediction with management option table and yield per recruit routines
Initial stock size. Taken from the XSA for age 5 and older. The recruitment at age 2 and 3 in the last data year is estimated using RCT3 and the corresponding numbers at age 3 and 4 in the start year of the projection is calculated applying a natural mortality of 0.2 and fishing mortality according to the catches taken of these age groups. The long-term geometric mean recruitment is used for age 2 in all projection 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: 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: TAC constraint

Stock recruitment model used: None, the long term geometric mean recruitment at age 2 is used

Procedures used for splitting projected catches: Not relevant

E. Medium-Term Projections

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. Yield and Biomass per Recruit / Long-Term Projections
Not done

G. Biological Reference Points

Precautionary approach reference points have remained unchanged since 1999. B_{pa} is set at 3,100t and is based on an lowest observed SSB (ACFM 1999). There is not considered to be clear evidence of reduced recruitment at the lowest observed SSBs. F_{pa} is set at 0.45 on the technical basis of high probabilities of avoiding F_{lim} and of SSB remaining above $B_{pa.}$

Annex 13: Quality Handbook Annex: WGNSDS- WhitingVIIa

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 2006
Updates:	Inclusion of 2005 Discard Data form IR-OTB

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 is 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 pre-recruits 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 pre-recruits of whiting, as shown by the results of frame-trawl surveys of pelagic pre-recruits 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 20-40cm, averaging around 30cm. 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 characterised by catches of immature and first-maturing whiting, whilst the eastern Irish Sea has a broader age-range of whiting. This pattern persists to the present day.

- The evidence for 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. 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 pair trawlers 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 70mm and 80mm 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 by-catch 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 effected 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 decommissioning of vessels in the Irish Sea, most recently at the start of 2002. 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. Whilst 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.

A.3. Ecosystem aspects

Recruitment in Irish Sea whiting appears less variable than in cod and haddock, although there is some similarity in the timing of strong and weak year classes that may indicate a similar response to changes in environmental conditions affecting spawning or early-stage survival. The diet of Irish Sea whiting has been examined in some detail since the 1970s using samples collected from research vessels. Cannibalism occurs in adult whiting, however the effect of this on the assessment of the stock has not yet been investigated. Young whiting are common in the diets of larger predators such as cod and anglerfish.

B. Data

B.1. Commercial catch

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 mis-reporting 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 sub-set 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 the ICES files. Discard rates in this series were variable compared with previous estimates based on the UK NI self sampling scheme. Given the differences in raising procedure applied to the NI Discard estimates and the Irish discard estimates further examination of the discard data is needed before international estimates of discard numbers at age can be made. The Working Group did therefore not estimate international discard volumes and numbers at age 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 research on gadoid maturity conducted by the UK (NI) gives no evidence for substantial change in whiting maturity since the 1950s, although there has been an increase in the incidence of precocious maturity at age 1, particularly in males, since 1998.

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:

$$(CW_{i,j} + CW_{i+1,j+1})/2 = SW \text{ at start of year.}$$

These values are then smoothed using a 3-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 13.65cm and 19.76cm, respectively. Maturity-at-age for both sexes are similar for most stock area (VIIa, b, j and g) with the notable exception of age 1 males in the Celtic Sea where the estimates are outside the 95% CI bounds for VIIa and considerably lower than VIa. In most areas whiting were mature by age three and most were mature at age 2. The sex ratio for whiting tended to increase with length for nearly all the age classes in all areas indicating that females tend to have larger length at age than males (Gerritsen 2005).

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 (UKE&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 3-mile tows at fixed station positions in the northern Irish Sea, with an additional 12 1-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 3-mile tow are calculated separately by stratum, and weighted by surface area of the strata to give a weighted mean for the survey or group of strata. The strata are grouped into western Irish Sea and eastern Irish Sea, and a separate age length key is derived for each area to calculate abundance indices by age class. The survey design and time series of results including distribution patterns of whiting are described in detail in Armstrong *et al* (2003).

- UK (Northern Ireland) March Groundfish Survey (NIGFS-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 ground gear and a 20mm cod-end 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 (9 stations). The survey extends from the Northern limit of the Irish Sea to around 53^{o} 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 20mm mesh liner on the cod end. The survey covers VIIa, b, j g and VIa in its entirety. Prototcols 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.

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 data series 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 data set 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. By-catches 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

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 5 years or the 2 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 3 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 7,000t and is defined as B_{lim}*1.4. B_{lim} is defined as the lowest observed SSB (ACFM 1999), considered to be 5,000t. 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 Assessement 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 oulined in Borges et al (2005)

	1996		1997		1998		1999		2000		2001		2002		2003		2004		2005	
	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight	Numbers	Weight
Age	('000)	(kg)	('000)	(kg)	('000)	(kg)	('000)	(kg)	('000)	(kg)	('000)	(kg)	('000)	(kg)	('000)	(kg)	('000)	(kg)	('000)	(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

Annex 14: Quality Handbook Annex: WGNSDS- Haddock VIIa

Stock specific documentation of standard assessment procedures used by ICES.

Stock:	Irish Sea Haddock (Division VIIa)
Working Group:	Assessment of Northern Shelf Demersal Stocks
Last updated:	19 May 2005

A. General

A.1. Stock definition

Haddock in Division VIIa …

A.2. Fishery

Directed fishing for haddock in the Irish Sea is mainly carried out by UK(Northern Ireland) midwater trawlers using 100mm mesh cod-ends, 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 100mm 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 80mm cod-ends.) By-catches of haddock are made in the UK(NI) and Irish *Nephrops* fisheries using single nets with 70mm cod-ends or twin trawls with 80mm cod-ends. 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 minimise the by-catch 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 mid-water 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 1995-97, 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: 10 days for demersal trawls, seines and similar towed gears with mesh size >= 100mm, 14 days for beam trawls of mesh size >= 80mm and static demersal nets, 17 days for demersal longlines, and 22 days for demersal trawls, seines and similar towed gears with mesh size 70-99mm. 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 >= 100mm) and beam trawlers (mesh >=80mm) 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

To do

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 data bases maintained by national Government Departments and research agencies. These figures may be adjusted by national scientists to correct for known or estimated mis-reporting 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.

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 *Nephrops* fishery. The fisher self-sampling scheme that provides discards data for VIIa whiting was altered in 1996 to record quantities of other species in the samples. The quantity of haddock discarded from the UK (NI) *Nephrops* fishery is estimated on a quarterly basis from samples of discards and total catch provided by skippers. The discards samples contain the heads of *Nephrops* tailed at sea. Using a length-weight relationship, the live weight of *Nephrops* that would have been landed as tails only is calculated from the carapace lengths of the discarded heads. The number of haddock in the discard samples is summed over all samples in a quarter and expressed as a ratio of the summed live weight of *Nephrops* in the discard samples (i.e., those represented as heads only in the samples). The reported live weight of *Nephrops* landed as tails only is then used to estimate the quantity of haddock discarded using the haddock:*Nephrops* ratio in the discard samples. Length frequencies of haddock in the samples are then raised to the fleet estimate. No otoliths were collected, but the length frequencies could be partitioned to age class based on appearance of modes and comparison with length-at-age distributions in March and October surveys. The age data from 2001and 2002 were derived using survey and commercial fleet ALKs. The UK (NI) estimates are available since 1996 but the reliability of these estimates has not been determined. Roughly 40 discard samples are collected annually. There are several limitations to these data: only a small sub-set 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 mid-water trawl and twin-trawl fleets. These fleets were sampled randomly by observers as part of two EU contracts. Data were available for quarters 2-4 in 1997, 1-3 in 1998, 3-4 in 1999, 1-4 in 2000 and 1 in 2001.

- 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 By-catch 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 for 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 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 minimising $\Sigma(\ln(\text{observed } L_t / \text{expected. } L_t))^2$.

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 2005. 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 - 2005)

  The survey series commenced in its present form in 1992. It comprises 45 3-mile tows at fixed station positions in the northern Irish Sea, with an additional 12 1-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 sea bed 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 2004)

  Description as for UKNI-GFS-March above.

- UK(NI) Methot-Isaacs Kidd (MIK) net survey in June (age 0; years 1994 – 2004)

  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 ground gear and a 20mm cod-end 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.

- 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. The survey uses a GOV otter trawl with standard ground gear and a 20mm cod-end liner. The survey operates over the whole of the Irish Sea. Indices are calculated as arithmetic means of all stations, without stratification by area.

- UK(Scotland) groundfish survey (SCOGFS) in spring (age classes 1 to 6, years 1996 – 2005)

  This survey represents an extension of the Scottish West Coast groundfish survey (Area VI), using the research vessel *Scotia*. The survey gear is a GOV trawl, and the design is two fixed-position stations per ICES rectangle from 1997 onwards (17 stations) and one station per rectangle in 1996 (9 stations). The survey extends from the Northern limit of the Irish Sea to around 53^{o} 30'.

- 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.

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

No CPUE data are provided to the WG for VIIa haddock.

B.5. Other relevant data

None.

C. Historical Stock Development

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 analysis of alternative procedures see WG reports from WGNSDS 1997-2003.

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 (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

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 3 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.

G. Biological Reference Points

The ACFM view on this stock (ACFM, October 2002) is that there is currently no biological basis for defining appropriate reference points, in view of the rapid expansion of the stock size over a short period. ACFM proposes that F_{pa} be set at 0.5 by association with other haddock stocks. The absolute level of F in this stock at present is poorly known. The point estimate of F(2-4) for 2002 (0.89), however, is above F_{pa}.

H. Other Issues

None.

I. References

Armstrong, M.J., Peel, J., McAliskey, M., McCurdy, W., McCorriston, P. and Briggs, R. 2003. Survey indices of abundance for cod, haddock and whiting in the Irish Sea (Area VIIaN) : 1992-2003. Working Document No. 3 submitted to 2003 meeting of the ICES Working Group on Assessement of Northern Shelf Demersal Stocks. 33pp.

Borges, L., Zuur, A.F., Rogan, E. and Officer, R. 2005. Choosing the best sampling unit and auxiliary variable for discards estimations. Working Document No. 3 submitted to 2005 meeting of the ICES Working Group on Assessement of Northern Shelf Demersal Stocks. 25pp.

Annex 15: ACFM sub-group Review of the Working group on the Assessment of Northern Shelf Demersal Stocks [RGNSDS]

ICES Headquarter, 20- 22 June 2006

Composition of the review group

ACFM sub-group chair: Morten Vinther (Denmark)

ICES WGNSDS chair: Robert Scott (UK, England and Wales)

Reviewers: Massimiliano Cardinale (Sweden) and Olga Moura (Portugal, by correspondence)

General considerations

The members of ACFM review group (RGNSDS) commended the WGNSDS for the way in which they have managed to deal with a lengthy list of terms of reference, and the progress made following the guidance from $RGNSDS_{2005}$.

The $RGNSDS_{2005}$ made a substantial progress in categorising the stocks into possible type of assessment based on the data available and quality. Further $RGNSDS_{2005}$ proposed different methodological approaches to the various stock assessments. Most of these proposals have been followed by WGNSDS and $RGNSDS_{2006}$ found no reasons to repeat such exhaustive review of methods. The main focus for $RGNSDS_{2006}$ was evaluation of the assessment as the basis for advise.

Sampling levels for all the stocks are documented in a nice overview table. It is however just a very few stocks where these data actually are used to evaluate if sampling levels have been adequate. WGNSDS should comment on the sampling levels, not just give the number of samples.

WGNSDS considers that mis-reporting of landings is significant for most stocks in the area. Limited information is however presented in the report that document or quantify mis-reported landings. WGNSDS should, as specified in the TOR, provide more specific information on mis-reporting.

RGNSDS had its meeting a month after the end of WGNSDS and the report was a rather draft version for some stocks which slowed down the review process. It should be considered to have the review group meeting later in the year, or alternatively to speed up the completion of the WG report.

TSA software and documentation should be made available on the ICES web as done for most other fisheries assessment software applied at ICES.

1 Cod in Division VIa

The recommendation from the $RGNSDS_{2005}$ to WGNSDS for this stock was that there is a need for a thorough simulation testing to evaluate SURBA's performance. It has not been done by this $WGNSDS_{2006}$ or the WGMG. The WGNSDS still consider it is very difficult to determine up to which point commercial catch data can be considered to be reliable and decided on an assessment based on mainly survey data. This was done using TSA with catch data for the period 1978-1994 only and survey data for the period 1985-2006. The result of this configuration of TSA was compared with SURBA runs using the same survey.

1.1 Comment to the assessment and report

It is unclear how the official landing in 2005 (499 t) become 511 t in the TSA assessment (probably SOP-corrections, and not correction for misreported landings?)

It is unclear why a modified TSA (and not B-ADAPT) was chosen for this stock.

The WG should consider excluding the Scottish commercial CPUE time series from the main report, as it is known that effort might be seriously biased for several years.

Misreporting of catch has not specifically been considered for this stock, but treated in a common section (2.1.2). No attempt has been made to allocate misreported landings to countries. References to the methods for discards estimation are given. Sampling levels of data are presented but not compared to previous years levels or evaluated further by the WG. The relatively high sampling levels for this stock seem to be sufficient.

The quality and consistency of survey data has been evaluated correctly. Various model formulations with SURBA using ScoGFSQ1 data have been tried and consistent estimates of the trend in SSB are obtained.

The RGNSDS agree with WGNSDS that the final TSA assessment (with omission of catch data 1995-2006) and ScoGFQ1 survey is a way of transforming a basically survey based assessment giving relative stock estimates into an absolute estimate. The results rely however very much on the quality of survey data and this cannot be judged on, as no proper additional time series exist.

The omission of catch data 1995-2006 seems to give a larger standard deviation of SSB for the most recent period (and a even larger increase in CV due to the decline in SSB). The retrospective analysis show however a rather consistent estimate of SSB. The SD of mean F in the years without catch is as expected very high and the retrospective analyse shows in addition that mean F relies very much on the terminal year. RGNSDS considers that the final assessment show the historical stock development and present status with a SSB clearly below Blim. Due to the poor estimate of F it is not possible to make a traditional short term forecast.

1.2 RGNSDS conclusion and recommendations

RGNSDS considers catch data are unreliable for a traditional age based assessment and the choice of the modified TSA and SURBA seems appropriate. Both methods give the same clear downward trend in SSB and the final assessment (modified TSA) gives SSB far below Blim and this assessment is a valid basis for advice of this stock.

The RGNSDS recommends a full review including a full simulation testing of both the modified TSA and B-ADAPT approach.

2 Haddock in Division VIa

The WGNSDS has followed the recommendation from the $RGNSDS_{2005}$ to use a modified TSA as final assessment. This was done using TSA with catch data for the period 1978-1994 only and two survey series covering the period 1985-2006. The result of this configuration of TSA was compared with SURBA runs using the same surveys. The WGNSDS still consider misreporting is a major problem for this stock, but no specific information of the quantity and sources of misreporting are mentioned.

2.1 Comment to the assessment and report

The over all impression is a well-written and documented assessment with justified choices of data sources and methods.

The WG should consider excluding the Scottish commercial CPUE time series from the report, as it is known that effort might be seriously biased. Is there an error in Table 4.1.1? or is reported effort really that low for the period 2002-2005?

Misreporting of catch has not specifically been considered for this stock, but treated in a common section (2.1.2). No attempt has been made to allocate misreported landings to countries. Methods for discard estimation is briefly presented and references to methodology is given. Sampling levels of data are presented but not compared to previous years levels or evaluated further by the WG.

The quality consistency of survey data has been evaluated correctly. The SURBA “scan setting mode” seems very useful and consistent estimates of the trend in SSB and recruitment are obtained.

The choice of a TSA assessment (with omission of catch data 1995-2006) seems appropriate. The choice of The Ricker R/SSB relation seems however wrong – the slope at the origin cannot be estimated. Is it possible to use a GM as recruitment function in TSA?

The WG notes that there seems to be some retrospective pattern in SSB estimated by TSA that is not present in the SURBA estimate. Reason for this should – as the WG suggests – be investigated further in full simulation testing of the modified TSA.

The TSA retrospective analysis shows a rather variable estimate of F for the terminal year. SSB is variable as well and with consistently over estimation of SSB in the terminal year. Despite these shortcomings, the assessment RGNSDS considers that the final assessment shows the historical stock development and present status.

The assessment indicates that the stock is inside safe biological limits. Although the estimation of F is very uncertain RGNSDS considers the short term forecast provides a suitable basis for determining a TAC. The method for estimation of mean weight at age for the slow growing 1999 year-class seems suitable.

2.2 RGNSDS conclusion and recommendations

RGNSDS considers catch data are unreliable for a traditional age based assessment and the choice of the modified TSA and SURBA seems appropriate. Both methods give the same clear downward trend in SSB and the final assessment (modified TSA) gives a valid basis for advice of this stock. The present F values are uncertain but the presented short term forecast can be used as basis for advice.

The RGNSDS recommend a full review including a full simulation testing of both the modified TSA and SURBA.

3 WHITING VI a

The $RGNSDS_{2005}$ raised several problems with data, namely incorrect reporting and high level of discards. These problems still exist. However, work is underway (for several years) to revise the Scottish discard estimates with the aim of reducing bias and increase precision.

So a survey based assessment was undertaken. Two runs with SURBA were performed: one for Scottish Ground Fish Survey Q1 and other for Scottish Ground Fish Survey Q4. The later gave poor convergence and unreliable stock trends. RGNSDS agrees that it was the right choice to not consider it further.

No particular problems arise with running SURBA with this stock, only the general ones, which are dealing elsewhere. One of those problems is linked with Z. That is, if there is an increasing trend in mortality, the final year value is always lower than the year before, because the final year Z estimate are assumed to be equal to the mean of the previous 3 years.

The SURBA analysis presented here is for one survey only and cannot be compared with other sources of information on the stock status. The retrospective analysis shows high variability in estimates of SSB and recruitment, not seen in analyses of other stocks in the working group. RGNSDS considers therefore, that the results of the SURBA analysis is only indicative of stock trends.

The level of SSB estimated in 2006 is the lowest in the time series (1985-2006) and recruitment is also at a low level in the two most recent years.

The title of Figure 5.9 is mistaken.

3.1 RGNSDS conclusion and recommendations

Until the revising work of the Scottish discard estimates is not finished, and the Irish discards are not considered an analytical assessment is not possible for this stock.

4 Anglerfish on the Northern shelf and IIa

The WGNSDS gives a very extensive presentation of available information on the species and fishery compiled for WGNSDS or a proceeding STECF review meeting on anglerfish. Little is however added to the knowledge about the actual stock status, since last year. Preliminary analysis of observer and "Tallybook" data, and analysis of LPUE data from official logbooks gave no clear indication of stock development. There have been an overall decline in effort in the shelf area, but to what extend that is reflected on the fisheries targeting anglerfish or having anglerfish as an important by-catch species is unclear.

There has, until recently, been no survey that is considered sufficiently representative of this stock. Numerous data collection schemes have been instigated recently, however, there is currently an insufficient time series to use this information in a quantitative manner. It is considered that it would take at least 2 to 5 years before this information can be used to form the basis of management advice.

5 MEGRIM VI a

As $RGNSDS_{2005}$ suggested Megrim Via is considered as a monitored stock in 2006, only the compilation data are presented and no analytical assessment is attempted.

Catches of megrim in Sub-area VI comprises two species *Lepidorhombus whiffiagonis* and *L. boscii*. For the Scottish and Irish fleets the proportion of L. boscii is negligible and for Spanish and French fleets is unknown.

Official statistics are quite different from WG estimates due to underreporting, misreporting, discards and high grading.

Estimates of discarding from the Irish otter trawl fleet were updated according to the new raising procedure by trip. These data suggest that discarding is significant for this stock and the pattern may change over time. Discard estimates are not provided by other countries.

The new anglerfish survey took place in November 2005 and is described in section 6.3.2. Section 7 does not give any notice about the usefulness of this survey to obtain indices for megrim, it would be interesting to know.

5.1 Recommendations

RGNSDS notes that a new survey is to be conducted. The use of this survey for assessment of megrim should be investigated.

6 MEGRIM VI b

As Megrim VIb is a monitored stock only the compilation data are presented and no analytical assessment is attempted.

Megrim in Division VIb are mainly caught by a Scottish and an Ireland fishery targeting haddock using gears with a mesh size > 100 mm, so the discards is not though to be significant.

In Division VIb also operates a Spanish fleet conducting a mixed fishery that catches also four-spotted-megrim (Lepidorhombus boscii). Spain don't supply landings breakdown by species. The WG had no current information about gears or discards of this fleet. According to official landings, this fleet accounts for 13 % to 64 % of the total landings in Division VI b in the period 1985-2205.

A new anglerfish survey took place in November 2005 and another one is proposed for November 2006. Section 7.10 don't inform if this type of survey can provide reasonable indices for megrim.

6.1 Recommendations

RGNSDS notes that a new survey is to be conducted. The use of this survey for assessment of megrim should be investigated.

7 Cod in Division VIIa

The recommendation from the $RGNSDS_{2005}$ to WGNSDS for this stock was to perform and also review a B-ADAPT model assessment (or a TSA) where the unreported catches are estimated. This is particular relevant in the case of misreported landings estimated in the order of 40-80% of the actual values. However, the way these values of misreported landings are estimated is not fully presented in the report.

7.1 Comment to the assessment and report

The stock was classified as an observation list stock. However, the working group took into account the comments of the review group in 2005 and, thus the assessment in 2006 is basically a benchmark assessment. The comments in previous technical minutes have been addressed. As for 2005, the working group considered that an XSA assessment is impracticable due to unreliable catch data in recent years. Thus, the working group opted for a survey based assessment (SURBA), as in 2005 but also for a B-ADAPT model assessment where the unreported catches are estimated as suggested by the review group in 2005.

Survey data are considered generally consistent and covering sufficiently the stock to give at least robust estimates of stock trends. Also the quality of the fishery dependent data has been evaluated and presented in the report. However, a full review, including simulation testing, of B-ADAPT was not performed by the working group.

Although, the different methodologies used, the models shows similar trends in both recruitment and SSB in the recent years. F is estimated on the same order of magnitude but with different temporal trends. In any case, both models give a perception of a stock at the minimum levels of SSB and high fishing mortality. Considering the limitation of the catch data, the use of SURBA and B-ADAPT is considered as a valid approach to estimate historical stock development and show the present status. However, the present low quality of the catch data implies that the assessment as such is only indicative of trends and thus, it should not be used in short and medium term forecast. Nevertheless, RGNSDS considers that the forecasts show the potential of stock recovery (for this stock with high growth rates and fast maturity) in cases of no fishery or very low levels of fishing mortality

7.2 RGNSDS conclusion and recommendations

RGNSDS considers catch data unreliable for a traditional age based assessment and the both the B-ADAPT and SURBA give the same clear downward trend in SSB. Nevertheless, although the above mentioned limitations and in the presence of an agreed management plan, RGNSDS considers the present assessment as a valid basis for advice of this stock.

8 Haddock in Division Vb

$RGNSDS_{2005}$ recommends that WGNSDS should explore alternative approaches to assessment and advice using the data from existing and future planned surveys. This was tackled by the working group this year.

8.1 Comment to the assessment and report

There are no sampling data from Russian fleet for 2002. The age composition of the Russian landings in 2002 was estimated using length dependent selectivity as derived in 2003 and age length key for all years of Russian catches combined. RGNSDS consider this method as appropriate.

There are problems linked to the estimation of historical discard level since no observations are available. The proportion of discard is very high and the landings are only a small part of the catches for EU fleet. Russian fleet has no discard and thus catches generally corresponds to landings. Discard observation from EU fleets are scanty and although RGNSDS notice that the way how discard at age estimates are derived is fully documented, there are several missing discard information in terms of years and fleet covered. Also in the latest years where discard information are partially available, data are often borrowed from other years and surveys to estimate discard at age for the stock. The use of stock length composition from survey to derive discard ogives is not considered as an optimal approach. However, the catch at length compositions obtained by the theoretical curve of selectivity stock length composition from survey agree with observation made in 1999 and 2001.

Also, misreporting is mentioned as a problem but no quantitative information is given. The working group should also address those.

Although, the working group has made progress to unravel the issue of missing discard information, RGNSDS notice that the actual estimation of catch data are based on a large set of assumption and this makes results from XSA uncertain. However, in the recent years 90% of the landings are taken by the Russian fleet. If the situation continues problems related to missing discard information became less relevant.

Due to the above mentioned problems in the catch data and as suggested by the review group in 2005, the WGNSDS run a SURBA assessment based on the Scottish survey. There are several missing year observations in the surveys. SURBA will estimate a year effect and then able to run also with missing observations. However, the robustness of the estimation form survey only based assessment in case of missing values, especially in the latest years is questionable. Also, the working group has done no calibration for gear changes in 1999.

RGNSDS notes that tuning fleet residuals from the XSA run are small and randomly distributed indicating that there is no large discrepancy from the signals in the catch and that coming from the survey in the recent years. XSA and SURBA assessment gives a similar picture of the stock development, indicating that the catch data are consistent with the survey information.

8.2 RGNSDS conclusion and recommendations

In spite of uncertain catch information, especially the way discard estimates are derived, and, missing observations in the survey, results from the XSA and SURBA are indicating a similar trend and the XSA assessment can be used as basis for advice. However, the degree of uncertain in the stock estimates should be reflected in the advice derived from short and medium term predictions. Also, RGNSDS reiterates the message that the assessment of this stock should be based on survey data but that this would be achieved only when a longer time series of the acoustic survey will be available.

9 Haddock in Division VIIa

As pointed out in 2005 by the review group, WGNSDS should explore the use of a separable model (e.g. ICA) to estimate age distributions for missing years and catches. This could then be followed by the use of an ADAPT approach modified to overcome problems of incomplete/missing catch (c.f. the additional analyses for cod in Division VIIa presented in the Annex 2 of the 2005 technical minutes).

9.1 Comment to the assessment and report

The working group attempted the approach suggested by the review group. Nevertheless, although the working group spent considerable amount of time exploring the possibility to use ICA and B-ADAPT model, the results were considered unsatisfactory. Thus, working group decided to base the assessment of the stock on trends derived on survey based model (SURBA) as in 2005.

The surveys data are considered generally consistent and covering sufficiently the stock to give at least robust estimates of stock trends. Trends in SSB and R as estimated by SURBA are similar for both surveys. The temporal trend in F is different although the magnitude is similar for the two surveys. Considering the limitation of the catch data, the use of SURBA is considered as a valid approach to estimate historical stock development and show the present status.

The approach taken is particular relevant in the case of misreported landings. However, misreported landings are simply mentioned but no estimates are presented in the report. This should be clearly explained since it forms the rationale of the choice of SURBA assessment models as a base for assessment of this stock. The SURBA assessment results as such are only indicative of trends and thus it should not be used in short and medium term forecast.

The working group presented also a yield per recruit analysis (YPR) based on XSA assessment run in 2004. Those are based on catch at age during a period when misreporting landings occurred. However, the YPR is more sensitive to proportion and selection at age than on the absolute number. The proportion at age estimated using catches are similar to those given by survey data only; therefore this should in theory not impair the estimates of F_{01} and F_{max} derived from this analysis. However, since the XSA assessment has rejected, YPR that are based on it should not be used.

9.2 RGNSDS conclusion and recommendations

RGNSDS notice that a TSA approach could be applied to solve the issue of missing catches in 2003 and poor sampling in 2004. This should be addressed in the next working group. RGNSDS considers also that catch data unreliable for a traditional age based assessment and the SURBA gives a reliable picture of the status of the stock at least in terms of SSB and R. Thus, RGNSDS considers the present assessment as a valid basis for advice of this stock.

10 WHITING VII a

The stock is classified as a monitoring stock, so no assessment was carried out.

Landing figures supplied to the WG indicates a value around 158 t in 2005, the lowest in the recorded time series (1988-2005), that also shows a constant declining trend, demonstrating the need for concern for this stock.

No estimates from the Nephrops fishery discards, previously used by the WG, were available in 2005. Only Irish discards, with the new raising procedure, were available and it is necessary some intersessionally work before international discard estimates become available.

Data on abundance indices by age group for six research surveys were available to the WG showing a decline in recent years, for older age groups.

Empirical SSB estimates for spring and autumn UK(NI) groundfish surveys shows a declining trend in recent years.

11 Plaice in Division VIIa

$RGNSDS_{2005}$ recommended a further investigation of possible catchability trend of the only available age disaggregated survey available. This recommendation has been followed and a benchmark assessment was done this year using the same methods as last year but with a slightly different configuration in the final assessment.

Belgian landings data for 2005 have been updated since the WG, but the RGNSDS has reviewed the available assessment. The assessment will be updated (medio August) after the RGNSDS meeting but the changes are expected to be minor.

11.1 Comment to the assessment and report

Mis-reporting of landings is not considered as a major problem. Discards are not included in the assessment but discard rates are generally known to be very high and supported by observed data presented in the report. A guess on ~ 80% discard rate is given by $RGNSDS_{2005}$. With such a high discard rates, WGNSDS should investigate the effect a potential massive change in fishing pattern, due to decommissioning and a general shift to smaller mesh sizes. The underlying assumption in an assessment without discard, that the discard rates are constant, might be seriously violated with massive changes in the fishery.

The exclusion of age-1 from the assessment seems to be a correct decision. The effect of including more ages in the plus-group should be investigated as well. The residual plot from the separable VPA shows very high residuals from the older ages (as expected), but also mainly positive residuals from the ages, which contribute most to the landings.

The investigation made by the WGNSDS of a potential trend in catchability for the only age-disaggregated survey does not indicate a trend, however no firm conclusion can be made.

The ICA diagnostic plot has simply been squeezed too much to read.

Wrong population numbers have been applied to the sensitivity analysis (table 11.9.4). Input will be edited when updates of the full assessment are done.

11.2 RGNSDS conclusion and recommendations

The assessment clearly shows a healthy stock with a high spawning stock and low fishing mortality (of landings). The main concern is the effect on the very high discard rate for an assessment without discard. However, given that there are no concerns about the state of the stock, and that advice is likely to be driven more by the sole stock, the assessment was accepted as the basis of advice.

Further investigations should be made to evaluate the effect of a reduced age-span in the assessment and effort should be made to include discard in the assessment.

12 Sole in Division VIIa

WGNSDS has experienced severe problem to get a consistence age-based assessment after the addition of 2004 data. Numerous assessment methods were investigated at the WGNSDS this year but the WG was not able to resolve the problem with catch at age data.

A working paper “A review of difficulties in arriving at an assessment for the sole stock in Division VIIa” (Darby, 2006) (Appendix 1) was available to RGNSDS. This paper recommends removing the Belgian commercial fishery tuning fleet. There remain problems with the estimation of the 2000 year-class, which create odd mean F and SSB in the terminal year. Although the revised assessment did not resolve the problems completely, it presented an assessment that was more consistent with the time series of landings data and provided an improved basis for advice.

However, following the preparation of the working paper to RGNSDS substantial revisions have been made to the catch at age data for this stock necessitating a further revision of the assessment. A new document “Sole 7a Re-assessment” (Scott, July 2006) (Appendix 2), includes updates of catch data and presents a new assessment. Due to the timing of the RGNSDS meeting, this new assessment has not been reviewed by RGNSDS.

13 Nephrops in Division VIa and VIIa

Following the uncertainty raised by the review group in 2005 linked to a XSA methodology for assessing those stocks, the WGNSDS proposed an alternative approach based on the biomass estimates available from TV surveys. The RGNSDS supports this decision. However, as pointed out from the last review group, there is a degree of circularity involved in proposing a harvest threshold based on an F derived from an XSA-based assessment. It would be preferable to derive the threshold from the ratio of catch to biomass estimate and thus not have to base the value on the XSA approach at all. The working group should have addressed this in 2006.

13.1 Comment to the assessment and report

The derivation of the harvest threshold from the ratio of catch to biomass was not done during the meeting but postponed to an *ad-hoc* workshop that has been planned in the end of 2006. However, there are also concerns in the way the YPR is estimated. Specifically, which length frequency distribution (LFD) and selection pattern are used in the YPR estimation should be clearly specified and the rationale for doing so clearly explained by the WGNSDS. This has important consequences on the estimated F_{01} value. There is also need to explain into details how the density estimations are provided and importantly, how the confidence intervals around those estimates are derived. The use of TV surveys to estimate stock size is considered appropriate here. It shows a general increase in stock size for all units except the FU 15. Also, there is no sign of a reduction in mean carapace length of the catches in the recent years. The TAC is set as the exploitation rate that corresponds to 20% of removal (and this corresponds to approximately F_{01}) of the mean stock abundance estimated by the last three years survey. While this is justified in the case of FU 11-13 (i.e. the stock shows a quite stable SSB in the latest years), the situation is different for FU 15 where a decreasing trend has been observed. In this case, it would be more appropriate to base the advice on the last 2 years (or the last year if considering the trend as real) average instead.

After the $RGNSDS_{2006}$, a sub-group of WGNSDS members met during 1-2 August in Lowestoft to address specific issues raised regarding the assessment of Nephrops in the Irish Sea. The document (Scott et al., 2006) (Appendix 3) details the methods used to derive indices of abundance from the UWTV surveys and highlights the similarities and dissimilarities between the approach used for the West of Scotland and that used for the Irish Sea. A revised estimate of abundance in 2005 for FU15 has been calculated and catch options for 2007 based on the revised estimates are presented.

13.2 RGNSDS conclusion and recommendations

RGNSDS considers that the assessments based on TV survey estimates of abundance, give a realistic picture of the status of the stocks. RGNSDS recommends that future work is conducted to further refine the application of the UWTV assessment method. Nonetheless, RGNSDS considers that the assessments conducted during WGNSDS for FU11-13 and the assessment conducted by the sub-group for FU15 can be used as a valid basis for advice.

14 Cod Management Plan Evaluations

A specific term of reference requested the working group evaluate existing management plans to the extent that they had not yet been evaluated. Management plans exist for the stocks of cod in sub-divisions VIa and VIIa. The working group developed a simulation model to investigate whether the management plans were consistent with the precautionary approach.

The approach uses an underlying biological population and a single fishing fleet to simulate the commercial fishery. The assessment and management of the stock is modelled in a generic manner so as not to be specific to any individual stock assessment method but replicates the process through which the management plan will be implemented. The management component of the model derives a TAC in accordance with the management plan and the effort level associated with that TAC is then used to determine the future behaviour of the modelled fleet. The approach specifically incorporates the time lag that occurs through determining a TAC for 2 years after the last data year. RGNSDS considers that the approach adopted to evaluate the management plan follows the guidelines of SGMAS and is appropriate.

The simulations indicate that for both VIa and VIIa cod the stock will recover to spawning biomass levels above Bpa. For VIa cod recovery to levels above Bpa is expected to occur by about 2015, for VIIa cod recovery is expected to occur by about 2011. However, the results of the evaluation are conditional on a large number of assumptions and it is important to stress numerous caveats when considering the output of the simulations.

Specific concerns about the evaluation are with regard to

a) Assumptions about the biology of the stock
b) Assumptions about the behaviour of the fleet
c) Assumptions regarding the implementation of the HCR
d) Assumptions regarding noise and implementation bias.

Assumptions about the biology of the stock

Section 1.4.1 of the WGNSDS report considers environmental drivers of stock productivity and highlights a potential relationship between cod recruitment and sea surface temperatures in the Irish Sea, indicating that recruitment levels may be reduced at higher sea temperatures. Recent sea surface temperatures are higher than historic levels yet the stock and recruitment relationship used in evaluating the plan for both stocks uses the full time series of data and takes no account of the potential decline in recruitment due to environmental effects. This is an important consideration and should be investigated further before making firm conclusions about performance of the management plan.

A log-normal error term has been assumed for estimates of recruitment but no temporal correlation in the recruitment values has been implemented. The VIIa cod stock has experienced 3 successive years of reduced recruitment. Successive years of low recruitment can lead to drastically reduced SSB. The inclusion of an AR(1) process in recruitment should be considered as this may extend the period until stock recovery.

Although not stated in the report, it is understood that the underlying population has been based on the results of the most recent (2006) assessment. The underlying population therefore bears very close relationship to the assessed stock.

Assumptions about the behaviour of the fleet

A scenario incorporating an implementation bias of 25% has been considered in order to investigate the effect of over-capacity in the fishing fleet. The 25% value appears to be arbitrarily chosen. Either an effort implementation bias that can be shown to be appropriate for the fishery should be used or else the simulations should be run with a range of implementation biases in order to show the sensitivity of the results to different assumptions.

It is noted that the used implementation bias cannot be applied when fishing effort is set to zero. RGNSDS considers this to be an unrealistic assumption as it is likely that there will always be some level of catch. A more appropriate method of applying implementation bias in the context of mixed fishery considerations should be considered.

Assumptions regarding the implementation of the HCR

A constant recruitment value has been assumed in the short term forecast. In order for the stock to recover in the short term it is necessary that this recruitment value is small so that predicted landings are not over-estimated. However, this reduced recruitment value is maintained in the short term forecast throughout the simulation. This will lead to reduced yield being taken from the modelled fish stock and may result in faster increases in SSB at high stock levels than may be realised in practice.

Assumptions regarding noise and implementation bias

A limited set of noise and bias scenarios have been investigated here and in many cases the values assumed appear to be arbitrarily determined. The variability in recruitment is derived from the stock and recruit relationship and is considered to be appropriate. However, the justification for the level of “noise” associated with the assessment is not clear. As stated above, a value that can be shown to be appropriate for this stock should be used or else a range of values should be considered to investigate sensitivity of the results to this assumption. Bias in the perceived state of the stock may also be investigated.

General comments on the section

- Figures 4 and 5 should show the data points (or else error bars) as well as the median line to show the spread of the results.
- Figures 6,7,8 and 11,12,13 should have constant y-axis scales to enable easier comparison of the different scenarios.
- The report should not read like an FLR manual and much of the jargon and terminology specific to the software should be removed.

14.1 Recommendations and recommendations

Based on the work from WGNSDS, RGNSDS cannot fully evaluate the management plan. More work should be done to resolve the concerns listed above and to allow for mixed fishery considerations that will impact on any proposed measures to reduce fishing mortality of cod.

Appendix 1:

Darby, C.D 2006. A review of difficulties in arriving at an assessment for the sole stock in ICES Division VIIa

Appendix 2:

Scott, R. 2006. Sole 7a re-assessment.

Appendix 3:

Scott, R., M. Armstrong, N. Baily and J. Elson 2006. Re-assessment of *Nephrops* in the Irish Sea: Management Area J.

WORKING PAPER TO THE 2006 ICES REVIEW GROUP FOR THE NORTHERN SHELF DEMERSAL STOCKS REPORT:

A REVIEW OF DIFFICULTIES IN ARRIVING AT AN ASSESSMENT FOR THE SOLE STOCK IN ICES DIVISION VIIa

C.D.Darby
Cefas

SUMMARY

INTRODUCTION

The 2006 ICES Northern Shelf Demersal Working Group (NSDSWG, ICES 2006) encountered difficulties in achieving a consistent stock assessment model fit to the data for the sole stock in the Irish Sea (ICES Division VIIa). This paper examines the data sets to which the assessment model was fitted; reviews the consistency of the catch at age data and the cpue series used to calibrate or tune the assessment and suggests an alternative model formulation based on a restricted age range.

The problems that the Working Group encountered are not removed completely but the assessment model formulation does appear to be more consistent with the time series of data and the severe retrospective pattern in the assessment estimates is reduced considerably; allowing the provision of advice for this stock rather than a “role over” of information from historic analyses.

THE DATA

The data files were prepared by the NSDSWG at its 2006 meeting in Copenhagen; they are listed in tables 1 – x.

CATCH AT AGE DATA

The catch at age data listed in Table 1, were examined for consistency in the cohort structure using a separable VPA model. There is a clear change in selection in the fishery or a data mismatch between the years 2002 and 2003 indicated by residual patterns in the log catch ratio residuals Table 5 and similarly in the ICA diagnostic output. The NSDSWG established that ICA indicated a sharp increase in fishing mortality in 2003 this is unlikely and most probably an artefact of the model trying to fit a constant selection at age pattern to a change or a significant error in the catch at age data structure.

THE TUNING DATA

The diagnostic output from the XSA assessment fitted to the most recent 10 years of tuning data, with equal weight, indicates a marked change in catchability at the oldest ages in the data from the Belgian commercial fleet (Table 6). Log catchability residuals have extremely high values of greater than 0.5 and appear to be becoming progressively worse in time especially at the oldest ages. The data for this fleet has severe problems and it should be ideally be excluded from the assessment.

Assessments with this degree of noise in the fleet data will suffer from severe changes in catchability from year to year and consequently lack of consistency as noted in the retrospectives patterns noted by NSDSWG.

The second commercial tuning fleet and the survey do not seem to suffer from the same increase in noise (Table 7). They have strong residuals at the oldest ages but not systematic patterns.

AN ALTERNATIVE ASSESSMENT

The Belgian commercial data should be removed from the model fit until the degradation in the quality of the time series is examined in detail. It is questionable whether any commercial tuning series should be left within the assessment fit but this is left to the NSDSWG and ACFM review group to consider.

At the oldest ages the data quality begins to degrade a 9 or 10 plus group assessment could resolve this issue. As an example an assessment fitted to 9+ without the Belgian commercial series has been included with this note.
Equal weight was given to all years of tuning data and after a series of exploratory runs, all ages were fitted with catchability independent of population size and a q plateau at age 5. The XSA diagnostics (tun05-Bel.csv) exhibit a relatively good fit of the survey data to the estimated populations. There are some indications that the survey residuals tend to be positive in recent years a possible indication of unallocated removals that should be examined further at a later stage.

Figures 1 and 2 present a retrospective runs for the assessment model structure. Fishing mortality is estimated to have declined and in recent years has fluctuated around 0.3. There is a high value of fishing mortality estimated for age 5 (0.87) compared to the adjacent ages, this seems to be caused by problems estimating the abundance of the relatively weak 2000 years class. If the value is excluded from the mean F calculation fishing mortality in the final year is estimated to be consistent with previous years.

SSB is less consistently estimated. The recent apparent sudden drop in SSB is partly caused by the difficulty in estimating the abundance of the relatively weak 2000 cohort at age 5 in 2005; but also difficulty in estimating the abundance of the plus group which in recent years was estimated to be increasing, but in 2005 shows a sudden decline.

The problem with the plus group is linked to noisy data at the oldest age in the survey series, which would indicate a requirement to reduce the age range for the assessment, and the variability in estimated plus group abundance when substantial numbers are included within it. The drop in the 2005 SSB level is therefore considered uncertain because of the noise. “SSB appears to be declining following the recent weaker recruitment abundance; the trend in the final year is uncertain”

SUMMARY

The catch data for 2002 and 2003 should be examined in detail there appears to have been a short-term selection change in those years or there is a problem with the catch at age data. Catch data at the oldest ages is noisy. There has been a reduction n the contribution of older fish in the last ten years.

The Belgian tuning series has very high residuals in the recent years that hve become gradually worse. Until the problems are resolved it should be removed from the assessment.

The inclusion of the UKE&W commercial data does not appear to conflict with the survey estimates, but it is a commercial series and, as such, its status should be regularly reviewed.

The research survey data are noisy at the oldest ages which would indicate a reduction in the assessment age range is required if the commercial tuning information is excluded. However, the abundance in the plus group then becomes a problem in that noisy F’s at the oldest age could result in highly variable SSB estimates.

Fishing mortality at age seems to be consistently estimated although there is a problem in the final year with estimating the mortality at age 5 for what appears to be a weak year class.

Table 1 Sole in ICES Division VIIa: Landings (tonnes)

```
IRISH SEA SOLE,2006 WG,COMBSEX,PLUSGROUP,LANDINGS.
1 1            Updated WvH 11/05/2006
1970 2005
2 15
5
     1785.00
     1882.00
     1450.00
     1428.00
     1307.00
     1441.00
     1463.00
     1147.00
     1106.00
     1614.00
     1941.00
     1667.00
     1338.00
     1169.00
     1058.00
     1146.00
     1995.00
     2808.00
     1999.00
     1833.00
     1583.00
     1212.00
     1259.00
     1023.00
     1374.00
     1266.00
     1002.00
     1003.00
      911.00
      863.00
      818.00
     1053.00
     1087.00
     1013.90
      698.60
      800.50
```

Table 2 Sole in ICES Division VIIa: Catch numbers at age (thousands)

```
IRISH SEA SOLE,2006 WG,COMBSEX,PLUSGROUP,CATCH NOS.
1 2            WvH 11/05/2006
1970 2005
2 15
1
29 895 1009 467 1457 289 228 803 265 729 91 74 14 333
113 434 2097 1130 232 878 141 106 327 376 265 298 54 320
31 673 730 1537 537 172 522 97 46 279 142 152 98 164
368 363 2195 557 815 267 112 329 74 104 150 135 87 152
25 891 576 1713 383 422 232 58 226 44 55 103 110 143
262 733 2386 539 842 157 227 158 91 139 24 24 110 233
29 375 1332 2330 247 544 134 151 80 16 98 28 9 223
221 416 1292 774 1066 150 218 89 64 46 7 63 49 112
65 958 649 1009 442 638 98 204 29 69 33 16 48 90
108 1027 3433 829 637 326 285 65 76 20 65 6 1 102
187 939 1968 3055 521 512 361 352 45 107 53 26 14 187
70 580 1668 1480 1640 114 184 86 258 22 130 26 22 137
8 346 1241 1298 711 641 91 113 23 81 46 10 2 31
37 165 998 758 757 416 334 69 74 35 83 23 36 55
651 786 380 610 343 424 178 251 23 30 19 36 3 17
154 1601 1086 343 334 164 259 188 127 45 22 6 37 55
141 3336 3467 961 235 277 210 187 125 157 27 46 22 74
189 3348 4105 3185 844 307 224 139 153 87 87 17 17 84
32 444 4752 2102 1310 203 83 76 45 93 70 62 7 80
179 771 775 3978 1178 552 121 23 28 8 41 4 8 22
564 1185 986 598 2319 592 333 38 17 18 13 11 5 31
1317 1270 841 300 226 1173 255 125 27 4 6 14 5 23
363 2433 918 556 190 156 523 217 156 23 3 1 0 6
83 543 1966 559 251 199 147 257 114 93 19 12 10 34
122 1342 1069 1578 394 133 98 141 171 37 55 4 8 10
132 920 1444 737 1010 179 62 48 61 80 32 40 9 18
60 469 1188 741 430 509 142 49 28 37 35 23 14 19
789 713 474 710 408 258 295 85 58 34 13 26 5 15
167 1728 466 256 315 191 126 150 51 45 18 17 6 10
301 1069 1258 297 115 136 82 37 45 22 10 5 8 23
88 1013 1180 556 190 66 53 63 26 25 16 3 13 25
442 995 922 608 475 69 62 73 52 12 12 5 8 8
108 549 1498 961 486 177 46 17 13 6 3 2 1 1
329 1082 1042 704 308 155 118 20 9 10 4 10 16 14
362 1065 398 302 251 91 28 23 9 5 2 5 2 7
555 1066 559 358 244 119 105 24 30 4 12 7 5 11
```

Table 3 Sole in ICES Division VIIa: Stock weights at age (kg)

```
IRISH SEA SOLE,2006 WG,COMBSEX,PLUSGROUP,STOCK WTS AT AGE.
1 4 Updated  WvH 11/05/2006 (Revised full time series to Jan 1st)
1970 2005
2 15
1
.118 .141 .166 .191 .218 .246 .275 .305 .337 .370 .404 .439 .476 .514
.139 .165 .191 .217 .244 .271 .298 .326 .354 .383 .412 .442 .472 .502
.106 .145 .183 .219 .255 .289 .322 .354 .385 .414 .443 .470 .496 .521
.138 .164 .191 .217 .243 .270 .296 .322 .348 .374 .400 .426 .451 .477
.119 .156 .192 .225 .257 .287 .315 .341 .365 .388 .409 .428 .445 .461
.108 .151 .191 .228 .260 .290 .315 .338 .356 .371 .383 .391 .396 .397
.100 .141 .181 .220 .258 .295 .331 .366 .400 .433 .465 .496 .526 .555
.052 .116 .175 .227 .273 .312 .346 .373 .393 .408 .416 .418 .414 .403
.065 .120 .172 .220 .265 .306 .344 .378 .408 .435 .458 .478 .494 .506
.119 .149 .182 .216 .252 .291 .331 .373 .418 .464 .512 .563 .615 .669
.135 .157 .181 .206 .233 .261 .290 .321 .353 .386 .421 .458 .495 .534
.152 .172 .195 .220 .249 .280 .313 .350 .390 .432 .477 .525 .575 .629
.081 .142 .198 .251 .299 .342 .381 .416 .447 .473 .495 .513 .526 .535
.179 .200 .224 .252 .282 .315 .350 .389 .431 .475 .523 .573 .626 .683
.174 .208 .241 .273 .303 .332 .360 .387 .413 .437 .460 .482 .503 .523
.121 .167 .210 .252 .291 .328 .363 .396 .427 .455 .482 .506 .528 .548
.101 .143 .183 .222 .259 .294 .328 .360 .390 .418 .445 .470 .493 .515
.121 .149 .180 .213 .249 .287 .328 .372 .418 .467 .518 .572 .629 .688
.093 .129 .165 .200 .235 .269 .302 .335 .368 .399 .430 .461 .491 .520
.105 .144 .182 .219 .254 .288 .320 .351 .381 .409 .436 .461 .484 .507
.123 .148 .176 .209 .245 .286 .330 .378 .431 .487 .547 .611 .679 .751
.113 .153 .190 .225 .257 .286 .313 .337 .359 .378 .394 .408 .418 .427
.135 .162 .192 .223 .256 .292 .330 .369 .411 .455 .501 .549 .599 .652
.073 .130 .181 .227 .267 .302 .332 .356 .375 .388 .396 .398 .395 .386
.165 .186 .212 .243 .280 .323 .371 .424 .483 .548 .617 .693 .774 .860
.101 .156 .207 .255 .298 .338 .373 .405 .432 .456 .475 .491 .503 .511
.136 .174 .211 .246 .279 .312 .343 .372 .400 .427 .453 .477 .500 .521
.132 .176 .217 .257 .294 .328 .361 .391 .420 .446 .469 .491 .511 .528
.177 .198 .221 .248 .279 .312 .349 .390 .434 .481 .531 .585 .643 .703
.159 .199 .235 .269 .300 .328 .354 .377 .397 .414 .429 .441 .451 .458
.119 .167 .213 .256 .296 .334 .368 .400 .429 .455 .479 .499 .517 .532
.179 .221 .259 .293 .324 .352 .376 .397 .415 .429 .439 .447 .451 .451
.092 .160 .223 .282 .336 .385 .385 .430 .506 .537 .563 .585 .602 .615
.109 .175 .235 .287 .332 .370 .400 .424 .440 .449 .451 .445 .433 .431
.104 .183 .256 .322 .382 .435 .482 .523 .557 .585 .606 .621 .630 .632
.171 .208 .244 .277 .309 .339 .367 .393 .418 .440 .461 .480 .498 .513
```

Table 4 Sole in ICES Division VIIa: Catch weights at age (kg)

IRISH SEA SOLE,2006 WG,COMBSEX,PLUSGROUP,CATCH WTS AT AGE.
1 3 Updated WvH 11/05/2006 (SMOOTHED DATA FOR WHOLE TIME SERIES)
1970 2005
2 15
1

.130	.153	.178	.204	.232	.260	.290	.321	.353	.387	.422	.458	.495	.533
.152	.178	.204	.230	.257	.284	.312	.340	.369	.398	.427	.457	.487	.517
.126	.164	.201	.237	.272	.306	.338	.369	.400	.428	.456	.483	.508	.533
.151	.178	.204	.230	.256	.283	.309	.335	.361	.387	.413	.439	.464	.490
.138	.174	.209	.241	.272	.301	.328	.353	.377	.399	.419	.437	.453	.468
.130	.172	.210	.244	.275	.303	.327	.347	.364	.378	.387	.394	.396	.396
.120	.161	.200	.239	.276	.313	.348	.383	.416	.449	.480	.511	.541	.569
.085	.146	.202	.251	.293	.330	.360	.384	.401	.413	.418	.417	.409	.395
.093	.147	.197	.243	.286	.326	.361	.394	.422	.447	.468	.486	.500	.511
.134	.165	.199	.234	.271	.311	.352	.395	.441	.488	.537	.589	.642	.697
.146	.169	.193	.219	.247	.275	.305	.337	.370	.404	.439	.476	.515	.555
.162	.183	.207	.234	.264	.296	.331	.369	.410	.454	.500	.550	.602	.657
.112	.171	.225	.275	.321	.362	.399	.432	.461	.485	.505	.520	.531	.538
.189	.212	.238	.266	.298	.332	.369	.410	.453	.499	.548	.599	.654	.712
.191	.225	.257	.288	.318	.347	.374	.400	.425	.449	.472	.493	.513	.532
.144	.189	.231	.272	.310	.346	.380	.412	.441	.469	.494	.517	.538	.557
.122	.164	.203	.241	.277	.311	.344	.375	.404	.432	.458	.482	.505	.525
.135	.164	.196	.231	.268	.308	.350	.395	.442	.492	.545	.600	.658	.719
.111	.147	.183	.218	.252	.286	.319	.352	.384	.415	.446	.476	.505	.534
.125	.163	.201	.237	.271	.304	.336	.366	.395	.422	.448	.473	.496	.517
.135	.162	.192	.227	.265	.307	.354	.404	.458	.516	.578	.644	.714	.788
.133	.172	.208	.241	.272	.300	.326	.349	.369	.386	.401	.413	.423	.430
.149	.177	.207	.239	.274	.310	.349	.390	.433	.478	.525	.574	.625	.679
.102	.156	.205	.248	.285	.318	.345	.366	.382	.392	.397	.397	.391	.380
.175	.198	.227	.261	.301	.346	.397	.453	.515	.582	.654	.732	.816	.905
.129	.182	.232	.277	.318	.356	.389	.419	.444	.466	.484	.497	.507	.513
.156	.193	.228	.263	.296	.327	.358	.387	.414	.440	.465	.488	.510	.531
.154	.197	.237	.275	.311	.345	.376	.406	.433	.458	.481	.501	.519	.536
.187	.209	.234	.263	.295	.331	.369	.411	.457	.506	.558	.614	.672	.735
.179	.217	.252	.285	.314	.341	.365	.387	.406	.422	.436	.446	.454	.460
.143	.190	.235	.276	.315	.351	.384	.415	.442	.467	.489	.508	.525	.538
.200	.240	.276	.309	.338	.364	.387	.406	.422	.434	.443	.449	.451	.450
.127	.192	.253	.310	.361	.408	.451	.489	.522	.551	.575	.594	.609	.620
.143	.206	.262	.310	.352	.386	.413	.433	.445	.451	.449	.440	.424	.400
.145	.221	.290	.353	.410	.460	.504	.541	.572	.597	.615	.627	.630	.632
.190	.226	.261	.293	.324	.353	.380	.406	.429	.451	.471	.489	.506	.520

Table 5. Sole in ICES Division VIIa: Lowestoft PA suite separable VPA log catch ratio residuals

Lowestoft VPA suite matrix of residuals

Years	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	TOT	WTS
2/ 3	**-0.817**	**0.659**	**-0.641**	0.332	**-0.656**	**0.985**	**-0.598**	-0.160	**0.895**	-0.001	0.446
3/ 4	0.038	0.221	-0.098	-0.147	0.230	**-0.892**	**-0.602**	0.309	**0.940**	-0.001	0.607
4/ 5	0.163	-0.010	-0.384	0.373	0.391	**-0.970**	0.369	0.087	-0.021	-0.001	0.735
5/ 6	0.219	0.155	-0.060	-0.018	-0.148	**-0.742**	**0.712**	-0.159	0.040	-0.001	0.842
6/ 7	-0.125	-0.163	-0.296	-0.173	0.458	-0.254	0.468	-0.257	0.342	-0.001	1
7/ 8	0.151	0.049	-0.035	0.454	-0.249	**-0.566**	-0.018	**0.516**	-0.303	-0.001	0.927
8/ 9	0.031	-0.080	0.252	-0.315	**-0.715**	0.232	0.327	0.347	-0.080	-0.001	0.929
9/10	**-0.512**	-0.102	0.377	-0.087	-0.066	**0.815**	0.271	-0.333	-0.364	-0.001	0.771
10/11	**-0.659**	-0.482	-0.115	0.024	0.399	**1.122**	-0.218	**-0.675**	**0.605**	-0.001	0.531
11/12	0.495	-0.179	0.458	-0.340	0.285	0.275	-0.138	0.274	**-1.130**	-0.001	0.627
12/13	0.177	**-0.639**	**0.686**	**0.979**	**1.143**	**1.141**	**-1.314**	**-1.085**	**-1.088**	-0.001	0.313
13/14	**1.399**	**1.081**	**0.154**	**-1.180**	**-1.020**	**0.938**	**-2.219**	**0.724**	0.122	-0.001	0.265
TOT	-0.002	-0.001	-0.001	-0.001	0	0	0	0	0	-0.01	
WTS	1	1	1	1	1	1	1	1	1		

Table 6. Sole in ICES Division VIIa: XSA log catchability residuals for the Belgian tuning cpue series. XSA fitted to all tuning series using the final 10 years of data with equal weight.

Fleet : BELGIUM BEAM TRAWL E

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
4	-0.12	-0.2	-0.18	0	0.21	-0.4	0.02	0.36	0.13	0.18
5	-0.12	-0.08	-0.01	0.25	-0.45	**-0.59**	0.35	0.27	-0.39	**0.76**
6	0.18	-0.32	-0.11	-0.13	**0.53**	-0.21	0.1	0.25	-0.07	-0.22
7	0.2	**0.54**	0.15	-0.14	0.12	0.05	-0.35	0.17	-0.32	-0.42
8	0.16	0.22	**0.86**	0.04	**-0.56**	**0.5**	0.33	**-0.93**	**-1.25**	**0.63**
9	**-0.52**	0.07	**0.53**	**0.55**	**0.81**	**0.78**	-0.27	0.2	**-0.96**	**-1.2**
10	-0.01	**0.55**	**0.7**	-0.04	**0.86**	**1.09**	**-1.89**	**-0.79**	**0.66**	**-1.13**
11	**0.53**	0.44	**1.1**	**0.52**	-0.47	**-1.78**	**-2.16**	**-1.86**	-0.14	**-0.91**
12	0.23	0.24	**0.63**	**0.56**	**1.2**	**-1.57**	**-1.74**			**1.48**
13	**1.08**	0.46	**0.97**	0.26	**-1.29**	**-2.65**	**-2.74**	-0.25		**-0.55**
14	-0.26	-0.36	0.23	**1.03**	**1.57**	0.46		**-2.07**		**-1.21**

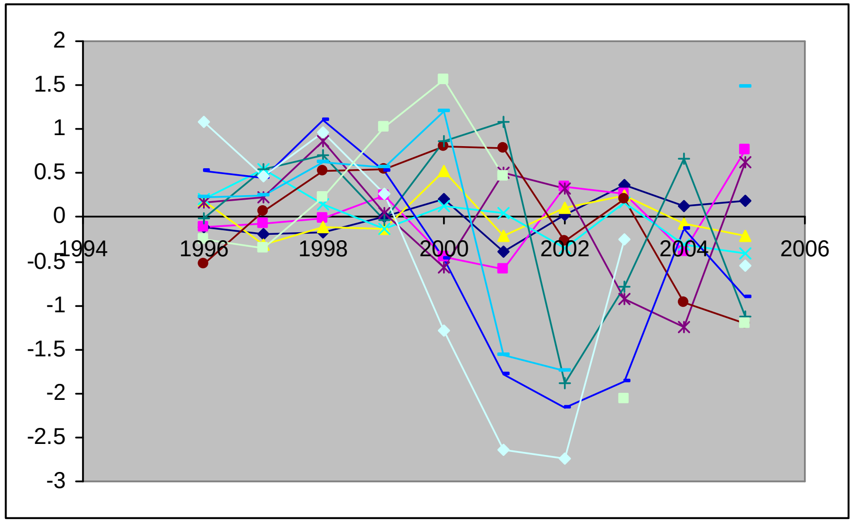


Table 7. Sole in ICES Division VIIa: XSA log catchability residuals for the UK(E&W) commercial and survey tuning cpue series. XSA fitted to all tuning series using the final 10 years of data with equal weight.

Fleet : UK(E+W) BEAM TRAWL (

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2			0.25	0.45	-0.24	0.13	**-1.21**	0.04	**1.2**	**-0.63**
3	**-1.57**	**0.66**	0.46	-0.12	0.26	0.2	-0.06	-0.13	0.33	-0.04
4	-0.28	0.04	-0.25	-0.01	0.15	-0.34	**0.54**	0.47	-0.05	-0.27
5	-0.05	0.17	-0.04	**-1.07**	0.46	0.44	-0.06	**0.56**	0.14	**-0.56**
6	-0.45	0.01	0.12	-0.43	-0.37	0.33	**0.68**	0.38	-0.19	-0.07
7	0.01	-0.28	0.02	-0.04	-0.32	-0.13	**0.5**	0.36	-0.33	0.2
8	0.28	0.13	-0.14	**-0.59**	0.12	**-0.77**	0.12	**0.91**	-0.19	0.11
9	**-0.69**	**0.95**	0.02	0.1	-0.28	0.44	0.21	0.48	**-0.79**	-0.44
10	-0.49	0.08	0.27	-0.2	0.35	0.33	0.14	0.05	**-0.53**	-0.01
11	-0.47	**0.55**	0.47	**0.56**	-0.02	**0.78**	-0.13	0.13	**-0.64**	0.49
12	**0.51**		**-0.7**		0.14	**-0.62**	**-0.81**	-0.49	0.28	
13	**1.06**	**0.79**	**-1.16**	**-1.09**	-0.34	**0.6**	**-1.8**	**0.92**		-0.25
14	-0.01	-0.02		-0.03	-0.06	0.02	-0.1	0.49	-0.02	0.19

Fleet : E+W September beam t

Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
2	-0.3	0.33	**0.73**	-0.23	0.33	0.03	**-0.93**	0.04	0.04	-0.04
3	**-0.79**	-0.01	0.44	0.38	0.04	0.15	-0.09	-0.25	0.45	-0.31
4	-0.04	**-0.52**	**-0.85**	**0.66**	**0.82**	-0.06	0.26	0.42	-0.22	-0.48
5	-0.4	0.05	**-1.4**	0.06	0.47	0.33	0.18	**0.5**	**0.51**	-0.28
6	**-0.6**	-0.49	-0.38	**-0.76**	**0.82**	0.36	**0.51**	0.25	0.31	-0.02
7	**-1**	**-0.67**	-0.33	0.02	-0.09	**1**	0.36	0.36	0.45	-0.11
8	**-0.6**	0.26	-0.43	**-0.72**	**-1.49**	0	**2.21**	**0.76**	0.34	-0.32
9	**-1.51**	0.01	0.32	0.23	**0.77**	0.41		**-0.61**	**0.6**	-0.23

Figure 1 Sole in ICES Division VIIa: Retrospective analysis of XSA estimated fishing mortality. The final year has two options - the hashed line includes the high values estimated at age 5, the solid line excludes age 5 from the average.

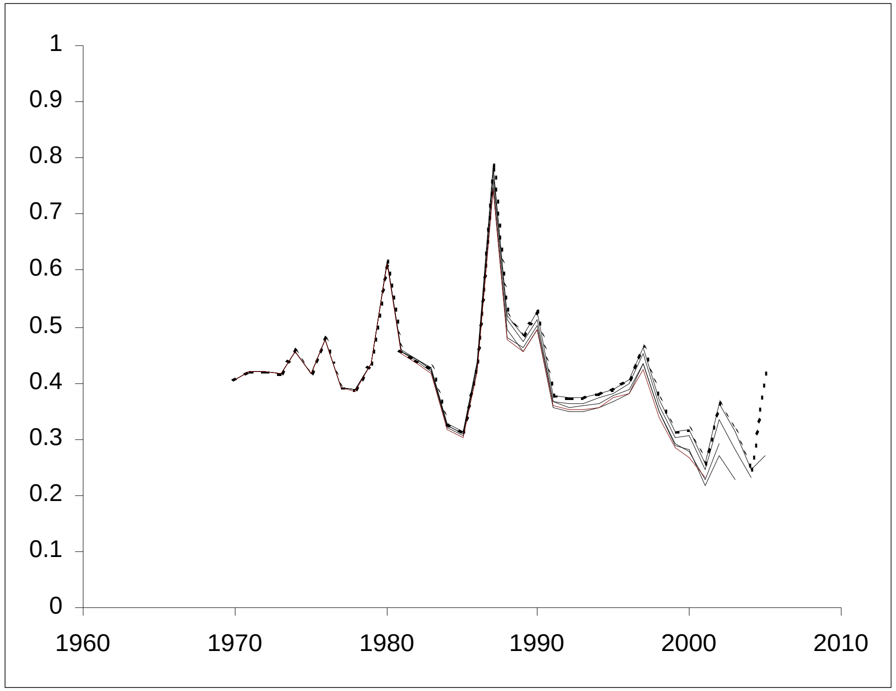
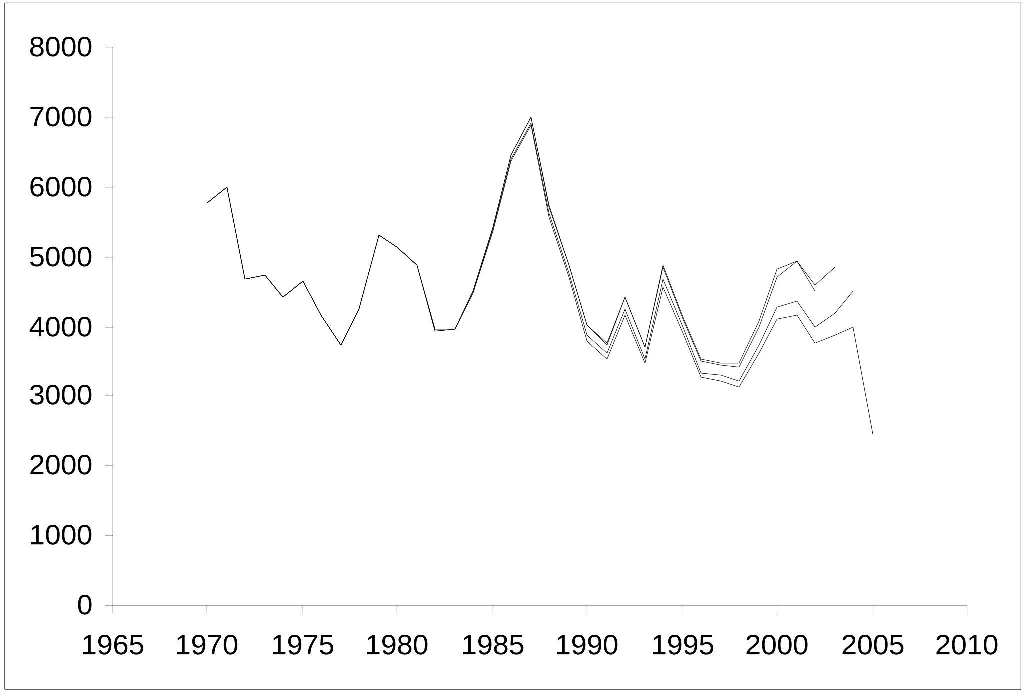


Figure 1 Sole in ICES Division VIIa: Retrospective analysis of XSA estimated spawning biomass.



Sole 7a Re-assessment

Robert Scott[1]
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July 2006

Package	: *Version*	: *Built*
FLCore	: 1.3-3	: R 2.3.1; ; 2006-07-13 14:09:30; windows
FLAssess	: 1.2-2	: R 2.3.1; i386-pc-mingw32; 2006-07-13 14:12:43; windows
FLEDA	: 1.3-2	: R 2.3.1; ; 2006-07-13 14:13:26; windows
FLSURBA	: 1.2-2	: R 2.3.0; ; 2006-07-18 13:09:59; windows
FLXSA	: 1.2-2	: R 2.3.0; i386-pc-mingw32; 2006-07-18 12:18:28; windows
FLSTF	: 1.3.1	: R 2.3.1; ; 2006-07-17 15:37:41; windows

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List of Figures

Part I
Report

1 Introduction

The 2006 ICES Northern Shelf Demersal Stocks Working Group (WGNSDS 2006) was unable to produce a final stock assessment model that provided a consistent fit to the catch at age data for sole in VIIa. Specific problems were evident in the catch at age data for recent years which appeared to be related to the data raising process. Although a number of approaches were attempted to resolve this problem during the working group meeting, no acceptable final assessment could be determined and it was agreed that work would be conducted prior to the review of the Northern Shelf Demersal Stocks Working Group (RGNSDS 2006) to produce an agreed assessment for this stock.

A working document (Darby 2006: A review of difficulties in arriving at an assessment for the sole stock in ICES division VIIa) was submitted to RGNSDS. Although the revised assessment did not resolve the problems completely, it presented an assessment that was more consistent with the time series of landings data and provided an improved basis for advice. However, following the preparation of the working document to RGNSDS, substantial revisions have been made to the catch at age data for this stock necessitating a further review of the assessment.

This document presents a revised assessment of the stock of sole in VIIa based on the new catch at age data set.

2 Input Data

Following revisions to the catch statistics for one country the catch numbers at age and catch weights at age have been revised. Stock weights at age are interpolated from a quadratic fit to the catch weights and have consequently also been revised though the changes to weights at age are minor. The revisions have been made to the 2005 catch numbers at age and weights at age. No changes have been made to the figures for previous years.

It is noted that the catch weights presented in this assessment are subject to in-year smoothing (see figure 2) and that the shape of the fitted curve is not consistent from year to year, in some years being convex and in others concave. The changes in the shape of the fitted curve largely affect the older ages which are condensed into the plus group. However, use of the raw weights at age or cohort smoothing may be more appropriate.

Natural mortality, maturity and proportions of f and m before spawning remain the same as for previous years. Natural mortality is set to 0.1 yr^{-1}

(all ages and all years), maturity is set to 0.0 (age 1); 0.38 (age 2); 0.71 (age 3); 0.97 (age 4); 0.98 (age 5) and 1.0 (ages 6 and above). The proportions of m and f before spawning are both set to 0.

2.1 Catch at Age Data

Catch numbers at age and catch weights at age are tabulated above and total landings are plotted in figure 1. The standardised catch proportions at age are shown in figure 3. The majority of the catch comprises fish of age 3 to 6 but the mean age of the catch has reduced since the mid 1980's. Individual cohorts can be traced through the catch at age data (fig 3) but are less apparent in the older ages and in the most recent years. The catch data become noticeably noisier at the older ages (particularly in the earlier years) and lose any ability to track cohort strengths beyond age 11 indicating that a plusgroup around age 9 or 10 may be appropriate.

Log catch curves by cohort are shown in figure 4 and the gradients of the catch curves across different age ranges in figure 5. The gradients of the catch curves are variable but show an increasing trend across most of the time series indicating that total mortality levels in the stock have been increasing.

2.2 Commercial Catch Effort and Research Survey Data

LPUE and CPUE tuning series were available from 2 commercial fleets (UK(EW) Trawl Fleet; Bel Beam Trawl Fleet) and from 2 survey series (UK(EW) Sept Beam Trawl Survey; UK(EW) Mar Beam Trawl Survey). All tuning series show a relatively good ability to to consistently identify cohort strength at adjacent ages (particularly at the younger ages) but reduced ability at older ages and with larger age lags.

Plots of the mean standardised indices by cohort are shown in figures 6 to 9. Both of the survey series identify the 1990 and 1996 cohorts as being strong but the commercial series fail to identify similar trends. Neither of the commercial series appear to track cohort strengths effectively in the most recent years of the time series.

Effort levels in both the Belgian and UK(E&W) commercial fleets have been variable in recent years. There is some evidence that vessel horsepower has been under-reported historically but that recent figures are more in line with true values (WGFTFB 2006). This raises questions as to the usefulness of commercial LPUE, particularly the Belgian tuning fleet which applies a horsepower corrected effort series.

3 Preliminary Analyses

3.1 SURBA Analsyses

A single fleet surba analysis was conducted for the UK(EW) September beam trawl survey. The reference age was set to 4 and the fbar calculated over the range 3 to 6. A lambda smoothing value of 1.0 was applied and the analysis conducted over the age range 2 to 9.

The results, in terms of SSB trends, are shown in figure **??**fig:ssb-surba). SSB shows a general declining trend over the period 1988 to 2005 with periodic increases following the higher recruitment levels of 1990 and and 1996. SSB in 2005 is estimated to be close to the lowest levels observed in the 14 year time series.

3.2 Exploratory XSA Analyses

Darby (2006) recommended XSA model settings that provided a more consistent fit to the catch data. Since the data set used in this analysis has changed from the previous set only in the final year, this analysis explored initial alternative model settings that were close to those recommended for the previous data set.

3.2.1 Single fleet XSA analyses

Single fleet XSA analyses were conducted for the four tuning series. A plusgroup of 10+ has been used for all single fleet runs. Other settings are an f-shrinkage value of 1.5, applied over 5 years and 3 ages, q-plateau at age 5, catchability independent of stock size and equal weighting applied to all years and all ages.

Estimates of SSB and Fbar(4:7) from the single fleet runs are shown in figures 11 and 12. The results show similar trends for all four fleets but are scaled differently in the final years.

The Belgian Beam Trawl tuning index shows very high fishing mortalities and low SSBs in the last 10 years. The Belgian Beam Trawl fleet accounts for a substantial proportion of the total catch of sole from the Irish Sea. It will therefore correspond very closely to the international catch at age and may not represent an independent tuning series. The UK(EW) March Beam Trawl Survey shows similarly high Fs and low SSBs. This survey was dis-continued in 1999 and, as a tuning index, has little influence on the assessment in the most recent years.

All fleets show a pronounced dip in estimates of fishing mortality in 2004 indicating that fundamental problems remain in the catch at age data for this stock.

The log catchability residuals from the single fleet runs are shown in figure 13 and 14. The Belgian Beam Trawl index shows blocks of residuals that are positive in the early part of the time series, negative during during the mid period and largely positive in the later part of the time series which would indicate that there have been changes in the selection pattern over time. Residuals for the Belgian Beam Trawl fleet are generally small, however, this may be expected given that this fleet accounts for a large proportion of the catch. The residuals of the other three fleets are on occasion large but show little evidence of blocking or persistent trend.

3.2.2 Plusgroup settings

Sensitivity to the level of the plusgroup was investigated. Figure 15 shows estimates of SSB resulting from plusgroup settings between ages 7 and 11. The results show little difference in SSB estimates for the most recent years for plusgroup settings in this range although historic levels are re-scaled substantially when the plusgroup is set at 7.

A significant problem with recent assessments of this stock has been a retrospective step change in the time series of SSB. Darby 2006 noted that this was partly due to an apparent shift in selection by the commercial fishery in the most recent years. But whether this is a genuine feature of the fishery, or an artefact of the sampling and data raising procedure remains unclear. The change is most apparent at the older ages and results in extremely large negative catchability residuals in both the UK and Belgian commercial tuning series.

Given that the Belgian beam trawl fleet accounts for a substantial component of the total international catch and the concerns raised above regarding the commercial tuning series, the Belgian beam trawl fleet and the UK trawl fleet have been removed from the assessment. The assessment is therefore tuned by the UK(EW)-BTS September and UK(EW)-BTS March survey series.

The use of an 8plus plusgroup reduces the effect of the noisy catch data in the most recent years and removes the retrospective step change in SSB. It also reduces the influence of f shrinkage at the older ages where the survey series provides less consistent tuning information. However, although estimates of SSB and fishing mortality are now more consistently estimated the assessment continues to show a retrospective pattern that extends back for a number of years and indicates poor convergence.

4 Final Assessment

Settings for the final XSA assessment are shown in the text table below. No analytical assessment of this stock was conducted in 2005 so model settings from this years assessment are compared with those of the 2004 assessment.

Log catchability residuals from the final assessment are shown in figure 16. Estimates of population abundance and fishing mortality from the final assessment are shown below. .

.

Assmnt Year	: *2004*	: *2006*
Assmnt Model	: XSA	: XSA
Fleets	:	:
Bel Beam Trawl	: 1975-2003 4-9	: omitted
UK Trawl	: 1991-2003 2-9	: omitted
UK Sept BTS	: 1988-2003 2-9	: 1988-2005 2-7
UK Mar BTS	: 1993-1999 2-9	: 1993-1999 2-7
Time Series Wts	: tricubic 20yrs	: none
Power Model	: none	: none
Q plateau	: 5	: 5
Shk se	: 0.8	: 1.5
Shk age-yr	: 5 yrs 5 ages	: 5 yrs 3 ages
Pop Shk se	: 0.3	: 0.3
Prior Wting	: none	: none
Plusgroup	: 10	: 8
Fbar	: 4-7	: 4-7

.

.

Survivors estimates by cohort are shown in figure 17 for the two survey tuning series. They show relatively consistent estimates of abundance for the majority of cohorts although estimates of cohort strength for large yearclasses tend to reduce for the older ages. Overall survivors estimates for the terminal year and corresponding scaled weightings are shown in figure 18. The March survey ends in 1999 and therefore does not contribute to survivors estimates in the terminal population.

The 2000 yearclass is estimated to be very small and survivors estimates for this cohort (age 6 in 2006) are inconsistently estimated by the survey index and f shrinkage. The survey, with the lower abundance estimate, receives the greater wieghting. As a consequence the estimate of fishing mortality at age 5 in 2005 is very high causing a marked increase in fbar(4:7) in 2005.

4.1 Retrospective Analysis

A retrospective analysis was conducted for an 8 year period. The results are shown in figure 22. A retrospective pattern is apparent in both SSB and fishing mortality, indicating an overestimation of SSB and an underestimation of the level of Fbar(4-7) in the some years.

Fishing mortality is relatively consistently estimated in recent years but shows overestimation earlier in the time series at around the point where the UK(EW) BTS March survey series terminates. Similarly, estimates of SSB show apparent underestimation up to this point and slight overestimation in the years the follow. Recruitment levels appear to be consistently estimated throughout the retrospective period.

Increased levels of F shrinkage were investigated in an attempt to reduce the retrospective pattern. However, an F shrinkage s.e. of 0.8 did little to reduce the level of bias and extended the point of convergence back in time, exacerbating the the effect. Increasing the F shrinkage s.e. to 2.0 resulted in little change from the final settings.

4.2 Comparison with Previous Year's Assessment

No comparison with previous assessments are shown here since a full analytical assessment of this stock has not been conducted since 2004.

4.3 Long Term Trends in Biomass, Fishing Mortality and Recruitment

A summary plot of the long term trends in SSB, yield, fishing mortality and recruitment for this stock are shown in figure 19. They indicate that SSB and yield have been in general decline throughout the time series and that fishing mortality levels have been at or around Flim for much of this period.

Recruitment levels have been variable particularly in the earlier years but have remained around the long term geometric mean level for the last decade. Recent recruitment levels have not shown any of the large peaks apparent in the earlier part of the time series.

Fishing mortality levels appear to have reduced in recent years to a level close to Fpa but are estimated to have increased in 2005 to a higher level. This increase in Fbar 4-7 is largely driven by a very high estimate of F on one age group.

5 Stock Projections

5.1 Estimating Recruiting Year-Class Abundance

Age 1 fish are poorly selected in this fishery and have consequently been removed from the assessment. Age 2 fish may also not be fully selected. Although discarding of younger fish is not considered to be an important factor for this stock, any stock and recruit relationship is difficult to determine due to noise associated with the sampling of the recruiting age groups. Therefore, no stock-recruit curve has been fitted.

Recruitment in recent years has not shown any of the peaks apparent in the early part of the time series and has remained below the long term geometric mean of 6070 since 2000. A short term (1995:2004) geometric mean of 4640 has been assumed for future recruitments in the short term forecast.

5.2 Short Term Forecast

A 3 year short term forecast was conducted. Population numbers in 2006 at ages 3 and above were taken from the VPA output of survivors at age. Numbers at age 2 were taken as the short term (1995:2004) geometric mean. Fishing mortalities were the mean of F at age over the period 2003 to 2005. Catch weights, stock weights, maturity and natural mortality were also taken as means over the same period.

The short term forecast was run as a *status quo* projection. Inputs to the short term forecast are shown below. Future fishing mortalities were taken as the unscaled 3 year mean of F at age (2003:2005). The use of an unscaled mean gives future F levels that are less than the 2005 estimate which, as mentioned above, is largely driven by a single year class.

The predicted landings are shown in the tables below (multiples of both Fsq and Fpa have been calculated and are shown in separate tables). With zero fishing mortality it is just possible for the stock to achieve Bpa (3800) by 2008, consequently the effort multiplier required to achieve Blim (2800) in 2008 is shown.

The results of the short term forecast indicate that at F *status quo* landings in 2007 will be in the region of 800 tonnes and that spawning biomass in 2008 will be around 3030 tonnes.

Current (*status quo*) fishing mortality is close to Fpa and SSB in 2008 is predicted to be close to Blim. There is no multiple of current fishing mortality that would lead to an SSB greater than Bpa in 2008.

6 Quality of the Assessment

6.1 Catch Data and Tuning Information

With the removal of the two commercial tuning series the assessment is now tuned only by the two UK(EW) Beam Trawl Survey series and only one of these contributes to survivors estimates in the terminal year. Such reliance of the assessment on a single tuning series is less than ideal. Work should be undertaken either to provide additional survey information for this stock or else to resolve the specific problems that are apparent in the commercial tuning series.

6.2 Forecast

The retrospective analysis indicates poor convergence of the assessment for both SSB and Fbar(4-7) but little evidence of substantial retrospective bias for recent years. Survivors estimates used in the forecast are considered to be appropriate. The terminal estimate of Fbar(4-7) shows an increase on the levels of previous years which is driven by a large fishing mortality on age 5. The value of F carried forward to the forecast is based on an unscaled

3-year mean of F at age and will therefore be revised down slightly from the higher level in 2005.

7 Management Considerations

Recruitment levels to this stock in recent years have not shown any of the peaks apparent in the early part of the time series and have remained below the long term geometric mean since 2001. SSB has declined to low levels and is estimated to be, in 2006, close to the lowest observed level. SSB has remained below Bpa (3800 t) since 1995 and is estimated to be close to Blim (2800 t) in 2005. Any rapid increase in SSB in the short term is unlikely given the recent low recruitment levels.

Fishing mortality levels appear variable in recent years but have been close to Flim (0.4) throughout the time series. F *status quo* is estimated to be close to Fpa and and predicted landings in 2007 assuming F *status quo* are approximately 825 t.

Sole are taken in a mixed demersal fishery along with other flatfish aswell as gadoids. Management measures for sole should be considered in the context of mixed fisheries.

It is not possible for the stock to reach Bpa in one year without a complete closure of the fishery. 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.

Part II
R Script

```
> path <- "M:\\exchange\\Nosh Dump\\2006\\VIIa sole\\data\\"
> path <- "C:\\ICES\\WGNSDS\\2006\\Sole\\new data\\"
> sol7a <- no.discards(read.FLStock(paste(path, "Sol7aind.dat",
+     sep = "")))
> units(harvest(sol7a)) <- "f"
> sol7a.tun <- read.FLIndices(paste(path, "SOL7ATN.DAT", sep = ""))
> for (i in 1:length(sol7a.tun)) sol7a.tun[[i]]@type <- "numbers"
```

```
> sol7a.pg10 <- setPlusGroup(sol7a, plusgroup = 8)
> sol7a.xsa.control <- FLXSA.control(fse = 1.5, rage = -1, qage = 5,
+     shk.n = FALSE, shk.yrs = 5, shk.ages = 3, tspower = 1, maxit = 30)
> sol7a.xsa.final <- FLXSA(sol7a.pg10, FLIndices(sol7a.tun[[2]],
+     sol7a.tun[[3]]), sol7a.xsa.control)
> sol7a.final <- sol7a.pg10 + sol7a.xsa.final
```

```
> sol7a.stf.control <- FLSTF.control(fbar.min = 4, fbar.max = 7,
+     rec.yrs = c(1995, 2004))
> sol7a.stf <- FLSTF(sol7a.final, sol7a.stf.control)
> sol7a.stf.options <- stf.options(sol7a.stf, fmults = seq(0, 2,
+     by = 0.2), fpa = 0.3, bpa = 2800)
> sol7a.stf.options.pa <- stf.options(sol7a.stf, fmults = seq(0,
+     2, by = 0.2), fpa = 0.3, bpa = 2800, fpa.mult = TRUE)
```

Part III
tables

```
[1] "Catch numbers at age"

An object of class "FLQuant":

, , unit = unique, season = all, area = unique

    year
age  1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984
  2    29  113   31  368   25  262   29  221   65  108  187   70    8   37  651
  3   895  434  673  363  891  733  375  416  958 1027  939  580  346  165  786
  4  1009 2097  730 2195  576 2386 1332 1292  649 3433 1968 1668 1241  998  380
  5   467 1130 1537  557 1713  539 2330  774 1009  829 3055 1480 1298  758  610
  6  1457  232  537  815  383  842  247 1066  442  637  521 1640  711  757  343
  7   289  878  172  267  422  157  544  150  638  326  512  114  641  416  424
  8   228  141  522  112  232  227  134  218   98  285  361  184   91  334  178
  9   803  106   97  329   58  158  151   89  204   65  352   86  113   69  251
  10 1506 1640  881  702  681  621  454  341  285  270  432  595  193  306  128
    year
age  1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999
  2   154  141  189   32  179  564 1317  363   83  122  132   60  789  167  301
  3  1601 3336 3348  444  771 1185 1270 2433  543 1342  920  469  713 1728 1069
  4  1086 3467 4105 4752  775  986  841  918 1966 1069 1444 1188  474  466 1258
  5   343  961 3185 2102 3978  598  300  556  559 1578  737  741  710  256  297
  6   334  235  844 1310 1178 2319  226  190  251  394 1010  430  408  315  115
  7   164  277  307  203  552  592 1173  156  199  133  179  509  258  191  136
  8   259  210  224   83  121  333  255  523  147   98   62  142  295  126   82
  9   188  187  139   76   23   38  125  217  257  141   48   49   85  150   37
  10  292  451  445  357  111   95   79  189  282  285  240  156  151  147  113
    year
age  2000 2001 2002 2003 2004 2005
  2    88  442  108  329  362  590
  3  1013  995  549 1082 1065 1182
  4  1180  922 1498 1042  398  611
  5   556  608  961  704  302  375
  6   190  475  486  308  251  240
  7    66   69  177  155   91  134
  8    53   62   46  118   28  122
  9    63   73   17   20   23   24
  10  108   97   26   63   30   68

attr(,"units")
[1] "NA"
```

```
[1] "Catch weights at age"

An object of class "FLQuant":

, , unit = unique, season = all, area = unique

    year
age   1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981
  2  0.130 0.152 0.126 0.151 0.138 0.130 0.120 0.085 0.093 0.134 0.146 0.162
  3  0.153 0.178 0.164 0.178 0.174 0.172 0.161 0.146 0.147 0.165 0.169 0.183
  4  0.178 0.204 0.201 0.204 0.209 0.210 0.200 0.202 0.197 0.199 0.193 0.207
  5  0.204 0.230 0.237 0.230 0.241 0.244 0.239 0.251 0.243 0.234 0.219 0.234
  6  0.232 0.257 0.272 0.256 0.272 0.275 0.276 0.293 0.286 0.271 0.247 0.264
  7  0.260 0.284 0.306 0.283 0.301 0.303 0.313 0.330 0.326 0.311 0.275 0.296
  8  0.290 0.312 0.338 0.309 0.328 0.327 0.348 0.360 0.361 0.352 0.305 0.331
  9  0.321 0.340 0.369 0.335 0.353 0.347 0.383 0.384 0.394 0.395 0.337 0.369
  10 0.420 0.434 0.469 0.432 0.422 0.387 0.514 0.405 0.478 0.568 0.478 0.501
    year
age   1982  1983  1984  1985  1986  1987  1988  1989  1990  1991  1992  1993
  2  0.112 0.189 0.191 0.144 0.122 0.135 0.111 0.125 0.135 0.133 0.149 0.102
  3  0.171 0.212 0.225 0.189 0.164 0.164 0.147 0.163 0.162 0.172 0.177 0.156
  4  0.225 0.238 0.257 0.231 0.203 0.196 0.183 0.201 0.192 0.208 0.207 0.205
  5  0.275 0.266 0.288 0.272 0.241 0.231 0.218 0.237 0.227 0.241 0.239 0.248
  6  0.321 0.298 0.318 0.310 0.277 0.268 0.252 0.271 0.265 0.272 0.274 0.285
  7  0.362 0.332 0.347 0.346 0.311 0.308 0.286 0.304 0.307 0.300 0.310 0.318
  8  0.399 0.369 0.374 0.380 0.344 0.350 0.319 0.336 0.354 0.326 0.349 0.345
  9  0.432 0.410 0.400 0.412 0.375 0.395 0.352 0.366 0.404 0.349 0.390 0.366
  10 0.498 0.565 0.473 0.485 0.450 0.538 0.456 0.451 0.628 0.401 0.448 0.387
    year
age   1994  1995  1996  1997  1998  1999  2000  2001  2002  2003  2004  2005
  2  0.175 0.129 0.156 0.154 0.187 0.179 0.143 0.200 0.127 0.143 0.145 0.188
  3  0.198 0.182 0.193 0.197 0.209 0.217 0.190 0.240 0.192 0.206 0.221 0.224
  4  0.227 0.232 0.228 0.237 0.234 0.252 0.235 0.276 0.253 0.262 0.290 0.259
  5  0.261 0.277 0.263 0.275 0.263 0.285 0.276 0.309 0.310 0.310 0.353 0.291
  6  0.301 0.318 0.296 0.311 0.295 0.314 0.315 0.338 0.361 0.352 0.410 0.322
  7  0.346 0.356 0.327 0.345 0.331 0.341 0.351 0.364 0.408 0.386 0.460 0.350
  8  0.397 0.389 0.358 0.376 0.369 0.365 0.384 0.387 0.451 0.413 0.504 0.377
  9  0.453 0.419 0.387 0.406 0.411 0.387 0.415 0.406 0.489 0.433 0.541 0.403
  10 0.576 0.473 0.465 0.468 0.530 0.428 0.489 0.432 0.547 0.430 0.606 0.460

attr(,"units")
[1] "NA"
```

```
> round(stock.n(sol7a.final), 0)

An object of class "FLQuant":

, , unit = unique, season = all, area = unique

   year
age 1970  1971 1972  1973  1974 1975 1976  1977  1978  1979 1980 1981 1982 1983
  2 3695 10180 3187 13141  5875 6688 3861 15813  9082  8932 5120 4585 2554 5800
  3 8350  3316 9103  2854 11541 5292 5803  3466 14098  8156 7979 4455 4082 2303
  4 4145  6704 2588  7597  2237 9595 4091  4894  2741 11845 6403 6327 3480 3365
  5 1368  2791 4071  1647  4786 1476 6412  2435  3199  1863 7452 3921 4138 1968
  6 4389   794 1451  2222   961 2701  823  3586  1467  1935  897 3837 2140 2510
  7  939  2586  498   802  1235  505 1643   510  2230   907 1145  316 1912 1260
  8 8213  5535 4321  3419  2830 3223 2223  2195  2045  1717 2546 2386 1179 2140
   year
age  1984  1985  1986  1987  1988  1989 1990  1991  1992 1993 1994 1995 1996
  2 16027 16754 26285  3766  3904  4696 6433 14178  5100 6726 6047 2178 3180
  3  5213 13882 15013 23650  3228  3502 4079  5284 11576 4269 6007 5355 1845
  4  1927  3969 11038 10411 18214  2498 2435  2563  3573 8160 3347 4159 3970
  5  2095  1382  2559  6690  5515 11961 1523  1266  1519 2360 5513 2011 2389
  6  1060  1315   924  1401  3024  2991 7039   810   860  846 1604 3488 1119
  7  1551   633   873   613   465  1490 1586  4163   518  597  527 1076 2195
  8  2031  2842  2661  1602  1175   685 1243  1624  3071 2051 2069 2100 1492
   year
age 1997 1998 1999 2000 2001 2002 2003 2004 2005
  2 9830 7895 6237 6710 5063 2851 3773 3785 3463
  3 2821 8144 6985 5358 5987 4160 2477 3101 3081
  4 1223 1874 5725 5303 3884 4471 3242 1212 1793
  5 2462  656 1252 3984 3676 2637 2621 1943  718
  6 1457 1553  350  851 3076 2748 1472 1702 1470
  7  603  930 1105  207  589 2331 2024 1039 1301
  8 1235 2055 1883  701 1977 1171 2622  924 2075

attr(,"units")
[1] "NA"
```

```
> round(harvest(sol7a.final), 3)

An object of class "FLQuant":

, , unit = unique, season = all, area = unique

   year
age  1970  1971  1972  1973  1974  1975  1976  1977  1978  1979  1980  1981
  2 0.008 0.012 0.010 0.030 0.004 0.042 0.008 0.015 0.008 0.013 0.039 0.016
  3 0.120 0.148 0.081 0.144 0.085 0.157 0.070 0.135 0.074 0.142 0.132 0.147
  4 0.296 0.399 0.352 0.362 0.316 0.303 0.419 0.325 0.286 0.363 0.390 0.325
  5 0.444 0.554 0.506 0.439 0.472 0.484 0.481 0.407 0.403 0.631 0.564 0.505
  6 0.429 0.367 0.493 0.487 0.543 0.397 0.379 0.375 0.381 0.425 0.944 0.597
  7 0.391 0.442 0.452 0.431 0.445 0.396 0.428 0.370 0.358 0.475 0.635 0.477
  8 0.391 0.442 0.452 0.431 0.445 0.396 0.428 0.370 0.358 0.475 0.635 0.477
   year
age  1982  1983  1984  1985  1986  1987  1988  1989  1990  1991  1992  1993
  2 0.003 0.007 0.044 0.010 0.006 0.054 0.009 0.041 0.097 0.103 0.078 0.013
  3 0.093 0.078 0.173 0.129 0.266 0.161 0.156 0.263 0.364 0.291 0.250 0.144
  4 0.470 0.374 0.232 0.339 0.401 0.535 0.321 0.395 0.554 0.423 0.315 0.292
  5 0.400 0.519 0.365 0.302 0.502 0.694 0.512 0.430 0.532 0.287 0.486 0.286
  6 0.430 0.381 0.416 0.310 0.311 1.003 0.608 0.535 0.425 0.347 0.264 0.374
  7 0.435 0.426 0.339 0.318 0.406 0.748 0.615 0.493 0.498 0.351 0.381 0.431
  8 0.435 0.426 0.339 0.318 0.406 0.748 0.615 0.493 0.498 0.351 0.381 0.431
   year
age  1994  1995  1996  1997  1998  1999  2000  2001  2002  2003  2004  2005
  2 0.021 0.066 0.020 0.088 0.022 0.052 0.014 0.096 0.041 0.096 0.106 0.197
  3 0.268 0.199 0.311 0.309 0.252 0.175 0.222 0.192 0.149 0.615 0.448 0.516
  4 0.409 0.454 0.378 0.523 0.303 0.263 0.266 0.287 0.434 0.412 0.424 0.444
  5 0.358 0.487 0.395 0.361 0.528 0.287 0.159 0.191 0.483 0.332 0.178 0.797
  6 0.299 0.363 0.518 0.349 0.240 0.424 0.268 0.177 0.206 0.248 0.168 0.188
  7 0.309 0.192 0.279 0.597 0.243 0.139 0.407 0.131 0.083 0.084 0.097 0.115
  8 0.309 0.192 0.279 0.597 0.243 0.139 0.407 0.131 0.083 0.084 0.097 0.115

attr(,"units")
[1] "f"
```

```
> summary.table

   year recruits  TSB  SSB landings YbySSB  Fbar
1  1970     3695 6709 6071     1785  0.294 0.390
2  1971    10180 6982 5895     1882  0.319 0.440
3  1972     3187 5277 4652     1450  0.312 0.451
4  1973    13141 6141 4831     1428  0.296 0.430
5  1974     5875 5697 4707     1307  0.278 0.444
6  1975     6688 5704 4963     1441  0.290 0.395
7  1976     3861 5035 4508     1463  0.325 0.427
8  1977    15813 4609 3946     1147  0.291 0.369
9  1978     9082 5381 4496     1106  0.246 0.357
10 1979     8932 6322 5238     1614  0.308 0.473
11 1980     5120 6070 5213     1941  0.372 0.633
12 1981     4585 5630 4922     1667  0.339 0.476
13 1982     2554 4330 3992     1338  0.335 0.434
14 1983     5800 4786 3976     1169  0.294 0.425
15 1984    16027 6549 4480     1058  0.236 0.338
16 1985    16754 7296 5335     1146  0.215 0.318
17 1986    26285 8931 6591     1995  0.303 0.405
18 1987     3766 8503 7114     2808  0.395 0.745
19 1988     3904 6197 5739     1999  0.348 0.514
20 1989     4696 5517 4999     1833  0.367 0.463
21 1990     6433 4802 4117     1583  0.384 0.503
22 1991    14178 5123 3875     1212  0.313 0.352
23 1992     5100 5062 4064     1259  0.310 0.361
24 1993     6726 4208 3688     1023  0.277 0.346
25 1994     6047 5772 4782     1374  0.287 0.344
26 1995     2178 4756 4341     1266  0.292 0.374
27 1996     3180 3768 3370     1002  0.297 0.392
28 1997     9830 3804 2835     1003  0.354 0.458
29 1998     7895 5168 3819      911  0.239 0.329
30 1999     6237 5267 4202      863  0.205 0.278
31 2000     6710 4465 3657      818  0.224 0.275
32 2001     5063 6315 5318     1053  0.198 0.197
33 2002     2851 5001 4601     1087  0.236 0.302
34 2003     3773 4684 4265     1014  0.238 0.269
35 2004     3785 3495 3064      699  0.228 0.217
36 2005     3463 3588 3021      856  0.283 0.386
```

> *short.term.inputs*

	N	Sel	M	mat	SWt	CWt
age 2	4641	0.133	0.1	0.38	0.128	0.159
age 3	2573	0.526	0.1	0.71	0.188	0.217
age 4	1663	0.426	0.1	0.97	0.244	0.270
age 5	1041	0.436	0.1	0.98	0.295	0.318
age 6	293	0.202	0.1	1.00	0.340	0.361
age 7	1102	0.098	0.1	1.00	0.380	0.399
age 8	2724	0.098	0.1	1.00	0.452	0.460

> *sol7a.stf.options*

TSB 2007	SSB 2007	Fmult	Fbar	Landings 2007	TSB 2008	SSB 2008
3619	3035	0.000	0.0000	0	4448	3819
3619	3035	0.200	0.0581	185	4256	3636
3619	3035	0.400	0.1162	356	4077	3467
3619	3035	0.600	0.1743	516	3912	3310
3619	3035	0.800	0.2324	664	3758	3164
3619	3035	1.000	0.2905	803	3616	3028
3619	3035	1.033	0.3000	824	3593	3007
3619	3035	1.200	0.3487	932	3483	2902
3619	3035	1.374	0.3991	1037	3374	2800
3619	3035	1.400	0.4068	1053	3358	2785
3619	3035	1.600	0.4649	1166	3243	2676
3619	3035	1.800	0.5230	1272	3134	2573
3619	3035	2.000	0.5811	1371	3033	2478

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TSB 2007	SSB 2007	Fmult	Fpa.mult	Fbar	Landings 2007	TSB 2008	SSB 2008
3619	3035	0.000	0.000	0.0000	0	4448	3819
3619	3035	0.207	0.200	0.0600	191	4250	3630
3619	3035	0.413	0.400	0.1200	367	4066	3456
3619	3035	0.620	0.600	0.1800	531	3897	3295
3619	3035	0.826	0.800	0.2400	683	3739	3146
3619	3035	1.033	1.000	0.3000	824	3593	3007
3619	3035	1.066	1.033	0.3098	847	3571	2986
3619	3035	1.239	1.200	0.3600	956	3458	2879
3619	3035	1.374	1.330	0.3991	1037	3374	2800
3619	3035	1.446	1.400	0.4200	1079	3331	2759
3619	3035	1.652	1.600	0.4800	1194	3214	2648
3619	3035	1.859	1.800	0.5400	1302	3104	2545
3619	3035	2.065	2.000	0.6000	1402	3001	2448

Part IV
figures

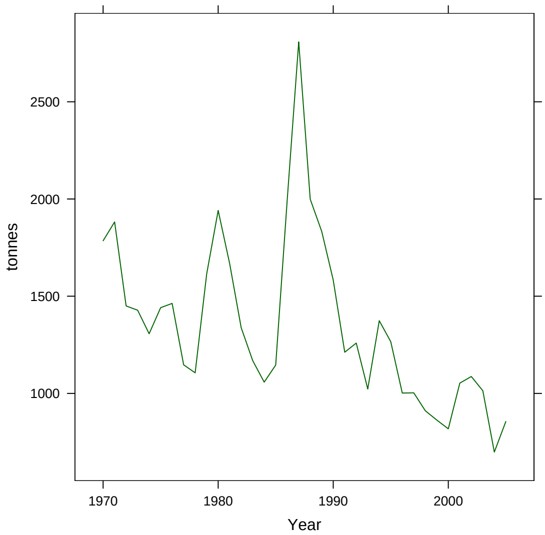

Figure 1: Irish Sea Sole: Total catch

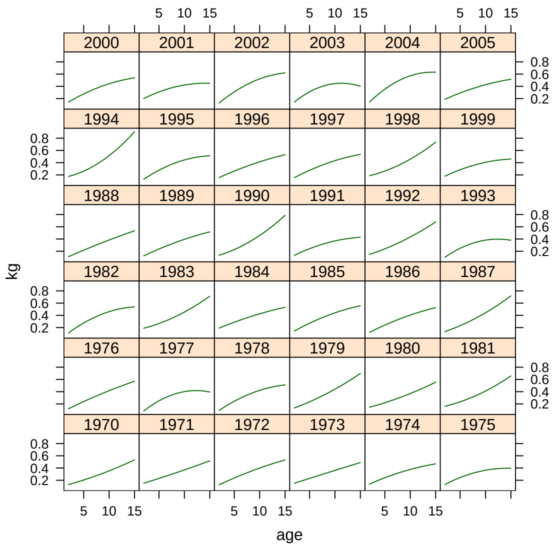

Figure 2: Irish Sea Sole: Catch weights at age by year

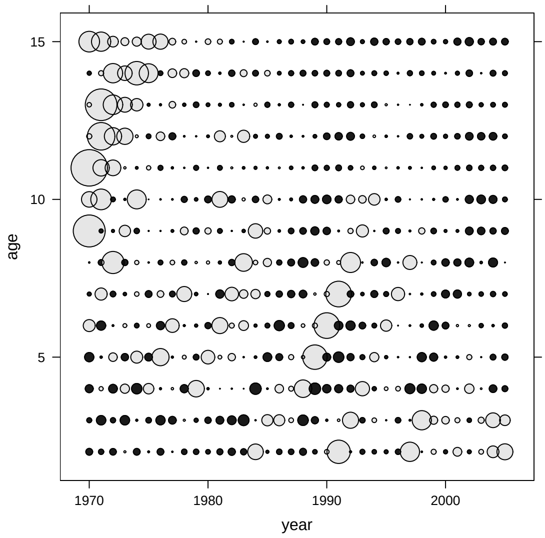

Figure 3: Standardised catch proportion at age

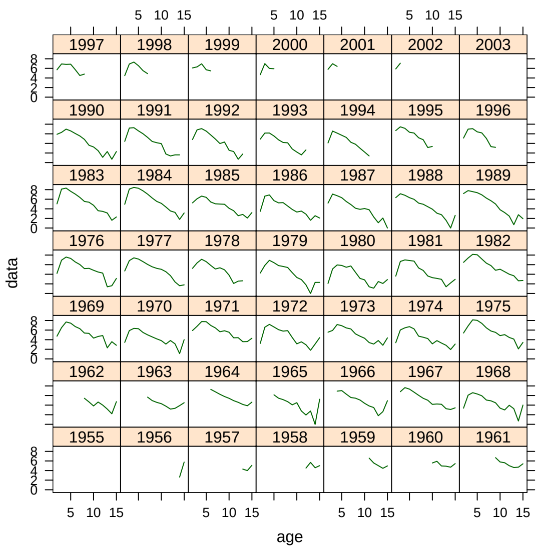

Figure 4: Log catch curves by cohort

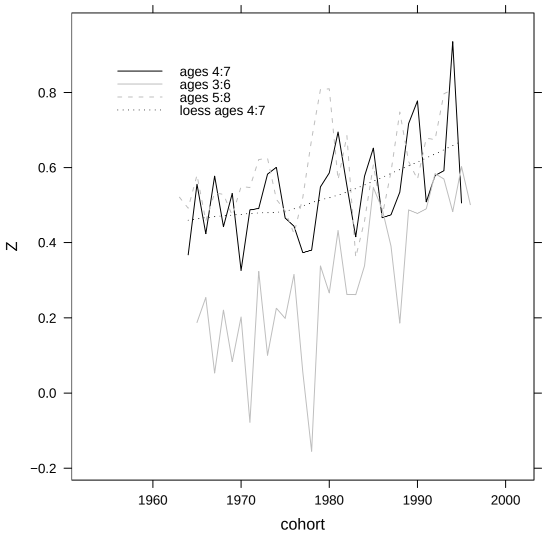

Figure 5: Catch curve gradients by cohort

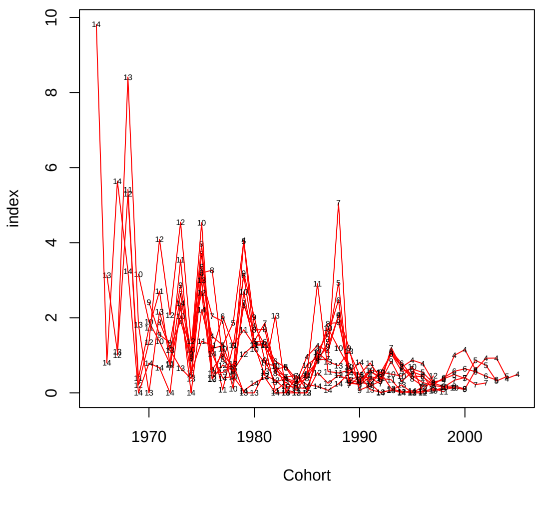

Figure 6: Belgian Beam Trawl tuning index by cohort

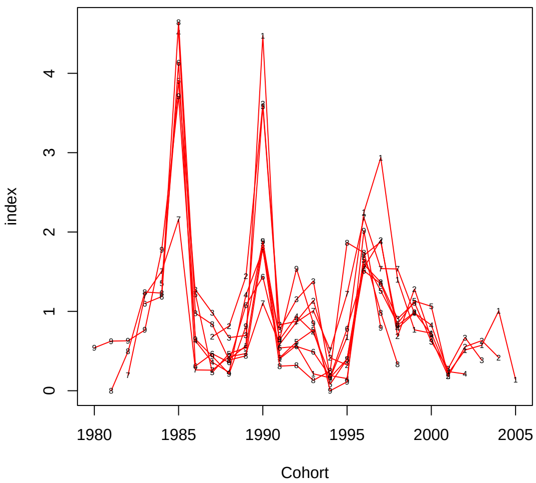

Figure 7: UK(EW)BTS Sept tuning index by cohort

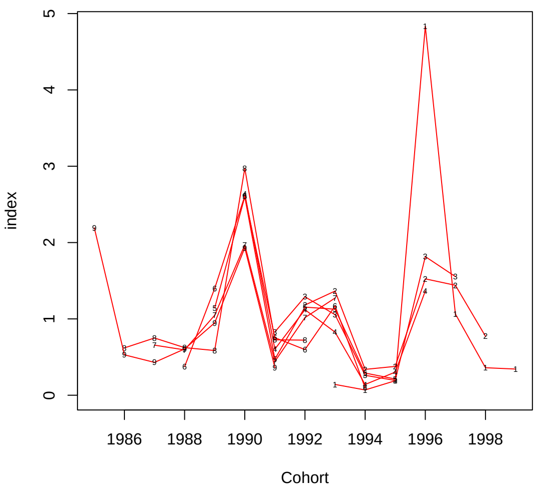

Figure 8: UK(EW)BTS Mar tuning index by cohort

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[1] "FLXSA"
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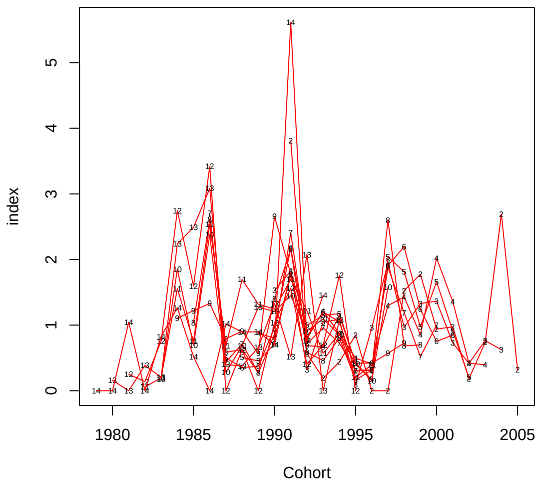

Figure 9: UK trawl tuning index by cohort

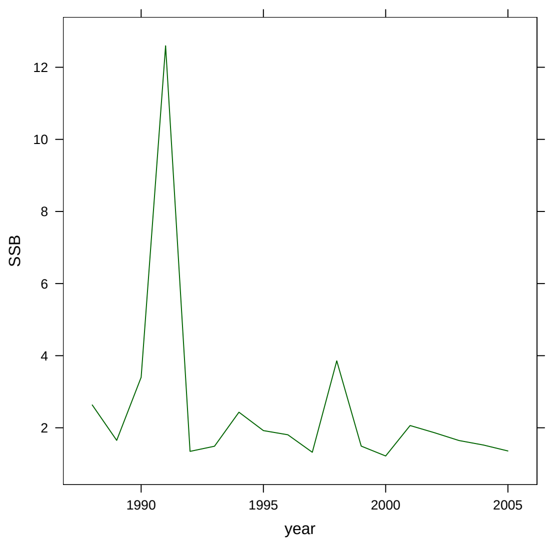

Figure 10: UK(EW)BTS Sept SURBA analysis: SSB

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[1] "FLXSA"
[1] "FLXSA"
[1] "FLXSA"
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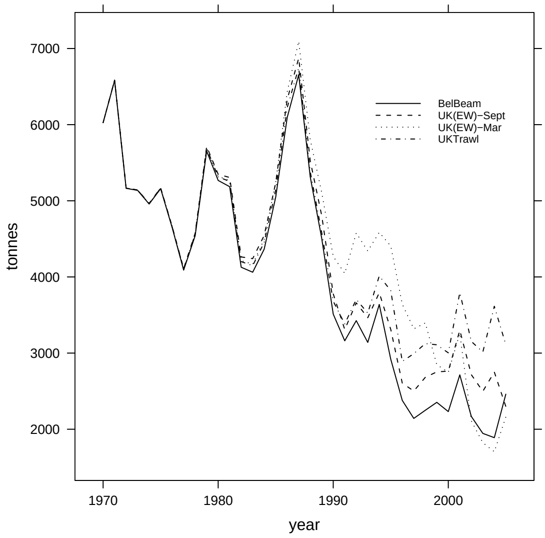

Figure 11: Single fleet XSA analyses: SSB

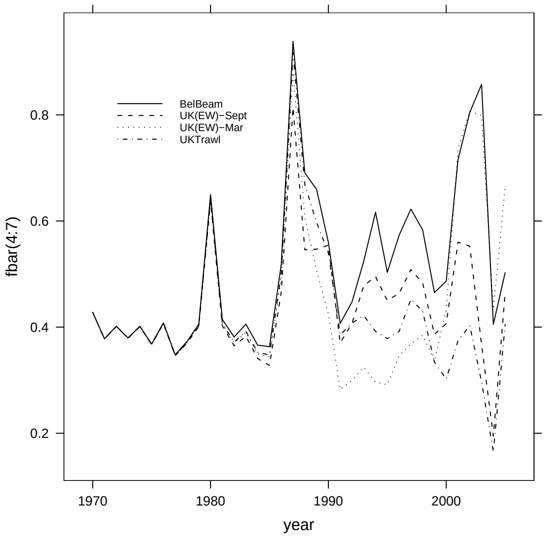

Figure 12: Single fleet XSA analyses: fbar(4:7)

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[1] "FLXSA"
[1] "FLXSA"
[1] "FLXSA"
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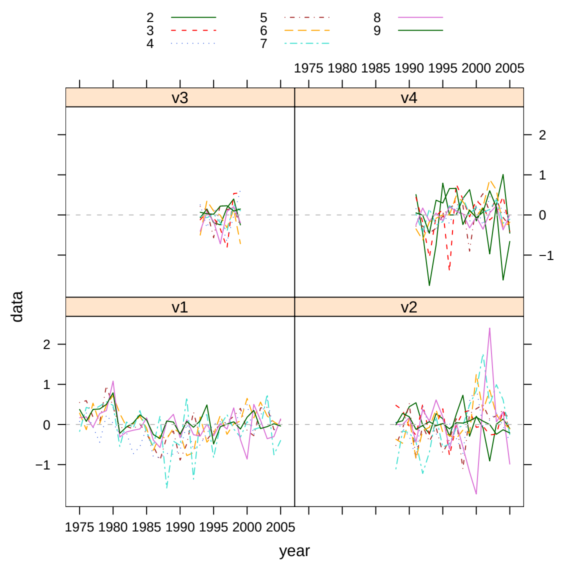

Figure 13: Single fleet XSA analyses: Log q residuals

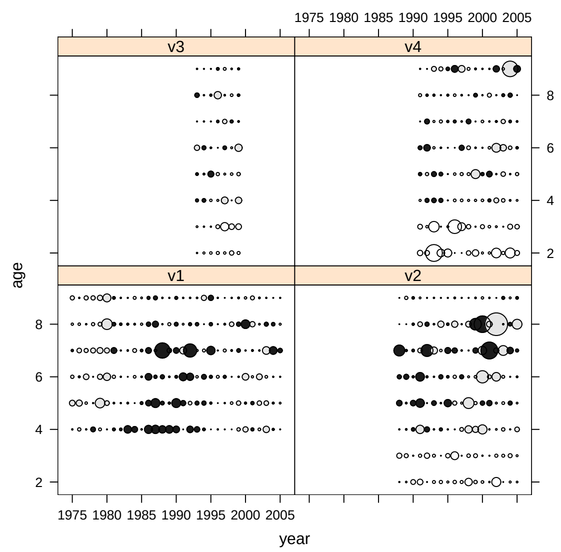

Figure 14: Single fleet XSA analyses: Log q residuals

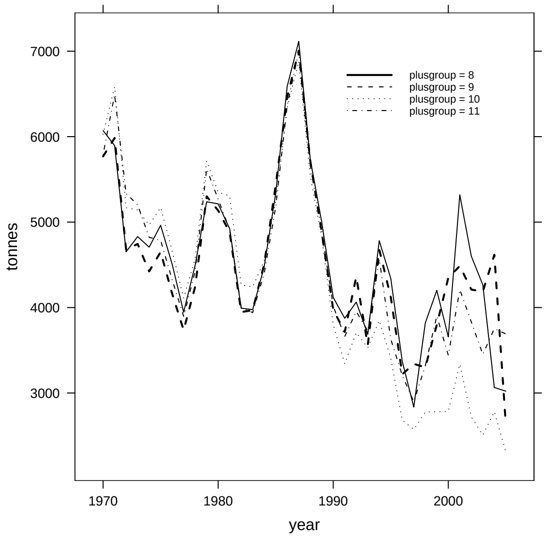

Figure 15: SSB resulting from different plusgroup settings

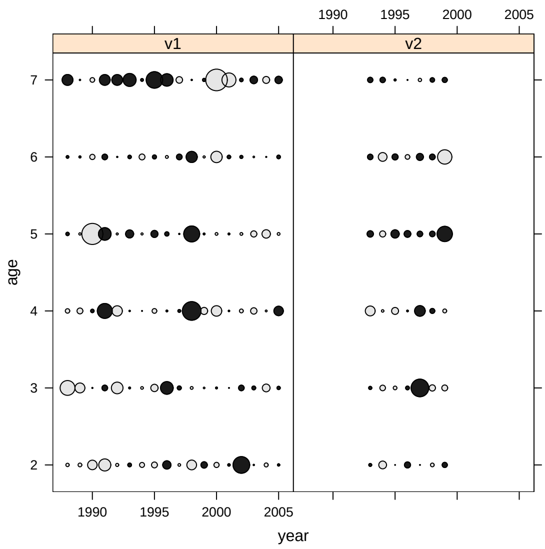

Figure 16: Log catchability residuals from final XSA

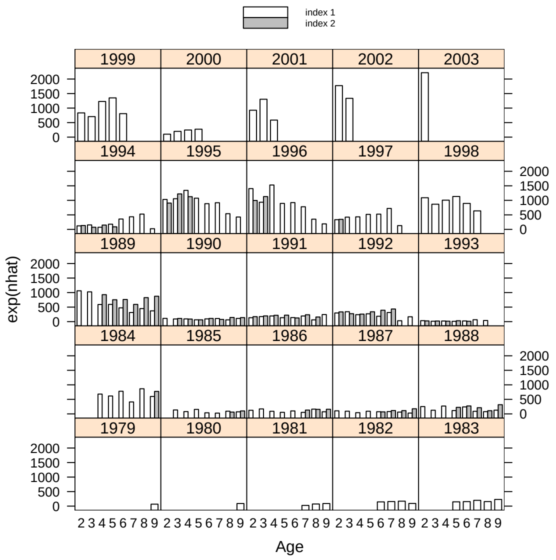

Figure 17: Survivors estimates by cohort for UK BTS survey from final XSA

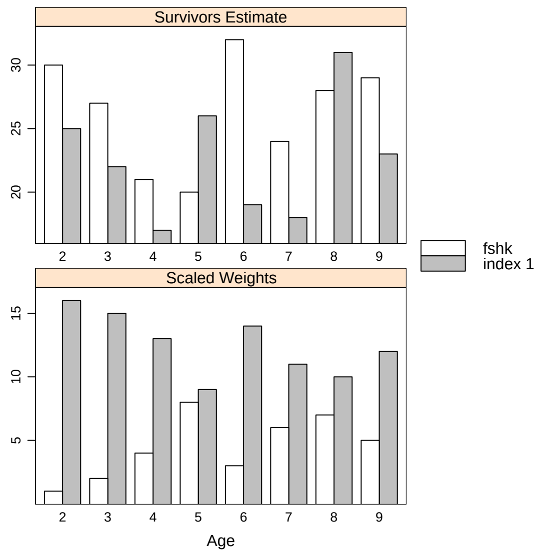

Figure 18: Fleet based survivors estimates and scaled weights from final XSA

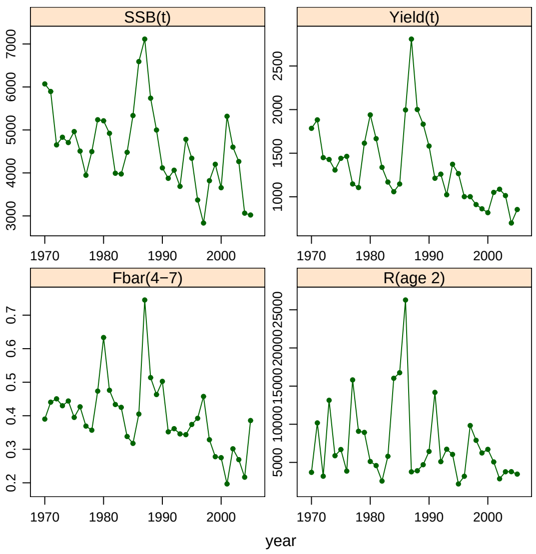

Figure 19: Summary plot of final assessment

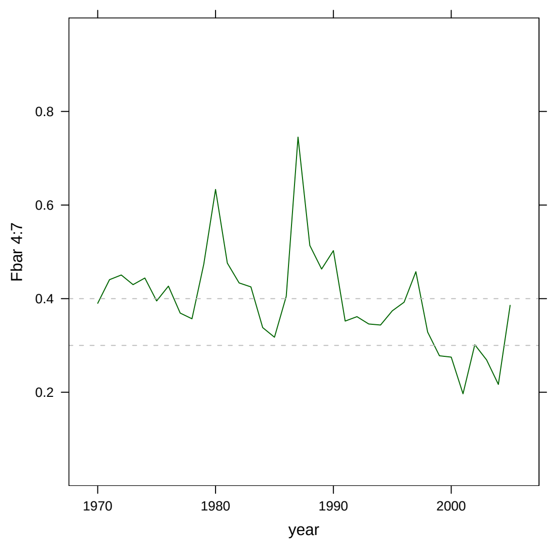

Figure 20: Mean fishing mortality ages 4:7

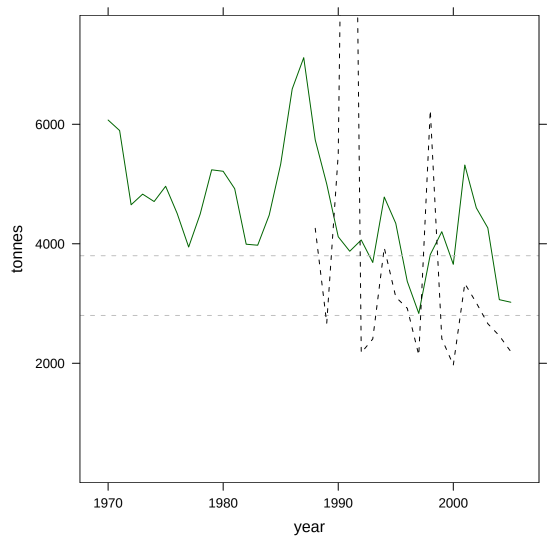

Figure 21: Spawning Biomass

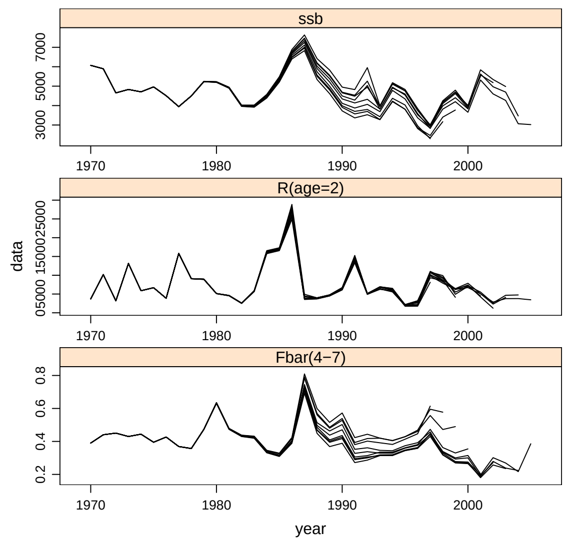

Figure 22: Retrospective analysis

Re-Assessment of *Nephrops* in the Irish Sea : Management Area J

R.Scott, M.Armstrong, N.Bailey, R.Briggs, J.Elson.
Lowestoft, 1-2 August 2006

A sub-group of WGNSDS members met during 1-2 August in Lowestoft to address specific issues raised by RGNSDS 2006 regarding the assessment of *Nephrops* in the Irish Sea.

1. Introduction

ACFM have recommended that underwater TV surveys could provide useful, fishery independent, information on the status of poorly assessed *Nephrops* stocks and have based the advice for the Fladen ground on this technique for a number of years. In 2006 WGNSDS conducted assessments using UWTV survey data for *Nephrops* stocks in management area C (FU11-13) and for FU15 in management area J. The method adopted for the derivation of the survey index and the assessment of *Nephrops* in FU15 was very similar to that used for stocks in management area C. However, a number of differences in the approach were considered to exist. These differences related primarily to the calculation of the UWTV abundance index.

This document details the methods used to derive indices of abundance from the UWTV surveys and highlights the similarities and dissimilarities between the approach used for the West of Scotland and that used for the Irish Sea. A revised estimate of abundance in 2005 for FU15 has been calculated and catch options for 2007 based on the revised estimates are presented.

2. Derivation of *Nephrops* population abundance estimates from underwater television (UWTV) surveys

2.1 Methodological background and process used for Irish Sea
The use of underwater television techniques to estimate *Nephrops* abundance was developed in Scotland during the 1980s and 1990s (Bailey et al 1993; Tuck et al 1997). Initially UWTV surveys were used to provide an index of abundance but have been further developed to provide an absolute estimate of population abundance – a description is given in Annex 2 of the 2005 WGNSSK report p834 (ICES, 2006). Recently, ICES working groups have presented a range of harvest rate landing options based on estimates from UWTV surveys (where available) and this has led to discussion of what appropriate harvest rates might be. Recommendations from STECF (2005) suggested that harvest rates based on $F_{0.1}$ were sustainable.

The method used to assess Irish Sea *Nephrops* is based on the approach developed in Scotland with modifications necessitated by local conditions and equipment availability. The western Irish Sea area of mud (FU15) is surveyed using a systematic grid approach with a spatial offset applied each year. This contrasts with the stratified random approach used in Scotland. Two vessels participate in the survey employing identical equipment and protocols on each. Between 144 -166 stations are surveyed using a 10 minute sledge run at each. Distance travelled is estimated from ship's navigation with a fixed width field of view assumed whereas in Scotland an odometer and rangefinder monitor track dimensions directly. The final work-up stages are the same as in Scotland. Detailed counts (see 2.2) are made in the laboratory and abundance estimates for the overall area surveyed by UWTV raised to the overall area of the mud (determined by reference to geological charts, direct observation and industry input). Commercial fishery data provide length compositions used in the derivation of a harvestable amount (see section 4 below) with an adjustment for discards based on ROI observer data.

2.2 Validation of burrow counts

A specific area of discussion has arisen relating to validation procedures and the treatment of variability in burrow counts between observers in the Irish Sea UWTV survey work. Although the ground-truthing of UWTV counts has not so far been possible, mechanisms aimed at providing some validation are in place. Participation of Irish scientists in Scottish surveys and Scottish scientists in Irish surveys has ensured exchange of expertise and cross-checking. Preliminary screening of the video recorded material is used to remove any runs where poor visibility or poor sledge contact with the seabed make counting impossible. In line with the Scottish approach, independent counts are made by more than one person ('counter') and an average taken. Where a large difference between counters is observed a recount takes place.

2.3 Other issues under discussion

Refinements and improvements to the method are continuing and WKNEPH 2006 identified a number of burrow counting issues requiring further attention – these include *inter alia* edge effects, other burrowing species, dual occupancy, empty burrows. A number of these will be addressed at a special ICES Workshop WKNEPHTV proposed for 2007 and adopted by PGCCDBS. Terms of reference for the meeting also include other aspects such as: survey design; improving biomass estimates from the surveys through estimation of size of burrows observed and animal size vs burrow size relationships; generation of a recruit index (again, making use of size information); further investigation of appropriate harvest rates consistent with observed selectivity and fishery patterns.

3. Survey indices and estimates of abundance

The NI August trawl survey has been conducted since 1994 and was adapted in 2003 to include part of a collaborative TV survey with the Republic of Ireland. As a consequence all the trawl stations are completed within a week of collecting the TV data. Where possible tides and *Nephrops* emergence behaviour are taken into account when trawling to optimise catch rates and provide representative LFDs of the population. The April survey has lower catch rates compared to the August survey due to seasonal emergence rhythms and is more subject to the effects of poor weather.

Between 1994 and 1998 the mean catch rates from the August survey fluctuated without any obvious trend. But from 1999 to 2002 they settled within 1 SE of each other, fluctuating around an average of 66 kg nm^{-1}. In 2003 there was a jump to a catch rate of 110 kg nm^{-1}. Since then the catch rate has declined to a level in 2005 that falls within the confidence limits of the 1992 to 2002 series (Figure 1).

This decline from 2003 to 2005 is consistent with the decline in abundance estimates from the TV surveys. As catch rates can be indicative of population size this corroborates the trend in the TV estimates and suggests that the indices calculated since the start of the TV series could be representative of population sizes larger than the ‘norm’.

The approach for calculating landings potential from TV surveys has been to use an average abundance index calculated over three years (ICES 1999). This, however, was developed for stocks where other population indicators were relatively static and the time series of TV estimates was relatively long. In this instance it is considered inappropriate to use three years because of the short time series and because of the apparent decline in stock size.

Since 2003 the trawl survey mean catch rates have been higher than previous observed values since 1994; they demonstrate the same declining trend as the TV estimates and only in 2005 does the value fall within the prior range. For this reason harvest options are provided using a point estimate from the 2005 TV survey.

4. Assessment Re-calculation and Management Options

The total burrow count for FU15 in the 2003-2005 surveys was calculated as the mean density for non-zero stations multiplied by the estimated survey area of 5,790 km^2. Zero stations were typically at or beyond the boundary drawn for calculating the survey area.

Table 1 summarises the statistics from the three UWTV surveys in 2003-2005. The mean density figure of 1.27 burrows m^{-2} for 2005 given in Table 14.14 of WGNSDS 2005 has been corrected to 1.16 m^{-2}.

The method of calculating an $F_{0.1}$ catch based on the UWTV surveys, given for FU15 in WGNSDS2005, converted the mean burrow count for 2003-2005 surveys to biomass before multiplying by a harvest rate of 0.20. Biomass was calculated using a mean weight obtained from trawl surveys. This differed from the method established for West-of-Scotland (VIa) and North Sea (IV) stocks, where the estimate of total <u>numbers</u> of burrows is multiplied by the harvest rate to give a figure of total numbers removed by the fishery (adjusted for discard survival). The numbers are then partitioned between landings and discards and landings numbers multiplied by the expected mean weight of landed *Nephrops*.

The $F_{0.1}$ catch for FU15 was recalculated using the method applied to stocks in areas VIa and IV. The $F_{0.1}$ harvest rate of 20% adopted for those stocks was also applied to FU15.

For stocks in the other two areas (VIa and IV), where a longer time series of UWTV survey observations are available, a three-year mean of recent abundance estimates has been used for forecasting future yields. In such instances, the surveys indicate an increasing abundance and traditionally, a mean of recent years has been taken to allow for uncertainty in the estimates for individual years. In this case (VIIa), however, only a short, 3-year, time series of abundance estimates is available. The series shows a declining trend and comparison with the UK(NI) August trawl survey indicates that it is deccreasing from the highest observed level in the trawl survey time series. A three-year mean of recent abundance estimates would not be appropriate in this instance.

The 2005 trawl survey index of abundance (75 Kg/nm) lies within the 95% confidence interval (47 to 77 Kg/nm) of the mean of the time series over the period 1994 to 2004. The development of stock abundance in future years is not clear but given the available evidence, the 2005 UWTV abundance estimate provides an appropriate value for use in projections.

A harvest rate of 20% ($F_{0.1}$) has been applied. Harvest rates of 25% and 15% are also provided for illustrative purposes.

Table 2 gives the details of the calculation. The length frequencies for male and female landings and discards are the means of the data for the international fishery in 2003-2005, raised up to the $F_{0.1}$ landings figure of 16,748t. A 25% survival rate of discards is assumed, based on studies in Scottish waters.

Table 3 summarises the total removals and landings figures.

5. Management considerations

Individual vessel quotas are restrictive and under-reporting of catches is known to occur. Reported landings are therefore likely to be an under-estimate of total removals from the fishery in FU15, particularly if the stock has increased over time as indicated by the trawl survey results.

Both the UWTV survey and the trawl survey indices indicate that the stock has declined in recent years from the high levels of 2003. However, the trawl survey catch rates in 2005 remain at a level above the long-term geometric mean. The likely trajectory of stock abundance in future years remains unclear, but evidence from trends in population data (mean size and sex ratio, see 2006 WGNSDS report) would suggest that the fishery is able to sustain current exploitation levels.

Nephrops in Sub-Area VII are broken down into 3 management areas (MA) and 7 functional units. MA J (FU 14 & 15), MA L (FU 16 - 19) and MA M (FU 20 - 22). An annual TAC applies to the whole of Sub-Area VII. The landings estimate for 2007 from FU15 assuming a 20% harvest rate and biomass based on the 2005 estimate is 16,748 t. If the management area L and M allocation remains at the 2003 level of 3,300 and 4,600 t respectively and allocated landings for FU14 remain at 500 t, then the TAC for Sub-Area VII in 2007 would be 25,148t This represents an approximate 17% increase on the TAC for 2006 (21,498 t).

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ICES, 2006. ICES WGNSSK 2005. ICES Advisory Committee on Fisheries Management CM 2006/ACFM:09

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Tuck, I.D., Chapman, C.J., Atkinson, R.J.A., Bailey, N. and Smith, R.S.M. 1997. A comparison of the methods for stock assessment of the Norway lobster, *Nephrops* norvegicus, in the Firth of Clyde. Fisheries Research, 32, 89-100.

TABLES

Table 1. Summary table of NI/ROI collaborative UWTV surveys of *Nephrops* grounds in 2003, 2004 and 2005.

Year	No. stations	Non Zero stations	total area of tows (M2)	Burrow count for tow tracks	Mean of density estimates (No./m2)	St.dev of density estimates	SE of mean density	CV of mean	Mean density raised to survey area (X10^3)	-2SE	+2SE
2003	166	147	27566	42493	1.66	0.87	0.07	4.3%	9,614,257	8,779,531	10448983
2004	147	131	23214	38484	1.43	0.75	0.07	4.6%	8,288,735	7,527,584	9049887
2005	144	125	21415	22100	1.16	0.59	0.05	4.6%	6,728,971	6,113,721	7344221
							2003-05	Mean	8,210,654		
	Survey area	5790	km2				2004-05	mean	7,508,853		

Table 2. Calculation of total removals and landings of FU15 *Nephrops* for $F_{0.1}$ harvest rate of 20% applied to total burrow count in 2005 UWTV survey. Length frequencies are mean 2003-05 international fishery LFDs raised to potential $F_{0.1}$ removals in 2005.

Males — Weight = a*CLb; a = 0.00032; b = 3.21

Females — a = 0.00068; b = 2.96

Mean 2003-05 international removals raised to 20% of 2005 survey burrow count

CL	Males Landings ('000)	Males Discards ('000)	Males Removals ('000)	Males Removals (t)	Males Landings (t)	Females Landings ('000)	Females Discards ('000)	Females Removals ('000)	Females Removals (kg)	Females Landings (t)
10.5	0	7	5	0	0	0	0	0	0	0
11.5	0	0	0	0	0	0	2	2	0	0
12.5	0	0	0	0	0	0	0	0	0	0
13.5	0	0	0	0	0	0	106	80	0	0
14.5	0	337	252	0	0	0	471	353	1	0
15.5	0	176	132	0	0	0	273	205	0	0
16.5	2	783	589	2	0	0	1036	777	2	0
17.5	43	1792	1387	4	0	77	3040	2357	8	0
18.5	196	4178	3330	12	1	333	5741	4639	18	1
19.5	661	9024	7429	33	3	737	10326	8481	38	3
20.5	1459	15904	13387	70	8	1706	18040	15236	79	9
21.5	3704	21463	19801	120	22	4932	29386	26972	161	29
22.5	8324	28071	29377	206	58	10181	35321	36672	251	70
23.5	15662	34561	41583	335	126	17035	39409	46591	362	132
24.5	25148	36840	52778	486	232	24914	38985	54153	476	219
25.5	36368	32452	60707	636	381	32823	33772	58152	576	325
26.5	43349	26640	63328	751	514	38139	26544	58047	644	423
27.5	54168	19361	68689	917	723	40291	16423	52608	652	499
28.5	57403	13781	67738	1014	859	37309	8532	43708	602	514
29.5	63394	8804	69998	1170	1060	33048	4647	36533	557	504
30.5	57521	5476	61628	1147	1070	25535	2347	27295	459	430
31.5	47788	3113	50123	1035	986	17685	1378	18719	347	327
32.5	40220	1792	41565	948	918	13279	653	13769	280	270
33.5	33602	832	34226	861	845	10046	343	10303	229	223
34.5	28894	0	28894	799	799	7750	0	7750	188	188
35.5	21549	0	21549	653	653	5413	0	5413	143	143
36.5	16773	0	16773	556	556	3801	0	3801	109	109
37.5	12371	0	12371	447	447	2562	0	2562	79	79
38.5	11060	0	11060	435	435	2113	0	2113	71	71
39.5	7518	0	7518	321	321	2088	0	2088	76	76
40.5	4706	0	4706	218	218	1189	0	1189	46	46
41.5	3380	0	3380	169	169	1042	0	1042	44	44
42.5	2097	0	2097	113	113	558	0	558	25	25
43.5	1300	0	1300	76	76	809	0	809	39	39
44.5	1283	0	1283	80	80	394	0	394	20	20
45.5	501	0	501	34	34	290	0	290	16	16
46.5	576	0	576	42	42	303	0	303	18	18
47.5	341	0	341	26	26	147	0	147	9	9
48.5	241	0	241	20	20	125	0	125	8	8
49.5	251	0	251	22	22	0	0	0	0	0
50.5	296	0	296	28	28	46	0	46	3	3
51.5	89	0	89	9	9	42	0	42	3	3
52.5	90	0	90	10	10	33	0	33	3	3
53.5	0	0	0	0	0	73	0	73	6	6
Total	602328	265386	801367	13,802	11,862	336847	276774	544427	6,649	4,886

Note "removals" includes 75% of discards

proportion landed 0.8189 by weight; 0.6979 by number

Landings calculation for 20% removals:

	mean	burrows -2SE
TV burrow count (thousands)	6,728,971	6113721
catch number:	1345794	1222744
Proportion landed	0.6979	0.6979
number landed	939175	853303
mean wt landed	0.0178	0.0178
landings:	**16,748**	15217

Table 3. Catch options for 2007 for different harvest rates using the burrow count only for 2005..

Surveys used	Burrow count x 10^{-3}	Harvest rate	Removals (t)	landings (t)
(i) 2005	6,728,971	25%	25,564	20,935
		20% (F0.1)	20,451	16,748
		15%	15,338	12,561

FIGURES

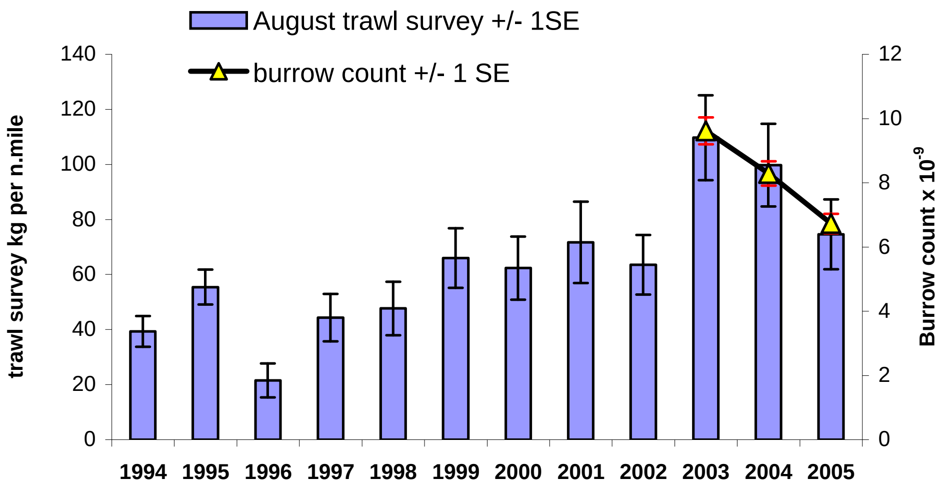

Figure 1. Indices of abundance from the UK(NI) August trawl survey and the underwater TV survey.