

**Final Report**

***Irish Sea Roundfish Surveys***

Prepared by:

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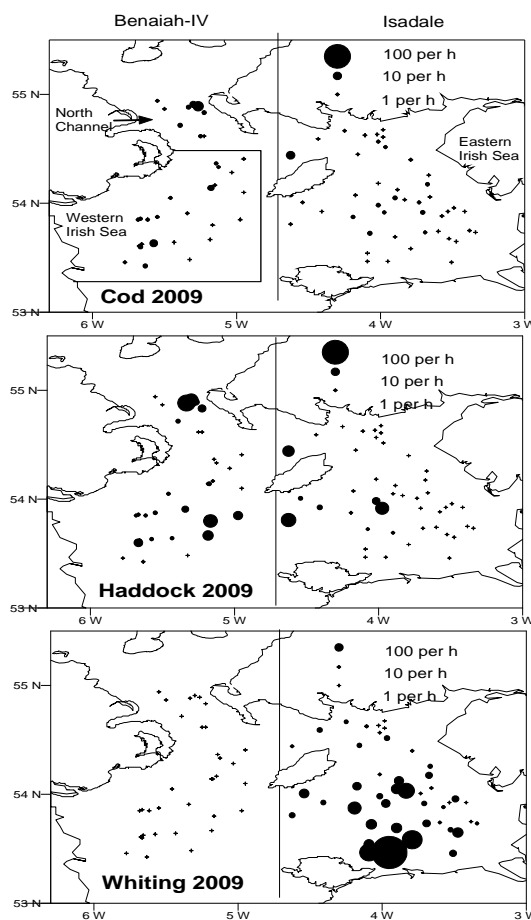
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## Summary: 2008/09 FSP Irish Sea Roundfish surveys and time-series data

This report presents the results of the sixth in a series of FSP surveys of cod, haddock and whiting in the Irish Sea that commenced in spring 2004, and evaluates the time-series of data on catch-rates, distribution and age composition. In 2009, the commercial whitefish otter trawler FV *Isadale* (Fleetwood) completed 44 valid tows of average duration 4.3 h in the eastern Irish Sea from 16 to 27 February. The midwater trawler *Benaiah IV* (Kilkeel) completed 34 valid tows of average duration 6.1 h in the western Irish Sea and North Channel from 9 to 20 February.

The *Isadale* (skipper Steve Whelan) fished with an otter trawl (80 mm codend) throughout the eastern Irish Sea while *Benaiah IV* (skipper John Teggarty) fished with a semi-pelagic trawl (100 mm codend) in the western Irish Sea, North Channel and the outer Clyde. The maps show the distribution of cod, haddock and whiting during these 2009 FSP surveys. The cod fishery closure in the Irish Sea is indicated in Figure S1.



**Fig. S1.** Distribution patterns in 2009 FSP

Cod were again widely distributed in 2009, but catch rates were still generally poor. The latter averaged only 1.1 fish per h in the *Isadale* survey and 2.3 fish per h in the *Benaiah IV* survey. The highest catch rates of cod were recorded just south of the Clyde in the North Channel, on the spawning grounds off the Irish Coast and off Morecambe Bay in the east, and off the northwest and west coasts of the Isle of Man (Fig. S1).

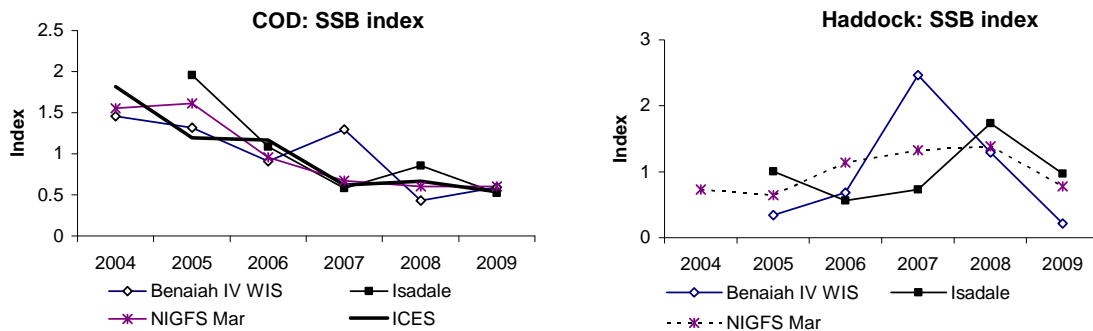
Haddock were most abundant in the western Irish Sea, North Channel and near the Isle of Man. The *Benaiah IV*'s catch rates of haddock were very poor in 2009, whereas those of the *Isadale* were close to average.

As in previous years, whiting were most abundant in the southern part of the eastern Irish Sea. The catch rates in 2009 were the largest in the series. The small numbers of whiting taken by *Benaiah IV* reflect the large mesh (100 mm) codend used, as well as the scarcity of large whiting in the western Irish Sea.

The catches of cod, haddock and whiting in the western and eastern Irish Sea in the 2004-2009 FSP roundfish surveys were dominated by young fish up to four years of age, with very few fish more than 5 years old (Tables S1 – S3 below). The age compositions of cod in the surveys reflect the results of ICES assessments, indicating a continued high mortality rate with no signs of a significant recovery in age composition. The very steep age profile

indicates that some 80% of adult cod are lost from the Irish Sea stock each year. This could be due to fishing, natural death or emigration.

Overall, the trends in abundance of cod from the FSP surveys are roughly similar to the trends given by the most recent ICES assessment for cod and the main trawl survey series used by ICES for cod (Fig. S2). There is currently no ICES assessment for Irish Sea haddock, but the FSP survey indices appear more variable than the indices from Northern Ireland's Agri-Food and Biosciences Institute (AFBI) research trawl survey in March (Fig. S2).



**Fig. S2.** Trends in spawning-stock biomass (SSB) of cod and haddock in the Irish Sea given by FSP surveys compared with the ICES (2008) assessment model result for cod and the AFBI groundfish survey index of SSB for haddock.

**Table S1** FV *Isadale*: Mean catch-rates (numbers per h) of cod, haddock and whiting for the whole of the eastern Irish Sea, by age class, in the period 2005–2009.

<b>COD</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2005	0.060	4.020	0.250	0.380	0.004	0.010	0.000	4.71
2006	0.830	0.770	0.670	0.007	0.042	0.000	0.001	2.32
2007	0.590	1.430	0.090	0.080	0.000	0.000	0.000	2.19
2008	0.012	1.796	0.317	0.016	0.028	0.003	0.008	2.18
2009	0.501	0.355	0.211	0.091	0.007	0.004	0.000	1.17

<b>Haddock</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2005	0.09	2.65	0.20	0.45	0.00	0.01	0.00	3.40
2006	2.55	2.45	0.38	0.01	0.03	0.00	0.01	5.43
2007	1.81	3.10	0.52	0.06	0.00	0.01	0.00	5.50
2008	0.39	8.09	0.87	0.01	0.00	0.00	0.00	9.36
2009	0.23	1.12	1.74	0.22	0.01	0.00	0.00	3.33

<b>Whiting</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2005	0.22	11.06	21.12	5.28	0.98	0.00	0.69	39.3
2006	8.69	46.65	15.22	1.85	0.53	0.01	0.00	72.9
2007	4.24	10.77	5.55	1.01	0.28	0.02	0.00	21.9
2008	3.70	10.29	8.58	1.99	0.38	0.29	0.00	25.2
2009	27.30	84.91	48.67	3.61	0.33	0.00	0.00	164.8

**Table S2.** FV *Benaiah IV*: Mean catch-rates (numbers per h) of cod by age class, 2004–2009. (The time-series of *Benaiah-IV* indices for cod and haddock have been reworked this year using a more appropriate spatial stratification scheme, and the results are therefore altered from previous FSP reports.)

<b>COD: western Irish Sea</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2004	0.000	0.350	2.500	0.250	0.250	0.042	0.000	3.390
2005	0.000	0.370	1.355	1.032	0.099	0.023	0.044	2.923
2006	0.000	0.083	1.745	0.253	0.073	0.011	0.005	2.170
2007	0.000	0.672	1.636	0.715	0.070	0.073	0.036	3.203
2008	0.004	0.068	0.560	0.135	0.097	0.019	0.022	0.905
2009	0.012	0.078	0.759	0.312	0.087	0.017	0.010	1.276

<b>COD: North Channel</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2005	0.000	0.651	1.621	0.829	0.024	0.030	0.000	3.155
2006	0.015	2.291	6.964	1.102	0.225	0.007	0.013	10.617
2007	0.041	0.374	0.104	0.079	0.000	0.000	0.000	0.598
2008	0.000	0.816	1.847	0.190	0.035	0.023	0.007	2.918
2009	0.000	0.529	2.675	0.627	0.147	0.018	0.021	4.018

<b>COD: Total Irish Sea</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2005	0.000	0.427	1.409	0.990	0.084	0.025	0.035	2.970
2006	0.003	0.536	2.815	0.427	0.104	0.010	0.007	3.901
2007	0.008	0.611	1.322	0.585	0.055	0.058	0.029	2.669
2008	0.003	0.221	0.824	0.147	0.084	0.020	0.019	1.317
2009	0.009	0.171	1.152	0.377	0.099	0.018	0.012	1.838

**Table S3.** FV *Benaiah IV*: Mean catch-rates (numbers per h) of haddock by age class 2005–2009 (no age compositions for haddock in 2004). (The time-series are revised).)

<b>Haddock: western Irish Sea</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2004								72
2005	0.000	0.993	0.508	1.983	0.203	0.245	0.021	3.9
2006	0.383	9.459	6.958	0.373	0.897	0.000	0.036	18.1
2007	0.247	53.295	45.645	7.455	0.876	0.162	0.025	107.7
2008	0.000	5.291	11.660	8.486	0.842	0.158	0.037	26.5
2009	0.000	0.684	3.612	1.052	0.408	0.059	0.022	5.8

<b>Haddock: North Channel</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2005	0.000	4.804	5.380	16.616	0.631	0.298	0.009	27.7
2006	0.015	1.114	8.802	1.217	1.959	0.210	0.097	13.4
2007	0.055	1.722	4.851	1.764	0.000	0.088	0.000	8.5
2008	0.000	2.195	17.396	2.275	0.609	0.000	0.159	22.6
2009	0.000	0.579	5.455	2.960	1.056	0.334	0.068	10.5

<b>Haddock: Total Irish Sea</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2005	0.000	1.774	1.506	4.981	0.291	0.256	0.018	8.8
2006	0.308	7.749	7.336	0.546	1.115	0.043	0.048	17.1
2007	0.208	42.727	37.286	6.289	0.697	0.147	0.020	87.4
2008	0.000	4.657	12.836	7.213	0.794	0.126	0.062	25.7
2009	0.000	0.662	3.990	1.443	0.541	0.115	0.031	6.8

## Introduction

The Irish Sea roundfish survey was developed in 2003 as a fully collaborative project between the fishing industry and Cefas scientists. It forms part of the UK Fisheries Science Partnership funded by the UK's Department for Environment, Food and Rural Affairs (Defra). The scope of the FSP programme, and reports for all completed projects, are available on the FSP page of the Cefas website ([www.cefas.co.uk/fsp](http://www.cefas.co.uk/fsp)).

The main objective of the Irish Sea roundfish survey is to develop a time-series of data to track year-on-year changes in abundance, population structure and distribution of the target species (cod, haddock and whiting). The results of the surveys provide information supporting the scientific assessment of the stocks and the management of the fisheries in the Irish Sea.

The first FSP surveys of Irish Sea roundfish were conducted in spring 2004 using the semi-pelagic trawler *Benaiah IV* (Kilkeel) and the otter trawler *Kiroan* (Fleetwood) (Cotter *et al.* 2004a and b). The *Benaiah IV* fished in the western Irish Sea, and the *Kiroan* covered two relatively small cod hotspots 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, and the FV *Isadale* (Fleetwood) fished a rockhopper otter trawl throughout the eastern Irish Sea (Armstrong *et al.* 2005). As the survey design and fishing methods appeared promising for developing a time-series of data, they formed the basis for an open tender for appropriate vessels to carry out equivalent surveys in subsequent years. The *Benaiah IV* and the *Isadale* were chartered and repeated the survey in 2006, 2007 and 2008. A further three years were then funded to cover surveys from 2009 to 2011. The results of the 2006–2008 surveys are reported in Armstrong *et al.* (2006, 2007, 2008). The surveys in spring 2009 are described in the present report, and the trends in abundance, distribution and population structure from all time-series of surveys are reported. The difference between the 2009 *Benaiah* survey and earlier years was a shortening of the survey period and the exclusion of the areas north of ICES Division VIIa (i.e. the Clyde closure and the northern part of the North Channel were excluded).

The workplan for the surveys involved trawling under dispensation from the quota regulations. Dispensations were also provided for fishing in the cod closures in the western Irish Sea, and through the Irish Foreign and Commonwealth Office for carrying out a survey in Irish waters.



Catch coming on board *Benaiah IV*

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# Objectives

The objective of the *Benaiah IV* and *Isadale* surveys in 2009 was to repeat the FSP surveys of cod, haddock and whiting in the Irish Sea carried out from 2005 to 2008 to provide time-series data of abundance, distribution and population structure of cod, haddock and whiting<sup>1</sup>.

# Methods

## Survey design

The surveys were designed to achieve full coverage of potential cod, haddock and whiting habitats within the area of the main roundfish fisheries of the Irish Sea, while deploying additional trawling effort in areas expected to have the greatest densities of cod, haddock or whiting. The design agreed between Cefas and the vessels is given in the Detailed Operational Plans for each vessel (Appendices 1 and 2).

In order to provide adequate spatial coverage, the *Benaiah IV* survey area was divided into blocks of 15 minutes (latitude) by 20 minutes (longitude), with the intention to make one tow in each block. The *Isadale* survey was divided into blocks of 10 minutes (latitude) by 20 minutes (longitude). The different block size for the two surveys reflects the different anticipated average tow durations of the two vessels (nominally 6 h for *Benaiah IV*, 4 h for *Isadale*).

Additional tows were permitted in rectangles where high densities of cod, whiting or haddock were anticipated. The number of additional tows per rectangle was expected to vary depending on the abundance of cod in each rectangle, up to a maximum of two additional 6-h tows for *Benaiah IV* and three additional 4-h tows for *Isadale*. The resultant spatial differences in fishing intensity were allowed for at the analysis stage.

## Vessels and gears

The *Benaiah IV* changed ownership and skipper before the 2008 survey, but the previous skipper/owner (Mr Dennis Jones) was on board in 2008 to advise on fishing grounds during the first two trips of the three-trip survey, to ensure continuity of the survey. The vessel is an 18.76 m (registered length), 451 kW trawler operating out of Kilkeel. The gear used was a 22 × 14 fm semi-pelagic trawl of the type used for whitefish fishing by vessels from Northern Ireland. A net diagram supplied by the skipper in 2005 is given in Appendix 5. The net has very large meshes in the wings and front panel (3200 mm stretched mesh) grading down to 100 mm (single braided twine) in the codend. The 3.4 m<sup>2</sup> (360kg) Poly Ice trawl doors were deployed with 20 fm bridles. This type of net is towed with the footrope very close to (or on) the seabed, with a net opening of 8–10 fm (15–18 m) and an average door spread of about 50 m. Typical speed over the ground averages 2–2.5 knots.

The *Isadale* is a 24.4 m (registered length), 447 kW trawler operating out of Fleetwood. The gear used was a Boris rockhopper otter trawl with 118 ft headline and 160 ft ground gear comprising 100 ft of 14-inch hoppers and 2 × 30 ft ground chains. The net was towed on 40 fathom bridles and attained an average door spread of about 140 ft (43 m). A codend of 80

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<sup>1</sup> A more-or-less comparable coverage of the western Irish Sea by *Benaiah IV* in 2004 allows the time-series for cod in this area to be extended back to 2004 (no age data were collected for haddock in 2004).

mm × 4 mm double twine was fitted. A 90 mm square-mesh panel was fitted 10–12 m from the codend. Typical speed over the ground averages 2.5–3 knots.

## Sampling methods

Sampling of all catches was carried out using standard methods employed by Cefas on FSP trips. This entailed recording the numbers and lengths of all the large or unusual fish that stand out from the rest of the catch, and sorting, counting and measuring a known fraction of the remaining catch of smaller fish. Numbers in this sample were then raised to total numbers in the haul. Data were recorded separately for fish discarded and retained, although no distinction is made for computing abundance indices.

Otoliths from samples of cod, haddock and whiting were taken to determine the age of the fish, and to allow the age composition of the catches to be calculated. Numbers of whiting taken on the *Benaiah IV* were too small to warrant calculation of age compositions. The otolith sampling schemes are given in the Detailed Operation Plans (Appendices 1 and 2).

## Data analysis

### *Survey stratification and calculation of mean catch rates*

The *Benaiah IV* and *Isadale* surveys both employ a design using small statistical rectangles as the basic survey strata. The intention is to treat the tows within each of these strata as more-or-less random samples of fish abundance, and to calculate the average catch rate (numbers of fish per hour towed) as the total numbers caught in each stratum divided by the total duration of all tows in the stratum:

$$C_s = \sum_{h,s} C_{h,s} / \sum_{h,s} T_{h,s} \dots\dots\dots (1)$$

where  $C_s$  is the mean numbers caught per hour in stratum  $s$ ,  $C_{h,s}$  the total catch numbers in tow  $h$ , stratum  $s$ , and  $T_{h,s}$  is the tow duration (h) for tow  $h$ , stratum  $s$ . The overall mean catch rate for a survey is then obtained as an average of the stratum (rectangle) values. Where there are additional tows carried out in rectangles with expected high abundance of fish, these act to improve the precision of the abundance indices without introducing significant bias.

The analysis requires that each tow during the survey is allocated to a stratum (statistical rectangle). This has been possible for the *Isadale* surveys, where the tow duration is fairly consistent around 4 h (see Table 1). Tows often stray to some extent across rectangle boundaries, and the allocation to a rectangle is based on the rectangle in which the bulk of the tow took place.

This approach has proved impossible to apply in previous *Benaiah IV* surveys owing to the number of very long tows passing through several rectangles. The original survey design based on 15' × 20' rectangles was being used in only a very loose fashion to try and spread the survey effort across the area, but the rectangles were too small to be used as a basis for analysis. The previous analyses therefore lumped the rectangles into two large strata (the western Irish Sea and the North Channel) and one smaller one (the Clyde spawning closure). The tows in the resultant strata were treated as more-or-less random transects of differing length, and the mean catch per hour in each stratum was determined as the total catch divided by total tow duration over all the tows, as in Equation (1) above.

The previous analytical method for *Benaiah IV* surveys was less than satisfactory because of the clumping of tows within the larger strata (a consequence of allowing additional tows in areas of greater fish abundance). An evaluation of the data collected over the full time-series indicates that a further stratification of the western Irish Sea area is required to reduce bias caused by non-random tow distribution. The density of tows is often higher on or around the known spawning concentrations of cod off the Irish Coast between Dundalk Bay and Dublin, so this was designated as a separate stratum (WIS2) for this year's analysis. The remaining area of the western Irish Sea was then subdivided into two separate strata north and south of 54°N (WIS1 and WIS3). The new stratification scheme is shown in Fig. 1. The mean catch per hour in each of the new strata was calculated using Equation (1). The mean catch rates (numbers per h by species and length class) for the western Irish Sea as a whole were calculated as weighted means of the catch rates in WIS1–WIS3, using the approximate number of 15' × 20' rectangles in each stratum as weighting factors:

$$C_{WIS} = (3.5 * C_{WIS1} + 2.67 * C_{WIS2} + 4.5 * C_{WIS3}) / 10.67 \dots\dots\dots(2)$$

The *Benaiah IV* tow durations in 2009 were more closely controlled around the 6-h nominal tow duration than in previous years, when some tows exceeded 10 h.

To ensure compatibility throughout the time-series for the *Benaiah IV* surveys, data for 2005–2008 were reworked using the new stratification scheme. This included removing a few North Channel stations north of 55°N (i.e. in Area VIa South) in the 2005–2008 data, as this area has been excluded from the survey since 2009. The 2004 survey employed a high density of stations throughout the new western Irish Sea strata WIS2 and WIS3, but excluded WIS1. This renders the 2004 survey less compatible with the full time-series. However, an evaluation of the relative catch rates of cod in WIS1–WIS3 in the years 2005–2009 does not indicate a consistent difference between the catch rates in WIS 1 and in WIS2/3. Hence, the original 2004 data have been included in the present report for computing time-series of spawning-stock biomass (SSB) indices for the western Irish Sea.

The revision of the 2005–2008 data means that the abundance indices for the *Benaiah IV* in this year's report do not match those in previous FSP reports.

#### *Distribution patterns*

The mean numbers of cod, haddock and whiting caught per h in each tow were calculated and mapped to show the distribution pattern of abundance for each species. Note that the results for the *Benaiah IV* and *Isadale* are not comparable in absolute terms because of the different trawl gear used.

#### *Length compositions*

The length frequencies of the catch of each species are presented as the numbers in each 2-cm length class per h fished. The average length frequency was determined for each species in each of the following two areas in the *Benaiah IV* survey (see Fig 1.):

- 1) The North Channel from 54°30'N to 55°N
- 2) The western Irish Sea south of 54°30'N (this is equivalent to the area surveyed in 2004)

Length data for the Clyde closure are given in last year's FSP report (Amstrong *et al.* 2008).

The length frequency for each species caught during the *Isadale* survey was determined for the whole area of the eastern Irish Sea by taking the mean of the catch rates (numbers per h

per length class) over the 10' latitude  $\times$  20' longitude rectangles, after calculating the mean catch per h in each rectangle [Equation (1)]. The mean for each rectangle was calculated as the total catch divided by the total tow duration for the tows in the rectangle for each species.

#### *Age compositions*

The age compositions of cod, whiting and haddock were calculated for the eastern Irish Sea, using age/length keys for the whole area compiled from otoliths collected from the catches made by the *Isadale* during each survey in the series. The age-length keys were applied to the average length frequency for the eastern Irish Sea to give the mean number caught of each age per h fished for each species.

Age compositions for cod and haddock were obtained separately for the North Channel and western Irish Sea areas, using separate age/length keys for each area compiled from otoliths collected from the catches made by *Benaiah IV*. The age/length key for each area was applied to the mean length frequency for the area to give the mean number caught at each age per h fished for each species.

#### *Indices of spawning-stock biomass (SSB)*

For cod and haddock, indices of SSB were calculated from the mean numbers caught per hour in each age class, multiplied by the proportion mature at age given by ICES and the mean weight at age in the stock given by ICES (2008) for cod and haddock. The SSB indices were calculated for the *Benaiah IV* and *Isadale* age compositions (excluding the North Channel). The North Channel was excluded because that area lies well outside the known cod spawning grounds.

Weights-at-age were not available for 2009 in ICES data and were calculated as the average stock weights for the years 2006–2008 for cod, and as the 2008 values for haddock given by a model fitted to AFBI trawl survey data. For whiting, the mean weights at age from FSP data for whiting in the eastern Irish Sea in the years 2006–2009 were used. All haddock and whiting 2 years of age and older were considered to be mature.

## Results

### Survey coverage in 2009

The *Benaiah IV* survey achieved good coverage of waters deeper than about 60 m in the western Irish Sea and North Channel (Fig. 1). The *Isadale* survey successfully covered the bulk of the designated survey area (Fig. 2). Table 1 and Appendices 6a and b summarize the fishing activities of both survey vessels.

**Table 1.** FSP Irish Sea roundfish surveys: Details of fishing activities in 2009.

Vessel	Dates in 2009	Valid tows	Fishing gear	Codend mesh (mm)	Tow duration (h) and average for valid tows (range, h)
FV <i>Isadale</i>	16–27 February	44	Rockhopper otter trawl	80 double-braided	4.3 (3.0–6.0)
FV <i>Benaiah IV</i>	9–20 February	34	Semi-pelagic trawl	100 single-braid	6.1 (5.5–7.5)

## Catch compositions

Gurnard and haddock were the dominant roundfish in the *Benaiah IV* survey by numbers (Appendices 7 and 9), with cod ranked fifth. The *Isadale* catches were dominated by flatfish (plaice, dab and flounder). Whiting and herring were the most abundant roundfish caught (Appendix 8 and 9). Whiting and haddock were more abundant than cod in the *Isadale* catches.

As in previous FSP surveys in this series, seals caused some damage to the *Benaiah IV*'s catches. Encounters with seals are typically more common in the northern half of the survey area. The photograph shows a cod partly eaten by a seal during *Benaiah IV* tow 6 in 2009. It is not known if seals enter the net during towing to prey on the catch, but if so, this would affect the indices of abundance.



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## Distribution of the target species

### Cod

In 2009, cod were caught in 31 of the 34 tows carried out by *Benaiah IV* and in 39 of the 44 of the tows carried out by *Isadale*. Catch rates were generally low, averaging 1.1 cod per h in *Isadale*'s catches, and 2.3 cod per h in *Benaiah IV*'s catches (Fig. 3). Cod catch rates were highest just south of the Clyde in the North Channel, on the spawning grounds off the Irish Coast and off Morecambe Bay in the east, and off the northwest and west coasts of the Isle of Man (Fig. 3). Catch rates were generally lower in 2009 than in all previous years. As in previous years, the cod taken by *Benaiah IV* were generally larger than those taken by *Isadale* (Fig. 4).

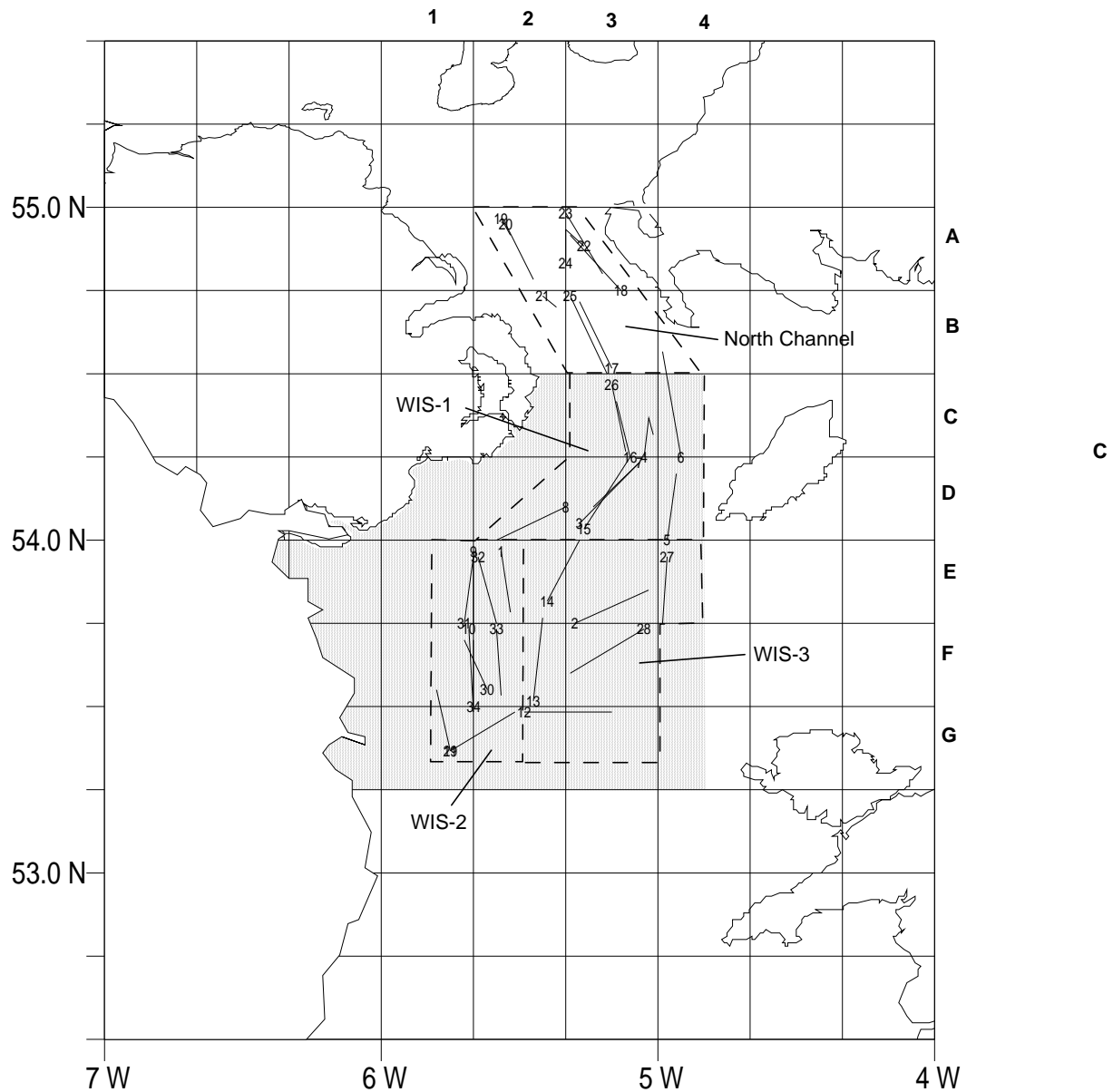
### Haddock

The previously observed spatial pattern of haddock abundance, with higher catch rates in the western Irish Sea, North Channel and around the Isle of Man, continued in 2009 (Fig. 5). The *Isadale*'s catch rates of haddock off the SE coast of the Isle of Man were relatively high in 2008, but were closer to average in 2009.

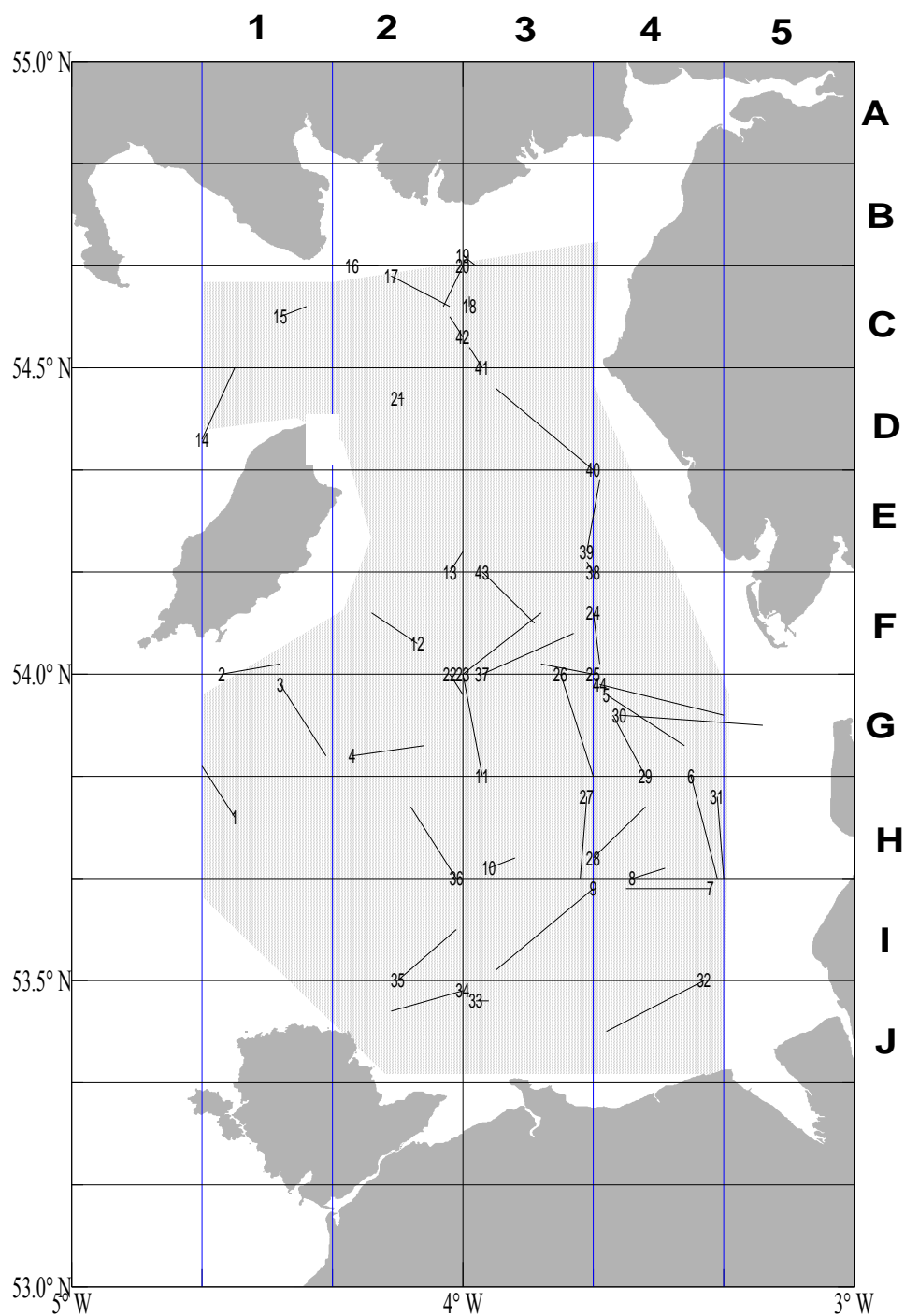
### Whiting

As was the case in 2005–2008<sup>2</sup>, the *Benaiah IV* caught very few whiting in 2009 (Fig. 6). This partly reflects the large meshes in the semi-pelagic trawl, but also the scarcity of adult whiting in the western region. The *Isadale*, fishing with 80 mm codend mesh, showed broadly similar patterns of whiting distribution in all years, with highest catch rates in the southern half of the survey area (Fig. 6).

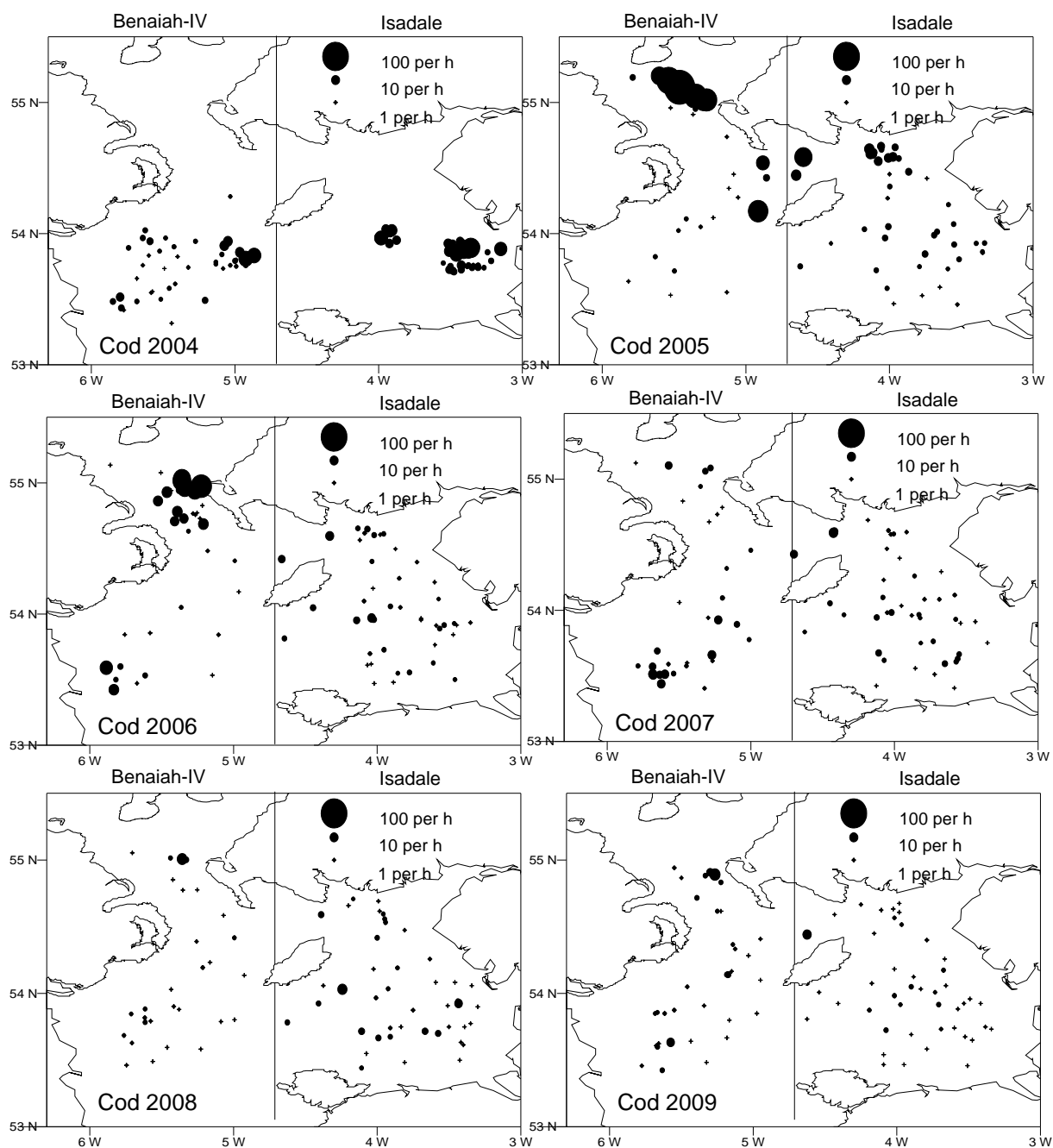
<sup>2</sup> Whiting were not recorded in the 2004 *Benaiah IV* survey.



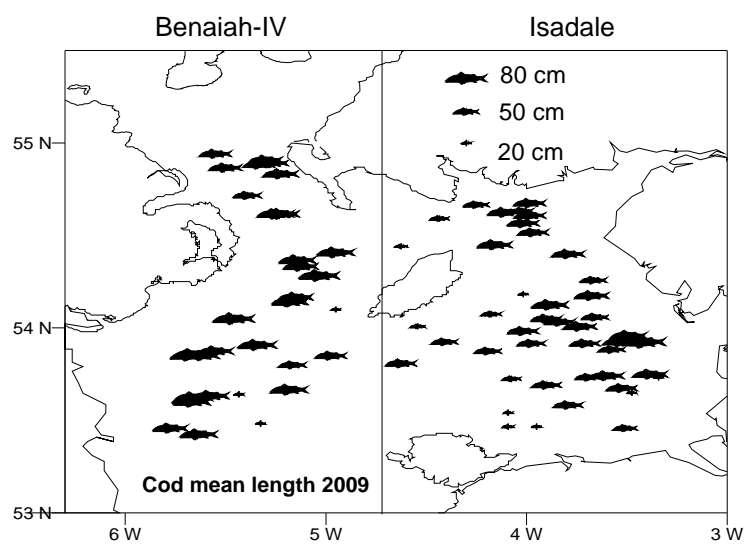
**Fig. 1.** Tows carried out by *Benaiah IV* using a semi-pelagic trawl during February 2009. Lines join the start and end positions of each tow, with any intermediate positions recorded by the skipper (the true vessel tracks will cover a larger distance owing to unrecorded changes in direction). Tow numbers are indicated at the starting positions. The closed area for fishing cod in the Irish Sea is shaded. The four area strata used for computing abundance indices in this and previous surveys are indicated by dashed lines (“North Channel”, “WIS-1”, “WIS-2” and “WIS-3”.)



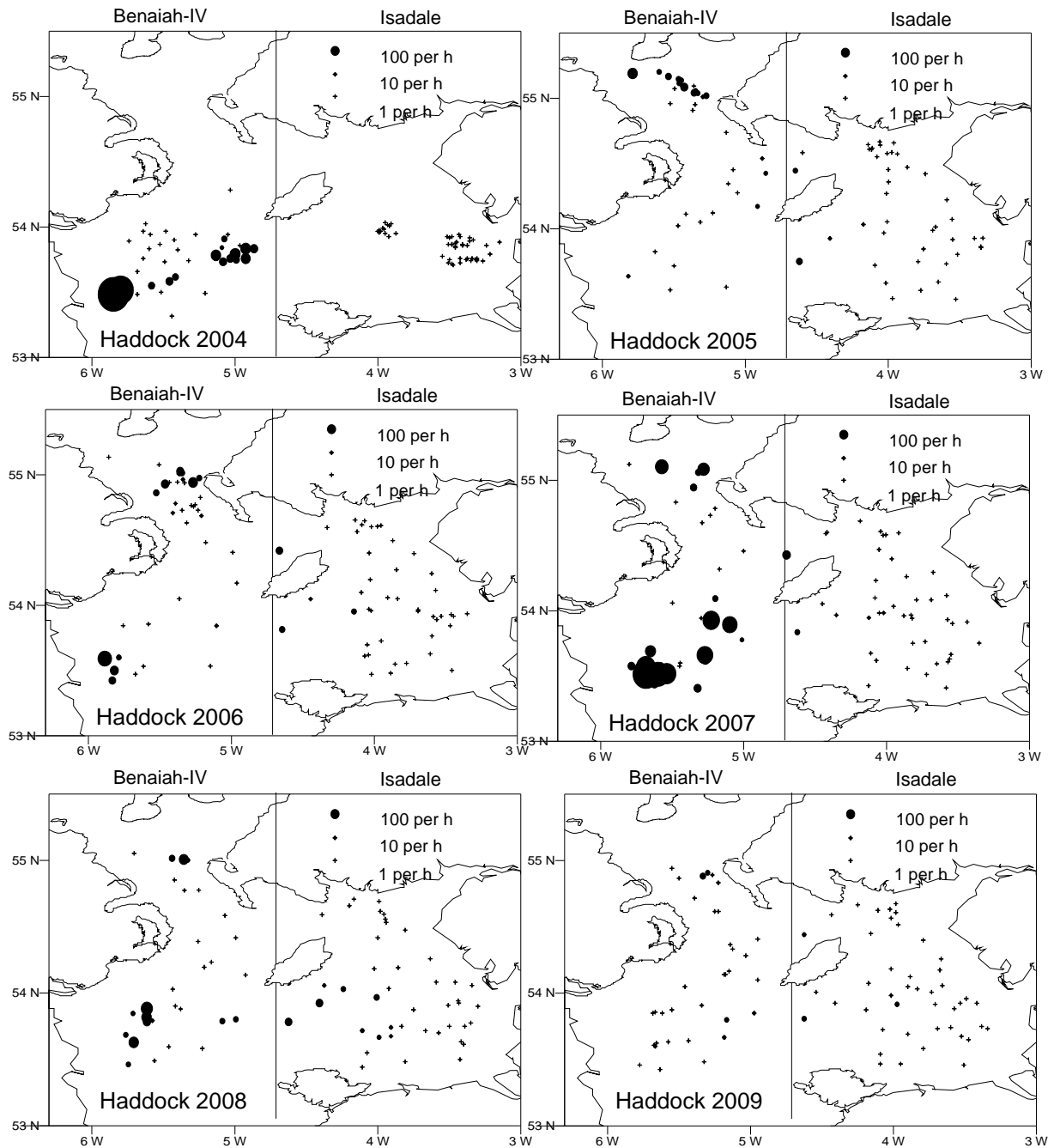
**Fig. 2.** Tows carried out in the eastern Irish Sea by *Isadale* using a rockhopper otter trawl during February 2009. Lines join the start and end positions of each tow (the true vessel tracks may cover a larger distance owing to unrecorded changes in direction). Tow numbers are indicated at the starting positions. The shaded area denotes the extent of the survey area.



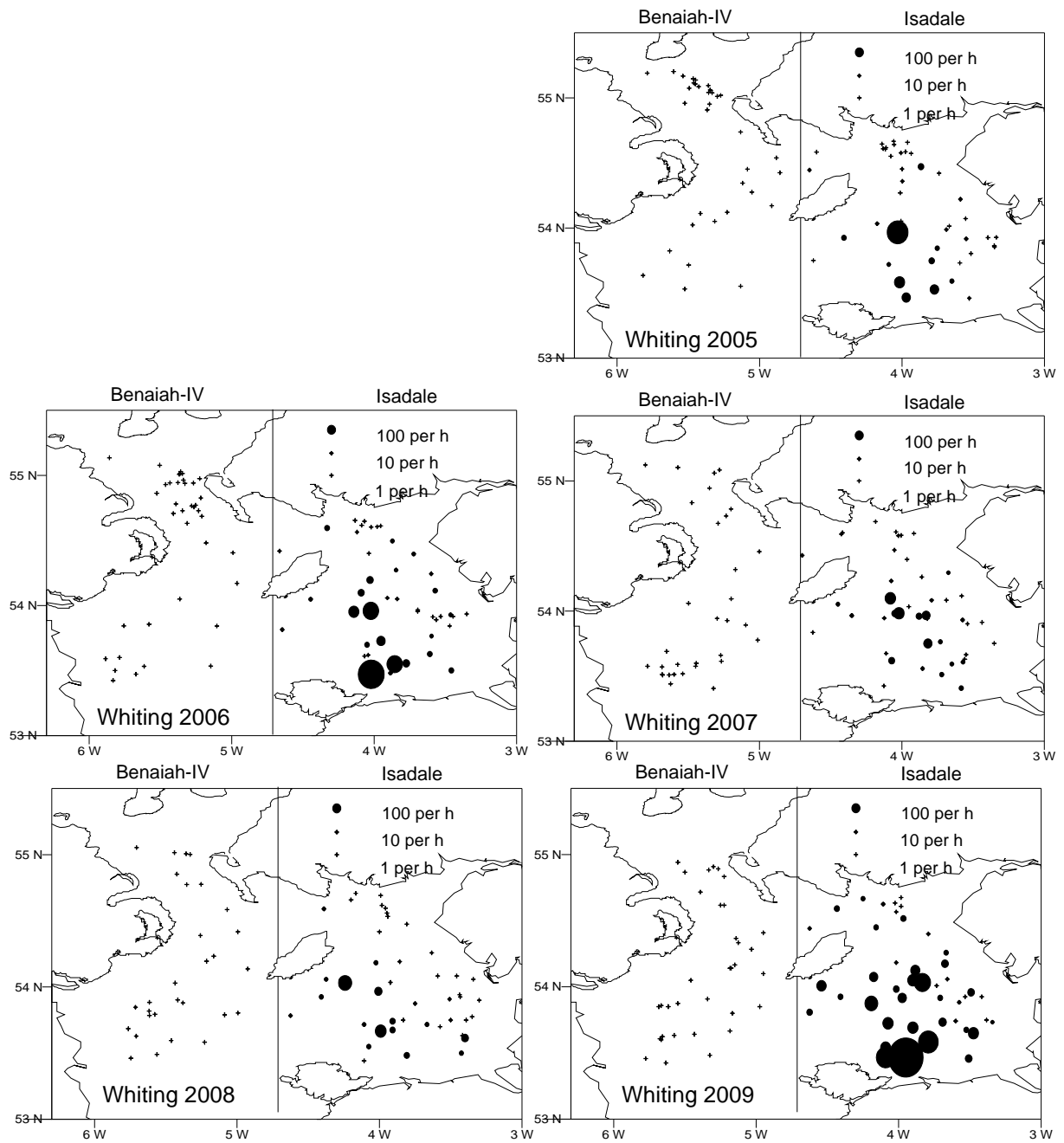
**Fig. 3.** Distribution of cod during the 2004–2009 Irish Sea roundfish surveys. The areas of the circles are proportional to the numbers caught per h (same scale for all plots). The vertical line separates the western Irish Sea surveys on *Benaiah IV* from the eastern Irish Sea surveys on *Kiroan* (2004) and *Isadale* (2005–2009). (Note that the scale for the plots is increased by factor of 10 compared with plots for haddock and whiting, because of the small numbers of cod caught.)



**Fig. 4.** Spatial pattern in mean length of cod measured during the 2009 surveys. The width of the symbols is proportional to mean cod length.



**Fig. 5.** Distribution of haddock during the 2004–2009 Irish Sea roundfish surveys. The areas of the circles are proportional to numbers caught per h (same scale for all plots). The vertical line separates the western Irish Sea surveys on *Benaiah IV* from the eastern Irish Sea surveys on *Kiroan* (2004) and *Isadale* (2005–2009).



**Fig. 6.** Distribution of whiting during the 2005–2009 Irish Sea roundfish surveys. The areas of the circles are proportional to the numbers caught per h (same scale for all plots). The vertical line separates the western Irish Sea surveys on *Benaiah IV* from the eastern Irish Sea surveys on *Isadale* (whiting catches were not recorded during the *Benaiah* survey in 2004).

## Time-series of length and age compositions

The numbers of otoliths collected for compiling age-length keys in the *Benaiah IV* and *Isadale* surveys in each year are presented in Table 2.

The eastern Irish Sea survey on *Kiroan* in 2004 was very localized and the results not comparable with the more widespread surveys of 2005–2008. The *Isadale* surveys from 2005 have used a similar design and fishing gear, so can provide a 5-year series of comparable data (Table 3).

As the western Irish Sea part of the *Benaiah IV* survey encompasses a known spawning area for cod and haddock, age compositions are presented separately for the North Channel and the western Irish Sea (strata WIS1–WIS3 combined) in Table 4 (cod) and Table 5 (haddock). Combined North Channel – western Irish Sea age compositions are also given in Tables 4 and 5. The figures for 2005–2008 are revised using the new stratification scheme.

**Table 2.** The numbers of otoliths collected during each survey, 2004–2009

Vessel	Year	Cod	Haddock	Whiting
<i>Benaiah IV</i>	2004	344		
	2005	397	429	0
	2006	269	188	18
	2007	325	212	25
	2008	226	170	30
	2009	405	230	-
<i>Kiroan</i>	2004	197		
<i>Isadale</i>	2005	369	104	66
	2006	223	68	76
	2007	454	138	207
	2008	508	103	130
	2009	204	74	167

### *Length and age compositions of cod*

Cod caught by *Benaiah IV* in the western Irish Sea and North Channel since 2004 have been mainly 2- to 4-year-olds in the length range 40–80 cm, with 3-year-olds dominating in each year (Fig. 7a, b; Table 4). The length compositions in 2009 were of similar general shape to the average for previous years (Fig. 7a).

The *Isadale*'s catches of cod tend to be dominated by smaller and younger fish than are caught by *Benaiah IV*, with 2-year-olds dominating in most years (Fig. 8a, b; Table 3). Catch rates of 2-year-old cod were very poor in 2009 (Fig. 8b) and this resulted in a mean length composition with relatively fewer 35–50 cm fish than in the average length frequency for earlier years (Fig. 8a). Cod continued to be more variable in size in the otter trawl catches in the eastern Irish Sea than in the semi-pelagic trawl catches in the west.

### *Haddock*

The length compositions of haddock caught by *Benaiah IV* in 2009 were of similar general shape to the average for earlier years, although the absolute numbers caught in 2009 were

very low (Fig. 9a). The highly variable recruitment of haddock in the Irish Sea has resulted in marked interannual changes in age composition in the combined North Channel and western Irish Sea areas (Fig. 9b; Table 5). Haddock 2- and 3-years-old dominated in all years except 2005, when 4-year-olds were most common. The large mesh and relatively offshore distribution of *Benaiah IV* tows in the western Irish Sea may explain the typically very small catches of 1-year-old haddock during this survey.

As with cod, the *Isadale*'s catches of haddock tend to be dominated by smaller and younger fish than taken by the *Benaiah IV* in the west (Figs 10a, b; Table 3). The poor catches of 1-year-old haddock in 2008 and 2009 are consistent with the results of AFBI groundfish surveys of the Irish Sea in March each year, which indicate relatively poor spawning success in 2007 and 2008.

### Whiting

Length frequencies and age compositions of whiting are shown only for the *Isadale*'s catches in the eastern Irish Sea (Fig. 11), because the numbers caught by *Benaiah IV* continue to be too low to give meaningful results. The overall length composition in 2009 was generally similar in shape to the average for the previous years, but the catch rates were much higher than previously observed (Fig. 11a). The age compositions vary considerably between years, and it is difficult to discern any year-class signals (Fig. 11b; Table 3). The age of whiting is very difficult to discern using otoliths, so there are likely to be more ageing errors for that species than for cod or haddock.

**Table 3.** FV *Isadale*: indices of abundance (numbers caught per h) for cod, haddock and whiting, 2005–2009.

<b>COD</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2005	0.060	4.020	0.250	0.380	0.004	0.010	0.000	4.71
2006	0.830	0.770	0.670	0.007	0.042	0.000	0.001	2.32
2007	0.590	1.430	0.090	0.080	0.000	0.000	0.000	2.19
2008	0.012	1.796	0.317	0.016	0.028	0.003	0.008	2.18
2009	0.501	0.355	0.211	0.091	0.007	0.004	0.000	1.17

<b>Haddock</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2005	0.09	2.65	0.20	0.45	0.00	0.01	0.00	3.40
2006	2.55	2.45	0.38	0.01	0.03	0.00	0.01	5.43
2007	1.81	3.10	0.52	0.06	0.00	0.01	0.00	5.50
2008	0.39	8.09	0.87	0.01	0.00	0.00	0.00	9.36
2009	0.23	1.12	1.74	0.22	0.01	0.00	0.00	3.33

<b>Whiting</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2005	0.22	11.06	21.12	5.28	0.98	0.00	0.69	39.3
2006	8.69	46.65	15.22	1.85	0.53	0.01	0.00	72.9
2007	4.24	10.77	5.55	1.01	0.28	0.02	0.00	21.9
2008	3.70	10.29	8.58	1.99	0.38	0.29	0.00	25.2
2009	27.30	84.91	48.67	3.61	0.33	0.00	0.00	164.8

**Table 4.** FV *Benaiah IV*: indices of abundance (numbers caught per h) for cod, by area, 2004–2009.

<b>COD: western Irish Sea</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2004	0.000	0.350	2.500	0.250	0.250	0.042	0.000	3.390
2005	0.000	0.370	1.355	1.032	0.099	0.023	0.044	2.923
2006	0.000	0.083	1.745	0.253	0.073	0.011	0.005	2.170
2007	0.000	0.672	1.636	0.715	0.070	0.073	0.036	3.203
2008	0.004	0.068	0.560	0.135	0.097	0.019	0.022	0.905
2009	0.012	0.078	0.759	0.312	0.087	0.017	0.010	1.276

<b>COD: North Channel</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2005	0.000	0.651	1.621	0.829	0.024	0.030	0.000	3.155
2006	0.015	2.291	6.964	1.102	0.225	0.007	0.013	10.617
2007	0.041	0.374	0.104	0.079	0.000	0.000	0.000	0.598
2008	0.000	0.816	1.847	0.190	0.035	0.023	0.007	2.918
2009	0.000	0.529	2.675	0.627	0.147	0.018	0.021	4.018

<b>COD: Total Irish Sea</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2005	0.000	0.427	1.409	0.990	0.084	0.025	0.035	2.970
2006	0.003	0.536	2.815	0.427	0.104	0.010	0.007	3.901
2007	0.008	0.611	1.322	0.585	0.055	0.058	0.029	2.669
2008	0.003	0.221	0.824	0.147	0.084	0.020	0.019	1.317
2009	0.009	0.171	1.152	0.377	0.099	0.018	0.012	1.838

**Table 5.** FV *Benaiah IV*: indices of abundance (numbers caught per h) for haddock, by area, 2004–2009.

<b>Haddock: western Irish Sea</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2004								72
2005	0.000	0.993	0.508	1.983	0.203	0.245	0.021	3.9
2006	0.383	9.459	6.958	0.373	0.897	0.000	0.036	18.1
2007	0.247	53.295	45.645	7.455	0.876	0.162	0.025	107.7
2008	0.000	5.291	11.660	8.486	0.842	0.158	0.037	26.5
2009	0.000	0.684	3.612	1.052	0.408	0.059	0.022	5.8

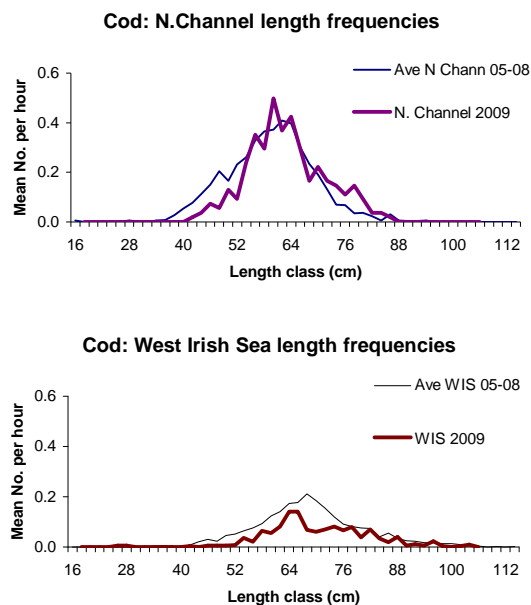
  

<b>Haddock: North Channel</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2005	0.000	4.804	5.380	16.616	0.631	0.298	0.009	27.7
2006	0.015	1.114	8.802	1.217	1.959	0.210	0.097	13.4
2007	0.055	1.722	4.851	1.764	0.000	0.088	0.000	8.5
2008	0.000	2.195	17.396	2.275	0.609	0.000	0.159	22.6
2009	0.000	0.579	5.455	2.960	1.056	0.334	0.068	10.5

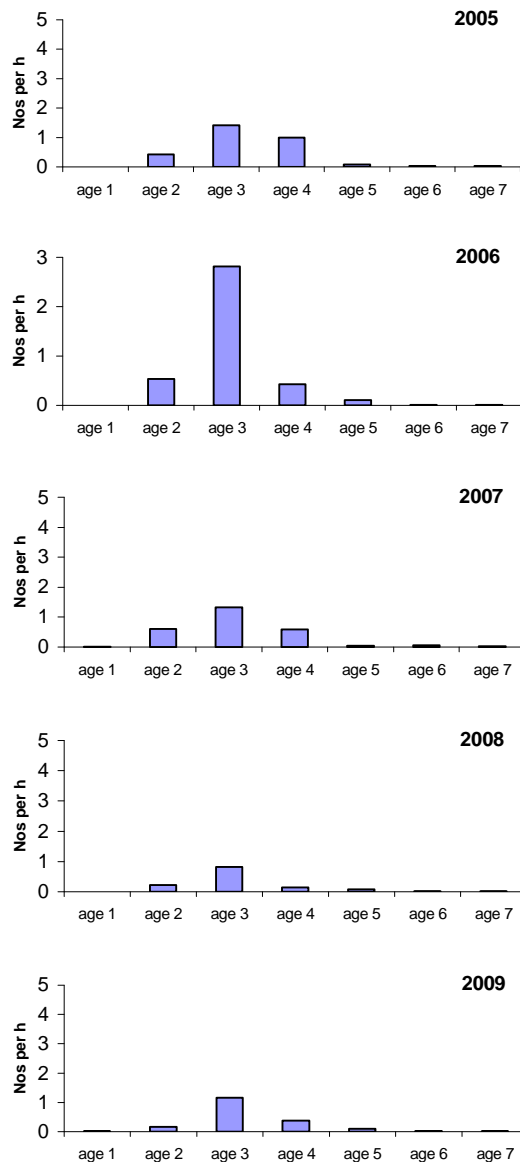
  

<b>Haddock: Total Irish Sea</b>	age 1	age 2	age 3	age 4	age 5	age 6	age 7	total
2005	0.000	1.774	1.506	4.981	0.291	0.256	0.018	8.8
2006	0.308	7.749	7.336	0.546	1.115	0.043	0.048	17.1
2007	0.208	42.727	37.286	6.289	0.697	0.147	0.020	87.4
2008	0.000	4.657	12.836	7.213	0.794	0.126	0.062	25.7
2009	0.000	0.662	3.990	1.443	0.541	0.115	0.031	6.8

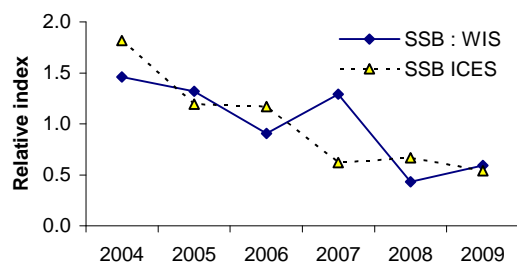
(a) Length frequencies



(b) Age compositions

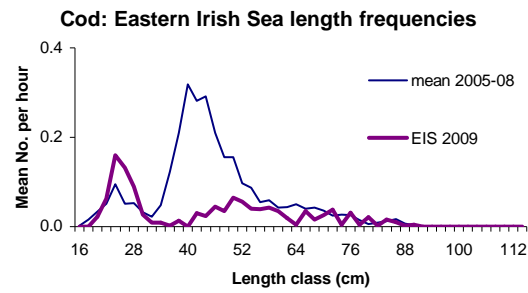


(c) Spawning stock biomass index

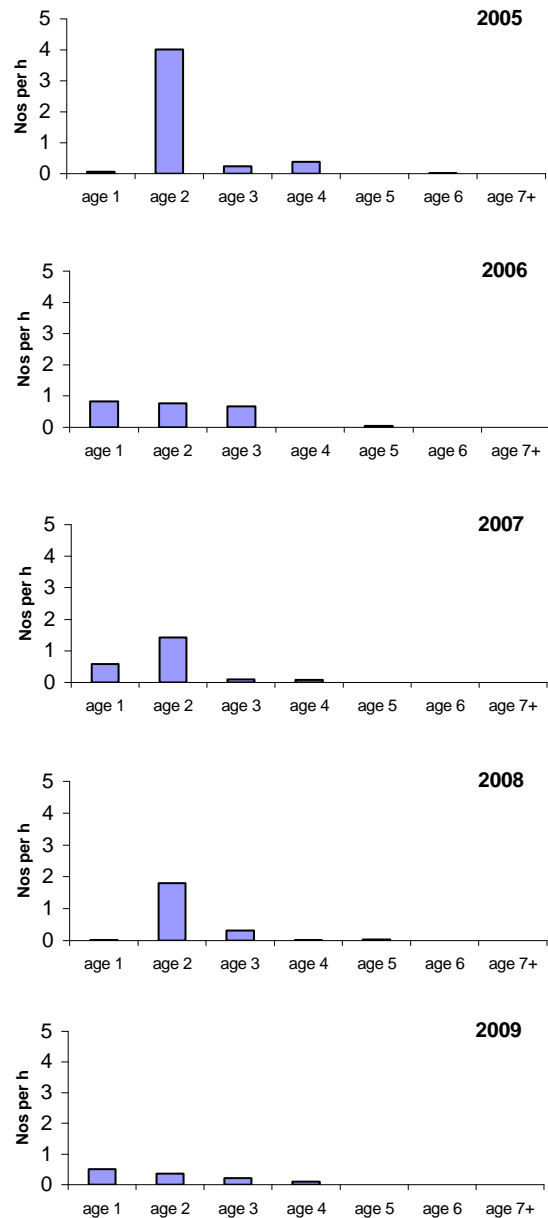


**Fig.7.** *Benaiah IV* survey data for cod: (a) Length frequency of cod in 2009 compared with the mean for previous FSP surveys; (b) time-series of catch rates of cod by age class (numbers per h towed) calculated for western Irish Sea and North Channel combined; (c) index of SSB of cod in the western Irish Sea (annual values divided by the series mean) compared with the trend from the ICES (2008) assessment.

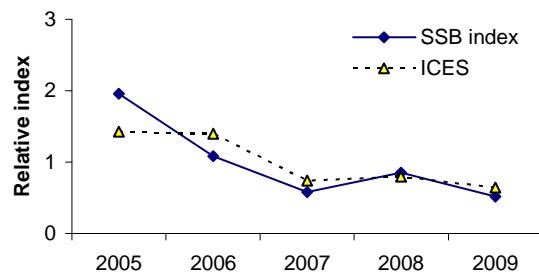
(a) Length frequencies



(b) Age compositions

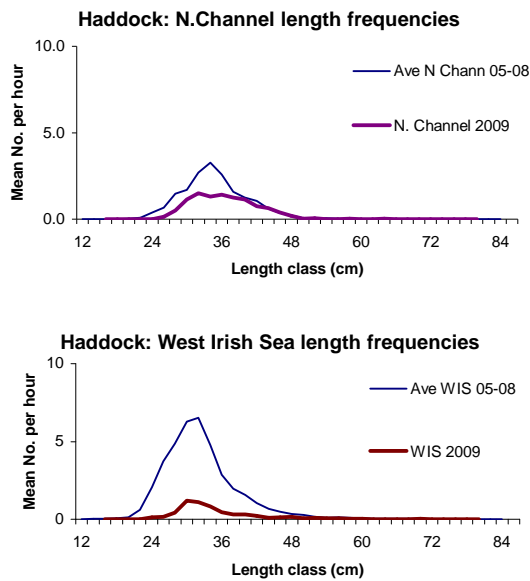


(c) Spawning stock biomass index

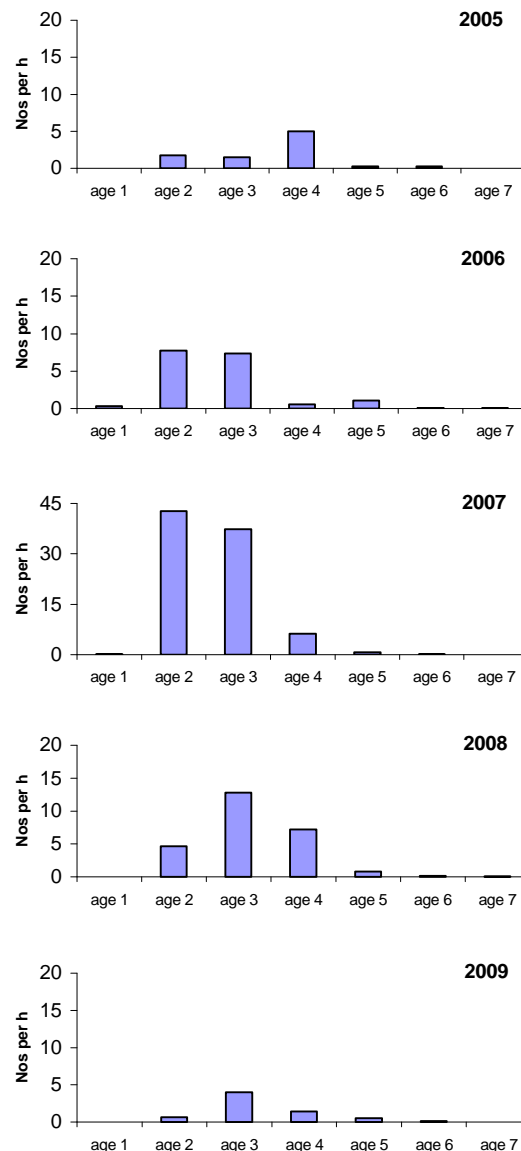


**Fig. 8.** *Isadale* eastern Irish Sea survey for cod: (a) Length frequency of cod in 2009 compared with the mean for previous FSP surveys; (b) time-series of catch rates of cod by age class (numbers per h towed); (c) index of SSB of cod (annual values divided by the series mean) compared with indices from the ICES (2008) assessment.

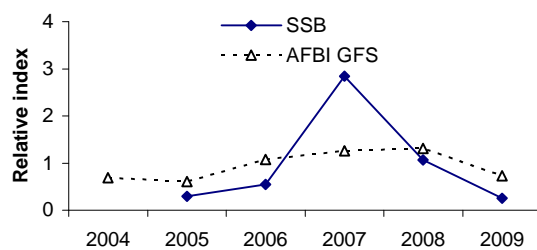
(a) Length frequencies



(b) Age compositions

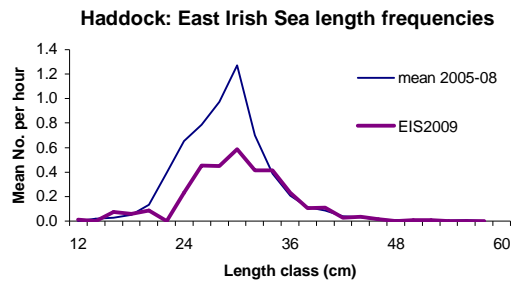


(c) Spawning stock biomass index

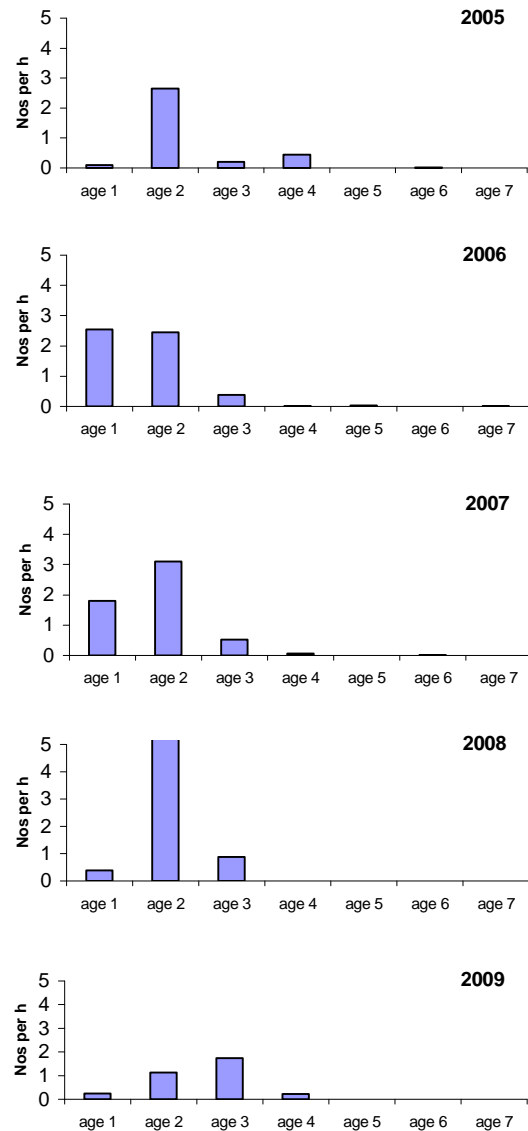


**Fig.9.** *Benaiah IV* survey data for haddock: (a) Length frequency of haddock in 2009 compared with the mean for previous FSP surveys; (b) time-series of catch rates of haddock by age class (numbers per h towed) calculated for western Irish Sea and North Channel combined; (c) index of SSB of haddock in the western Irish Sea (annual values divided by the series mean) compared with the time-series for the whole Irish Sea from AFBI groundfish survey (data courtesy AFBI).

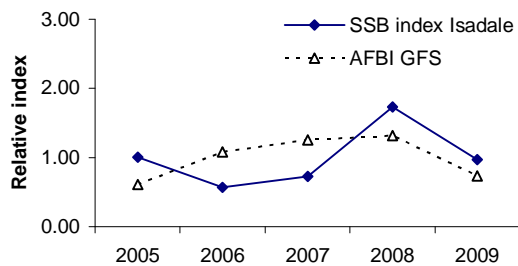
(a) Length frequencies



(b) Age compositions

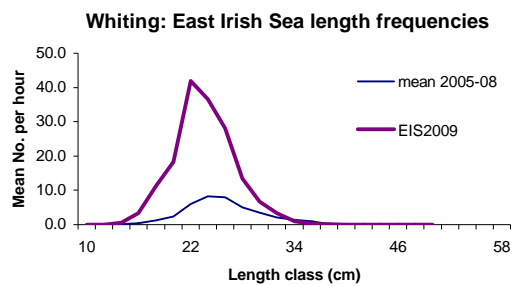


(c) Spawning stock biomass index

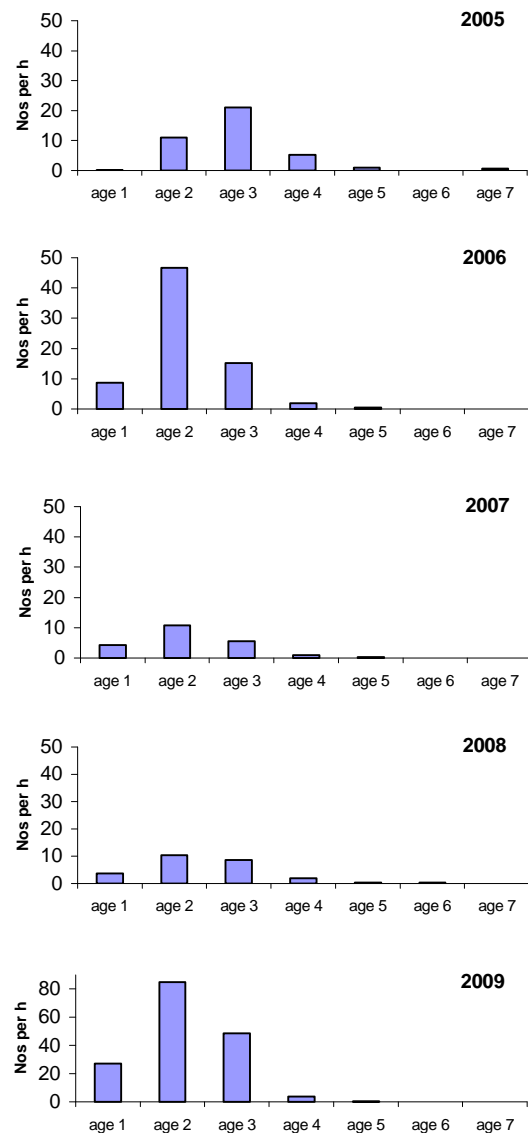


**Fig. 10.** *Isadale* eastern Irish Sea survey data for haddock: (a) Length frequency of haddock in 2009 compared with the mean for previous FSP surveys; (b) time-series of catch rates of haddock by age class (numbers per hour towed); (c) index of SSB of haddock (annual values divided by the series mean) compared with time-series for the whole Irish Sea from AFBI groundfish survey (data courtesy AFBI).

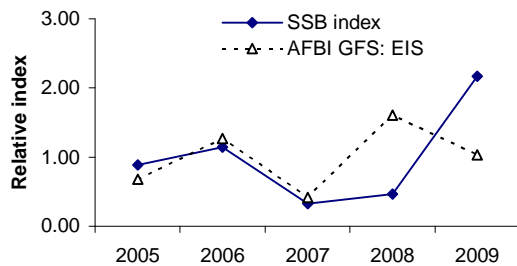
(a) Length frequencies



(b) Age compositions



(c) Spawning stock biomass index



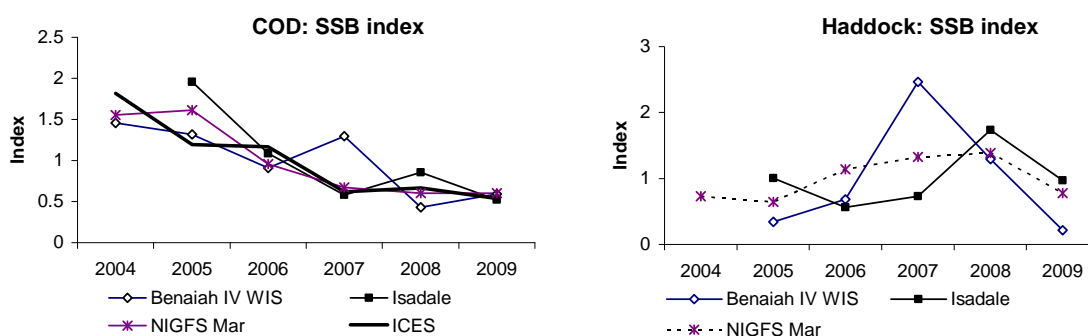
**Fig. 11.** *Isadale* eastern Irish Sea survey: (a) Length frequency of whiting in 2009 compared with the mean for previous FSP surveys; (b) time-series of catch rates of whiting by age class (numbers per h towed); (c) index of SSB of whiting (annual values divided by the series mean) compared with the equivalent index for the eastern Irish Sea from the AFBI groundfish survey in March (numbers at age data courtesy AFBI). (Note the different scale on the 2009 age composition plot because of the very large catches of whiting).

## Time-series of spawning stock biomass (SSB) indices

The SSB indices for cod in the *Benaiah IV* survey (Figs 7c and 12), calculated for the combined western Irish Sea strata WIS1–WIS3, show a decline over time consistent with the results from the ICES assessment in 2008 (ICES, 2008) and the AFBI groundfish survey in March. The SSB index from the *Isadale* survey also shows a similar trend to the ICES estimates from 2006 to 2009 (Figs 8c and 12). The FSP surveys therefore confirm the results of the ICES assessments showing a decline in cod SSB since the mid 2000s.

The SSB indices for haddock have been highly variable in the FSP surveys (Figs 9c, 10c and 12). There is currently no accepted ICES assessment for Irish Sea haddock, but the AFBI groundfish survey in March each year showed an increasing SSB up to 2008 followed by a decline in 2009 attributable to poor recruitment.

The index of whiting SSB from the *Isadale* survey followed a similar pattern to the equivalent eastern Irish Sea index from the AFBI March surveys of 2005–2007 (Fig. 11c). The FSP indices have, however, been highly variable in 2008 and 2009, with a particularly large index for 2009. The AFBI indices for eastern Irish Sea whiting declined sharply in the mid 2000s and have subsequently been much lower than recorded in the 1990s.



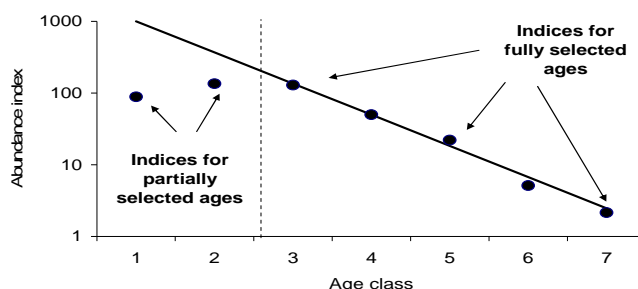
**Fig. 12.** Trends in SSB of cod and haddock in the Irish Sea given by FSP surveys compared with the ICES (2008) assessment model result for cod and the AFBI (Agri-Food Biosciences Institute, Northern Ireland) groundfish survey index of SSB for haddock.

## Mortality estimates for cod from the FSP surveys

All ICES assessment data for stocks of cod, haddock and whiting in recent years show a steep age profile, with few fish apparently surviving beyond about 5 years old. The FSP surveys exhibit the same pattern throughout the Irish Sea and North Channel, confirming this aspect of the ICES assessment results. This is in sharp contrast to other demersal fish species such as sole in the eastern English Channel, where fishing mortality rates are closer to what ICES considers optimum for the stocks, and where fish >12 years old are common and some fish are still recorded up to 20–30 years of age on occasion (Roel *et al.* 2007).

Mortality rates can be estimated from a time-series of surveys, by calculating the rate at which the numbers caught per-unit-survey-effort-change with increasing age in each year class

(where a year class refers to all fish born in a given year). The principle is illustrated in the hypothetical example below:



The straight line (on a logarithmic scale) indicates the decline in numbers at a constant mortality rate of about 60%, and the individual points represent survey estimates at successive ages, with the youngest fish being only partially selected by the trawl gear.

A plot of catch rates against age for a single year class is known as a “catch curve”, and the slope of the curve for the fully selected age classes provides an estimate of mortality. There may also be circumstances where the slope is influenced by changes in availability or vulnerability of fish to the fishing gear as the fish get older.

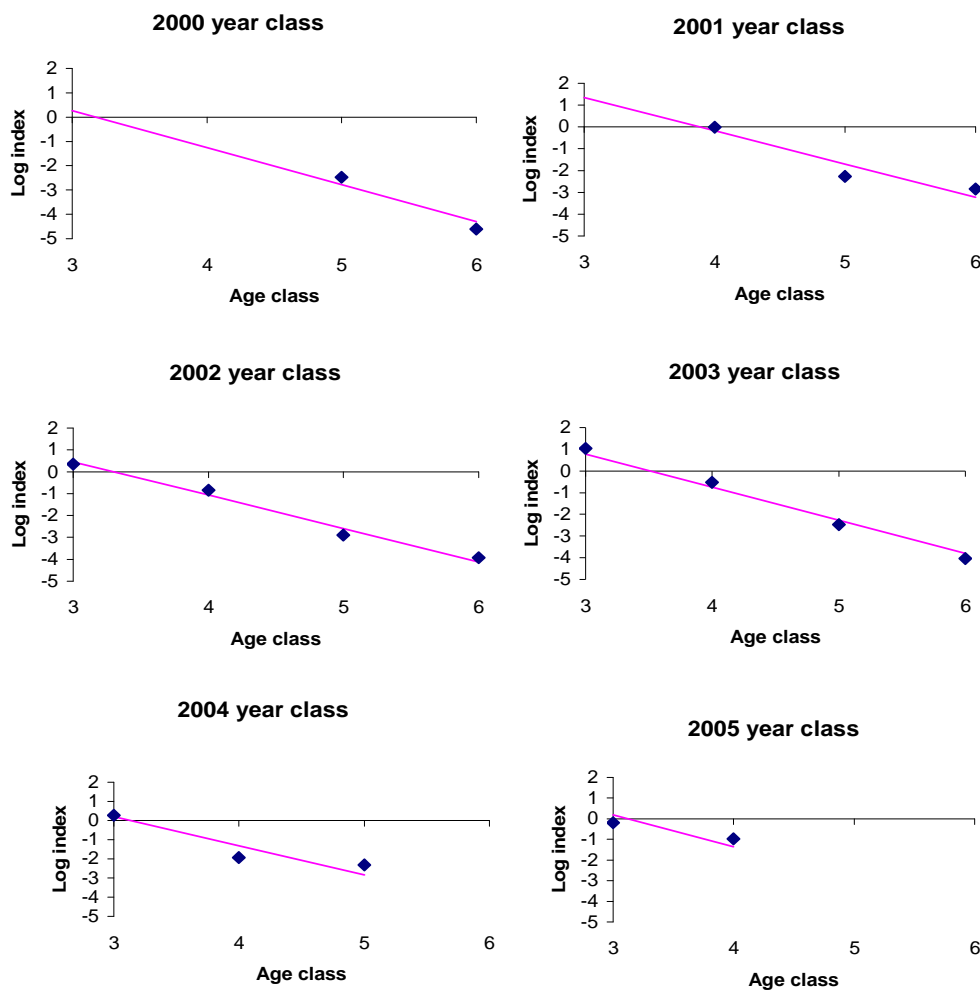
An examination of catch curves from the Irish Sea FSP surveys indicate that cod may be effectively fully selected at age 2 in the 80 mm mesh trawl used by *Isadale* in the eastern Irish Sea, and at age 3 in the 100 mm mesh semi-pelagic trawl used by *Benaiah IV* in the west. The restriction of the semi-pelagic trawl tows to waters deeper than about 70 m in the western region may reduce the availability of cod younger than 3 years old to the survey.

With reference to the hypothetical example given above, the mortality rate of cod was estimated from the *Benaiah IV* and *Isadale* survey data by fitting regression lines to the logarithms of the catch rates from individual year classes over the range of fully selected age classes. The slope of each regression line provides an estimate of total mortality rate  $Z$  assuming that all fully-selected cod have the same probability of being caught.

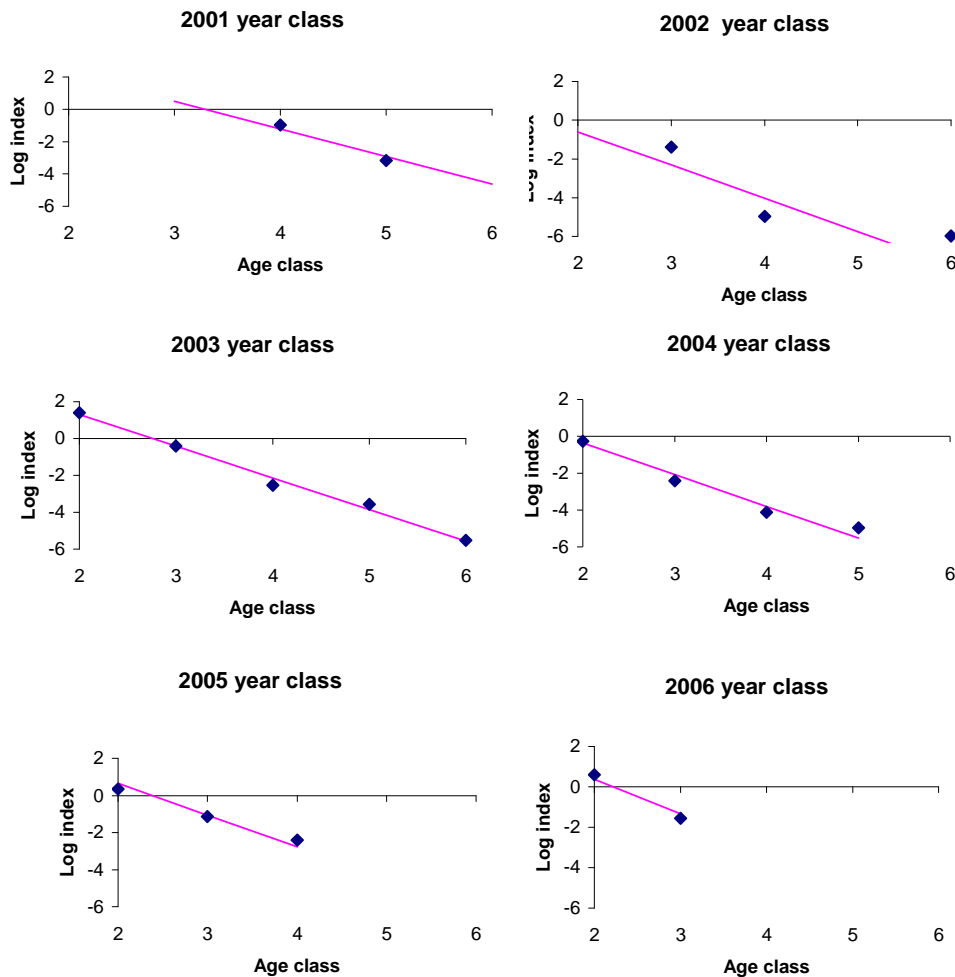
In practice, with only five years of survey data, and an oldest true age of just 6 years, this approach cannot be applied independently to all individual year classes because some have insufficient observations or zero catch rates. Hence, a constant rate of mortality was estimated for all years with FSP data, for the fully selected age classes in each survey. The analysis therefore indicates the general level of mortality since 2004/2005. Values for  $Z$  were iteratively adjusted until the resultant regression line fitted all the data most closely, assuming log-normal measurement errors. Parameters fitted were the total mortality rate  $Z$  (the common regression slope) and the numbers of fish at the first age with data in each year class (see Figs 13 and 14 to see how the method works in practice).

The slopes of the common regression lines fitted to the data from all available year classes provided estimates of  $Z$  of 1.53 for the western Irish Sea (Fig. 13) and 1.71 for the eastern Irish Sea (Fig. 14). Restricting the eastern Irish Sea analysis to ages 3 and over gives a  $Z$  of 1.5, which is similar to the equivalent estimate for the *Benaiah IV* data. These are very large values for a stock such as cod, and indicate that around 80% of cod at ages 2 years and over in the eastern Irish Sea, and at ages 3 years and over in the western Irish Sea, are lost from the stock each year. This could be the result of fishing, natural death or emigration. The ICES assessment of the stock carried out in 2008, based on fishery catches and research surveys,

provided an estimate of  $Z$  of 1.6 (80% annual losses) for cod 2–4 years old throughout the Irish Sea since 2004, a value intermediate between the estimates from the FSP data for the western and the eastern Irish Sea.



**Fig 13.** Logarithms of abundance indices of cod from the *Benaiah IV* survey for the combined western Irish Sea and North Channel for 2005–2008, plotted against age for individual year classes. The best-fitting common regression line is shown (slope =  $-1.53$ ).



**Fig 14.** Logarithms of abundance indices of cod from the *Isadale* survey of the eastern Irish Sea for 2005–2009, plotted against age for individual year classes. The best-fitting common regression line is shown (slope =  $-1.71$ )

## Discussion

The vessels and fishing methods used in the western and eastern components of the FSP Irish Sea roundfish surveys are very different, and do not yield comparable data to evaluate the relative abundance of cod, haddock and whiting in the two areas. However, the surveys do provide time-series of data for each area that yield indices of abundance of cod, haddock and whiting in each age class adequately represented in the catches. The main sources of variation in catch rates between years is anticipated to be the changes in stock abundance and age composition, along with other factors such as tidal state and weather. A 13–15-day survey will inevitably cover a range of tides and sea conditions, including periods of strong tides that may depress catch rates. As the time-series develop, the effects of environmental variables that may be influencing the catch rates of a range of species across their size range can be evaluated, provided the fishing gear and survey design do not alter significantly.

Although the FSP time-series remain relatively short (5–6 years), the trends given for cod are generally in accord with the trends given by ICES assessments and the AFBI groundfish survey in March, which is an important contributor to the ICES assessment. The FSP survey

series, therefore, have good and increasing potential for contributing to the scientific assessment of the cod stock as the time-series lengthens. The FSP results for haddock appear to be more variable than for cod (see Fig. 12). This may be related to the patchy distribution of the species and perhaps also to their patterns of behaviour, which may affect the efficiency of the trawls at catching haddock under the varying conditions. For example, if haddock were tighter to the ground than cod under certain conditions, the semi-pelagic trawl may be less efficient at catching haddock than cod.

It is difficult to estimate the absolute values for mortality rates directly from trawl surveys without ancillary data to quantify the selectivity-at-age. The estimates of mortality of cod from the FSP surveys of the western and eastern Irish Sea are, however, of similar magnitude to those given by the most recent ICES assessment of the stock, which is based on a combined analysis of fishery catches-at-age and trawl survey indices (ICES, 2008). The western Irish Sea FSP survey takes place at spawning time on a major spawning ground for cod, using a large semi-pelagic trawl effective at catching adult cod. This survey may, therefore, give fairly accurate information on the mortality of adult cod in the region. The high mortality rates estimated (80% annual losses) reflect a combination of fishing and natural losses, and are clearly an impediment to recovery of the stock.

There are probably few natural predators for adult cod in the Irish Sea other than marine mammals (seals have been noted in the vicinity of the *Benaiah IV*'s net during hauling, particularly in the North Channel). Recent studies on the diet of grey seals conducted by the UK's Sea Mammal Research Unit indicated an increase in the annual consumption of commercial fish species in the North Sea and off western Scotland between 1985 and 2002 (Hammond and Grellier, 2006; Hammond and Harris, 2006), because of the increase in size of the seal populations. The estimated impact on cod stocks varied widely between areas, indicating that seals may have significant localized impacts. Similar studies are not yet available for the Irish Sea, but the magnitude of all sources of mortality, including fishing, predation and other natural causes of death, need to be evaluated to explain the continued steep age profile in the Irish Sea cod population.

The FSP surveys indicate a relatively poor state of the cod stock in 2009. Catch rates of whiting were, however, much higher in the eastern Irish Sea survey in 2009. The FSP indices for haddock are difficult to interpret because of great variability from year to year, with very poor catches in the west in 2009. The AFBI groundfish survey results showed strong haddock recruitment in the years 2004–2006, leading to an increase in SSB, and last year the prognosis for the stock appeared to be optimistic. However, recruitment from the spawning in 2007 and 2008 appears to have been much weaker, and this appears to have caused a downturn in the biomass of adult haddock in 2009.

### **Future development of the surveys**

The results obtained so far indicate that the Irish Sea roundfish surveys have good potential for supporting the assessment of the Irish Sea cod stock and management of the fisheries. The data on haddock and whiting appear to be less consistent, however, though may be useful for tracking longer-term, large-amplitude changes in the stocks rather than for evaluating short-term changes.

## Acknowledgements

The owners, skippers and crew of the *Isadale* and *Benaiah IV* are warmly thanked for making their vessels available for charter for this FSP programme, and for their willing cooperation during the planning and execution of the trips. AFBI staff are also thanked for their continuing positive contribution to these surveys, and the help provided by Greg Foster on *Benaiah IV* was much appreciated. Staff at Cefas involved in data capture and processing of otoliths are thanked for their valued contribution to the programme. This work has been funded by Defra.

## References

- Armstrong, M., Cotter, J., Dann, J., Witthames, P., Bevan, D. and Malone, D. (2005) Programme 4: Irish Sea Roundfish.. Fisheries Science Partnership 2004/05 Final report. 41pp. [www.cefas.co.uk/fsp](http://www.cefas.co.uk/fsp)
- Armstrong, M., Dann, J., Garrod, C., Shaw, S. and Velterop, R. (2006) Programme 3: Irish Sea Roundfish.. Fisheries Science Partnership 2005/06 Final report. 44pp. [www.cefas.co.uk/fsp](http://www.cefas.co.uk/fsp)
- Armstrong, M., Dann, J., Garrod, C. and Pasco, C. (2007) Programme 3: Irish Sea Roundfish.. Fisheries Science Partnership 2006/07 Final report. 53pp. [www.cefas.co.uk/fsp](http://www.cefas.co.uk/fsp)
- Armstrong, M.J., Tingley, G., Beeching, A, Peach, D. and Pasco, G. 2008. Irish Sea roundfish surveys. Fisheries Science Partnership 2007/08 Final report. 53pp. [www.cefas.co.uk/fsp](http://www.cefas.co.uk/fsp)
- Cotter, J., Witthames, P., Goad, D. and Boon, T. 2004a. Report on catches of cod and other species in the north eastern Irish Sea by FV Kiroan in Spring 2004. Fisheries Science Partnership final report, May 2004.22pp. [www.cefas.co.uk/fsp](http://www.cefas.co.uk/fsp).
- Cotter, J., Keable, J., Briggs, R., Henning, A. and Boon, T. 2004b. Report on catches of cod and haddock in the western Irish Sea by FV Benaiah IV in Spring 2004. Fisheries Science Partnership final report, May 2004.15pp. [www.cefas.co.uk/fsp](http://www.cefas.co.uk/fsp)
- Hammond P.S. and Grellier K. 2006. Grey seal diet composition and prey consumption in the North Sea. Final report to Department for Environment and Rural Affairs on project MF0319.
- Hammond, P.S. and Harris, R.N. 2006. Grey seal diet and prey composition off western Scotland and Shetland. Final Report to Scottish Executive and Rural Affairs department and Scottish Natural Heritage.
- ICES 2008 (in prep.). Report of the ICES Working Group on the Assessment of Northern Shelf Demersal Stocks. Copenhagen, May 2008.
- Roel, B.A., Dann, J., Velterop, R., Enever, R., Ware, O. and Armstrong, M.J. 2007. Programme 6: western Channel Sole and Plaice. Fisheries Science Partnership 2006/07 Final report. 47pp. [www.cefas.co.uk/fsp](http://www.cefas.co.uk/fsp)

## **Appendix 1: Operational Plan for western Irish Sea**

### **FISHERIES SCIENCE PARTNERSHIP 2009 Irish Sea Roundfish Survey: West**

#### ***Detailed Operational Plan***

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The Detailed Operation Plan conforms to the details in the Tender and Contract.

#### **Aims**

To carry out a further survey of Western Irish Sea cod, haddock and whiting following the similar FSP surveys in 2005, 2006, 2007 and 2008. For such surveys, the sampling needs to be more or less comparable from year to year, so that the main source of change is the abundance of the stocks and not other factors such as location, time of year, gear etc. The survey in 2009 differs from previous surveys in the series in no longer covering the area north of 55°N (including the Clyde cod closure) and reducing from 15 days to 13 days fishing.

**Vessel:** The vessel will be FV *Beniah IV*, Skipper: John Teggarty

**Cefas Observer:** The Cefas observer will be Shaun Doran.

#### **Departure date and duration**

The vessel will depart from Kilkeel at or around 10pm on Sunday 8 February 2009, to commence fishing on Monday 9 February. The total duration will be **13** days at sea. Weather permitting, this will be divided into two or three continuous periods, with a maximum of two days between each period in port to land fish, refuel and change scientist if necessary. Any calendar day when fishing takes place can be counted as one of the 13 days.

#### **Survey Area:**

Fishing will be undertaken within the area illustrated in the attached Figure from 53°20'N in the south, to a northern boundary at 55° N, and between longitudes 4° 50'W and 6°W. The survey will include tows throughout the western Irish Sea closed area for cod fishing.

#### **Dispensations:**

The following dispensations, provided through Cefas, must be carried on board:

1. Dispensation from Defra to retain under-sized fish, and to land fish outside quota (the fishing days will not be counted against days-at-sea allocation).
2. Dispensation from Irish Department of Foreign Affairs to permit fishing within Irish national waters.

#### **Fishing Gear**

Semi-pelagic whitefish otter trawl: 100mm cod-end, identical in construction and rigging to the trawl used in previous FSP Irish Sea roundfish surveys on *Benaiah IV*. There should be no alterations to the gear, or the way the net is fished in different areas and conditions, compared with previous surveys, otherwise the time-series of survey catch rates may no longer adequately reflect changes in fish abundance.

## Survey design

Fishing will be conducted in a way which samples across the entire area specified, and which gives an appropriate basis for comparison with previous surveys both geographically and by gear. Sampling will seek to get representative samples across the area.

The sampling scheme will represent a combination of a grid of tows to demonstrate the broad-scale patterns in distribution, size/age structure and abundance of cod, whiting and haddock, and an additional set of tows targeted in specific locations where high densities of fish are expected. The scheme will be as follows:

1. A broad scale mapping exercise to determine the overall distribution pattern of cod, haddock and large whiting in the western Irish Sea and North Channel. This will involve one tow of approximately 6 hours duration located as randomly as possible in each of the 15' lat x 20' long rectangles indicated on Fig. 1. This will involve approximately 20 tows (120 hours fishing).
2. Additional fishing in rectangles containing high abundance of cod/haddock/whiting, for the purpose of demonstrating location of high-density areas and to increase the amount of scientific data from these areas. This should involve a maximum of two additional targeted tows in suitable 15' lat x 20' long rectangles containing high catch rates. This will involve up to 20 tows (120 hours fishing).

Multiple tows within any rectangle should sample different tow tracks within the rectangle and not repeatedly cover the same ground. Tows should ideally be contained within rectangles. However, if the start or end point of a tow strays into a neighbouring rectangle, this is not critical as long as the bulk of the tow is in one rectangle.

## Working pattern

- Tow duration: 6 hours on average.
- The survey will take place during day and night.
- Cefas Health and Safety regulations stringently require limits to working time to avoid hazards associated with fatigue. The total working time for the observer on deck will be no more than 12 – 14 hours per day. The remaining 10-12 hours must include a sufficient continuous period of sleep (minimum 5 hours). If necessary, trawling activities should halt temporarily to allow for this rest period.
- All tows will form part of the survey and must be sampled by the observer as per the sampling requirements. No commercial fishing will take place outside of the survey.
- The crew should be available to help the observer

## Instructions for observers

- Record total catches of retained and discarded fish at each station as follows:
  - All cod caught should be sorted from the catch and the total volume of landed and discarded cod recorded.
  - The volumes of the retained catches of haddock, whiting and other species should be recorded.
  - Large individual discarded fish, sorted from the whole catch, should be recorded and measured (i.e. raising factor of 1.0).
  - All other discarded fish should be pooled, ensuring that the catch is well mixed. Record the total volume of discards, and sort all, or as big a sample as

time permits, to species level (absolute minimum of 1 basket to be sorted).  
Record the raising factor to estimate total discards.

- Carry out a length measure on representative samples of the catches of the main commercial species, both for the retained and discarded catches. The main species of interest are cod, haddock and whiting. Ensure that the raising factors for the length frequencies are recorded and the method is clearly described.
- Carry out length measures on other species as time permits. As a minimum, record of number of individuals in the total catch or in a measured sub-sample of both discards and retained.
- **Otolith collection:** Collect otoliths throughout the length range for cod, haddock and whiting. In 2008, 377 cod and 108 whiting were caught during the entire survey. If catches are similar in 2009, an appropriate scheme for **cod and whiting** is therefore to collect otoliths and associated biological data from **all** cod and whiting caught at each station, subsampling only the largest catches across the length range if there is insufficient time to sample all the fish. A nominal target of 400 cod and 100 whiting will apply if the total survey catches look as if they could be significantly in excess of these figures. Much larger catches of **haddock** are expected (8,300 caught in 2008). The otolith target for haddock is **200** fish for the survey. Haddock distribution is typically very patchy – in 2008, 13 tows had >100 haddock, 15 had less than 20 haddock, and one had about 30 haddock. A suitable scheme for haddock is to collect 10 fish per tow (or all if the catch contains <10 fish), spread as evenly as possible across the length range from largest to smallest. A spreadsheet can be used to check for gaps in the length frequency in the biological sample.

**Summary:**     **Cod** otoliths: all cod caught (nominal target 400 fish)

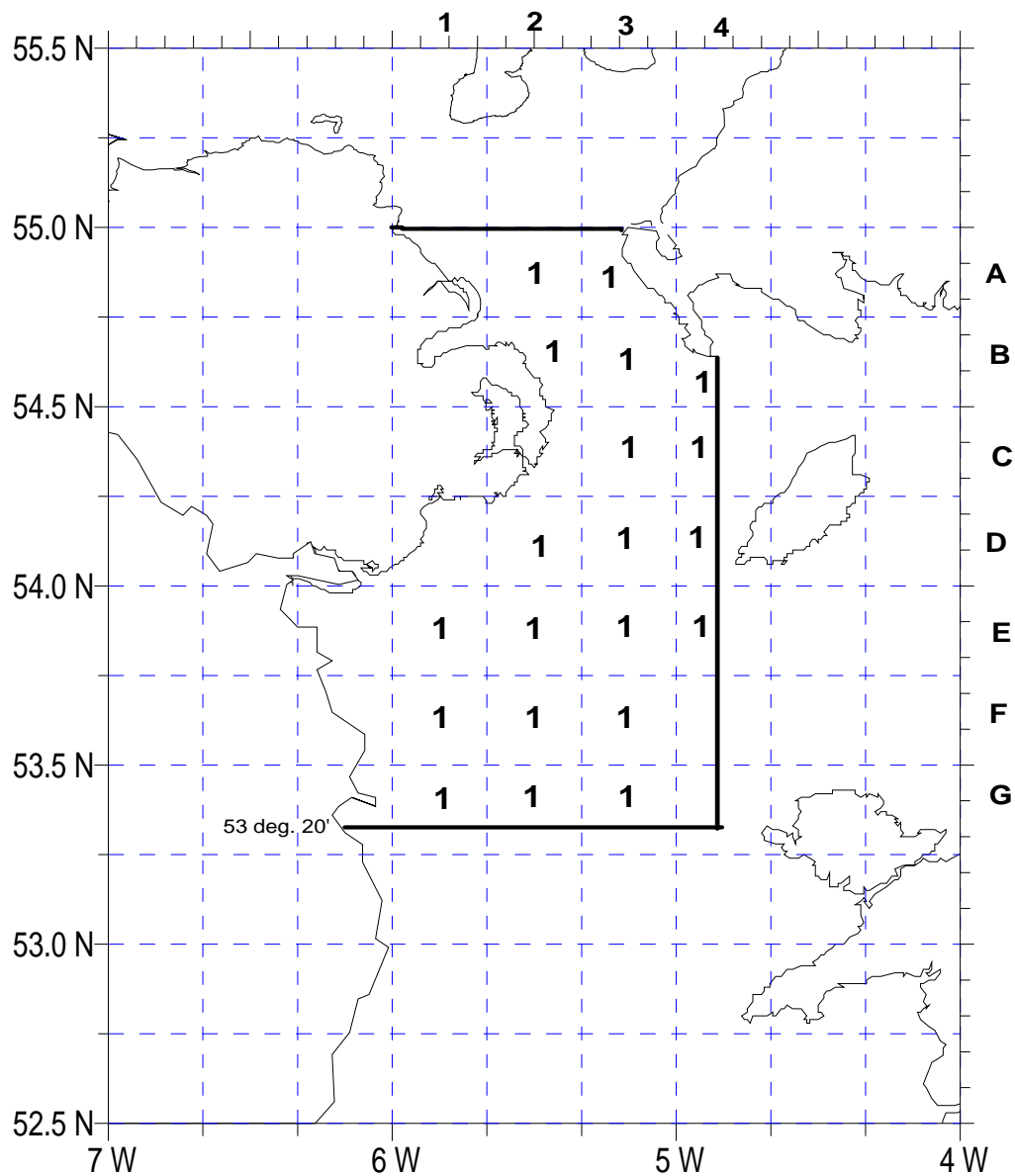
**Whiting** otoliths: all whiting caught (nominal target 100)

**Haddock** otoliths: target 200, collecting up to 10 evenly across length range at each station.

- The date, species, length and station number are the minimum requirement for otolith packets. Sex and maturity should also be recorded. The most appropriate method for extracting otoliths should be adopted.
- Record any observations of marine mammals and incidence of damage to catches by marine mammals.
- Record data on sheets provided by Cefas.
- Peter Randall to be contacted daily if possible for progress update and to resolve any operational or sampling difficulties.
- A written cruise report must be provided immediately after the survey. This should be read and agreed by the skipper (report should say “seen in draft by skipper”).

### **Instructions for skipper**

- Record gear details and parameters at each station.
- Record full details of any net damage and repairs carried out (these must not noticeably affect the performance of the net).
- Record times and positions of tows, including position at any significant change in towing direction.
- Record details of tide, weather, speed over ground.
- The catch sampling involves a lot of work on the deck, and the crew is expected to assist the accompanying Cefas scientist.



**Fig. 1. Irish Sea roundfish (west) survey 2009.** Location of 15' lat x 20' long rectangles within which one 6-hour tow will be located at random. Use codes "1A", "3F" etc. for reporting back to Cefas during the survey.

**TARGETS:** First 6-hr tow per rectangle to be an arbitrary choice from available clean tows.

Additional tows (up to 2) to be carried out in rectangles with expected high abundance of cod, whiting or haddock.

No more than 3 tows per rectangle in total.

Multiple tows in a rectangle to cover different parts of rectangle.

## **Appendix 2: Operational Plan for Eastern Irish Sea**

### **FISHERIES SCIENCE PARTNERSHIP 2009 Irish Sea Roundfish Survey: East**

#### ***Detailed Operational Plan***

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The Detailed Operation Plan conforms to the details in the Tender and Contract.

#### **Aims**

1. To carry out a further survey of Eastern Irish Sea cod, haddock and whiting following the similar FSP surveys in 2005, 2006, 2007 and 2008. For such surveys, the sampling needs to be more or less comparable from year to year, so that the main source of change is the abundance of the stocks and not other factors such as location, time of year, gear etc.

**Vessel:** The vessel will be FV *Isadale*, Skipper: Steve Whelan

**Cefas Observer:** Cefas observer will be Guy Pasco.

#### **Departure date and duration**

Departure date for first trip: Monday 16<sup>th</sup> February (boarding evening 15<sup>th</sup> February).

The vessel will fish in the designated area for a total of **15** days. This will be divided into two or three continuous periods, with a maximum of two days between each period in port to land fish, refuel and change scientist if necessary. Any calendar day when fishing takes place can be counted as one of the **15** days.

#### **Survey Area:**

Fishing will be undertaken within British Fishery Limits in the eastern Irish Sea between longitudes 3°20'W and 4°40'W, and bounded in the north by approx. 54°40'N and in the south by 53°20'N (see attached Figure 1). Fishing will be conducted in a way which samples across the entire area specified, and to the agreed Operations Plan.

#### **Fishing Gear**

The fishing gear to be fitted and used is a rock-hopper otter trawl of type, dimensions, construction, rigging and fishing characteristics as close as possible to the gear used in previous FSP surveys of eastern Irish Sea cod, in order to maintain continuity. The otter trawl, sweeps and doors used previously were as follows:

**Net:** Boris Rock-hopper otter trawl. 118ft headline. 80mm mesh (4mm double twine) cod –end. 90mm square mesh panel fitted.

**Ground gear:** 160ft ground gear comprising 100ft x 14-inch hoppers and 2 x 30ft ground chains.

**Sweeps (bridles):** 40 fathom

**Doors:** Door spread around 140 ft on average.

There should be no alterations to the gear, or the way the net is fished in different areas and conditions, compared with previous surveys, otherwise the time-series of survey catch rates may no longer adequately reflect changes in fish abundance.

### **Survey design**

Fishing will be conducted in a way which samples across the entire area specified, and which gives an appropriate basis for comparison with previous surveys both geographically and by gear. Sampling will seek to get representative samples across the area.

The sampling scheme will represent a combination of a grid of tows to demonstrate the broad-scale patterns in distribution, size/age structure and abundance of cod, whiting and haddock, and an additional set of tows targeted in specific locations where high densities of fish are expected. The scheme will be as follows:

1. To provide information on the broad-scale spatial pattern of distribution and size/age composition of cod, whiting and haddock, an attempt will be made to carry out one tow in every 20' longitude x 10' latitude rectangle (See Fig. 1). This first tow in the rectangle should be a more-or-less random selection from the potential tows in the rectangle. This phase will comprise 26-27 four-hour tows.
2. Additional tows will be carried out, as time permits, in 20'x10' rectangles where high densities of cod, whiting or haddock are known to be present. The number of additional tows per 20'x10' rectangle will vary according to the expected abundance of cod in each rectangle. For example, where very high fish abundance is expected, an additional three tows could be completed. In some other rectangles with moderately high fish abundance, one or two additional tows could be carried out. Excessive sampling in any one location will, however, not take place. There should be no more than 4 tows in total per 20'x10' rectangle unless agreed with Cefas. This phase will comprise up to 18 additional 4-hour tows, depending on weather and requirements for rest periods for the observer as detailed later.

Tows within any 20' x 10' rectangle should sample different tow tracks within the rectangle and not repeatedly cover the same ground. If the start or end point of a tow strays into a neighbouring rectangle, this is not critical as long as the bulk of the tow is in one rectangle.

### **Working pattern**

- Tow duration: 4 hours where possible.
- The survey will take place during day and night.
- Cefas Health and Safety regulations stringently require limits to working time to avoid hazards associated with fatigue. The total working time for the observer on deck will be no more than 12 – 14 hours per day. The remaining 10-12 hours must include a sufficient continuous period of sleep (minimum 5 hours). If necessary, trawling activities should halt temporarily to allow for this rest period.
- All tows will form part of the survey and must be sampled by the observer as per the sampling requirements. No commercial fishing will take place outside of the survey.

## Instructions for observers

- Record total catches of retained and discarded fish at each station as follows:
  - All cod caught should be sorted from the catch and the total volume of landed and discarded cod recorded.
  - The volumes of the retained catches of haddock, whiting and other species should be recorded.
  - Large individual discarded fish, sorted from the whole catch, should be recorded and measured (i.e. raising factor of 1.0).
  - All other discarded fish should be pooled, ensuring that the catch is well mixed. Record the total volume of discards, and sort all, or as big a sample as time permits, to species level (absolute minimum of 1 basket to be sorted). Record the raising factor to estimate total discards.
- Carry out a length measure on representative samples of the catches of the main commercial species, both for the retained and discarded catches. The main species of interest are cod, haddock and whiting. Ensure that the raising factors for the length frequencies are recorded and the method is clearly described.
- Carry out length measures on other species as time permits. As a minimum, record of number of individuals in the total catch or in a measured sub-sample of both discards and retained.
- **Otolith collection:** Collect otoliths throughout the length range for cod, haddock and whiting. In 2008, 389 cod were caught during the entire survey. If catches are similar in 2009, an appropriate scheme for **cod** is therefore to collect otoliths and associated biological data from **all** cod caught at each station, subsampling only the largest catches across the length range if there is insufficient time to sample all the fish. A nominal target of 400 cod will apply if the total survey catches look as if they could be significantly in excess of 400 fish. Much larger catches of **haddock and whiting** are expected (1,240 and 4,377 caught in 2008). The otolith target for each of these species is **100** fish for the survey. Haddock distribution is typically very patchy – in 2008, only 9 tows yielded >40 haddock in total. Whiting are less patchy – in 2008 19 tows yielded > 40 whiting. A suitable scheme for haddock is to collect 10 fish per tow (or all if the catch contains <10 fish), spread as evenly as possible from the largest to the smallest. For whiting, collect up to 5 fish per tow, again fairly evenly from the smallest to the largest. If catches are much smaller or more patchy than anticipated, increase the numbers per tow accordingly. A spreadsheet can be used to ensure that gaps in the length frequency in the biological samples for cod and whiting are avoided.

**Summary:**     **Cod** otoliths: all cod caught (nominal target 400 fish)

**Whiting** otoliths: Target 100, collecting up to 5 per tow, evenly across lengths.

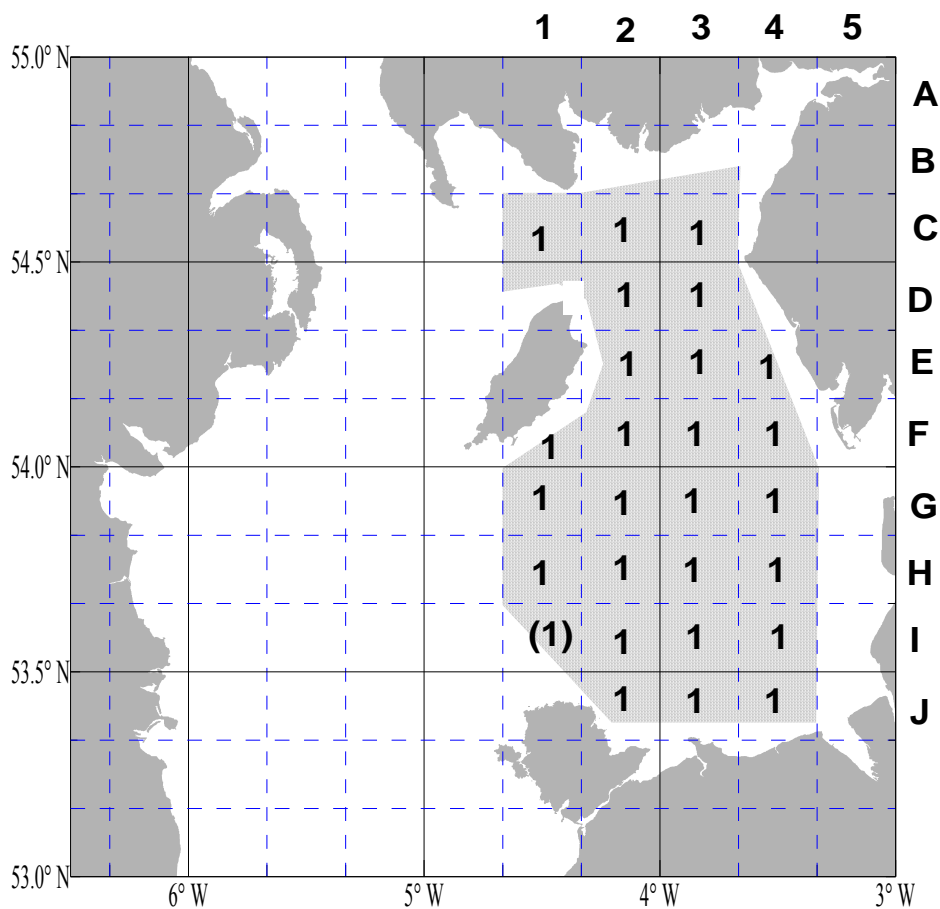
**Haddock** otoliths: Target 100, collecting up to 10 evenly across length range at each station.

The date, species, length and station number are the minimum requirement for otolith packets. Sex and maturity should also be recorded. The most appropriate method for extracting otoliths should be adopted.

- Record data on sheets provided by Cefas.
- Peter Randall to be contacted daily if possible for progress update and to resolve any operational or sampling difficulties.
- A written cruise report must be provided immediately after the survey. This should be read and agreed by the skipper (report should say “seen in draft by skipper”).

**Instructions for skipper**

- Record gear details and parameters at each station.
- Record full details of any net damage and repairs carried out (these must not noticeably affect the performance of the net).
- Record times and positions of tows, including position at any significant change in towing direction.
- Record details of tide, weather, speed over ground.
- The catch sampling involves a lot of work on the deck, and the crew is expected to assist the accompanying Cefas scientist.



### ***TARGETS***

**First 4-hr tow per rectangle to be an arbitrary choice from available tows.**

**Additional tows to be carried out in rectangles with expected high abundance of cod, whiting or haddock.**

**No more than 4 tows per rectangle in total.**

**Multiple tows in a rectangle to cover different parts of rectangle.**

**Fig. 1.** FV Isadale Irish Sea Roundfish (East) FSP survey, February – March 2009. Number printed in each 20' long x 10' lat rectangle is the minimum number of tows per rectangle

FISHERIES SCIENCE PARTNERSHIP 2009  
MF011: Irish Sea Roundfish

*Cruise Report Narrative*

Vessel: FV BENAIHAH IV

Duration: 9<sup>th</sup> February 2009

Area: Western Irish Sea, North Channel

Gear Semi-pelagice Whitefish Otter Trawl, 100mm Cod-End

Skipper: John Teggarty

Staff: Shaun Doran (CEFAS Observer)

Greg Foster (AFBI Part 1)

Aims: To carry out a survey of roundfish (cod, haddock and whiting) in the Western Irish Sea North Channel as part of a time series showing changes in abundance, distribution and age composition.

**Narrative:**

Part I: The 2009 Survey commenced with FV Benaiah IV sailing from Kilkeel at 12:00 UTC on Monday 9<sup>th</sup> February 2009 after approximately 3 hours steaming east vessel arrived in position 53°58' N 05°34'W rectangle 36E4 box E2 depth 99 metres, and commenced fishing for 6.5. A further 20 hauls were made in boxes E3, D3, C3, D4, C1 and B1, D3, D2, E1, F1, G1 and G2, G2 and G3, F2, E2, D2, C1, B3, A3, A2, A2 and finally B2. At 16:30 UTC on Monday 16<sup>th</sup> February the vessel commenced steaming to Bangor to take on stores and provisions and to land fish, arriving at 18:00 UTC.

Part II: The second part of the 2009 survey commenced with FV Benaiah IV sailing from Bangor at 19:30 UTC on Monday 16<sup>th</sup> February after approximately 3.5 hours steaming the vessel arrived in position 54°53'N 05°16'W statistical rectangle 38E4 box A3 depth 108m and commenced fishing for 6.25 hours.

A further hauls were made in boxes A3, A2, B3, C3, E4, F3, G1, F1, E1, E2, F2 and finally F1. At 03:30 UTC on Saturday 21<sup>st</sup> vessel commenced steaming to Kilkeel after five hours steaming arrived Kilkeel 08:30 UTC where the 2009 Irish Sea Roundfish Survey was completed.

Signed: Shaun Doran (CEFAS)  
John Teggarty (SKIPPER)  
Dermot Doyle (OWNER)

Seen in draft by John Teggarty (Skipper)  
21<sup>st</sup> February 2009

## **Appendix 4. Observer Cruise Report for FV Isadale**

### **FISHERIES SCIENCE PARTNERSHIP 2009 PROGRAMME 3b: Irish Sea Roundfish (Eastern Irish Sea)**

#### **Cruise Report Narrative**

**Vessel:** FV ISADALE

**Duration:** 15 February – 28 March 2009

**Area:** Eastern Irish Sea.

**Gear:** Boris rock-hopper otter trawl; 80mm cod-end mesh.

**Skipper:** Steve Whelan

**Staff:** Guy Pasco (CEFAS observer).

**Aims:** To carry out a survey of roundfish (cod, haddock and large whiting), in the Eastern Irish Sea, as part of a time-series showing changes in abundance, distribution and age composition.

#### **Narrative:**

The 2009 Eastern Irish Sea Round fish survey commenced with MFV Isadale (A678) departing Fleetwood at 1330 hours, Sunday 15<sup>th</sup> February. As the derogations were not valid until Monday 16<sup>th</sup> February, no fishing activity was undertaken on this day.

With a good forecast for the week, and the tidal range still high, the decision was made to steam to the westernmost exposed stations to the south of the Isle of Man. Fishing commenced just after midnight. A series of 4 tows were conducted in this area (cod catches ranged from 1-8 fish) before vessel steamed east to fish stations on the southeast boundary of the survey area. Last year some of these stations yielded reasonable catches of cod, but catches remained low this year. The vessel then fished westward across the I grid, before fishing northwards again to complete the required stations in the Northwest quarter of the survey area. Fishing continued in this area until late Thursday 19<sup>th</sup> February.

Optimal tidal conditions were expected for the weekend of 21<sup>st</sup>-22<sup>nd</sup> February, so vessel started fishing its way south again to ensure that we would be on last years 'cod hot-spots' over this period of optimum tides. A series of 10 tows were conducted over the weekend and into Monday 23<sup>rd</sup> February before the vessel headed into Fleetwood to unload, docking at 1030 hours. This first leg of the survey comprised of 30 valid tows spanning 8 fishing days and 9 calendar days.

After a 24-hour lay-over, the survey re-commenced with the Isadale departing Fleetwood at approximately 1200 hours, Tuesday 24<sup>th</sup> February. The vessel fished 1 station (H4) before steaming south to complete the 3 southernmost stations (J2-J4) along with I1 and I2 in the southwest quarter of the survey area. The vessel then fished/ steamed up into the northeast quarter, completing the last 3 required stations (E3, E4 and D3) on Thursday 26<sup>th</sup> February.

The last 4 tows completed during this survey entailed completing additional tows in areas where the skipper believed there could be higher concentrations of cod. The survey was completed on Saturday 28<sup>th</sup> February, with the vessel docking in Fleetwood at 0115 hours.

The observer would like to thank skipper Steve Whelan and all the crew of MFV Isadale for the assistance and co-operation throughout the survey.

Seen in draft by skipper 28.02.2009

Signed by: Steve Whelan (Skipper)  
28th February 2009

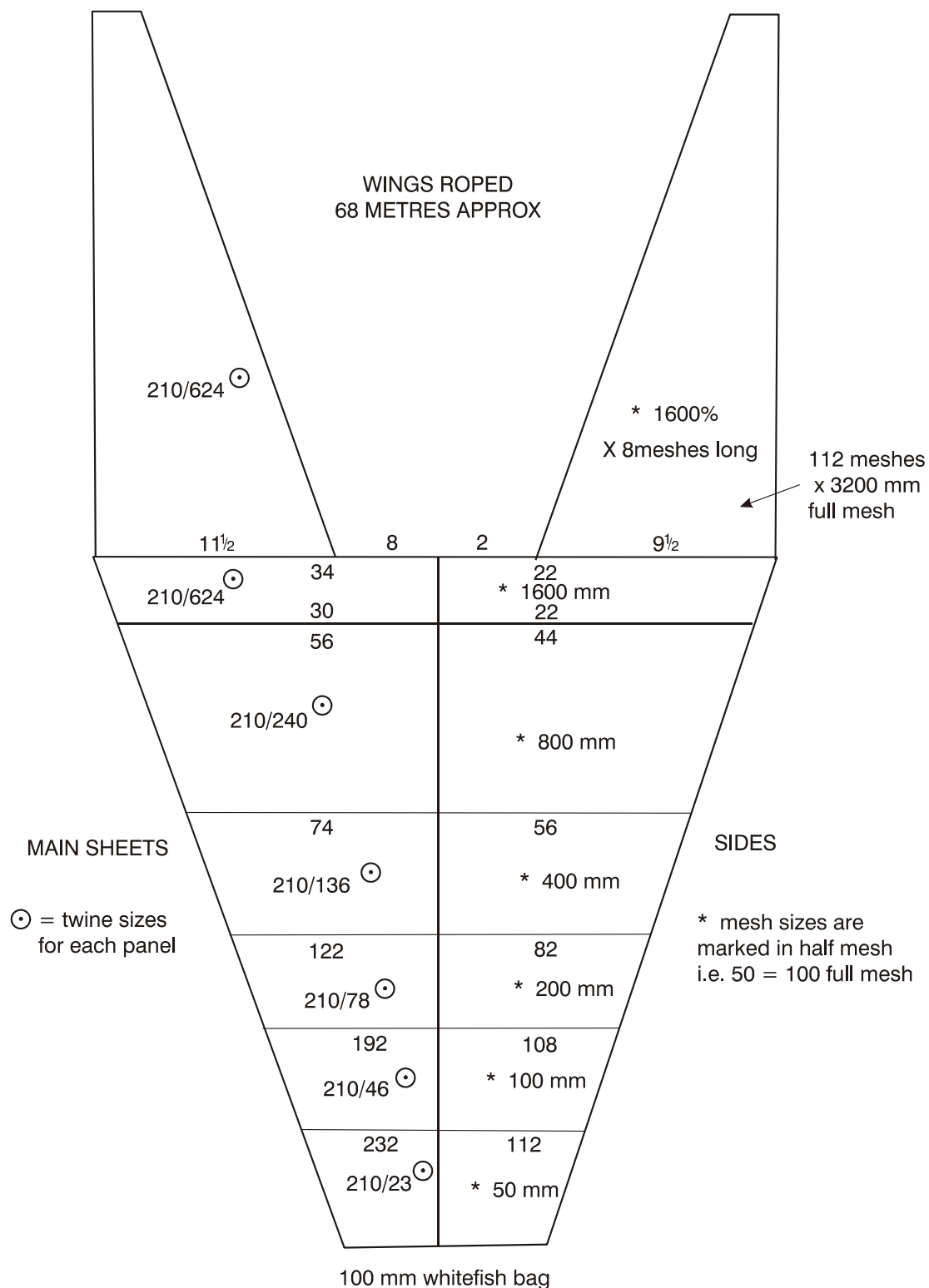
**Table 1: Survey grid reference numbers and associated station numbers**

<b>Grid reference</b>	<b>First tow station number</b>	<b>Valid Y/N</b>	<b>Additional station number/s fished</b>	<b>Valid Y/N</b>
<b>B2</b>	<b>16</b>	<b>Y</b>		
<b>B3</b>	<b>19</b>	<b>Y</b>		
<b>C1</b>	<b>15</b>	<b>Y</b>		
<b>C2</b>	<b>17</b>	<b>Y</b>	<b>20, 42</b>	<b>Y, Y</b>
<b>C3</b>	<b>18</b>	<b>Y</b>	<b>41</b>	<b>Y</b>
<b>D1</b>	<b>14</b>	<b>Y</b>		
<b>D2</b>	<b>21</b>	<b>Y</b>		
<b>D3</b>	<b>40</b>	<b>Y</b>		
<b>E2</b>	<b>13</b>	<b>Y</b>		
<b>E3</b>	<b>38</b>	<b>Y</b>		
<b>E4</b>	<b>39</b>	<b>Y</b>		
<b>F1</b>	<b>2</b>	<b>Y</b>		
<b>F2</b>	<b>12</b>	<b>Y</b>		
<b>F3</b>	<b>23</b>	<b>Y</b>	<b>25, 37, 43</b>	<b>Y,Y,Y</b>
<b>F4</b>	<b>24</b>	<b>Y</b>		
<b>G1</b>	<b>3</b>	<b>Y</b>		
<b>G2</b>	<b>4</b>	<b>Y</b>	<b>22</b>	<b>Y</b>
<b>G3</b>	<b>11</b>	<b>Y</b>	<b>26</b>	<b>Y</b>
<b>G4</b>	<b>5</b>	<b>Y</b>	<b>29, 30, 44</b>	<b>Y, Y, Y</b>
<b>H1</b>	<b>1</b>	<b>Y</b>		
<b>H2</b>	<b>36</b>	<b>Y</b>		
<b>H3</b>	<b>10</b>	<b>Y</b>	<b>27</b>	<b>Y</b>
<b>H4</b>	<b>6</b>	<b>Y</b>	<b>8, 28, 31</b>	<b>Y, Y, Y</b>
<b>I1</b>				
<b>I2</b>	<b>35</b>	<b>Y</b>		
<b>I3</b>	<b>9</b>	<b>Y</b>		
<b>I4</b>	<b>7</b>	<b>Y</b>		
<b>J2</b>	<b>34</b>	<b>Y</b>		
<b>J3</b>	<b>33</b>	<b>Y</b>		
<b>J4</b>	<b>32</b>	<b>Y</b>		

## Appendix 5

Net plan for *Benaiah IV* (taken from 2004/05 FSP report)

### Benaiah IV B350 - SWANN 22 x 14 fm SEMI-PELAGIC NET TOWED ON FSP SURVEY FEB-MARCH 2005



# **Appendix 6a**    *FV Benaiah IV* 2009 FSP: shooting details for valid hauls

<b>Tow</b>	<b>Date</b>	<b>Time</b>	<b>Depth (m)</b>	<b>ICES Rect</b>	<b>Latitude</b>	<b>Longitude</b>	<b>Duration (h)</b>
1	09/02/2009	15:00	106	36E4	53 58'	5 34'	6.5
2	10/02/2009	00:00	74	36E4	53 45'	5 18'	7.5
3	10/02/2009	11:00	111	37E4	54 3'	5 17'	6
4	10/02/2009	18:00	126	37E4	54 15'	5 3'	6
5	11/02/2009	04:30	68	37E5	54 0'	4 58'	6
6	11/02/2009	11:30	116	38E5	54 15'	4 55'	7
7	11/02/2009	21:30	119	37E4	54 14'	5 4'	6
8	12/02/2009	09:40	95	37E4	54 6'	5 20'	6
9	12/02/2009	17:00	76	36E4	53 58'	5 40'	6
10	13/02/2009	00:15	77	35E4	53 44'	5 41'	5.75
11	13/02/2009	08:00	79	35E4	53 22'	5 45'	6
12	13/02/2009	15:00	74	35E4	53 29'	5 29'	6
13	13/02/2009	23:00	112	36E4	53 31'	5 27'	6
14	14/02/2009	06:15	89	37E4	53 49'	5 24'	6
15	14/02/2009	13:00	110	37E4	54 2'	5 16'	6
16	14/02/2009	20:15	119	37E4	54 15'	5 6'	6
17	15/02/2009	03:30	138	38E4	54 31'	5 10'	6
18	15/02/2009	11:15	108	38E4	54 45'	5 8'	6
19	15/02/2009	20:15	141	38E4	54 58'	5 34'	6
20	16/02/2009	03:30	136	38E4	54 57'	5 33'	6
21	16/02/2009	10:30	119	38E4	54 44'	5 25'	6
22	16/02/2009	23:00	105	38E4	54 53'	5 16'	6.25
23	17/02/2009	06:30	115	38E4	54 59'	5 20'	6
24	17/02/2009	14:00	151	38E4	54 50'	5 20'	6
25	17/02/2009	22:30	131	38E4	54 44'	5 19'	6
26	18/02/2009	05:45	122	37E4	54 28'	5 10'	6
27	18/02/2009	15:00	62	36E5	53 57'	4 58'	5.5
28	18/02/2009	21:45	74	36E4	53 44'	5 3'	6
29	19/02/2009	07:15	69	36E4	53 22'	5 45'	6
30	19/02/2009	14:00	72	36E4	53 33'	5 37'	6
31	19/02/2009	21:00	74	36E4	53 45'	5 42'	6
32	20/02/2009	03:45	83	36E4	53 57'	5 39'	6
33	20/02/2009	11:30	98	36E4	53 44'	5 35'	6.5
34	20/02/2009	20:00	80	36E4	53 30'	5 40'	6.5

## Appendix 6b *FV Isadale* 2009 FSP: shooting details for valid hauls

Tow	Date	Time	Depth (m)	ICES Rect	Latitude	Longitude	Duration (h)
1	16-Feb-09	00:00	76	36E5	53 46'	4 35'	5.0
2	16-Feb-09	07:00	43	37E5	54 0'	4 37'	4.0
3	16-Feb-09	12:00	46	36E5	53 59'	4 28'	4.0
4	16-Feb-09	17:30	49	36E5	53 52'	4 17'	4.0
5	17-Feb-09	03:00	26	36E6	53 58'	3 38'	4.0
6	17-Feb-09	08:00	20	36E6	53 50'	3 25'	4.0
7	17-Feb-09	12:45	28	36E6	53 39'	3 22'	4.0
8	17-Feb-09	17:30	33	36E6	53 40'	3 34'	4.0
9	17-Feb-09	23:00	40	36E6	53 39'	3 40'	5.0
10	18-Feb-09	07:15	41	36E6	53 41'	3 56'	4.0
11	18-Feb-09	12:45	40	36E6	53 50'	3 57'	4.0
12	18-Feb-09	17:50	38	37E5	54 3'	4 7'	4.2
13	18-Feb-09	23:30	26	37E5	54 10'	4 2'	4.0
14	19-Feb-09	08:00	42	38E5	54 23'	4 40'	4.0
15	19-Feb-09	13:45	43	38E5	54 35'	4 28'	4.0
16	19-Feb-09	18:50	47	38E5	54 40'	4 17'	4.2
17	19-Feb-09	23:45	46	38E5	54 39'	4 11'	5.3
18	20-Feb-09	06:00	38	38E6	54 36'	3 59'	4.0
19	20-Feb-09	11:00	37	38E6	54 41'	4 0'	4.0
20	20-Feb-09	15:30	39	38E5	54 40'	4 0'	4.5
21	20-Feb-09	21:45	25	37E5	54 27'	4 10'	4.5
22	21-Feb-09	06:30	44	36E6	54 0'	4 2'	5.0
23	21-Feb-09	12:15	43	37E6	54 0'	4 0'	4.0
24	21-Feb-09	17:15	31	37E6	54 6'	3 40'	4.5
25	21-Feb-09	22:30	33	37E6	54 0'	3 40'	6.0
26	22-Feb-09	06:30	37	36E6	54 0'	3 45'	4.0
27	22-Feb-09	11:15	36	36E6	53 48'	3 41'	4.0
28	22-Feb-09	16:00	32	36E6	53 42'	3 40'	5.0
29	22-Feb-09	21:45	28	36E6	53 50'	3 32'	5.3
30	23-Feb-09	03:30	23	36E6	53 56'	3 36'	4.5
31	24-Feb-09	14:30	17	36E6	53 48'	3 21'	4.0
32	24-Feb-09	20:15	20	35E6	53 30'	3 23'	4.0
33	25-Feb-09	02:15	35	35E6	53 28'	3 58'	5.0
34	25-Feb-09	09:00	42	35E5	53 29'	4 0'	4.0
35	25-Feb-09	14:30	43	36E5	53 30'	4 10'	4.0
36	25-Feb-09	19:45	42	36E5	53 40'	4 1'	4.0
37	26-Feb-09	06:30	37	37E6	54 0'	3 57'	6.0
38	26-Feb-09	11:45	35	37E6	54 10'	3 40'	4.0
39	26-Feb-09	16:15	29	37E6	54 12'	3 41'	4.0
40	26-Feb-09	20:05	34	37E6	54 20'	3 40'	5.7
41	27-Feb-09	02:30	41	38E6	54 30'	3 57'	5.0
42	27-Feb-09	08:00	41	38E5	54 33'	4 0'	4.0
43	27-Feb-09	15:30	35	37E6	54 10'	3 57'	3.0
44	27-Feb-09	20:00	24	36E6	53 59'	3 39'	3.0

## Appendix 7.

FV *Benaiah IV* 2009 FSP: Numbers of fish caught per tow for selected species. Data for other species are retained in the Cefas FSP database.

Tow	Tow duration (h)	Cod	Haddock	Whiting	Hake	Pollack	Ling	Plaice	Gurnards <sup>3</sup>	Spurdog
1	6.5	10	16	1	0	0	0	2	133	0
2	7.5	1	211	45	0	0	0	4	1,431	1
3	6.0	28	16	4	1	1	0	2	69	182
4	6.0	1	2	0	0	0	0	0	2	7
5	6.0	0	0	0	0	0	0	0	21	2
6	7.0	6	1	0	0	2	0	0	49	35
7	6.0	5	6	0	0	0	1	1	39	42
8	6.0	8	11	1	0	0	0	1	16	0
9	6.0	11	10	0	0	0	0	8	60	0
10	5.8	7	22	0	0	1	0	7	72	1
11	6.0	18	6	0	0	2	0	21	1,160	1
12	6.0	0	0	0	0	0	0	16	1,056	4
13	6.0	0	12	3	1	3	0	1	109	3
14	6.0	5	42	1	3	0	0	3	100	1
15	6.0	21	9	3	1	1	0	3	23	62
16	6.0	8	1	5	0	0	0	0	22	41
17	6.0	2	2	0	2	1	1	0	3	10
18	6.0	16	55	0	2	2	1	2	1	0
19	6.0	8	2	1	1	1	4	0	24	2
20	6.0	6	1	0	3	0	4	0	20	3
21	6.0	18	17	1	5	1	0	2	17	18
22	6.3	44	180	0	0	0	0	3	13	0
23	6.0	94	37	0	0	3	0	3	17	1
24	6.0	18	273	0	1	1	1	1	2	2
25	6.0	12	0	0	15	4	1	0	7	13
26	6.0	11	1	0	1	2	0	0	6	9
27	5.5	3	68	0	0	0	0	1	880	1
28	6.0	1	96	0	0	0	0	2	1,920	0
29	6.0	7	2	0	1	0	0	0	0	0
30	6.0	6	4	1	1	0	0	2	4	0
31	6.0	10	9	5	2	0	0	8	53	0
32	6.0	10	10	0	1	0	0	5	49	0
33	6.5	57	13	0	2	6	0	2	186	0
34	6.5	20	71	0	0	3	0	13	335	0
<b>Totals</b>		472	1206	71	43	34	13	113	7899	441

<sup>3</sup> Gurnard data includes three species caught, *Eutrigla gurnadus* (grey gurnard), *Asprigla cuculus* (red gurnard) and *Trigla lucerna* (tub gurnard).



**Appendix 8.** FV *Isadale* 2008 FSP: Numbers of fish caught per tow for selected species. Data for other species are retained in the Cefas FSP database.

Tow	Tow duration (h)	Cod	Haddock	Whiting	Plaice	Dab	Flounder	Gurnards <sup>4</sup>	Thorn-back ray	Spotted ray
1	5.0	3	156	248	50	1	0	588	1	42
2	4.0	3	11	546	35	0	1	39	0	4
3	4.0	1	16	156	13	0	14	79	0	0
4	4.0	8	4	1,016	267	11	589	2,046	12	0
5	4.0	3	0	16	175	795	42	4	33	0
6	4.0	3	0	19	221	310	29	0	18	0
7	4.0	0	0	629	300	76	40	0	1	0
8	4.0	2	0	148	296	933	60	4	15	0
9	5.0	2	0	2,927	1,804	2,912	133	0	3	0
10	4.0	2	5	639	454	65	87	0	1	0
11	4.0	7	103	438	746	60	264	12	0	0
12	4.2	3	3	443	2,396	160	43	50	10	0
13	4.0	0	0	40	843	940	10	0	0	0
14	4.0	43	79	52	125	26	2	11	0	0
15	4.0	2	1	165	9	0	0	2	0	0
16	4.2	4	0	104	201	42	0	2	40	48
17	5.3	4	0	78	499	68	8	10	42	34
18	4.0	2	0	5	1,016	106	24	0	8	0
19	4.0	1	0	4	500	35	2	2	11	0
20	4.5	2	0	13	531	30	8	15	24	18
21	4.5	3	0	156	230	28	5	22	2	2
22	5.0	12	43	263	894	7	185	7	11	0
23	4.0	11	0	654	1,304	105	114	0	1	0
24	4.5	3	0	43	222	353	31	0	23	0
25	6.0	9	0	40	297	1,760	89	5	8	0
26	4.0	11	0	153	260	327	117	0	6	0
27	4.0	6	0	338	423	29	82	0	0	0
28	5.0	2	0	57	400	385	135	5	42	0
29	5.3	4	0	85	209	870	5	0	48	0
30	4.5	1	0	14	236	941	29	0	43	0
31	4.0	0	0	62	67	276	24	0	4	0
32	4.0	1	0	287	171	1,171	25	0	3	0
33	5.0	0	0	9,124	7,162	21,960	141	120	0	0
34	4.0	2	0	2,058	1,160	206	196	0	0	0
35	4.0	0	1	607	158	38	251	13	0	0
36	4.0	12	5	654	1,604	0	318	36	12	12
37	6.0	4	0	2,398	426	314	56	0	0	0
38	4.0	9	0	280	217	50	14	0	0	2
39	4.0	1	1	121	104	86	18	1	0	0
40	5.7	6	0	59	371	306	62	6	4	0
41	5.0	8	0	223	655	302	63	8	1	0
42	4.0	6	0	28	454	86	37	2	1	0
43	3.0	2	1	383	684	608	7	9	0	0
Total		210	428	25,978	28,553	37,460	3,367	3,102	440	161

<sup>4</sup> Gurnards include four species caught, *Eutrigla gurnadus* (grey gurnard), *Aspirigla cuculus* (red gurnard), *Trigloporus lastiviza* (streaked gurnard) and *Trigla lucerna* (tub gurnard).

## Appendix 9.

Total numbers of fish caught in the *Isadale* and *Benaiah IV* surveys in spring 2009

Spp Code	Scientific Name	Common Name	<i>Isadale</i>	<i>Benaiah IV</i>
BIB	<i>Trisopterus luscus</i>	Whiting-pout	139	-
BLL	<i>Scophthalmus rhombus</i>	Brill	63	-
BLR	<i>Raja brachyura</i>	Blonde ray	35	5
BNW	<i>Labrus bergylta</i>	Ballan wrasse	4	-
BRT	<i>Myoxocephalus scorpus</i>	Bullrout	24	-
CDT	<i>Callionymus lyra</i>	Common dragonet	32	-
COD	<i>Gadus morhua</i>	Cod	210	472
COE	<i>Conger conger</i>	European conger eel	0	67
CUR	<i>Raja naevus</i>	Cuckoo ray	63	-
CUW	<i>Labrus mixtus</i>	Cuckoo wrasse	11	
DAB	<i>Limanda limanda</i>	Dab	37460	48
DBM	<i>Galeus melastomus</i>	Blackmouthed dogfish	0	1
DGN	<i>Galeus murinus</i>	Mouse catshark	13	1
DGS	<i>Squalus acanthias</i>	Spurdog	7	440.5
ESB	<i>Dicentrarchus (morone) labrax</i>	European seabass	11	1
FLE	<i>Platichthys flesus</i>	Flounder (European)	3367	-
GAG	<i>Galeorhinus galeus</i>	Tope shark	0	1
GUG	<i>Eutrigla gurnadus</i>	Grey gurnard	2230	4293
GUR	<i>Aspirigla cuculus</i>	Red gurnard	810	3008
GUS	<i>Trigloporus lastiviza</i>	Streaked gurnard	6	-
HAD	<i>Melanogrammus aeglefinus</i>	Haddock	428	1206
HER	<i>Clupea harengus</i>	Herring	11171	22
HKE	<i>Merluccius merluccius</i>	European hake	3	43
HOM	<i>Trachurus trachurus</i>	Horse-mackerel (scad)	0	5
JOD	<i>Zeus faber</i>	John dory	4	223
LBE	<i>Homarus gammarus</i>	European lobster	1	-
LEM	<i>Microstomus kitt</i>	Lemon sole	285	1
LIN	<i>Molva molva</i>	Common ling	3	13
LSD	<i>Scyliorhinus canicula</i>	Lesser spotted dogfish	1348	98
LUM	<i>Cyclopterus lumpus</i>	Lumpsucker	0	25
MAC	<i>Scomber scombrus</i>	(European) mackerel	52	1
MLP	<i>Macropipus (liocarcinus) puber</i>	Velvet swimming crab	*	*
MON	<i>Lophius piscatorius</i>	Anglerfish (Monkfish)	5	2
NEP	<i>Nephrops norvegicus</i>	Norway lobster	0	1
NOP	<i>Trisopterus esmarkii</i>	Norway pout		3
PFX	<i>Syngnathidae</i>	Pipefishes		1
PLA	<i>Hippoglossoides platessoides</i>	Long rough dab		1
PLE	<i>Pleuronectes platessa</i>	European plaice	28553	113
POD	<i>Trisopterus minutus</i>	Poor cod	69	-
POG	<i>Agonus cataphractus</i>	Pogge (armed bullhead)	11	-
POK	<i>Pollachius virens</i>	Saithe	0	7
POL	<i>Pollachius pollachius</i>	Pollack	9	34
SDR	<i>Raja montagui</i>	Spotted ray	161	73
SDS	<i>Mustelus asterias</i>	Starry smoothhound	2	-
SOL	<i>Solea solea (S. vulgaris)</i>	Sole (dover sole)	36	-
SPR	<i>Sprattus (Clupea) sprattus</i>	Sprat	25	47
SQC	<i>Loligo spp</i>	Common squids	9	11
SSN	<i>Taurulus bubalis</i>	Sea scorpion	10	-
SYR	<i>Raja radiata</i>	Starry ray		5
THR	<i>Raja clavata</i>	Thornback ray (roker)	440	15
TKT	<i>Zeugopterus punctatus</i>	Topknot	1	-
TRS	<i>Salmo trutta</i>	Sea trout	1	-

TUB	<i>Trigla lucerna</i>	Tub gurnard	56	598
TUR	<i>Scophthalmus maximus</i>	Turbot	7	9
WHG	<i>Merlangius merlangus</i>	Whiting	25978	71
WIT	<i>Glyptocephalus cynoglossus</i>	Witch	0	5