

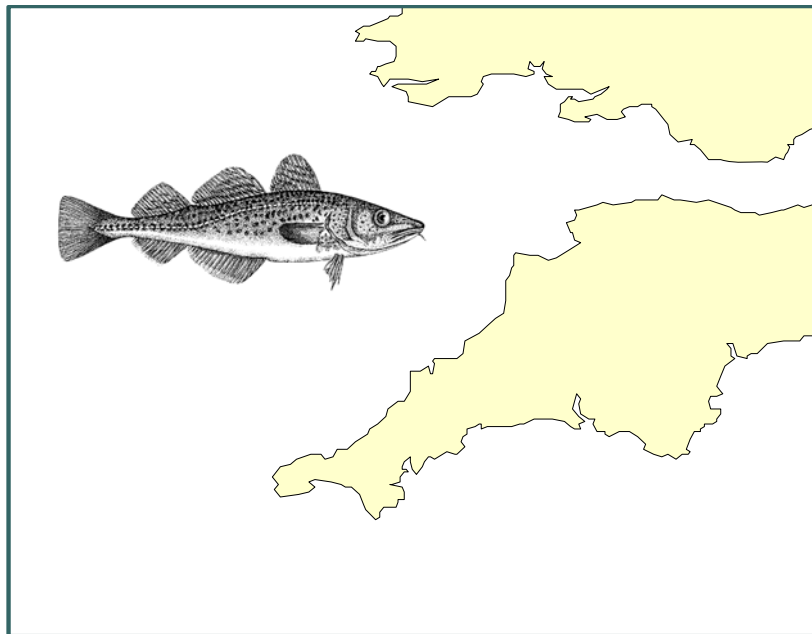
*Final Report*

***Programme 7: Western Cod***

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**May 2006.**

## Summary

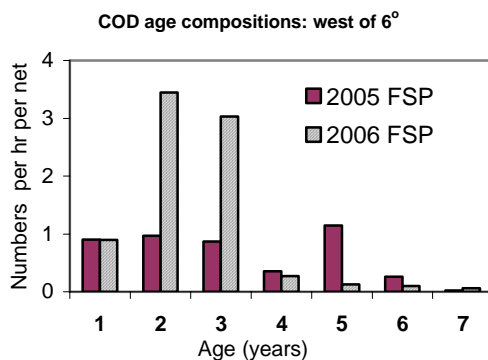
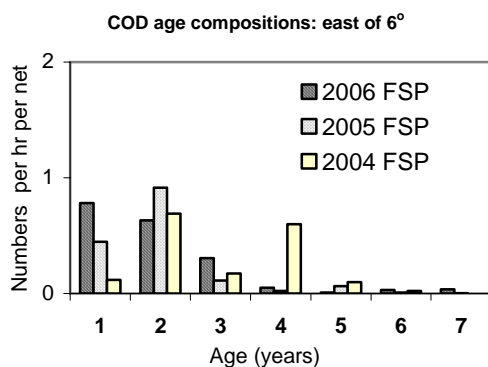
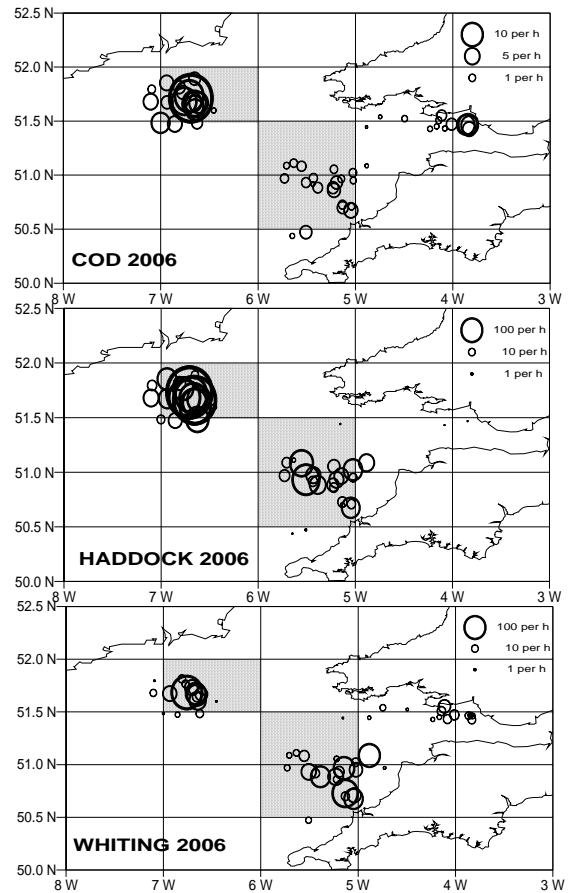
This report presents the results of the third in a series of FSP surveys of cod in the Bristol Channel and Celtic Sea. The first two surveys took place in spring 2004 and 2005 on FV *Our Josie Grace*, a commercial trawler based in Ilfracombe. Programme 7 in 2006 used the same vessel for 20 days between 5 February and 17 March.

Tows were carried out in and close to the three ICES rectangles closed to fishing in spring (shaded rectangles opposite), and in the Bristol Channel, using twin-rig and single-rig nets with 85mm codends. All results shown are standardised to catch rates of the single-rig net.

The objectives of the 2006 FSP survey were to investigate the potential of the western cod FSP survey for providing time-series data on abundance and population structure of cod, and to examine the distribution of a range of species in and near the closed rectangles.

Cod were caught in significant numbers in all three closed rectangles, and also in the inner Bristol Channel (see map opposite). Mature cod were caught in all areas. The highest catch rates of haddock and whiting were also within the closed rectangles.

*Distribution of cod, haddock and whiting during the 2006 FSP survey on Our Josie Grace*



Cod off NW Cornwall and in the Bristol Channel (east of 6°W) have been predominantly fish of 1-3 years of age, with the exception of the 2004 FSP when 4-year-olds of the relatively strong 2000 year-class were common. Cod in this year class were also prominent as 5-year-olds in tows off SE Ireland (west of 6°W) in the 2005 FSP. The majority of cod off the SE coast of Ireland were 2- and 3-year-olds in 2006.

The overall catch-rate of cod off NW Cornwall and the Bristol Channel has remained stable at just under 2 fish per hour per single net (see table on next page) although the age composition has varied as shown opposite. The catch rates off SE Ireland were 75% higher in 2006 than in 2005.

Haddock were 2 – 3 times more abundant in 2006 compared with 2005, whilst the catch-rates of whiting have been quite stable between years and areas in 2005 and 2006.

## Summary contd.

### Abundance indices

The indices of abundance from the 2004 to 2006 are given below as mean number of fish caught per hour, by age class, standardised to catch-rates of a single-rig trawl. No haddock and whiting otoliths were collected during the 2004 FSP trip.

#### Cod: 2004 to 2006 FSP

area	Year	1	2	3	4	5	6	7+	total
East of 6 <sup>0</sup> W	2004	0.115	0.690	0.171	0.597	0.097	0.022	0.000	1.69
	2005	0.446	0.914	0.111	0.023	0.063	0.009	0.004	1.60
	2006	0.782	0.631	0.304	0.051	0.008	0.030	0.036	1.84
West of 6 <sup>0</sup> W	2005	0.90	0.97	0.87	0.35	1.15	0.26	0.02	4.5
	2006	0.897	3.448	3.032	0.271	0.126	0.101	0.059	7.9

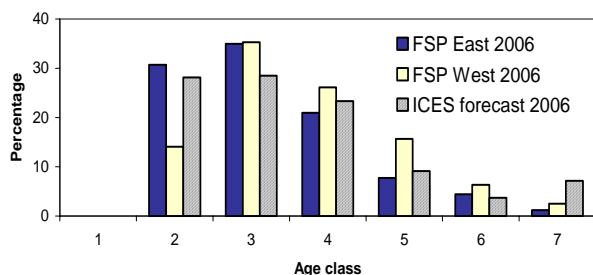
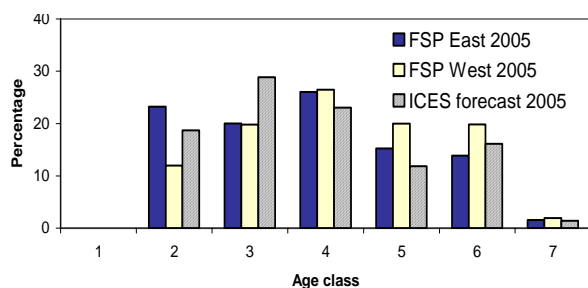
#### Haddock: 2005 to 2006 FSP

area	Year	1	2	3	4	5	6	7+	total
East of 6 <sup>0</sup> W	2005	1.95	2.30	6.49	0.94	0.13	0.09	0.00	12
	2006	6.41	13.35	1.11	2.31	0.37	0.02	0.02	24
West of 6 <sup>0</sup> W	2005	9.47	13.26	18.69	2.61	0.35	0.23	0.00	45
	2006	10.51	99.5	6.5	10.3	1.7	0.1	0.01	129

#### Whiting: 2005 to 2006 FSP

area	year	1	2	3	4	5	6	7+	total
East of 6 <sup>0</sup> W	2005	1.34	5.68	4.89	6.37	3.73	3.40	0.38	26
	2006	2.36	6.75	7.67	4.60	1.69	0.97	0.27	24
West of 6 <sup>0</sup> W	2005	0.38	3.16	5.22	6.98	5.27	5.24	0.51	27
	2006	0.54	4.69	11.73	8.68	5.21	2.11	0.84	34

Comparison of whiting % age compositions from FSP with ICES forecasts of landings in 2005 and 2006 (1-yr-olds excluded)



### Comparison with ICES data

There are currently no accepted assessments and forecasts for Celtic Sea cod and haddock to compare with the FSP results.

A broad range of age classes of whiting was present in both the eastern and western region during the 2005 FSP survey, with fish being relatively abundant up to six years of age. The proportion of older fish was not as high in the 2006 survey. Comparison with the most recent ICES forecast is difficult because the ICES assessment does not include discards. However, the ICES catch forecasts for 2005 and 2006 indicate a relatively broad age composition with a similar incidence of 2-4 year olds to that indicated by the FSP catches (see opposite).

## Introduction

The Fisheries Science Partnership (FSP) was established in 2003 to build relationships between fishermen and scientists, and to involve fishermen in the co-commissioning of science. The FSP is funded by the UK's Department for Environment, Food and Rural Affairs (Defra). Ten projects were carried out during 2003/04, ten in 2004/05 and nine in 2005/06, comprising a mixture of time-series surveys, fishing gear selectivity studies, and examination of spatial patterns of catch compositions. Reports for FSP projects already completed are available on the FSP page of the Cefas web site ([www.cefas.co.uk/fsp](http://www.cefas.co.uk/fsp)).

Industry proposals for FSP projects have typically been developed at a port/regional level, refined and agreed with Cefas from a scientific and operational perspective, and approved by the FSP Steering Group. Charter vessels are selected through an open tendering procedure.

This report presents the results of FSP 2005/06 Programme 7, a survey of cod in the Bristol Channel and Celtic Sea carried out in spring 2006. The programme used the commercial twin-rig trawler FV *Our Josie Grace* (Ilfracombe) for 18 days between 7 February and 16 March 2006. The design of the western cod survey was arranged in collaboration with Cefas and the skipper/owner of the vessel on 1 February 2006, and the resultant work plan is given in Appendix 1.

The first Western Cod FSP survey in 2004 covered only the Bristol Channel and the eastern Celtic Sea east of 6°W (Cotter *et al.* 2004). In 2005, the survey was extended to include tows in the western Celtic Sea off the SE coast of Ireland (Armstrong *et al.* 2005). In 2006, the survey was re-designed to try and ensure a broader coverage of the fishing grounds inside and immediately surrounding the three ICES rectangles closed to cod fishing during spring since 2005, whilst ensuring good coverage of the areas where cod were expected to be most abundant.

The work plan involved trawling under dispensation from the quota regulations and to fish in the Celtic Sea cod closure. Dispensations were also provided through the Foreign and Commonwealth Office for carrying out a survey in Irish waters.

## Objectives

The invitation-to-tender for this charter identified the following elements for the survey:

1. To carry out a further survey of Celtic Sea cod, following similar FSP surveys in 2003 and 2004, to evaluate whether a time-series could be developed. Such time-series will allow scientists and fishermen to track the increase and decrease of cod, whiting and haddock over time. 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.
2. Information from this survey will also add to knowledge of species composition and abundance inside and outside of the recently designated cod closed areas.

The Work Programme for the surveys is reproduced in Appendix 1.

## Methods

### Survey design

The survey was designed to address the two main objectives given above. As the UK fishery in spring targets cod on or near the Trevoise spawning grounds, which are also covered by the Celtic Sea cod closure, the focus of the survey was predominantly adult cod. The survey area was divided into a number of distinct areas or strata with different trawling rates. In areas with a low expected abundance of cod, one tow was requested in each 15' latitude x 20' longitude rectangle within the defined boundary of the survey. This was to ensure adequate coverage of areas where adult cod could potentially have occurred during the survey period, although not necessarily in concentrations suitable for commercial fishing. Higher densities of cod were expected in the three ICES rectangles closed to commercial cod fishing. At least two tows per 15'x20' rectangle were requested in these ICES rectangles in order to provide greater precision in this area (see Appendix 1 for full details). The extent to which the proposed survey design could be met in practice is examined in the Discussion section.

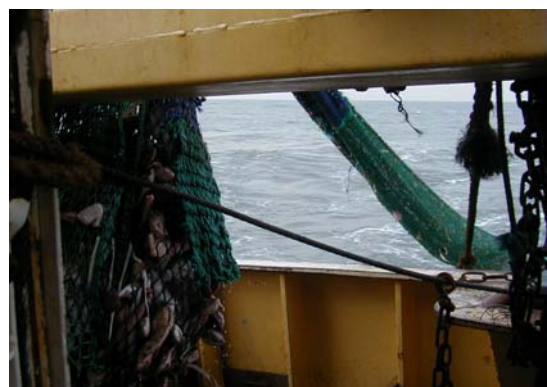
### Vessels and fishing gear

The FV *Our Josie Grace* (BD287) is a trawler of 14 m reg. length, gross tonnage 35, with a 221 kW engine. The gears used were:

Primary gear: Twin rig. 2 x 10 fathom box trawls with a heavy footrope (14 inch discs in the belly and 12 inch in the wings), 16 fathoms of split bridles, bottom split either chain or rubbered combination, and top split 10mm wire, followed by 3-4 fathoms of single bridle of tested chain. Maximum mesh size 150mm; codend 85mm single braided twine. 650 kg clump weight. Approx 7 ft headrope height. No. 7 Bison doors

In areas of very strong tides or where ground types were uncertain, for example in the Bristol Channel and off SE Ireland, the previous FSP trips used a single-rig net to avoid tangling of the twin-rig. A net of this type was also carried on board. The details of this net were as follows:

Single rig. 15 fathom Box trawl with 10 inch discs and the same bridle rig as the twin-rig. Approx 9-10 ft headrope height. No. 7 Bison doors. 85 mm cod-end.



## Catch sampling methods

Sampling of all catches was carried out using standard methods employed by Cefas. 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. Data were recorded separately for fish discarded and retained for landing. 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.

## Data analysis

The number of cod, haddock, whiting and other species caught per hour of trawling per net, (i.e. standardised to one net of a twin-rig trawl as in the previous western cod surveys), was calculated for each tow and mapped to show the distribution pattern of each species. This was not an ideal procedure as the catch-rate of the twin-rig gear will not have been double the catch-rate of the single-rig box trawl. However, no calibration data were available to determine a more appropriate conversion rate. This issue is considered further in the Discussion section.

The length structure of the catch was calculated as the number in each 1-cm length class per hour towed per net. Separate length frequency distributions were calculated for the area east and west of 6°W. Otoliths were collected using a length-stratified scheme applied to the entire survey, and consequently the age compositions of cod, haddock and whiting were calculated for the eastern and western survey areas using a single ALK for each species applied to the regional length frequency distributions.



## Results

### Tow details

A summary of trawling operations is given in Table 1. Details of position, date, time, tow duration, gear, along with numbers caught per hour pr net for nine commercial species are shown in Appendix 2 for all hauls made by *Our Josie Grace* in spring 2006. Data for other species are available on the Cefas database.

Mid-tow positions are illustrated in Figure 1. A relatively large fraction of the 15'lat x 20'long rectangles did not have the minimum of one tow specified in the Operation Plan, and a third of the 15'x20' rectangles inside the cod closure, where a minimum of two tows per rectangle were specified, were not covered. This was due to a mixture of extremely poor weather conditions limiting the activities of the vessel, and a lack of clear tow readings for a number of the rectangles.

**Table 1.** FSP Programme 5: Western cod. Details of fishing activities by *Our Josie Grace* (cruise code OJG 1/06) "Single-rig" was the 15-fathom single-rig box trawl.

Dates in 2006	Tows	No. hauls	Fishing gear	Cod-end mesh mm	Tow duration hrs. Average (range)
7-11 Feb	1-15	15	Twin rig	85	3.8 (3.3 – 4.2)
18 - 21 Feb	16 – 17 23 - 27	7	Twin rig	85	4.2 (4.0 – 5.0)
18 – 21 Feb	18 – 22	5	Single rig	85	4.0 (4.0)
27 Feb – 3 March	28 – 29 43 - 46	6	Twin rig	85	3.9 (3.7 - 4.0)
27 Feb – 3 March	30 - 42	13	Single-rig	85	4.0 (3.5 - 4.2)
14 – 17 March	47 - 56	10	Twin-rig	85	4.0 (3.8 - 4.2)

The tows where single and twin rigs were deployed are indicated on Figure 1

### Distribution patterns

The distribution of cod, haddock and whiting in the 2004, 2005 and 2006 FSP western cod surveys is shown in Figures 2 – 4. Note the expanded scale for cod compared to the other two species. The spatial pattern of mean lengths of the three species is shown in Fig. 5.

The highest catch rates of cod (Fig. 2) in the eastern region were off NW Cornwall and in the inner Bristol Channel. A similar distribution pattern was recorded in the 2004 and 2005 surveys. Catch rates in and near the closed ICES rectangle off the Irish Coast were generally higher than off Cornwall and in the Bristol Channel. Mean length of cod in the catches

showed that catches with mean length >60cm occurred throughout the eastern and western survey regions including in the Bristol Channel (Fig. 5).

Catch rates of haddock (Fig. 3) were higher than those of cod, those in the western area being generally much larger than in the east during the 2006 survey. The largest catches of haddock were found at broadly similar locations as for cod, although few haddock were taken in the Bristol Channel. The mean lengths of haddock were more variable off Cornwall than off the Irish Coast (Fig. 5).

Comparatively high catch rates of whiting were recorded at several tows in both the western region and off NW Cornwall (Fig. 4). Whiting were also consistently present in the catches in the inner Bristol Channel. As with haddock, the mean lengths of whiting were more variable in the eastern region than in the west. The majority of the whiting were discarded owing to there being no viable market for them.

The distributions of plaice, sole, lemon sole, monk and hake during the survey are shown in Figs. 6. Relatively high catch rates were recorded in and immediately adjacent to one or more of the three closed rectangles.

### **Length and age composition**

Length frequency distributions for cod, haddock and whiting in the eastern and western regions are shown in Figures 7-9, together with the equivalent results for the spring 2004-2005 surveys. The age compositions for the three species are also shown, and are summarised by area and year in Table 2.

The mean length frequencies of cod in the eastern and western areas (the columns in Figs 7 a,b) were comparatively “noisy” due to often small numbers caught per 1-cm length class. However, there are some consistent length groupings where the catch rates rise to form general peaks, reflecting the length compositions for the different age groups. For example, cod <35cm long are mainly 1-year-olds, whilst fish in the 35-65cm range are mainly 2-year-olds. The majority of cod in the eastern region in 2006 were 1 - 3 year olds (Fig. 7c). Although the catch-rates of 1-year-olds were similar in the east and the west, catch rates of 2- and 3-year-olds were much higher in the west, off the Irish Coast, than in the east. (Fig. 7c,d). Differences in the length frequencies between years reflect the changing age composition due to variations in the strength of year classes. Although there is currently no accepted ICES assessment for Celtic Sea cod, previous assessments have indicated comparatively strong 1999 and 2000 year-classes, which would have been present in the population in 2006 as 7-year-olds and 6-year-olds. It is difficult to discern these year-classes in 2006 due to the very low catch-rates at ages 6 and 7. However, the elevated catch rates at age 4 in the east in 2004 and at age 5 in the west in 2005 (Fig. 7c,d) indicate a significant continued presence of cod of the 2000 year class in those years.

Length frequencies of haddock in the eastern region during 2006 exhibited a modal length group of fish less than 25cm, comprising 1-year-olds, and a modal group within the length range 27-40 cm comprising mainly 2-year-olds (Figs 8a-d). Catch-rates of 2-year-olds were particularly high in the western region off the Irish Coast in 2006. Although there is no currently accepted ICES assessment for Celtic Sea haddock, survey and fishery data given by ICES indicate a strong 2002 year class, which is indicated in the FSP results as the predominant age class (3-year-olds) in 2005 and elevated catch-rates of 4-year-olds in 2006 (Figs 8c,d). However, the dominant age groups in 2006 were 1- and 2-year-olds.

Length frequencies of whiting were similar in the 2005 and 2006 FSP surveys, and in contrast to cod and haddock, were also similar in the western and eastern regions (Fig. 9a,b). There is a considerable overlap in the length distributions for different age groups in all years and areas, and there are no clear modal groups attributable to specific age classes. One-year-olds were poorly represented in the catches (Fig. 9c,d), which is probably due to the selectivity characteristics of the 85mm mesh trawl net. Age classes of whiting between 1 and 7 years old were represented in the catches in both the eastern and western region. The fish were relatively abundant up to five years of age with 3 year olds being the most abundant in 2006 (Figs 9c,d). The relative abundance of older whiting was lower in 2006 than in 2005. The percentage age composition of whiting in the 2005 and 2006 FSP surveys was similar to the composition of the landings-at-age forecasts for those years given by the ICES Working Group on the Assessment of Southern Shelf Demersal Stocks at its meeting in 2005 (ICES, 2005) (Fig. 10).

**Table 2.** Indices of abundance of cod, haddock and whiting, by age class and year. Indices are mean numbers caught per hour per net and are given separately for the eastern and western areas. (No age data for whiting and haddock in 2004.)

(a) Cod: 2004 to 2006 FSP

area	Year	1	2	3	4	5	6	7+	total
East of 6 <sup>0</sup> W	2004	0.115	0.690	0.171	0.597	0.097	0.022	0.000	1.69
	2005	0.446	0.914	0.111	0.023	0.063	0.009	0.004	1.60
	2006	0.782	0.631	0.304	0.051	0.008	0.030	0.036	1.84
West of 6 <sup>0</sup> W	2005	0.90	0.97	0.87	0.35	1.15	0.26	0.02	4.5
	2006	0.897	3.448	3.032	0.271	0.126	0.101	0.059	7.9

(b) Haddock: 2005 to 2006 FSP

area	Year	1	2	3	4	5	6	7+	total
East of 6 <sup>0</sup> W	2005	1.95	2.30	6.49	0.94	0.13	0.09	0.00	11.9
	2006	6.41	13.35	1.11	2.31	0.37	0.02	0.02	23.6
West of 6 <sup>0</sup> W	2005	9.47	13.26	18.69	2.61	0.35	0.23	0.00	44.6
	2006	10.51	99.5	6.5	10.3	1.7	0.1	0.01	128.6

(c) Whiting: 2005 to 2006 FSP

area	year	1	2	3	4	5	6	7+	total
East of 6 <sup>0</sup> W	2005	1.34	5.68	4.89	6.37	3.73	3.40	0.38	25.8
	2006	2.36	6.75	7.67	4.60	1.69	0.97	0.27	24.3
West of 6 <sup>0</sup> W	2005	0.38	3.16	5.22	6.98	5.27	5.24	0.51	26.8
	2006	0.54	4.69	11.73	8.68	5.21	2.11	0.84	33.8

### Abundance indices

Abundance indices for the FSP surveys are given for each age class as mean numbers caught per hour of fishing, standardised to the catch rates of the single-rig trawl (assuming the twin-rig catches twice as many fish per hour as the single rig, which is likely to be an over-estimate). The overall catch-rate of cod off NW Cornwall and the Bristol Channel has remained stable at just under 2 fish per hour per single net (Table 2) although the age composition has varied as shown in Figure 7. The overall catch rates off SE Ireland were 75% higher in 2006 than in 2005.

Haddock were 2 – 3 times more abundant in 2006 compared with 2005, whilst the catch-rates of whiting have been quite stable between years and areas in 2005 and 2006

### **Patterns of discarding**

The pattern of discarding was related to minimum landing size and marketing factors. Discarding of cod was almost entirely of 1-year-olds below the MLS of 35cm (Fig. 7a,b). Haddock were discarded well above the MLS of 30cm probably to meet market demands (Fig. 8a,b). The majority of whiting were discarded owing to the lack of a market for this species. (Fig. 9a,b). These patterns may not necessarily reflect those of the commercial fleet as a whole, as catches taken during the survey were outside of quota.

## **Discussion**

### **Distribution patterns of cod and other species in relation to the closed area**

The western cod FSP surveys have provided valuable information on spatial patterns in catch rates of cod and other demersal fish both within the three ICES rectangles closed to fishing in spring, and also in some surrounding areas. The number of FSP tows that have been located within the closed rectangles since 2004 indicate that some very productive areas for demersal fish are covered by the closure in spring. In general, tows within the closed area have provided some of the highest catch rates of cod, haddock and whiting (Figs 2-4), and also of a number of other flatfish and roundfish species (Fig. 6).

Although cod (including adult fish) are also found in regions surrounding the closed rectangles, including in the inner Bristol Channel, the survey has not had sufficient coverage of all potential cod habitats to allow an evaluation of the proportion of the spawning stock contained within the closed rectangles. Historical data on cod egg distribution in the eastern Celtic Sea, given in last year's FSP report (Armstrong *et al.*, 2005) and reproduced again in this year's report (Fig. 11), confirms that the two closed ICES rectangles off the NW coast of Cornwall encompass the main spawning site for cod in the eastern Celtic Sea. Brander (1994) also shows historically important spawning sites for cod off NW Cornwall and off the SE coast of Ireland. The concentration of cod in this area in the 2004-2006 FSP surveys, which have taken place in the first half of the spawning season off NW Cornwall, shows that this spawning site remains important for Celtic Sea cod. Aggregations of adult cod in the closed rectangle off SE Ireland also indicates that spawning is probably also taking place there.

### **Potential of the survey for providing time-series data**

Weather is a major limitation in the very exposed waters of the Celtic Sea. Conditions were particularly poor for much of the designated survey period in 2006, and skipper Marcus White of *Our Josie Grace* is to be commended for the amount of trawling that was completed under the circumstances. The vessel was near its working limits in poor weather for much of the time, and was restricted in its ability to work away from the UK coast except under fine conditions.

Whilst much useful information was obtained on fish distribution and size/age composition during the 2004-2006 FSP surveys, the patchy survey coverage will have had an impact on perceptions of how the fish abundance has changed from year to year. The poor weather and

the limitations of the *Our Josie Grace* for working in such conditions, together with a lack of clear tow readings for many areas, resulted in tows being centred in only 26 of the potential 45-46 15'lat x 20'long rectangles in the original survey design for 2006 (Fig. 1). The tow distribution reverted back towards the clumped distribution apparent in the surveys in 2004 and 2005.

In view of these limitations, no attempt has been made to compute abundance indices allowing for the clumping of tows and areas with missing tows. The simple averages of catch-rates at age across tows in the eastern and western regions (Table 2) must therefore be considered as only indicative of changes between years. The stability of cod catch-rates in the eastern region from 2004-2006, and of whiting catch rates in all areas in 2005 and 2006, suggest that the clumped tow distribution may still be capable of yielding time-series information on fish abundance, provided the tow distribution and the fish distribution remain reasonably stable across years and there is adequate coverage of the surrounding areas with lower catch rates. However such a design runs the risk of giving biased data on abundance should either the fish distribution or the tow positions change substantially over time. Should the surveys be continued, more appropriate methods for analysing the 2004-2006 data will be investigated. This was not possible in the time available for the present report.

A further problem has been the variable interchange between single-rig and twin-rig gears to cope with variable tidal conditions and ground types, without any calibration data to allow a proper standardisation of catch-rates between gears. The use of a single-rig trawl throughout would be preferable if the surveys were to be continued, to avoid problems of standardisation. In addition, twin-rig catches require more time for sorting. With only one observer on board, there were occasions when the catch from only one net of the twin rig could be sorted, leading to a reduction in accuracy of catch estimates for the smaller, more abundant species being sub-sampled. (Catches of cod, are however likely to be estimated quite accurately as they are caught in relatively small numbers but are easy to sort from the catch).

If this survey is to be continued to provide useful time-series data on cod abundance, a re-evaluation of the survey design, fishing gear and appropriate vessel size and power should be carried out, and clear tows should be sought over a wider area. The reduction in catch volume that would result from deploying a single-rig trawl throughout, and over a wider area away from the cod "hot spots", would need to be clearly highlighted so that it can be factored into any future tenders submitted. The usefulness of continuing the extension of the survey to the western Celtic Sea off SE Ireland requires further consideration, given the relatively limited coverage of this area that is possible in the time available, particularly when weather conditions are poor. Further information is required on the extent of the distribution of mature cod off SE Ireland during February – March to evaluate the appropriate coverage of a survey of this component of the Celtic Sea cod population.

### **Comparison with ICES assessments**

Comparison of FSP results with ICES assessments has been hampered by the lack of accepted assessments for cod and haddock. The cod assessment has recently suffered from poor fishery data for the younger age classes following changes in discarding practices by French vessels. The haddock assessment also suffers from inadequate time-series of discards estimates, given the relatively high rates of discarding of young haddock that have been observed, particularly from strong year classes. The ICES Advisory Committee on Fisheries Management has consequently been unable to provide updated analytical assessments and forecasts for these stocks.

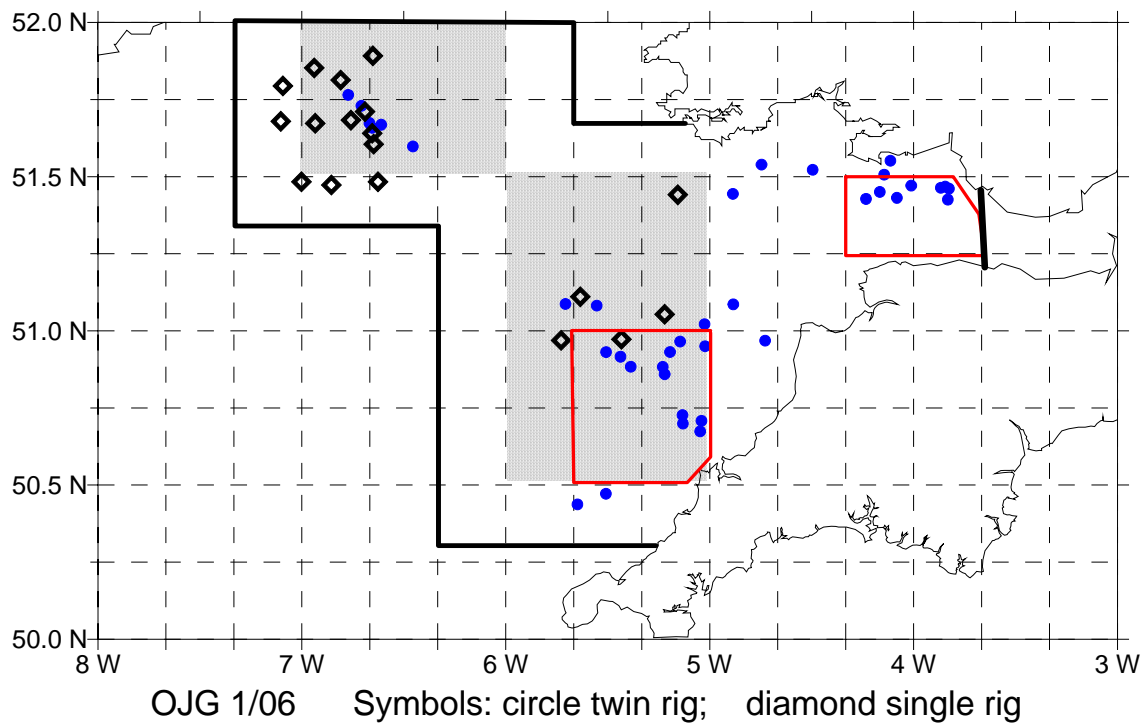
ICES continues to provide an analytical assessment for Celtic Sea whiting, although this excludes data on discards and therefore under-estimates the true catch of whiting. However, the catch forecast from the most recent ICES assessment for whiting (ICES, 2005) shows similar percentage age compositions in 2005 and 2006 to those given by the FSP surveys. The relatively broad age composition in the FSP catches of whiting contrasts markedly with the catches taken in the neighbouring Irish Sea fisheries, where the catches have a very steep age profile.

## **Acknowledgements**

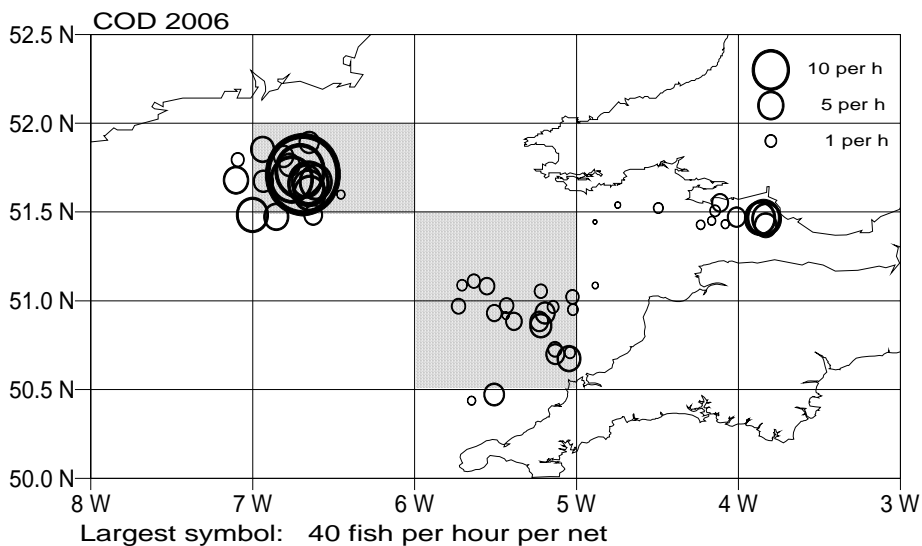
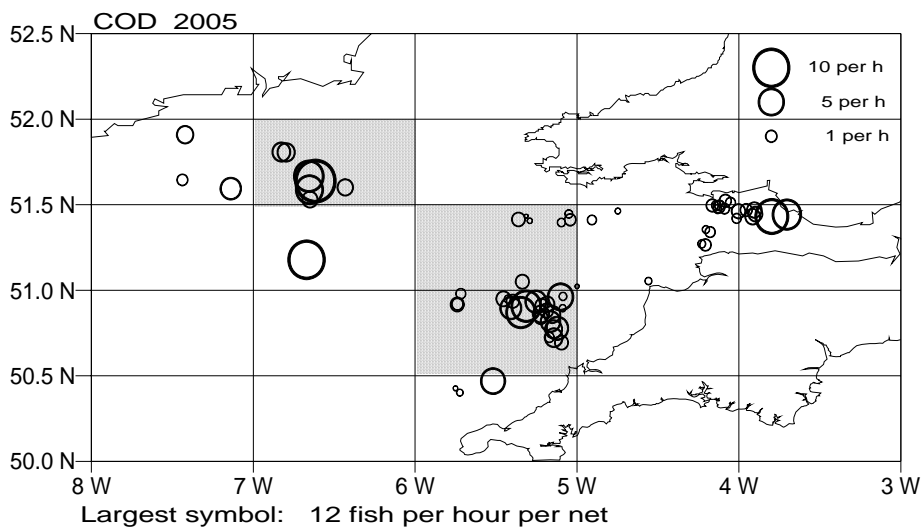
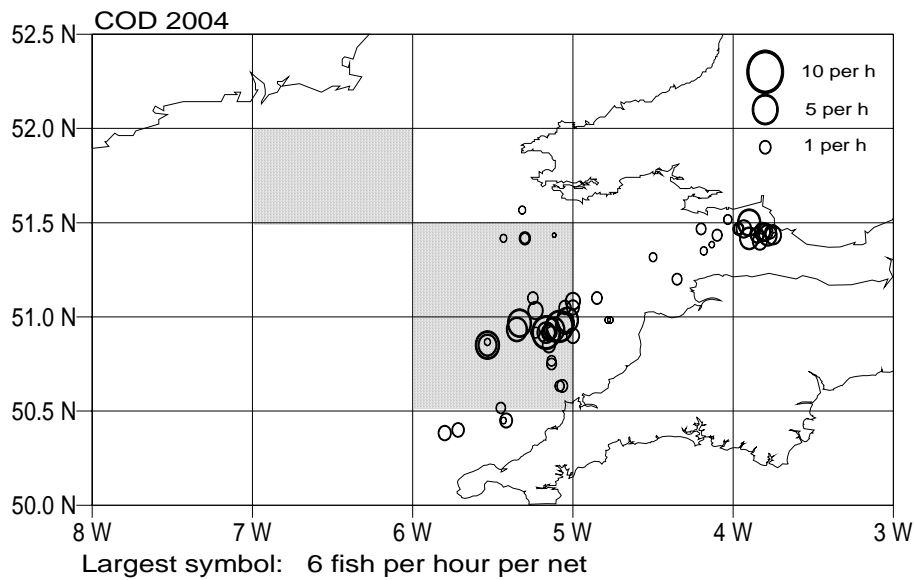
The owner, skipper and crew of the FV *Our Josie Grace* are warmly thanked for making the vessel available for charter during this FSP programme, and for their willing cooperation during the trips. Staff at Cefas involved in data capture and processing of otoliths are thanked for their valued contribution. The FSP programme was funded by Defra.

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**Fig. 1.** FSP 2006 Programme 7, Western Cod, spring 2006. Mid-tow positions. Boundaries of the survey are given by the thick dark lines. The area of the cod closure, where two tows per 15' lat x 20' long rectangle were intended is shaded. The red lines indicate potential areas identified in the cruise plan for > 2 tows per 15x20 rectangle (see Appendix 1).



**Fig. 2.** Distribution of cod in the 2004, 2005 and 2006 western cod FSP surveys. Same scale for all plots. Areas of circles are proportional to numbers caught per hour towed, standardised to a single-rig net.









































