

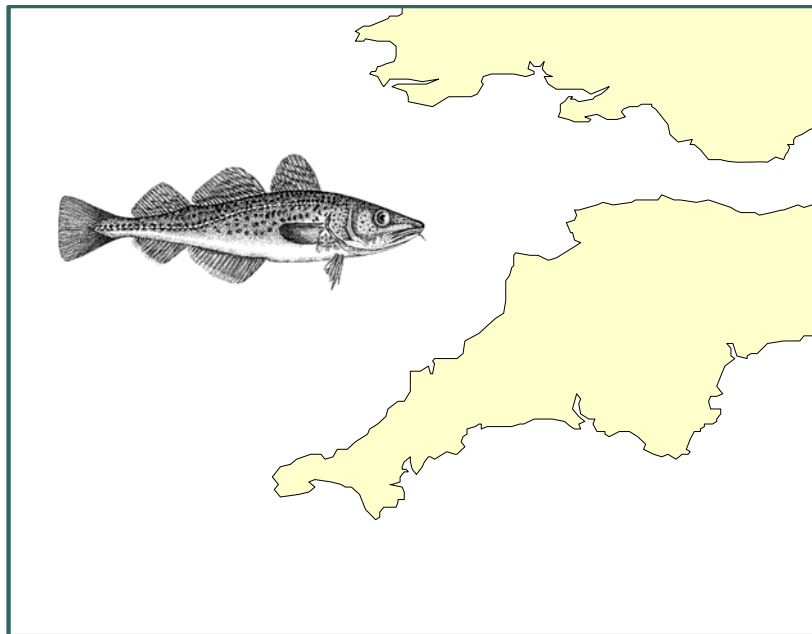
Final Report

Programme 7: Western Cod

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Summary

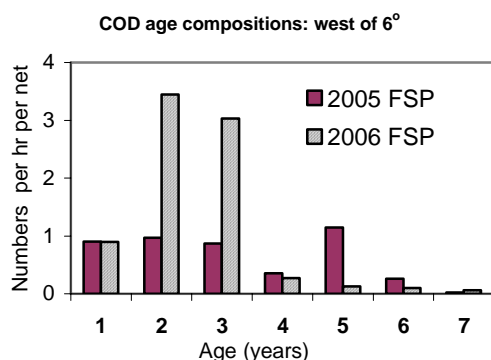
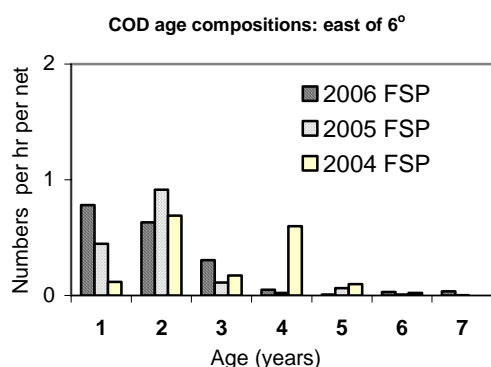
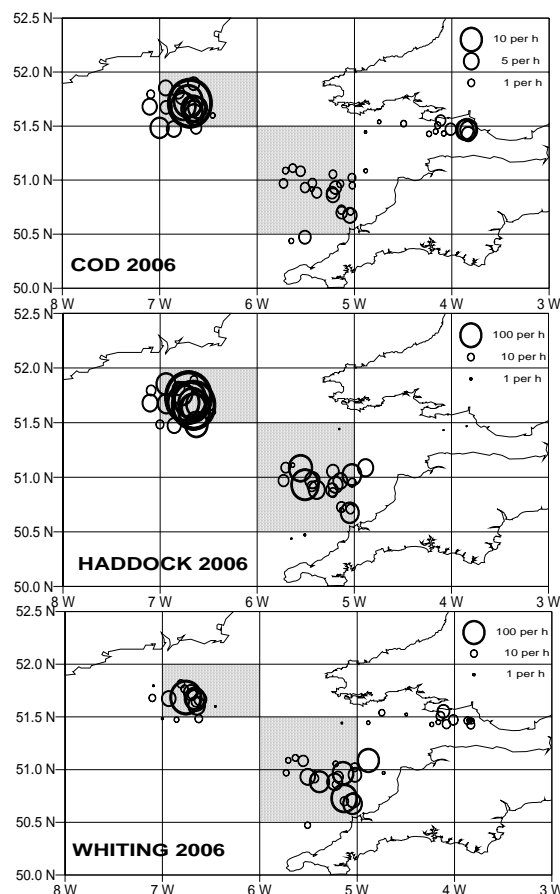
This report presents the results of the third in a series of FSP surveys of cod in the Bristol Channel and Celtic Sea. The first two surveys took place in spring 2004 and 2005 on FV *Our Josie Grace*, a commercial trawler based in Ilfracombe. Programme 7 in 2006 used the same vessel for 20 days between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

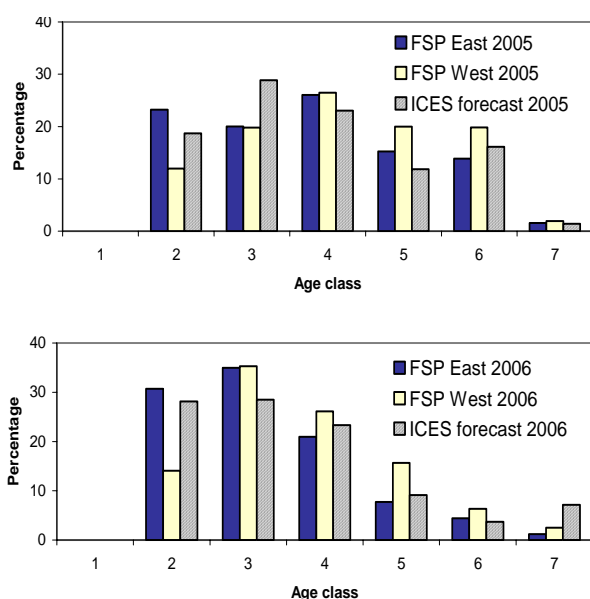
Haddock: 2005 to 2006 FSP

area	Year	1	2	3	4	5	6	7+	total
East of 6°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°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°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°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).

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.

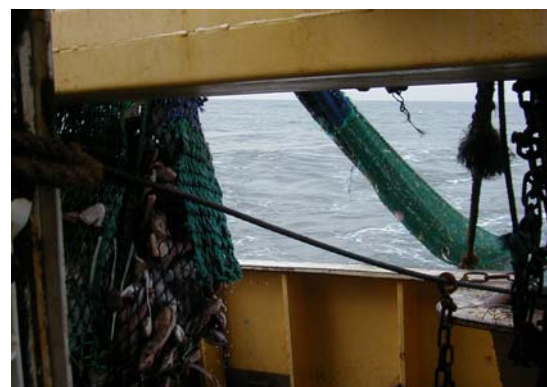
Vessels and fishing gear

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°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°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°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°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°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°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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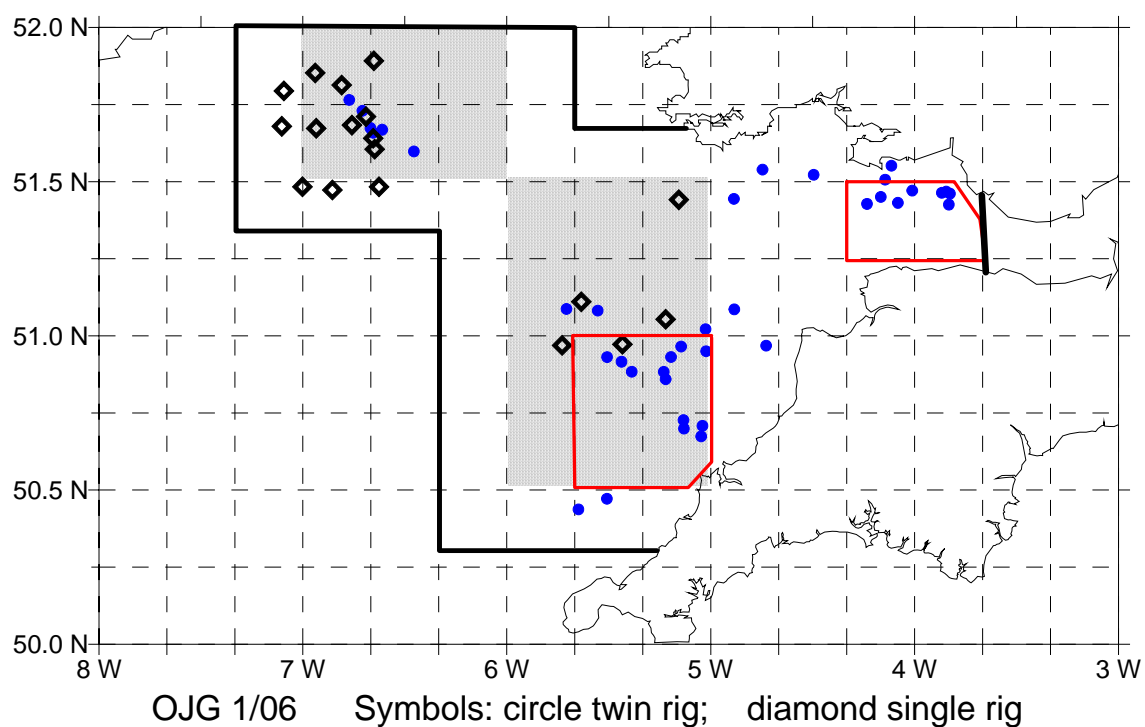


Fig. 1. FSP 2006 Programme 7, Western Cod, spring 2006. Mid-tow positions. Boundaries of the survey are given by the thick dark lines. The area of the cod closure, where two tows per 15'latx20'long rectangle were intended is shaded. The red lines indicate potential areas identified in the cruise plan for > 2 tows per 15x20 rectangle (see Appendix 1).

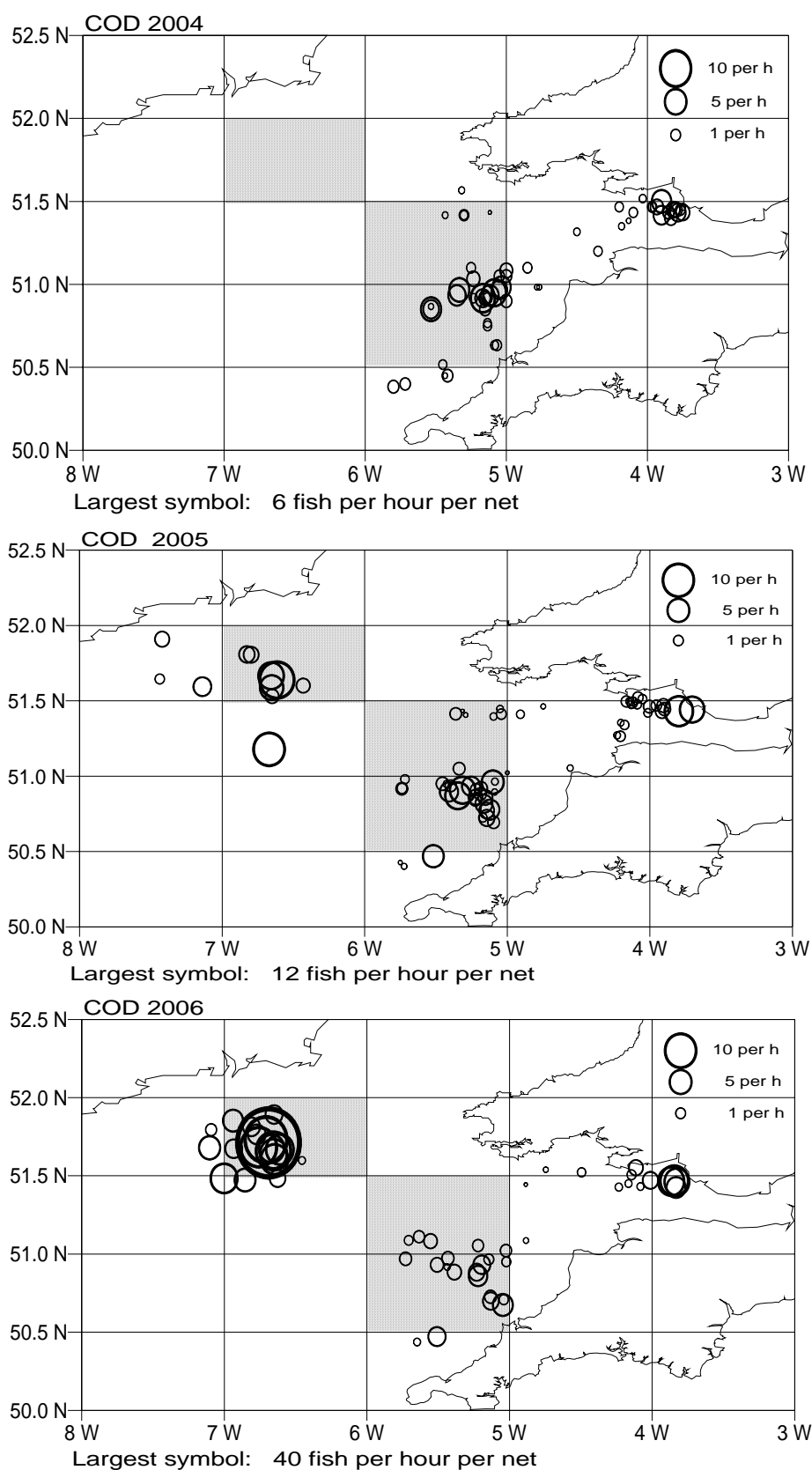


Fig. 2. Distribution of cod in the 2004, 2005 and 2006 western cod FSP surveys. Same scale for all plots. Areas of circles are proportional to numbers caught per hour towed, standardised to a single-rig net.

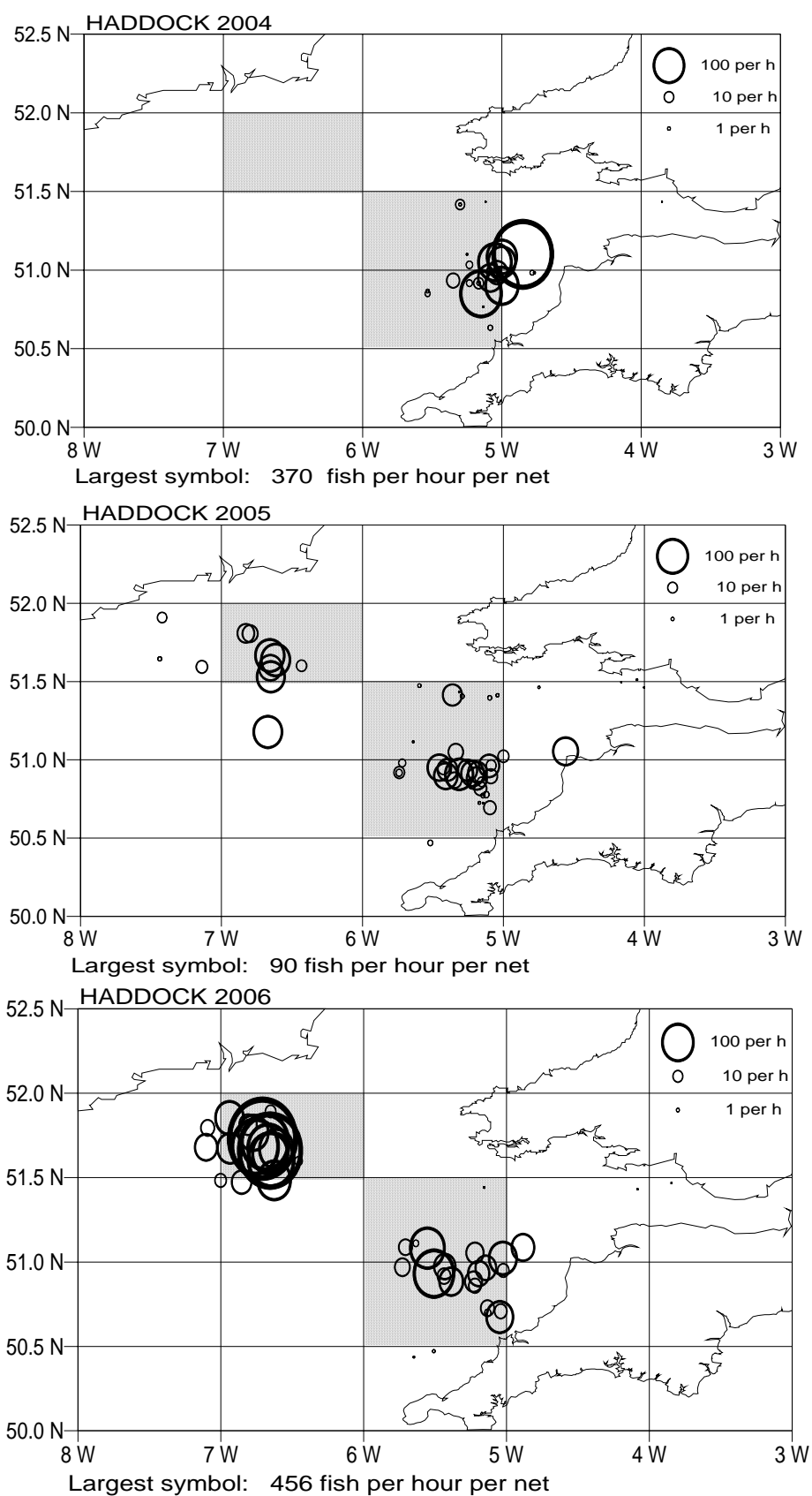


Fig. 3. Distribution of haddock in the 2004, 2005 and 2006 western cod FSP surveys. Same scale for all plots. Areas of circles are proportional to numbers caught per hour towed, standardised to a single-rig net.

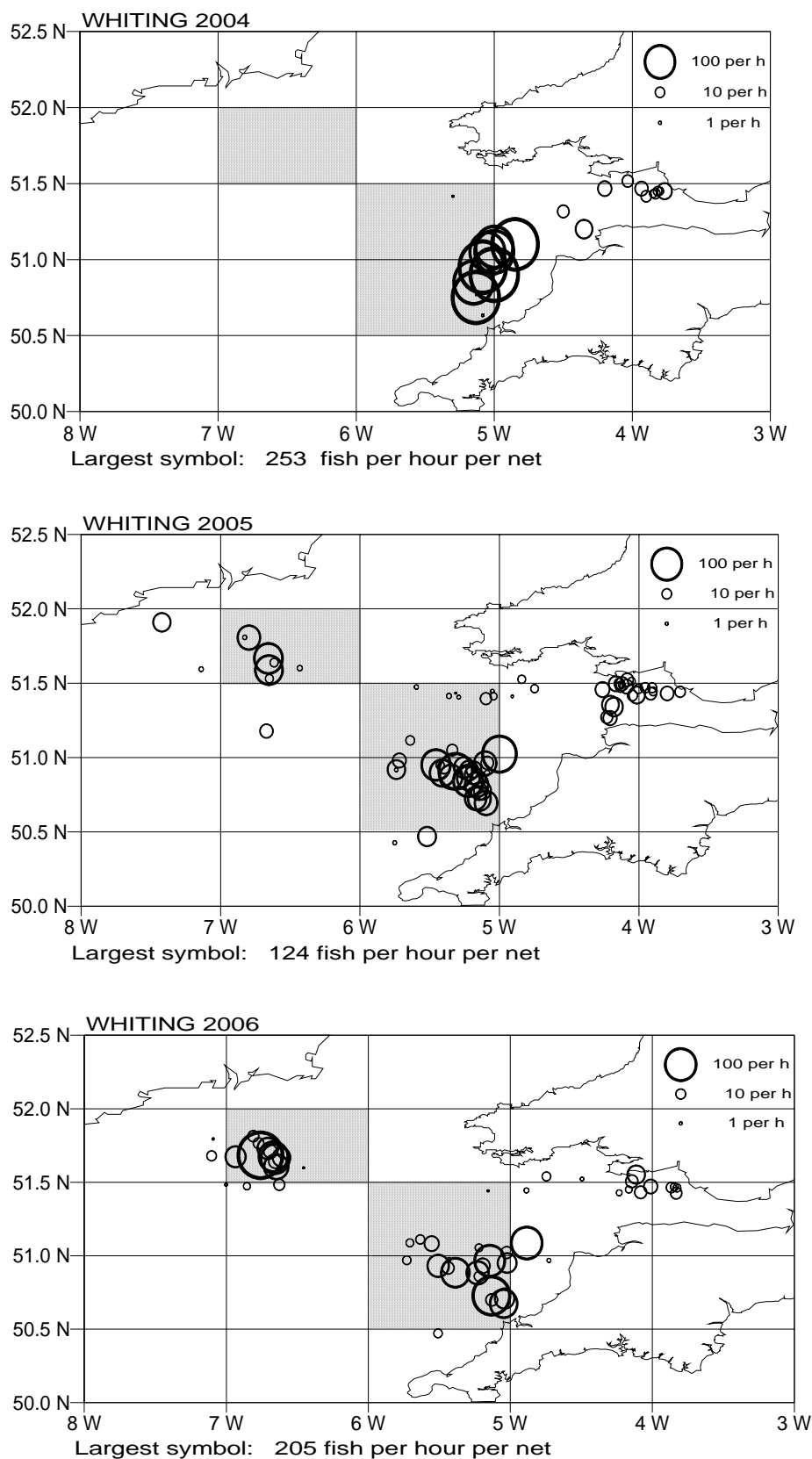


Fig. 4. Distribution of whiting in the 2004, 2005 and 2006 western cod FSP surveys. Same scale for all plots. Areas of circles are proportional to numbers caught per hour towed, standardised to a single-rig net.

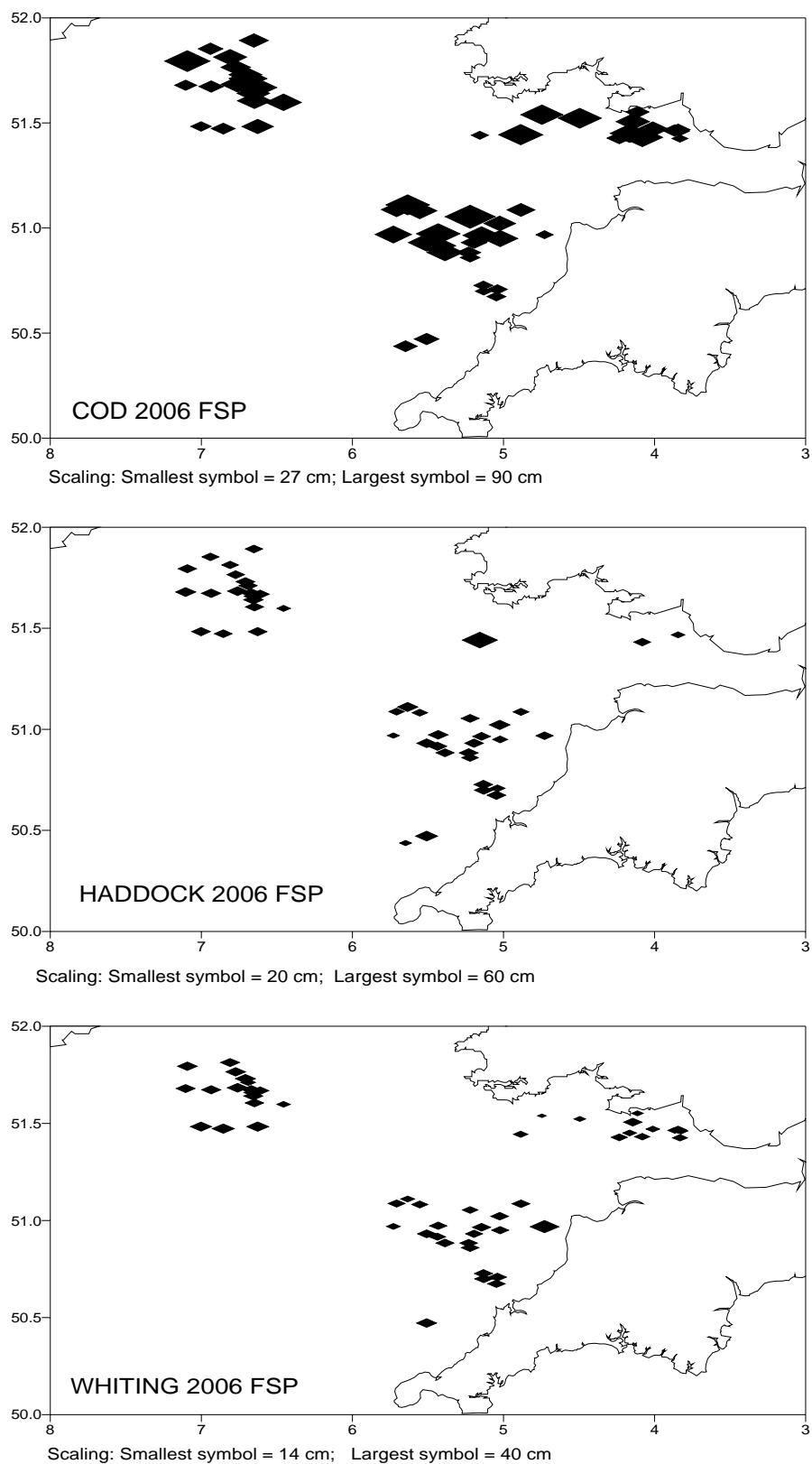
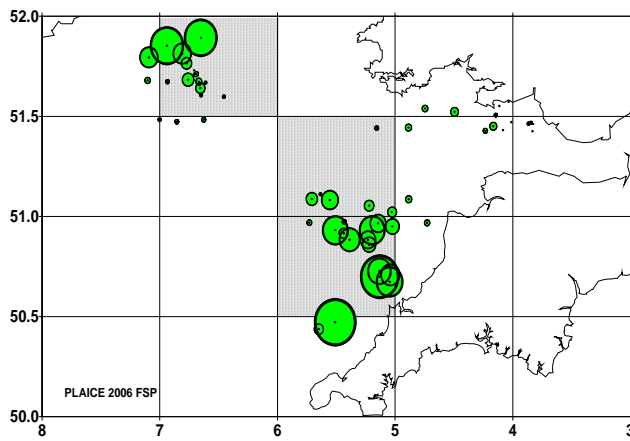
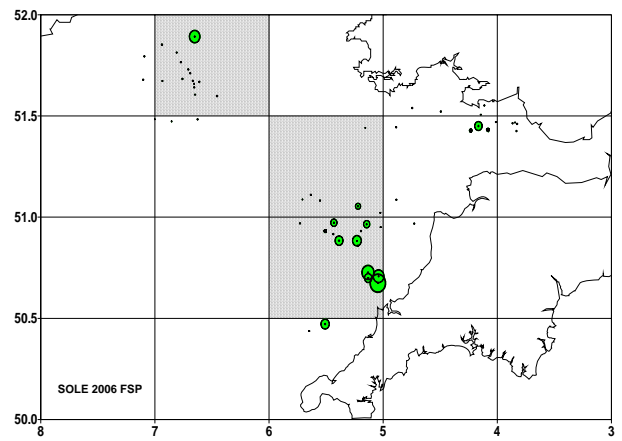


Fig. 5. Mean length of cod, haddock and whiting in each haul during the 2006 western cod FSP survey. The width of the symbols is proportional to the mean length of the fish.

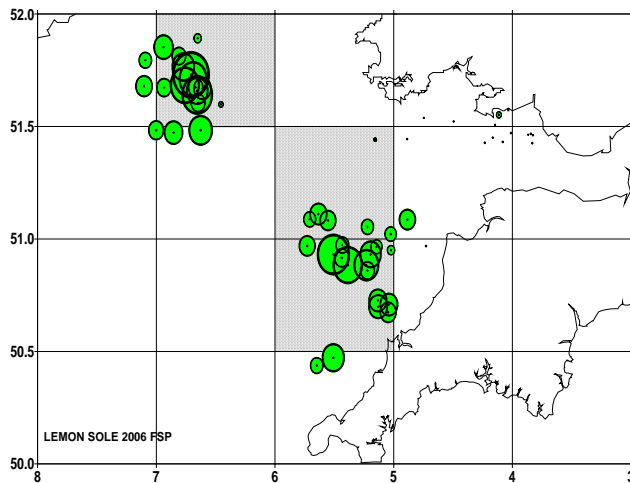
(a) Plaice (max 170 per h)



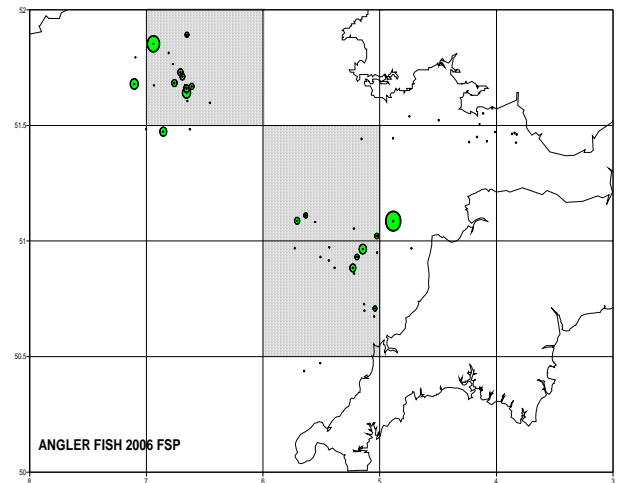
(b) Sole (max 6 per h)



(c) Lemon sole (max 136 per h)



(d) Anglerfish (max 3 per h)



(e) Hake (max 10 per h)

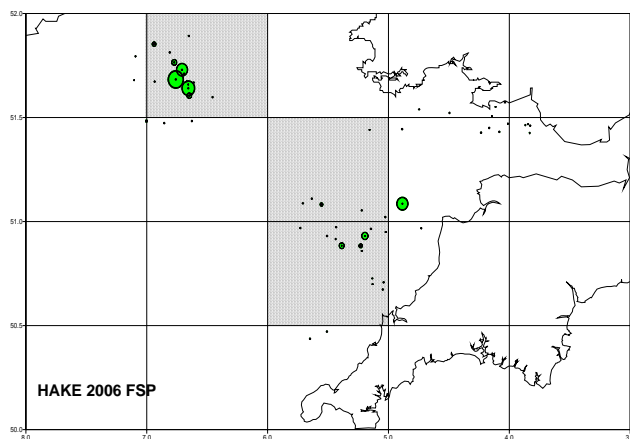


Fig. 6. Distribution of plaice, sole, lemon sole, anglerfish and hake during the 2006 western cod FSP survey, in relation to the area closed to cod fishing in spring (shaded; note that area within 6 miles of the Cornish coast is now excluded from the closure).

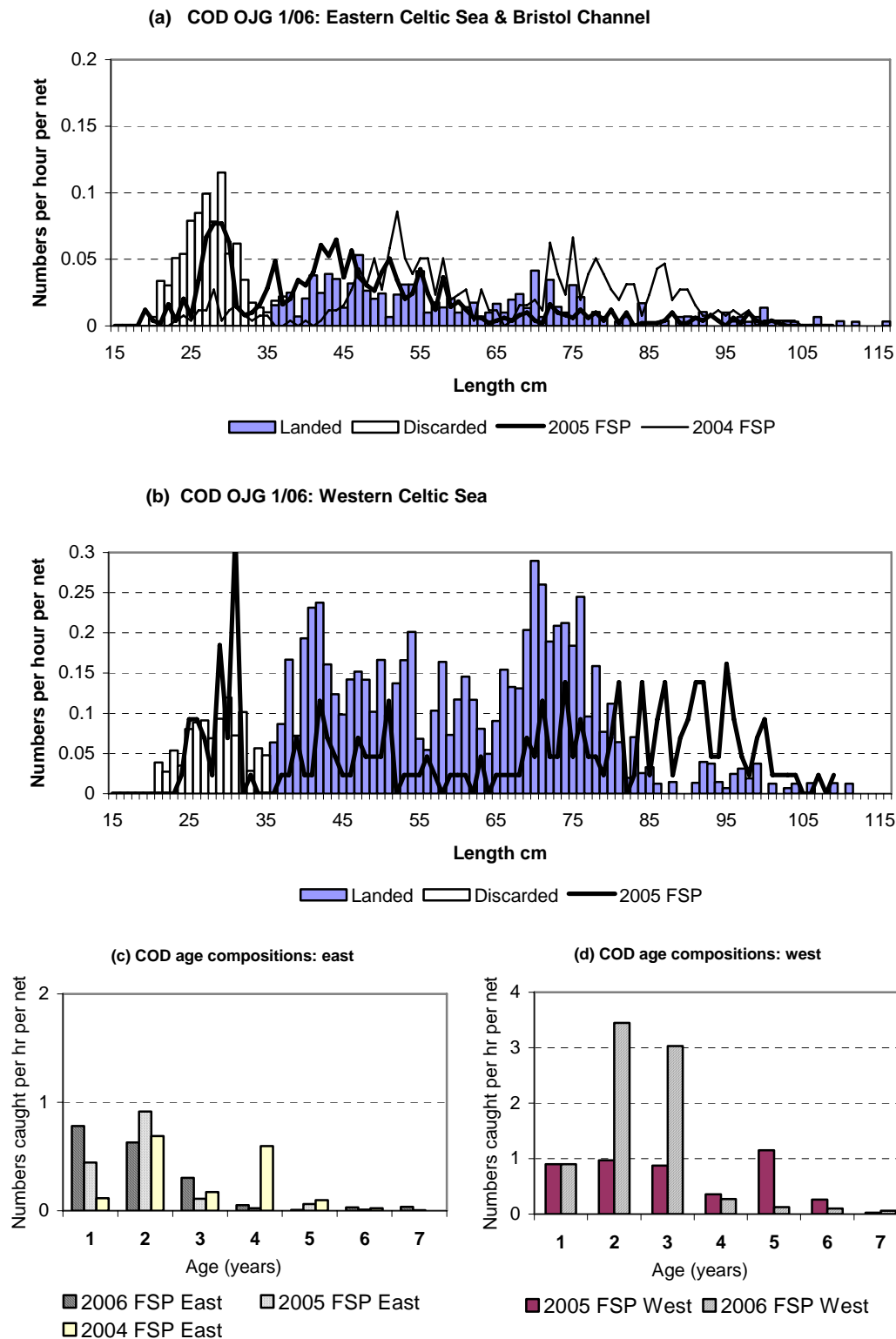


Fig. 7. Western cod FSP surveys, spring 2004 - 2006: COD a) Length frequency distribution of catch and discards east of 6°W, compared with 2004 and 2005 FSP results; b) Length frequency distribution West of 6°W compared with 2005 FSP; c&d) Age frequency distributions by area for FSP surveys 2004-2006 (note different y-axis scales).

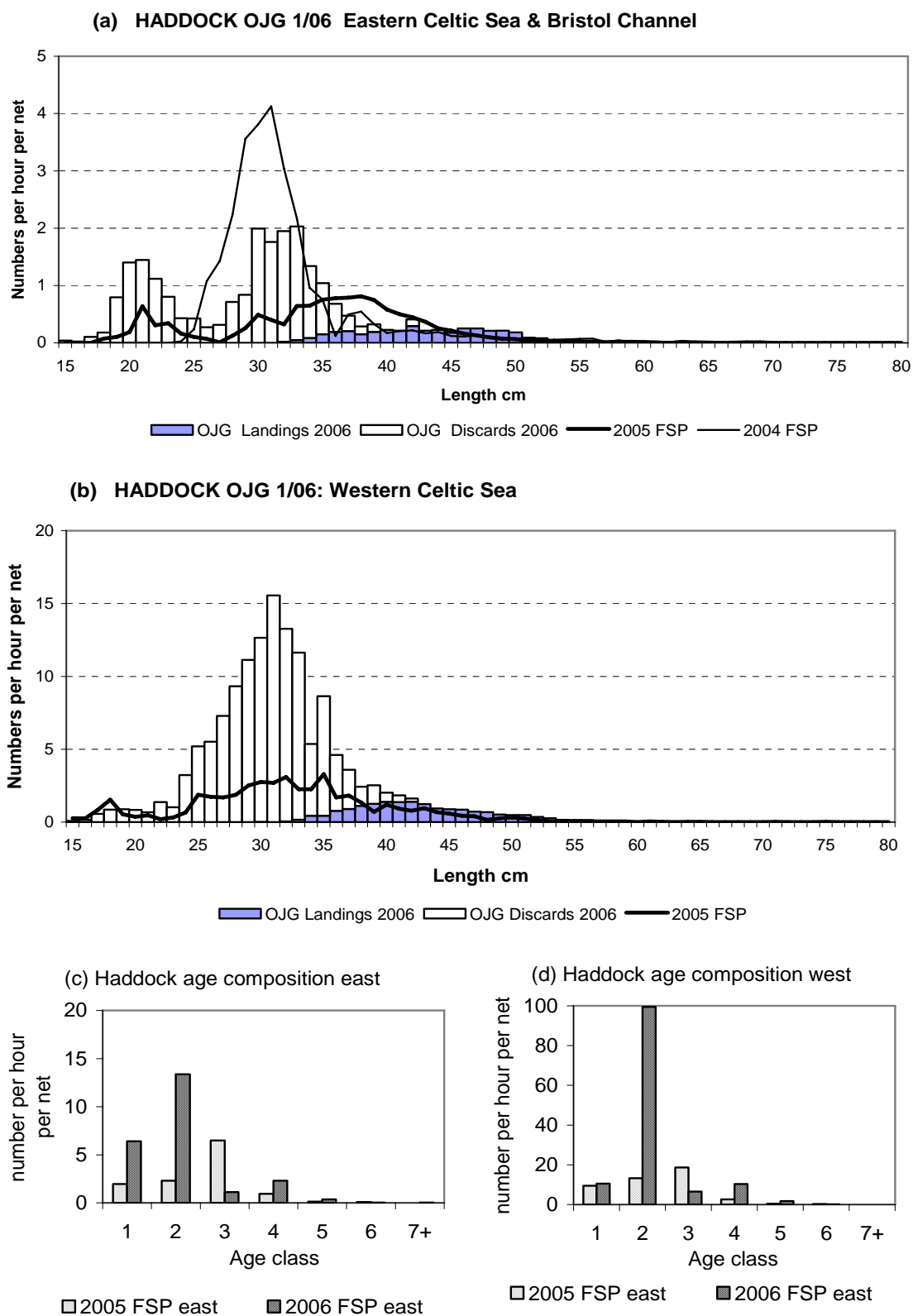
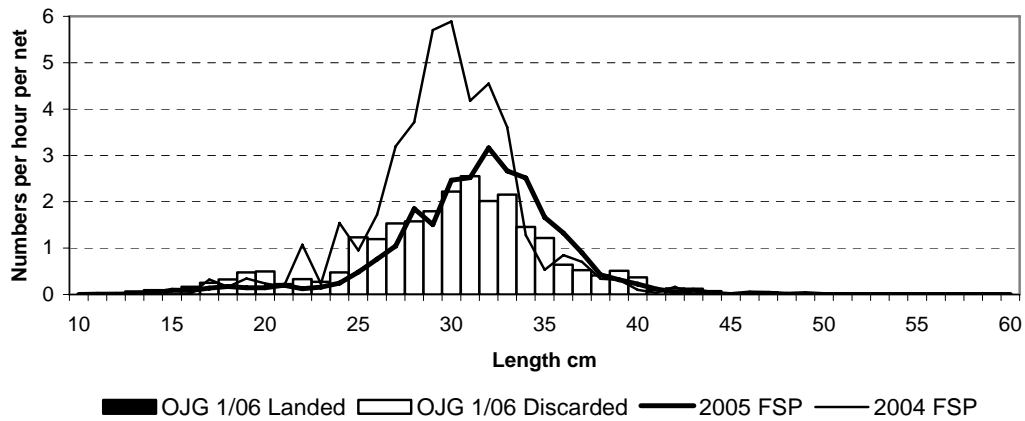
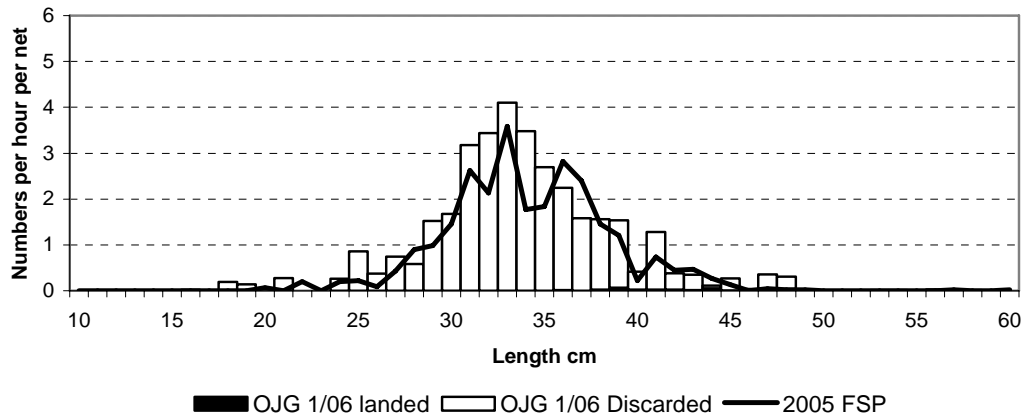


Fig. 8. Western cod FSP surveys, spring 2004 - 2006: HADDOCK a) Length frequency distribution of catch and discards east of 6°W, compared with 2004 and 2005 FSP results; b) Length frequency distribution West of 6°W compared with 2005 FSP; c&d) Age frequency distributions by area for FSP surveys 2004-2006 (note different y-axis scales).

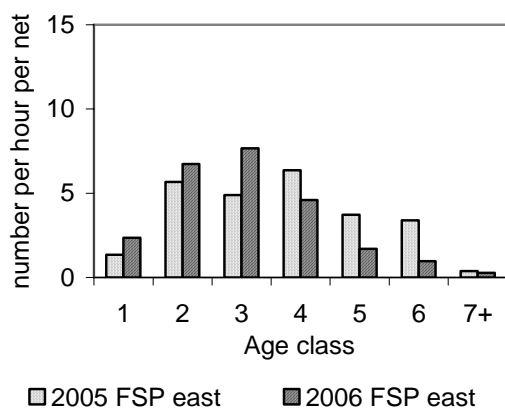
(a) WHITING OJG 1/06 : Eastern Celtic Sea & Bristol Channel



(b) WHITING OJG 1/06: Western Celtic Sea



(d) Whiting age compositions east



(d) Whiting age compositions west

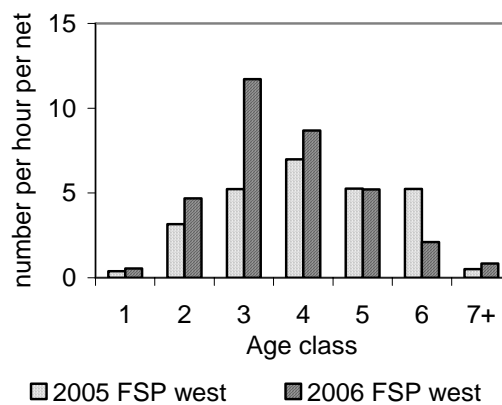


Figure 9. Western cod FSP surveys, spring 2004 - 2006: WHITING a) Length frequency distribution of catch and discards east of 6°W, compared with 2004 and 2005 FSP results; b) Length frequency distribution West of 6°W compared with 2005 FSP; c&d) Age frequency distributions by area for FSP surveys 2005-2006 (note different y-axis scales).

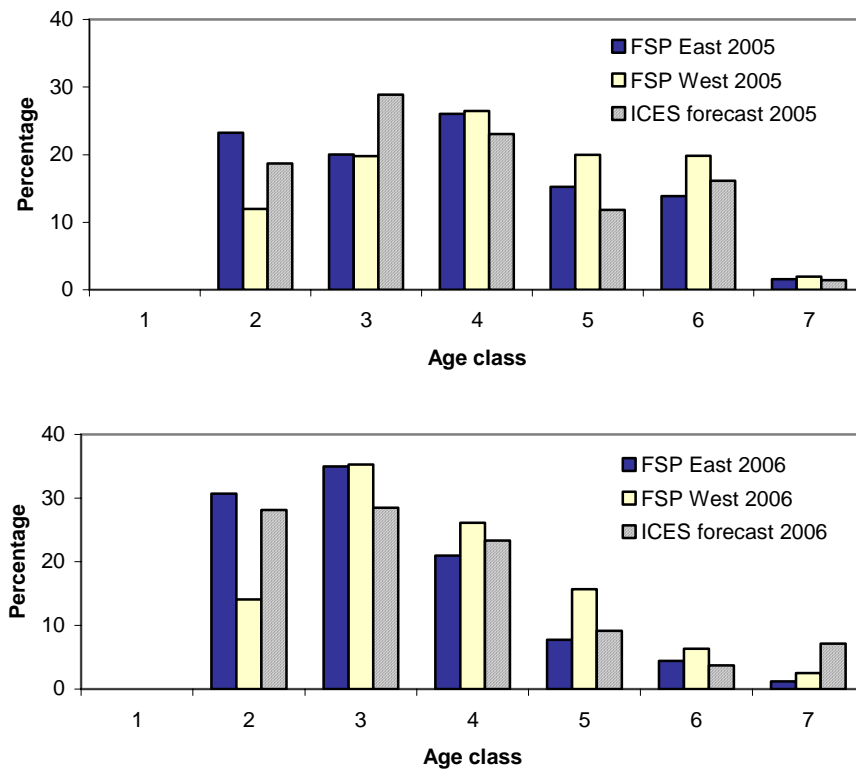


Fig. 10. Comparison of percentage age composition of whiting landings given for 2005 and 2006 by the most recent ICES catch forecast (ICES, 2005), with the age compositions recorded during the 2005 and 2006 FSP surveys. Catches of 1-year-olds are excluded due to small catches of this age class in spring.

Distribution of cod eggs (eggs > 1.3mm) in the Bristol Channel in 1990

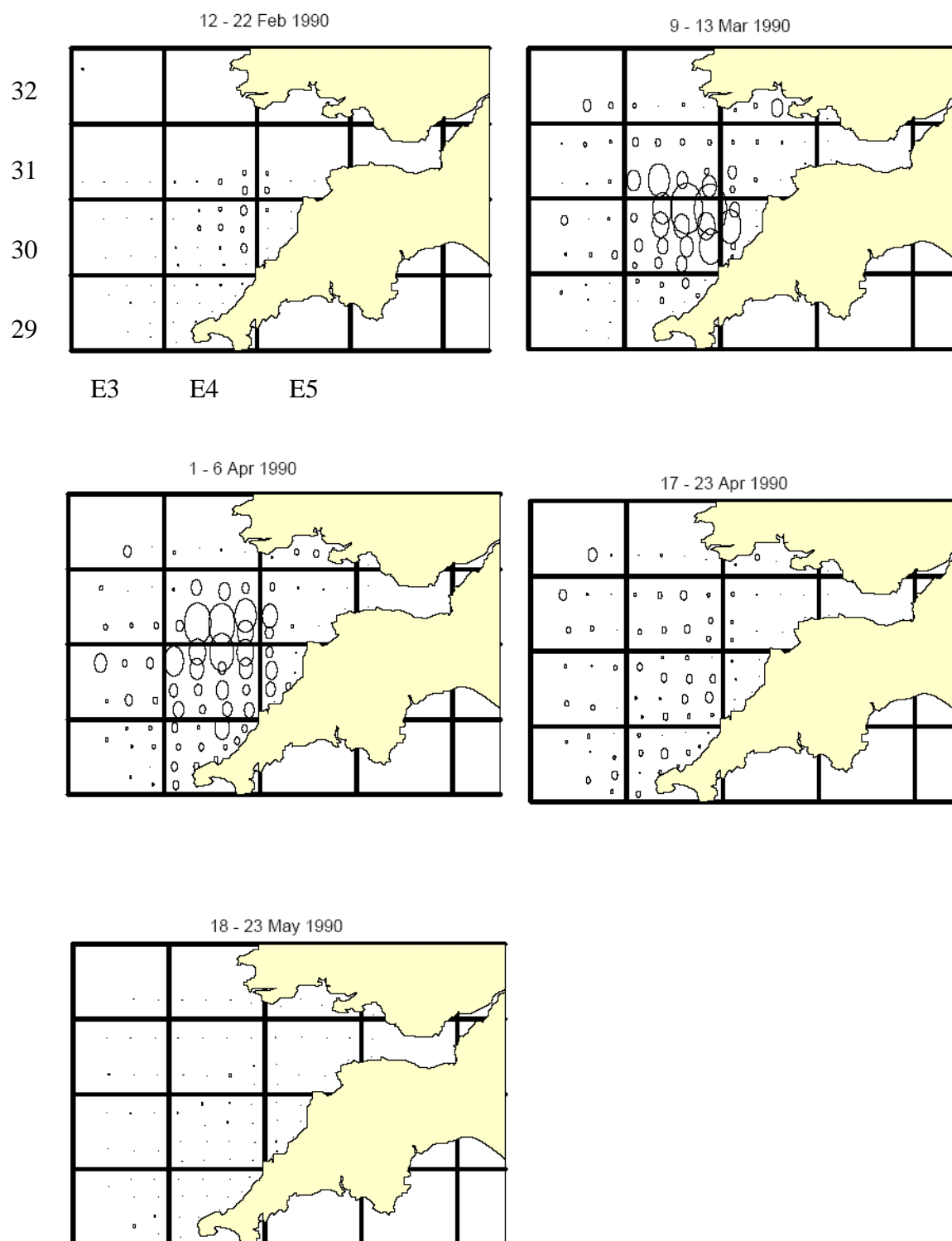


Fig. 11. Distribution of early-stage cod eggs (1.3mm diameter and above) during spring 1990, from sampling by Cefas (unpublished data).

Appendix 1

THE CENTRE FOR ENVIRONMENT, FISHERIES AND AQUACULTURE SCIENCE

LOWESTOFT LABORATORY, SUFFOLK, NR33 0HT, ENGLAND

FISHERIES SCIENCE PARTNERSHIP 2004 PROGRAMME 7: Western Cod

Detailed Operational Plan

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

Aims

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.

Vessel

The vessel will be *Our Josie Grace*, Skipper: Marcus White

Cefas Observer

Cefas observer will be John Ashworth

Duration

February-March 2006 for 25 days made up of a number of trips of varying duration.
Boarding date for first trip: 6th February.

Survey Area:

Bristol Channel and Celtic Sea. Fishing operations will be carried out within the area bounded by the following co-ordinates (see Figure 1):

South Wales coast at 51° 40' N
5° 40' W, 51° 40' N
5° 40' W, 52° N

7° 20' W, 52° N
7° 20' W, 51° 20' N
6° 20' W, 51° 20' N
6° 20' W, 50° 20' N
North Cornwall coast at 50° 20' N

Dispensations will be provided for fishing within any closed areas, and to fish within Irish waters. If the dispensation to fish in Irish waters is not received in time, the survey work will be confined to UK waters only.

Fishing Gear

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 80-85mm single braided twine. 650 kg clump weight. Approx 7 ft headrope height. No. 7 Bison doors

In areas of very strong tides, for example in the Bristol Channel, the previous FSP trips used a single-rig net to avoid tangling of the twin-rig. A net of this type should also be 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.

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. Representative tows are needed inside and outside the three closed rectangles to demonstrate the catch compositions in the different areas.

The sampling 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 inside and around the closed ICES rectangles, an attempt will be made to carry out one tow in every 20' longitude x 15' latitude rectangle (See Fig. 1). This tow should ideally be the first one carried out in the rectangle and should be a more-or-less random selection from the potential tows in each 20'x15' rectangle.
2. Additional tows will be carried out, as time permits, in 20'x15' rectangles in each of the three closed ICES rectangles and in the inner Bristol Channel. The number of additional tows per 20'x15' rectangle will vary according to the expected abundance of cod in each rectangle. Fig. 1 shows a possible arrangement where there is one additional tow per rectangle over most of the closed ICES rectangles, but 3 additional tows per rectangle on the cod spawning grounds off Trevose. This will provide more comprehensive data on cod in this area. Excessive sampling in any one location will,

however, not take place. There should be no more than 4 tows in total per 20'x15' rectangle unless agreed with Cefas.

The “random” tows (1 per 20'x15' rectangles) should be clearly indicated on the skipper's data sheet. The additional “targeted” tows should also be clearly indicated so that the data from the two stages of the survey can be analysed separately if required.

Tows within any 20' x 15' 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 the rectangle.

Working pattern

- Tow duration: Approximately 4 hours.
- The survey will take place during day and night.
- The observers must have sufficient rest periods (up to 8 hours per day in one or two periods). Longer tows can be carried out at night to enable a reasonable period of continuous sleep for the scientific staff.
- 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. All cod from both nets of the twin rig should be quantified. For other species, the catch of one of the nets should be quantified, and this should be clearly indicated on the data sheets together with the appropriate raising factor.
- 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.
- Measure other species as time permits. As a minimum, record of number of individuals either from total catch of one cod-end or from a measured sub-sample of both discards and retained.
- Large individual discarded fish, sorted from the whole catch, should be recorded and measured (i.e. raising factor of 1.0). Sort a minimum of 1 basket of the remaining smaller discarded fish to obtain catch composition details, and record the raising factor to estimate total discards.
- Collect otoliths throughout the length range for cod, haddock and whiting. Initial targets of 400 cod otoliths, 200 haddock otoliths and 200 whiting otoliths are required for the trip, spread evenly across the survey area. These targets may be revised prior to the survey. The date, species, length and station number are the minimum requirement for otolith packets. Sex and maturity should be recorded whenever possible. The most appropriate method for extracting otoliths should be adopted.
- Record data on sheets provided by Cefas.
- If possible, all data should be input into FSS on the laptop provided either between stations or at a time convenient to the scientific staff.
- John Dann to be contacted daily if possible for progress update and to resolve any operational or sampling difficulties.

Instructions for skipper

- Record gear details and parameters at each station.
- 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.

Contacts and procedures.

John Dann should be informed when you sail and dock, by phone.

John Dann or Mike Armstrong to be contacted by phone at intervals to record progress and problems encountered. (MJA: 01502 524362; mobile 07929202750. JD 01502 524544, mobile 07939373136

SFI Newlyn should also be informed each time you sail and dock. Phone. 01736 62805

Vessel owner Scott Wharton can be contacted on his mobile 07736 808134 or by sat phone (number to be provided before cruise).

Paul Trebilcock can be contacted on 01736 351050

Inform John Dann/ Mike Armstrong before working in Irish waters. Do not enter Irish waters unless in possession of the dispensation from the FCO.

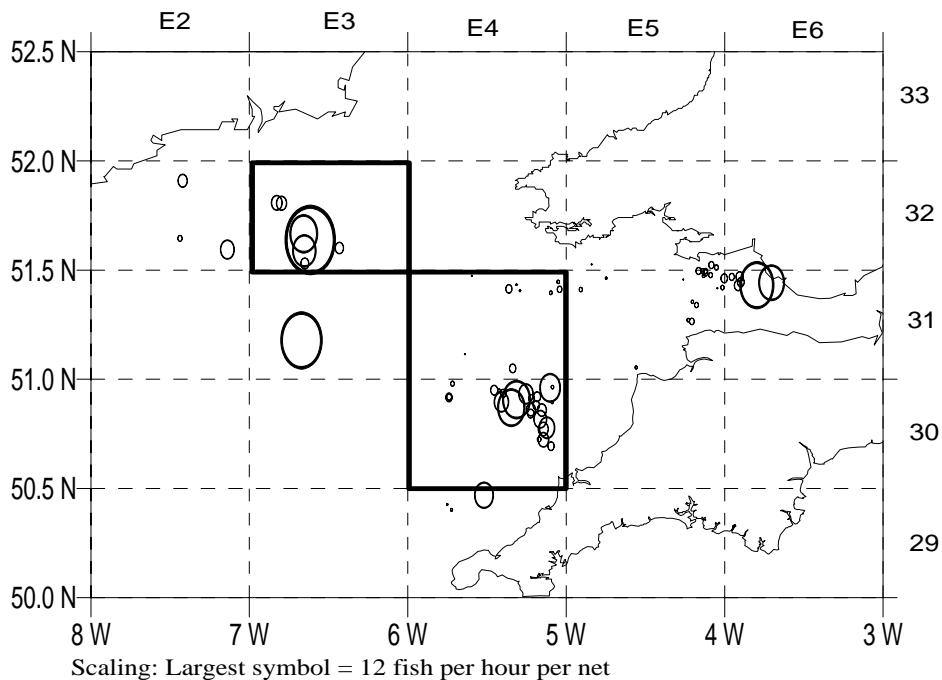
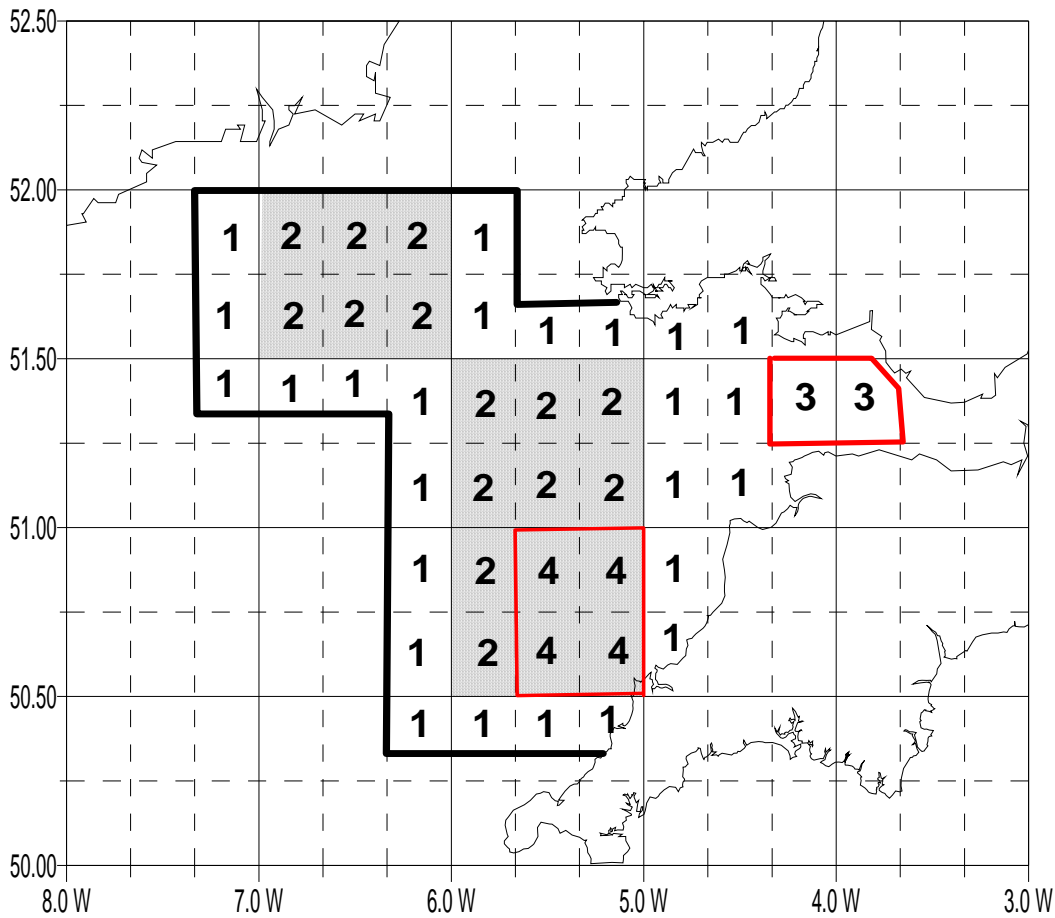
Signed

.....(Cefas).....(Date)

.....(owner/skipper).....(Date)

Appendix 1 contd.

Fig. 1. Survey area for Western Cod FSP survey, February – March 2006. Numbers are example target no. of tows per rectangle. Shaded areas are the closed rectangles. Catch rates of cod in the 2005 FSP western cod survey are shown below.



Appendix 2: Western cod FSP survey, FV *Our Josie Grace*, Feb-Mar 2006: (a) Tow details. (shtdep & haldep = depth in metres at shooting and hauling; hdurn = haul duration in hours).

tow	shooting position					hauling position					shot date-time	haul date-time	shtdep	haldep	hdurn	rig
1	51	32.7	4	49.0	W	51	32.0	4	40.5	W	07/02/06 08:15	07/02/06 12:00	32	42	3.8	twin
2	51	31.5	4	34.9	W	51	31.2	4	24.5	W	07/02/06 12:30	07/02/06 16:40	38	27	4.2	twin
3	51	29.3	4	16.4	W	51	31.4	4	0.9	W	07/02/06 18:25	07/02/06 22:00	37	35	3.6	twin
4	51	28.9	4	1.3	W	51	27.2	3	40.1	W	08/02/06 08:55	08/02/06 13:00	27	19	4.1	twin
5	51	27.7	3	43.6	W	51	28.0	4	0.4	W	08/02/06 13:30	08/02/06 17:30	19	30	4.0	twin
6	51	27.9	4	2.0	W	51	26.1	4	17.9	W	08/02/06 18:00	08/02/06 22:00	30	37	4.0	twin
7	51	5.3	4	50.1	W	51	5.0	4	56.0	W	09/02/06 06:00	09/02/06 09:30	60	62	3.5	twin
8	51	5.0	4	59.0	W	50	57.6	5	4.1	W	09/02/06 10:15	09/02/06 13:45	63	66	3.5	twin
9	50	57.0	5	5.6	W	50	54.7	5	17.8	W	09/02/06 14:30	09/02/06 18:00	66	73	3.5	twin
10	50	54.8	5	17.7	W	50	51.2	5	9.9	W	09/02/06 18:30	09/02/06 21:50	72	65	3.3	twin
11	50	31.1	5	26.1	W	50	25.5	5	35.0	W	10/02/06 06:30	10/02/06 10:30	59	58	4.0	twin
12	50	25.3	5	36.5	W	50	27.1	5	41.3	W	10/02/06 11:00	10/02/06 15:00	60	44	4.0	twin
13	50	31.3	5	1.1	W	50	43.6	5	4.5	W	10/02/06 19:45	10/02/06 23:30	54	56	3.8	twin
14	50	45.0	5	4.4	W	50	42.2	5	11.6	W	11/02/06 00:30	11/02/06 04:15	58	64	3.8	twin
15	50	52.4	5	31.9	W	50	57.5	5	20.6	W	11/02/06 09:15	11/02/06 13:15	76	75	4.0	twin
16	51	25.3	4	48.3	W	51	28.0	4	58.1	W	18/02/06 15:15	18/02/06 19:15	51	55	4.0	twin
17	51	27.9	4	58.8	W	51	25.1	5	20.0	W	18/02/06 19:45	19/02/06 00:45	55	67	5.0	twin
18	51	9.3	5	34.7	W	51	4.0	5	41.5	W	19/02/06 06:15	19/02/06 10:15	80	85	4.0	single
19	51	3.7	5	42.0	W	50	52.6	5	45.5	W	19/02/06 10:45	19/02/06 14:45	63	81	4.0	single
20	50	54.9	5	31.2	W	51	1.8	5	20.6	W	19/02/06 17:00	19/02/06 21:00	76	75	4.0	single
21	51	2.4	5	19.1	W	51	4.1	5	7.4	W	19/02/06 21:30	20/02/06 01:30	75	67	4.0	single
22	51	28.8	4	6.0	W	51	27.7	3	55.4	W	20/02/06 10:00	20/02/06 14:00	31	24	4.0	twin
23	51	27.8	3	55.2	W	51	27.6	3	44.0	W	20/02/06 14:30	20/02/06 18:30	24	16	4.0	twin
24	51	27.0	3	44.6	W	51	24.1	3	55.3	W	20/02/06 19:00	20/02/06 23:00	15	31	4.0	twin
25	51	24.1	3	57.0	W	51	27.6	4	12.8	W	20/02/06 23:30	21/02/06 03:30	36	35	4.0	twin
26	51	29.5	4	13.6	W	51	36.7	4	0.0	W	21/02/06 05:35	21/02/06 09:40	35	24	4.1	twin
27	51	27.8	4	5.0	W	51	23.6	4	23.0	W	21/02/06 13:00	21/02/06 17:30	35	41	4.5	twin
28	51	35.9	6	19.0	W	51	35.9	6	35.7	W	27/02/06 18:30	27/02/06 22:30	86	73	4.0	twin
29	51	36.6	6	37.0	W	51	44.3	6	43.3	W	27/02/06 23:00	28/02/06 03:00	70	71	4.0	twin
30	51	45.1	6	44.5	W	51	52.5	6	52.6	W	28/02/06 03:45	28/02/06 07:45	71	70	4.0	single
31	51	52.2	6	53.7	W	51	50.1	6	59.0	W	28/02/06 08:30	28/02/06 12:35	68	68	4.1	single
32	51	50.3	7	0.8	W	51	45.0	7	10.4	W	28/02/06 13:30	28/02/06 17:30	67	74	4.0	single
33	51	44.7	7	11.0	W	51	36.9	7	1.4	W	28/02/06 18:00	28/02/06 22:05	74	72	4.1	single
34	51	37.1	7	0.0	W	51	43.7	6	52.2	W	28/02/06 22:45	01/03/06 02:45	71	70	4.0	single
35	51	44.0	6	50.8	W	51	38.0	6	40.3	W	01/03/06 03:30	01/03/06 07:30	71	72	4.0	single
36	51	37.4	6	40.5	W	51	39.5	6	38.2	W	01/03/06 08:45	01/03/06 12:45	72	69	4.0	single
37	51	38.8	6	37.1	W	51	46.5	6	45.8	W	01/03/06 13:45	01/03/06 18:00	66	72	4.3	single
38	51	50.3	6	39.2	W	51	56.8	6	39.0	W	01/03/06 19:30	01/03/06 23:30	70	56	4.0	single
39	51	29.9	7	0.0	W	51	28.1	7	0.2	W	02/03/06 06:45	02/03/06 10:30	77	77	3.8	single
40	51	28.2	6	58.4	W	51	28.6	6	44.2	W	02/03/06 11:00	02/03/06 14:45	76	79	3.8	single
41	51	28.4	6	40.0	W	51	29.6	6	35.2	W	02/03/06 15:30	02/03/06 19:00	79	81	3.5	single
42	51	30.0	6	37.0	W	51	42.7	6	40.8	W	02/03/06 19:30	02/03/06 23:30	80	68	4.0	single
43	51	40.3	6	38.7	W	51	47.3	6	46.3	W	03/03/06 07:20	03/03/06 11:00	71	71	3.7	twin
44	51	49.0	6	49.1	W	51	42.8	6	43.6	W	03/03/06 12:15	03/03/06 16:00	70	70	3.8	twin
45	51	42.3	6	42.2	W	51	36.8	6	36.4	W	03/03/06 16:45	03/03/06 20:30	70	75	3.8	twin
46	51	36.2	6	37.1	W	51	44.0	6	36.2	W	03/03/06 21:30	04/03/06 01:30	73	65	4.0	twin
47	50	57.2	4	40.0	W	50	59.0	4	47.4	W	14/03/06 12:15	14/03/06 16:00	30	55	3.8	twin
48	51	0.8	5	1.1	W	50	55.0	5	16.3	W	14/03/06 18:15	14/03/06 22:15	67	69	4.0	twin
49	50	54.1	5	18.7	W	50	52.0	5	27.7	W	14/03/06 22:45	15/03/06 02:45	70	75	4.0	twin
50	50	51.9	5	28.5	W	50	59.8	5	32.5	W	15/03/06 03:30	15/03/06 07:10	76	81	3.7	twin
51	51	0.7	5	31.9	W	51	9.2	5	34.6	W	15/03/06 07:45	15/03/06 11:50	84	76	4.1	twin
52	51	9.0	5	41.3	W	51	1.5	5	43.5	W	15/03/06 13:45	15/03/06 17:30	78	87	3.8	twin
53	50	54.9	5	15.2	W	50	48.2	5	11.3	W	16/03/06 07:15	16/03/06 11:25	73	63	4.2	twin
54	50	44.8	5	10.6	W	50	39.1	5	5.1	W	16/03/06 12:30	16/03/06 16:30	60	56	4.0	twin
55	50	40.2	5	4.0	W	50	44.8	5	0.9	W	16/03/06 17:00	16/03/06 21:00	58	57	4.0	twin
56	50	56.4	5	5.1	W	50	57.6	4	57.6	W	17/03/06 01:15	17/03/06 05:30	62	65	4.3	twin

Appendix 2 contd: Western cod FSP survey, FV *Our Josie Grace*, Feb-Mar 2006: (b)

Numbers caught per hour, standardised to a single-rig net, for 9 selected species of fish.

Abbreviations: HAD=haddock, WHG = whiting HKE = hake, PLE = plaice, SOL = sole, LEM = lemon sole, MON = anglerfish. (hdurn = haul duration in h).

tow	hdurn	rig	cod	had	whg	hke	ple	sol	lem	mon
1	3.8	twin	0.3	0.0	7.8	0.0	4.2	0.3	0.0	0.0
2	4.2	twin	0.7	0.0	1.4	0.0	7.2	0.2	0.4	0.0
3	3.6	twin	0.8	0.0	15.6	0.0	2.0	0.7	0.1	0.6
4	4.1	twin	8.1	0.1	6.2	0.0	1.6	0.1	0.0	0.0
5	4.0	twin	7.0	0.0	10.5	0.0	1.6	0.0	0.1	0.0
6	4.0	twin	0.5	0.0	4.8	0.1	6.0	2.1	0.5	0.0
7	3.5	twin	0.3	52.9	100.0	5.7	4.9	0.6	28.0	5.4
8	3.5	twin	1.3	79.1	13.7	0.9	9.1	0.3	14.6	1.3
9	3.5	twin	3.0	46.9	21.7	2.4	69.6	1.0	46.7	1.3
10	3.3	twin	2.6	31.1	51.6	1.4	26.4	2.6	63.9	1.7
11	4.0	twin	3.1	0.8	7.5	0.0	182.5	2.4	51.1	0.1
12	4.0	twin	0.5	0.3	0.0	0.0	10.0	0.5	17.3	0.6
13	3.8	twin	4.1	73.2	77.3	0.1	75.2	6.0	27.6	0.0
14	3.8	twin	1.5	18.9	141.9	0.0	57.6	4.0	34.1	0.7
15	4.0	twin	0.4	18.3	14.4	0.6	9.4	1.0	22.8	0.3
16	4.0	twin	0.1	0.0	2.5	0.0	4.8	0.9	0.3	0.5
17	5.0	twin	0.0	0.3	0.5	0.0	2.4	0.6	1.6	0.2
18	4.0	single	1.3	3.3	8.3	0.8	1.5	0.8	31.0	1.3
19	4.0	single	1.5	23.5	7.3	1.0	3.3	0.5	27.5	1.0
20	4.0	single	1.5	47.1	1.9	0.0	2.6	1.8	18.4	0.9
21	4.0	single	1.3	31.5	6.0	0.3	10.5	1.5	16.3	0.5
22	4.0	twin	1.3	0.0	9.6	0.1	1.0	0.9	0.5	0.5
23	4.0	twin	6.4	0.0	6.4	0.0	0.0	0.6	0.1	0.0
24	4.0	twin	3.8	0.0	13.3	0.0	0.0	0.5	0.5	0.0
25	4.0	twin	0.5	0.1	15.0	0.0	0.6	1.1	0.8	0.3
26	4.1	twin	2.1	0.0	32.6	0.0	1.0	0.9	3.3	0.2
27	4.5	twin	0.6	0.0	3.4	0.1	2.8	1.1	1.0	0.0
28	4.0	twin	0.5	5.9	0.4	0.4	1.8	0.3	2.9	0.5
29	4.0	twin	6.8	169.5	87.9	0.0	4.6	0.3	23.1	0.3
30	4.0	single	3.0	32.0	12.3	0.0	36.4	0.3	20.9	0.8
31	4.1	single	4.2	82.0	0.0	1.5	117.1	0.7	39.2	3.9
32	4.0	single	1.3	18.8	0.5	0.0	35.8	0.3	17.3	0.8
33	4.1	single	4.7	51.4	9.6	0.2	3.9	0.5	29.4	2.2
34	4.0	single	3.0	67.3	42.8	0.0	2.3	0.0	22.5	1.0
35	4.0	single	13.5	218.8	205.0	10.0	15.3	0.5	87.5	1.5
36	4.0	single	7.5	127.0	17.5	7.3	10.0	0.3	97.0	2.3
37	4.3	single	40.2	225.4	18.1	0.0	2.8	0.0	80.0	1.4
38	4.0	single	3.0	11.3	0.0	0.3	113.3	3.3	6.3	1.3
39	3.8	single	7.5	13.3	0.8	1.1	1.9	0.3	24.3	0.3
40	3.8	single	4.5	40.3	5.1	0.5	2.4	0.0	36.0	1.9
41	3.5	single	2.6	111.7	12.1	0.3	2.7	0.0	57.3	0.6
42	4.0	single	7.8	214.0	61.4	1.8	1.6	0.3	21.8	1.0
43	3.7	twin	18.3	455.7	44.2	5.6	0.7	0.1	139.4	1.5
44	3.8	twin	3.3	92.9	11.5	1.9	12.0	0.1	52.4	0.4
45	3.8	twin	12.5	394.8	85.5	0.1	0.1	0.3	48.8	1.6
46	4.0	twin	7.9	118.1	33.0	0.4	1.5	0.6	32.5	1.4
47	3.8	twin	0.0	0.0	1.6	0.0	3.7	0.5	0.8	0.1
48	4.0	twin	1.0	44.1	95.0	0.0	27.8	1.8	13.9	2.0
49	4.0	twin	2.0	58.0	82.5	1.9	46.6	2.3	89.5	0.6
50	3.7	twin	1.8	161.7	47.9	0.0	69.5	1.1	106.8	0.4
51	4.1	twin	1.8	119.6	22.0	1.2	31.0	0.6	27.2	0.9
52	3.8	twin	0.8	18.7	6.1	0.3	14.7	0.1	16.1	1.5
53	4.2	twin	3.6	15.7	9.4	0.4	19.8	0.2	21.4	1.0
54	4.0	twin	2.6	4.1	14.4	0.0	155.1	2.1	37.3	0.5
55	4.0	twin	0.9	15.6	39.5	0.1	39.0	3.4	33.5	1.3
56	4.3	twin	0.8	13.4	37.4	0.0	20.6	0.5	6.4	1.0

Appendix 3: Cruise report by Cefas observer

FISHERIES SCIENCE PARTNERSHIP 2006

PROGRAMME: SW COD SURVEY

VESSEL: "Our Josie Grace" (BD 287)

SKIPPER: Marcus White

CEFAS OBSERVER: Jon Ashworth

DURATION: 06/02 – 28/03/06

LOCALITY: Bristol Channel and Celtic Sea

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. Cod-end mesh size 80-85mm of single braided twine. 650 kg clump weight. Approx 7 ft head rope height and No. 7 Bison doors.

AIMS

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.

DURATION

The survey was conducted between the dates 06/02/06 and 31/03/06 inclusive. Due to the poor weather encountered throughout this period trips were often cut short, in all 4 trips were completed for a total sea time of 19.5 days, the fact that the full 25 day schedule was not met was due to prolonged bouts of poor weather. The survey came to an end at midnight on the 31st of March 2006 but the decision to end the survey was made on the morning of 29th of March, as the weather forecast was to prevent any further sea time.

NARRATIVE (All times are in GMT, depths in metres and distances in nautical miles)

Trip 1 (trip code SWCOD106)

Departed Ilfracombe at 0100 on 7th February and steamed NW for 7 hours to shoot under the Welsh coast approximately 6 miles south of Caldey Island (grid ref. J4). The first days fishing produced very little cod and only moderate catches of mixed ray (grid ref. K4). The weather deteriorated considerably throughout the afternoon and was forecast to deteriorate further to

become south-westerly beaufort force 6 to gale force 8 through the night, after the 3rd tow of the day (grid ref. L5) skipper White felt it prudent to pick up a mooring in Swansea in order to shelter from the weather.

We sailed again at 0600 on the Wednesday in much better conditions as the wind had decreased and veered into the North. The gear was shot within 6 miles of Swansea and towed East towards Porthcawl (grid ref. M5), this haul produced 66 cod between 21cm and 75cm and the haul after 56 fish between 21cm and 116cm. Skipper White was not surprised by this as he fully expected to see cod in this area, indeed this area had provided some of the highest catch rates in previous surveys. The next tow was conducted a little to the West (grid ref. L5) and produced only 4 cod and moderate catch rates of mixed ray. Discard rates remained low throughout the Bristol Channel survey area typically < 2x33kg baskets from each net, Whiting figured quite highly in the composition of discarded species throughout the survey although this had nothing to do with size and everything to do with the price at market, Haddock did not feature in the catch composition for this area at all.

As the weather had improved dramatically it was decided to leave the stations to the East of Lundy Island and steam southwest to survey ground North of Padstow.

Shot approximately 9 miles SSW of Lundy Island (grid ref. J6) and towed in a SSW direction, weather NNW 3-4. Only 2 cod in this tow although catch rates for many other species increased substantially, Elasmobranchs (mixed ray, Lesser Spotted Dogfish, Nurse Hounds and Spur Dogs) were particularly abundant as were Whiting, Haddock and Lemon soles in the discarded element of the catch. The next haul was shot in grid ref. J6 and towed in a SW direction into grid ref. I7. (Where possible skipper White tried to avoid towing in more than one grid in one tow but on occasion, usually due to limited seabed information, it was deemed necessary.) The numbers of Elasmobranchs decreased somewhat this haul, however the catch rate for Haddock increased to 5.5x33kg baskets of which most were over 40cm, Cod accounted for only 1x33kg basket (9 individuals). The gear was shot back in grid ref. I7 and the next tow was conducted entirely within the grid, the trawl became fast on the seabed after 3.5hrs but it was decided to sample as the composition of the catch looked ok. Cod accounted for 0.75x33kg basket and catch rates on all species were less than the previous tow with the exception of mixed Gurnards and Lesser-spotted Dogfish.

Weather conditions continued to improve and so skipper White decided to take this opportunity to explore grids to the West. Several hours steaming put us in grid ref H9 where we encountered 0.75x33kg basket of small cod and increased numbers of flatfish, as one would expect around the wreck of HMS Warwickshire. The furthest tow West was conducted in grid ref. G9 and resulted in 4 cod and only 2 baskets of mixed fish.

Due to a lack of seabed information and an understandable reticence to tow blind in a 5.4m tide skipper White decided to steam NE to ground 6 miles from Padstow where fishing continued in grid refs. I8 (2 tows) and H7. The levels of discards encountered in grid ref. I8 were very high (typically <18x33kg baskets) and consisted of mainly small Lemon sole, Whiting, Haddock, Dabs and a small showing of immature cod, skipper White and I felt that the amount of fish being discarded was too high and as the amount of cod encountered remained relatively low in both hauls we decided to tow out of the area and explore grids to the North, indeed as soon as we had cleared the 6 mile limit North of Padstow the discard levels dropped substantially. Haul 15 was conducted entirely in grid ref. H7 and produced only 3 Cod. The next haul was shot and towed North into grid ref. H6, however after 1hr the gear became fast on the sea-bed, on hauling 4 large cod were observed, this haul was not sampled as the gear had not been on the sea bed long enough. It was decided to shoot back

and attempt the tow again. Haul 16 was shot and towed for 1.75 hrs before catching on the sea-bed again, this time however the tide was in full flood and when eventually the gear was retrieved to the surface considerable damage was observed in the Port net. As the weather forecast was appalling skipper White decided to call an end to the trip and we steamed back to Ilfracombe.

Trip 2 (SWCOD206)

Sailed from Ilfracombe at 1030 on the 18th February after several days of SW and NW storm force winds, the weather conditions on sailing were perfect (W 1-2), however, a very heavy ground sea and extremely murky water was evidence of the poor weather experienced over the past few days.

A new footrope had been fitted to the port side and this meant a change in sampling practice for the first two tows as each net was sampled separately. No discernable difference was observed during these hauls and so sampling effort returned to previous levels. Fishing proved very difficult throughout this trip, skipper White and I became convinced that this was due to a combination of ground sea and water conditions (visibility).

Haul 16 was conducted in grid ref. J5 and produced very little, 1.75x33kg baskets of mixed ray and <12kg of mixed fish and no cod. The haul 17 in grid ref. I5 was somewhat better for ray producing >12x33kg baskets but only 24 kg of mixed fish and no cod. Fishing remained particularly poor for haul 18,19,20 and 21 producing on average only 0.5 to 1x33kg basket of cod for each tow in grid refs. H6/G6, G7, H7 and I6 respectively. Weather conditions had steadily deteriorated throughout the day (NE 6-7) so it was decided to get the gear aboard and steam east into the Bristol Channel where it was hoped that sampling could continue under the lee of the Welsh coast.

The trawl was shot at 1000 hrs in grid ref. L5 and towed into M5, as the weather remained poor throughout the day. Although sea conditions were much better due to proximity to land fishing remained poor. We had expected to see some reasonable catches of cod on the ground to the south of Scarweather sands to Porthcawl (grids L5 and M5), perhaps similar amounts to the previous trip (i.e 3 to 4x33kg baskets), however with the exception of two hauls in grid M5 that produced a number of immature fish cod remained particularly scarce. No let up in the weather meant we could not venture to the West of Lundy and as we were soon to be in danger of over sampling the area it was decided to call a halt to this trip and return to port.

Trip 3 (SWCOD306)

As the forecast was for NW winds skipper White decided to fish the Irish element of the survey. The “Josie Grace” sailed from Ilfracombe at 0400 on the 27th of February and after a 14hr steam shot one net (skipper White continued to use a single net rig for the majority of the survey in Irish waters as he was unsure of much of the seabed information he possessed) in grid ref. E4 (NW3-4), fishing proved very poor in this grid, however the next haul also shot in E4 and towed into the north, produced approximately 200kg of good Cod, the same of medium to large Haddock and 18x33kg baskets of discard mainly small Whiting, Haddock and Dabs.

Weather conditions deteriorated throughout the night and following day (NW 6-7occ8) and so skipper White continued to tow in a northwesterly direction in grid refs. D3, D3 and C3

fishing remained average to poor with 80kg, 20kg and 26kg of cod from each grid respectively and only small amounts of other species.

As the weather moderated somewhat (NW5-6occ7) skipper White then towed off into grid ref. C4 and D4 where fishing deteriorated further each haul producing less than 6kg of Cod and only 46kg of medium Haddock. Although the weather had moderated somewhat it was still too fresh to survey the most southerly sections and so skipper White then towed back into grid E4 where we encountered 90kg of Cod and 112 kg of Haddock, we also had 66kg of good John Dory, skipper White mentioned this was encountered the previous year in roughly the same area. The next haul was shot in grid ref. E4, towed in a NNW direction into D3 and produced the highest catch rate for Cod encountered throughout the survey, approximately 500kg all large fish (up to 116cm) and all running, hyaline or spent, the next haul shot in E3 produced only 25kg of Cod. At this point with the forecast looking good for 24 hours or so it was decided to steam 30 miles SW to begin surveying the more southerly element of the grid.

Weather conditions improved tremendously (NW1-2 smooth sea and no swell+) and the first haul in grid ref. C5 was conducted without incident, however fishing in these more southerly rectangles was generally quite poor, it was here we encountered several large Sligo registered trawlers who may have been engaged in twin rigging. A large pod of Harbour porpoises (*Phocoena phocoena*) over 100 strong was observed in grid ref C5 and again in D5 quietly porpoising along the surface and visible up to approximately half a mile from the boat. Hauls were conducted in E5 and E4 and produced 16kg of Cod and 85kg of Cod respectively, as we towed back towards grids E4, E3 and D3 so Cod catch rates and general size of fish increased.

On returning to this productive area skipper White felt confident enough to shoot both nets and we conducted the final 4 hauls in the Irish sector towing the twin rig. These hauls were conducted in grids E4/D3, D3, D4/E4 and E4, although two nets were deployed and Cod catch rates were higher than average we did not better the earlier haul of 500kg (the final four hauls accounting for 350kg, 60kg, 190kg and 190kg respectively), however fish in these final hauls were mainly running or spent and of a similar size structure. Gear was boarded at 0230 on the 4th March and the “Josie Grace” returning to Ilfracombe at 2200 on the heels of yet another poor forecast.

Trip 4 (SWCOD406)

Ten days later! Sailed from Ilfracombe at 0730 on Tuesday 14th March and steamed West to attempt to finish areas to the North of Padstow, long range forecast at this point was giving strong to gale force Easterly winds by the weekend. Hauls were conducted in: - I7, I7, I8, I8, I8, H7, H7, I6 and finally in J6. Cod remained scarce throughout the trip and it was generally felt aboard the boat that fish may have spawned and dispersed over the previous spring tide, this theory may have been supported by the ratio of spent females encountered. Fishing gear was boarded on the morning of Friday 17th March in strong to gale force Easterly winds and skipper White then steamed the “Josie Grace” into the lee of Lundy Island where we lay until the tide was favourable for a return to Ilfracombe.

Summary

Poor weather prevented any further sampling in March and it was finally decided on Wednesday 29th to curtail the survey as yet another period of poor weather was forecast.

Of the possible 75 tows identified in the survey plan a total of 54 were conducted over 19.5 days at sea. From this 293 Cod, 149 Haddock and 134 Whiting otoliths and maturity stages were collected.

One phenomena observed when large cod (*Gadus Morhua*) were caught in small amounts was the number of females and attendant males. On a number of hauls where one or perhaps two large hyaline females were present there would almost certainly be three or four large running males, this was most evident on ground to the west of Lundy Island (I6, H6, G6 etc.).

Many small and medium sized Haddock (*Melanogrammus aeglefinus*) on the South Coast of Ireland were heavily infested with the parasite *Lernaeocera branchialis* in its impregnated female stage, these fish were often in very poor condition seeming to have no muscle tissue left at all.

Certain elements of the survey may have proved a little difficult to complete as skipper Whites portfolio of seabed information did not encompass some of the more westerly rectangles indeed some of the rectangles identified would be almost impossible to complete as they include some very stony ground rarely if ever fished by otter trawlers. In an attempt to create a database of seabed information to hopefully avoid this problem in future years I have collected and saved information from friends and associates within the fishing industry (particular thanks to Andrew Shaw and Paul Taylor). I would also like to take this opportunity to thank Marcus White and his crew for their hospitality, assistance and friendship throughout the survey.