

**Final Report**

***North East Cod survey: 2003-2011***

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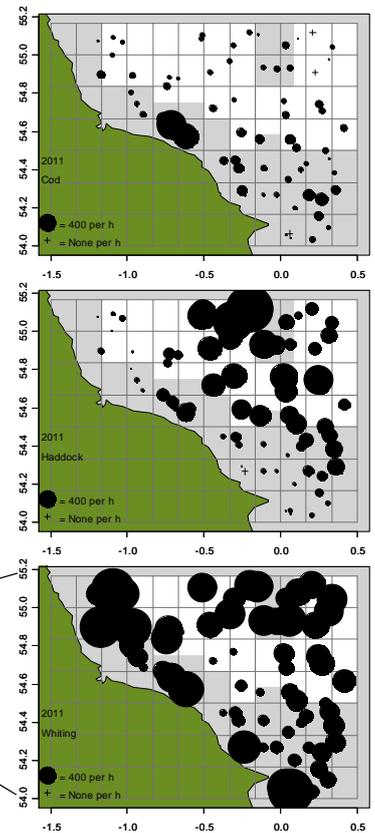
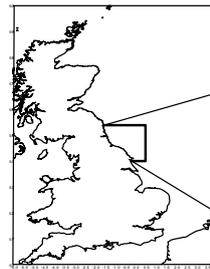
## Summary: NE cod FSP survey 2003-2011

The trawler *Abbie Lee* was chartered in October/November 2011 to carry out the ninth in a series of FSP surveys of cod and other gadoids off the NE coast of England. Surveys since 2005 have utilised tows spread out over the survey area, with additional tows in defined areas with coarser seabed types ("hard" ground) where cod abundance is expected to be greatest.

Cod continue to be most abundant on or near hard ground. Haddock were once again mainly on the softer seabed sediments offshore. Whiting continue to show no clear relationship with seabed type.

Some of the features of cod, haddock and whiting populations given by ICES assessments for the North Sea as a whole are reflected in results from this FSP survey.

*Distribution of cod, haddock and whiting in the 2011 FSP. Areas of spots are proportional to the numbers caught per hour. Shading within the grid lines indicates area with coarse seabed type. Same scale for all plots.*



Mean catch rate by age: 2003–2011 FSP  
(mean number caught per hour).

### (a) Cod

Year	'03	'04	'05	'06	'07	'08	'09	'10	'11
Age 0	0.0	0.0	2.6	0.3	0.0	0.0	0.6	0.0	0.0
Age 1	24.5	21.9	23.7	54.4	22.0	16.0	34.1	29.7	28.6
Age 2	38.0	5.9	6.8	9.4	18.3	9.1	11.4	7.2	12.9
Age 3	0.5	3.1	1.0	1.1	1.8	2.0	0.9	0.7	1.1
Age 4	0.5	1.0	0.1	0.6	0.0	0.1	0.1	0.3	0.1
Age 5	0.2	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0
Age 6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Age 7+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	64	32	34	66	42	27	47	38	43

### (b) Haddock (total 2003 = 34)

Year	'04	'05	'06	'07	'08	'09	'10	'11
Age 0	0.0	1.8	0.3	0.0	0.3	0.1	0.1	0.0
Age 1	1.1	12.3	159.8	13.0	5.9	3.7	52.4	9.3
Age 2	12.8	9.0	10.7	137.5	16.8	7.5	9.2	123.0
Age 3	0.0	14.6	12.1	6.4	75.0	25.0	6.1	16.0
Age 4	3.0	3.6	5.4	0.8	2.6	27.7	7.7	6.1
Age 5	25.9	2.8	1.7	1.6	1.9	0.2	17.9	12.0
Age 6	0.3	31.3	5.4	0.1	0.4	0.3	2.1	8.1
Age 7+	0.0	0.0	3.7	4.6	0.1	0.2	0.9	0.3
Total	43	76	199	164	103	65	96	175

### (c) Whiting (total 2003 = 88)

Year	'04	'05	'06	'07	'08	'09	'10	'11
Age 0	0.0	2.4	0.1	0.0	0.7	0.4	0.0	0.0
Age 1	2.5	26.7	31.3	21.1	159.8	55.8	24.3	78.5
Age 2	14.1	19.9	48.1	32.2	59.3	254.1	32.6	71.1
Age 3	26.7	31.0	17.5	55.7	36.1	79.2	67.0	57.7
Age 4	16.4	166.5	11.6	5.4	30.8	39.9	38.8	117.7
Age 5	9.9	109.9	97.0	11.6	2.9	19.0	18.2	25.6
Age 6	3.2	55.6	45.4	53.4	4.6	0.8	5.5	16.7
Age 7+	1.3	24.0	42.7	39.0	20.8	15.6	10.2	3.2
Total	74	436	294	218	315	465	197	370

The 2005 and 2009 year classes of haddock have been prominent, with the latter strong at ages 2 in 2011. In contrast, the last relatively strong year class of cod (2005) has not really featured in FSP catches since 2008.

The large increase in abundance of whiting noted in the FSP survey in 2005 was also reflected in high catch rates in the years 2006–2009, and 2011, but catch rates were lower in 2010. The catches of whiting in recent years contained relatively large numbers of fish spawned in 2001 and earlier, as 7+ year olds from 2005 on, but these are now in decline.

Catches of whiting in 2008, 2009 and 2011 contained a high proportion of 1- and 2- and 4-year-olds, respectively, indicating a notable abundance of the 2007 year class in the survey area, but this year class did not appear as strongly in the survey area in 2010.

The FSP NE cod survey is an intensive autumn survey of the cod fishing grounds off the NE coast of England, covering a relatively small part of the overall distribution of cod, haddock and whiting in the North Sea. The survey provides comprehensive data on the abundance, distribution, size/age structure and species mix of demersal fish.

## Introduction

The NE Coast cod survey is a designated time-series survey conducted since 2003 as part of the UK Fisheries Science Partnership (FSP). General background to the FSP Programme can be found at [www.cefas.co.uk/fsp](http://www.cefas.co.uk/fsp). The NE Coast cod surveys in 2003 and 2004 were largely exploratory, examining factors such as the effect of gear type and time of day on catch rates of cod and other species (Cotter *et al.*, 2004; Armstrong *et al.*, 2005). Subsequent surveys were conducted following an open tender for a vessel to carry out the surveys using specified gear during each of the years 2005–2007. The survey series thereafter continued on a similar basis following further open tenders covering the periods 2008–2010 and 2011 on (up to possibly 2013). The objective of the survey series is to provide year-on-year comparative information on distribution, relative abundance and size/age composition of NE coast cod and whiting. The surveys also provide data on catches of other species important to the NE coast fishery, including haddock.

The geographic limits of the survey were initially defined to encompass the main grounds for cod and allied species fished by bottom trawlers operating from ports such as Scarborough, Bridlington and Whitby on England's NE coast. The routine Cefas observer scheme clearly shows that vessels using whitefish otter trawls operate mainly on the strip of coarser sediments running along the coast, particularly between autumn and spring. (The area of coarse sediment is referred to as "hard ground" throughout this report.) Inshore hard ground provides a typical habitat for young cod up to 2–3 years old, which remain in the area until they mature, then migrate seasonally between feeding and spawning grounds. The immature cod are therefore present in such areas throughout the year. The FSP surveys of NE cod in 2003 and 2004 targeted mainly hard ground, with some stations farther offshore. The survey was redesigned in 2005 in collaboration with the vessel owner to provide broad coverage of a range of seabed types off the NE coast, at the same time allowing increased survey intensity on the hard ground. The same survey design was used in 2006 and 2007. A similar design, but with a coarser grid and fewer stations, was used in 2008 to allow for a ~10% curtailment of the survey concomitant with rising fuel costs, and that design was subsequently also used from 2009 to 2011.

This report presents the results of the 2011 survey and a comparison with the results obtained during the equivalent surveys of 2005–2010 and the more restricted data available for the 80 mm codend Whitby Jet trawl in 2003 and 2004. The survey in 2011 was the fourth carried out on the commercial trawler *Abbie Lee* (skipper John Hall) since the survey was redesigned in 2005; it took place from 3 October to 1 November. The vessel differed from that used in 2005–2007 (*Emulator*), but the same gear was used and a similar survey design followed. The equivalent FSP survey tows using the Whitby Jet trawl and 80 mm codend in 2004 were made by FV *Christina* (Armstrong *et al.*, 2004), and in 2003 by the fishing vessels *Abbie Lee* and *Emulator* (Cotter *et al.*, 2004).

The detailed operational plan for the 2011 survey is given in Appendix 1, and a post-cruise report, kindly provided by skipper John Hall, is reproduced in Appendix 2.

## Methods

### *Vessel and trawl gear*

FV *Abbie Lee* (WY211) is a steel-hulled trawler, overall length 18.25 m and breadth 6.11 m, with 298 kW main engine power. The vessel deployed a Whitby Jet otter trawl, which is used extensively by vessels off the NE coast to fish for cod. The construction and rigging of the net were as follows:

**Net:** 84 ft (26 m) fishing line, 66 ft (20 m) headline. Codend mesh: 80 mm diamond, constructed from 4/5 mm double-braided twine. Lifting bag mesh 260 mm.

**Ground Gear:** 16” rockhoppers with 8” spacers in central 20 ft. 14” rockhoppers with 8” spacers in 20 ft on either side. 12 ft wing chains of 5/8” links.

**Sweeps (Bridles):** Top: 24 fathom (6.8 m) wire. Bottom: 24 fathom chain.

**Doors:** Poly Ice. 6’6”, 72 stone (458 kg).

**Fishing characteristics:** Estimated headline height: 12 ft. Door-to-door spread estimated at ~90 ft with 80 fathoms of warp out, and 98 ft with 100 fathoms out, towing at 3 knots.

### *Survey design*

The survey was designed to achieve full coverage of potential cod habitats within the area covered by the main cod fishery off the NE coast of England, but placing additional trawling effort in areas expected to have the greatest densities of cod. Broad spatial coverage was ensured by dividing the survey area into 10 min (latitude) by 20 min (longitude) blocks, with two tows to be carried out in each block (note that for the 2005–2007 surveys, these specifications were 10’×10’ blocks, with one tow in each). In 2005, the vessel owner and skipper identified areas of hard ground where the best catch rates of cod were expected. An additional tow was allocated to each of the rectangles containing these areas of hard ground. Some of the tows in 2005 could not be carried out because of the presence there of static gear or the absence of adequate information on clear tow paths. The number of tows per block was slightly modified for the years 2006–2011 to account for this (Appendix 1).

The same gear was originally intended to be used throughout the survey, regardless of ground type, but the use of tickler chains, attached to the gear for a number of tows conducted on soft ground, was noted during the 2008 survey. This modification of the gear had not been included in the gear description in the tender, and scientists were previously not made aware of it. Nevertheless, to remain consistent with previous reports, the analyses presented here do not make any allowance for the presence or absence of tickler chains on soft ground.

### *Sorting and processing the catch*

Standard methods employed by Cefas staff for sorting and recording catches on commercial fishing vessels were followed (see the FSP reports for 2004 and 2005 for details). Length measures were carried out on the retained and discarded components of the catch. Where catches were sampled rather than fully sorted, an appropriate raising factor was determined to allow the total catch to be estimated. Otoliths of cod, whiting and haddock were

collected from samples of fish taken across the survey area, to allow the age composition of the catches to be determined.

### *Analytical methods*

Distribution patterns of cod, whiting, haddock, plaice and lemon sole were examined by compiling maps showing the mean numbers caught per hour towed at each station. The distribution of cod in length ranges comprising mainly 0-group (5–20 cm), 1-group (21–45 cm) and 2+ group fish (>45 cm) was also examined.

The “hard ground” and “soft ground” survey strata that formed the basis for the survey design were retained for comparisons of catch rate and length composition, because the survey intensity on the hard ground was intentionally greater (see Survey design section above). The patch of hard ground in the NE sector of the survey area was treated as being in the same stratum as the more-coastal area of hard ground.

The mean length composition (number caught per hour) of cod, haddock and whiting was calculated for each survey stratum. No distinction was made between landed and discarded fish because the data of interest are catch rates for all length and age classes in the catch. Further, discarding patterns may also be influenced by the vessel’s catches not counting against quota. In practice, though, discarding of the main commercial fish species was strongly influenced by minimum landing sizes (35 cm for cod, 30 cm for haddock, 27 cm for whiting). Market conditions also influenced discarding of whiting.

In order to calculate an average length frequency for the entire survey area, it was necessary to take into account the relative size of each survey stratum, based on the number of 10’×20’ rectangles sampled in each. As the hard ground stratum made up approximately 50% of the total area surveyed in the years 2005–2011, the mean length frequencies (numbers per hour) in the hard-ground and soft-ground strata were averaged, with equal weighting.

Age compositions of cod, haddock and whiting were estimated by applying an age/length key to the mean length composition from each stratum. The age/length keys for each species were compiled from samples collected throughout the survey. No otoliths of haddock or whiting were collected during the 2003 FSP survey, so for that year only the length frequencies and total numbers caught per hour can be compared with the 2004–2011 survey results. The more limited coverage of the grounds by the Whitby Jet trawl in 2003 and 2004 means that the catch rates for those years give only a rough indication of abundance and age composition relative to the more extensive surveys in subsequent years.

Although catch weights were not recorded during the survey, the approximate total live weight of the catch of each fish species during the survey was calculated from the total raised length frequency for the survey tows, multiplied by the expected average weight of fish in each length class using a length–weight relationship. These catch-weight estimates therefore only approximate the landings recorded in the vessel logbook.

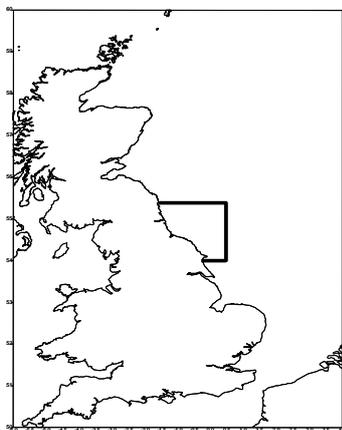
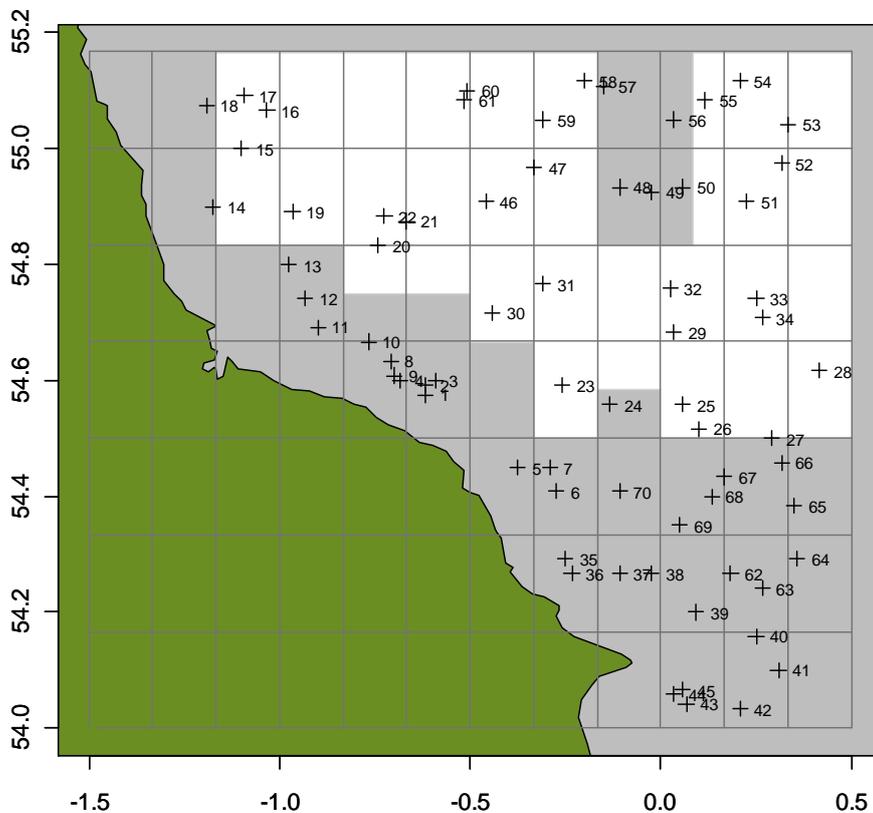
# Results

## Fishing stations

Details of the fishing activities of *Abbie Lee* are given in Table 1. Midpoints of tows are shown in Figure 1. The position, date and time, along with numbers of the main commercial species caught, are given by tow in Tables 1 and 2 of Appendix 3. Data for other species caught are held at Cefas.

**Table 1.** FSP 2011 Survey: North East cod. Details of fishing activities.

Vessel	Dates in 2011	Stations	Number of valid hauls	Fishing gear	Codend mesh (mm)	Tow duration (h) Median (range)
FV <i>Abbie Lee</i>	3 Oct – 1 Nov	1 – 70	70	Whitby Jet trawl	80	2.00 (1.00 – 2.50)



**Figure 1** FSP NE cod survey in 2011: tow midpoint positions and numbers. The shaded area within the grid lines in this and subsequent plots represents hard ground, and the non-shaded area soft ground. Ground types are inferred from sediment charts and skipper’s knowledge. Note that, for ease of plotting, the grid pattern for 2011 in this and subsequent plots is kept consistent with that of previous surveys, but the survey design in 2011 was actually based on the grid pattern shown in Appendix 1.

### *Catch compositions*

As in previous years, the largest catches in 2011 by weight were whiting, haddock and cod (Table 2), constituting 80% of the total estimated weight of fish taken during the survey. The total catch weight of these three species was 77% more than in 2010, with whiting, haddock and cod up 80%, 124% and 20%, respectively. Lemon sole, dab, bib, plaice and grey gurnard constituted a further 15% of the total catch weight in 2011. The three target species plus these five other species therefore made up 95% of total catch weight and 92% of total catch numbers.

**Table 2.** Total estimated catch numbers and catch weight of fish species recorded during the 2011 NE cod survey. Percentages are also shown. Equivalent catch weights from the 2010 FSP are given.

Species	Total number in 2011	%	Total weight in 2011 (kg)	%	Total weight in 2010 (kg)
Whiting	50 719	42.5	11 417	33.7	6 331
Haddock	23 033	19.3	10 812	31.9	4 834
Cod	6 301	5.3	5 011	14.8	4 181
Lemon Sole	5 768	4.8	1 235	3.6	1 092
Dab	8 456	7.1	1 162	3.4	649
Bib	5 495	4.6	1 031	3.0	187
Plaice	3 587	3.0	871	2.6	1 346
Grey Gurnard	5 979	5.0	638	1.9	432
Herring	2 653	2.2	400	1.2	193
Poor Cod	3 666	3.1	282	0.8	245
Common Squids	1 307	1.1	250	0.7	328
Mackerel	470	0.4	131	0.4	120
Anglerfish	35	0.0	103	0.3	73
European Hake	126	0.1	100	0.3	58
Long Rough Dab	743	0.6	60	0.2	14
Horse-Mackerel	186	0.2	53	0.2	21
Spotted Ray	30	0.0	49	0.1	51
Tope Shark	4	0.0	40	0.1	9
Common Ling	32	0.0	39	0.1	38
Thornback Ray	13	0.0	25	0.1	75
Lesser Spotted Dogfish	53	0.0	23	0.1	99
Red Gurnard	152	0.1	22	0.1	14
Brill	26	0.0	21	0.1	22
Edible Crab	49	0.0	15	0.0	29
Sole	50	0.0	14	0.0	15
Turbot	7	0.0	13	0.0	11
Saithe	11	0.0	11	0.0	35
Red Mullet	37	0.0	8	0.0	8
Tub Gurnard	16	0.0	8	0.0	28
Cuckoo Wrasse	5	0.0	7	0.0	-
Witch	76	0.1	6	0.0	4
John Dory	10	0.0	5	0.0	10
Twaite Shad	6	0.0	5	0.0	3
Starry Smooth Hound	2	0.0	5	0.0	86
Pollack	1	0.0	3	0.0	186
Wolffish	6	0.0	3	0.0	-
Cuckoo Ray	4	0.0	3	0.0	14
Smooth Hound	1	0.0	3	0.0	52
Common Dragonet	27	0.0	1	0.0	1
Other species	116	0.1	4	0.0	194
<b>TOTAL</b>	<b>119,255</b>		<b>33,889</b>		<b>21,090</b>

### *Distribution patterns*

Distribution maps for cod, haddock, whiting, plaice and lemon sole are provided in Figures 2–7. The plots all have the same scale relating the surface area of the symbols (spots) to numbers caught per hour.

#### COD

Small cod <21 cm long (0-group fish), spawned in spring of the same year as the survey, were caught mainly in the northwestern corner of the survey area in 2005, but were less evident in 2006, absent or near-absent in 2007, 2008, 2010 and 2011, and caught in 23% of stations scattered throughout the survey area, but in small numbers, in 2009 (Figure 2, top row). The presence of such small fish in the 2005 survey mirrored the very high densities of 0-group cod recorded along the east coast of Scotland in the North Sea IBTS quarter-3 and Scottish quarter-4 groundfish surveys (ICES Dattras database; ICES–WGNSSK, 2006), a pattern that has not been repeated since. This feature provided the first indications of a relatively strong 2005 year class.

The bulk of the FSP cod catches in 2005–2011 were fish 21–45 cm long, mainly 1-year-olds, which were most abundant on the inshore hard ground (Figure 2, middle row). Catch rates of cod in this length range were generally higher in 2006 than in the other years (see also Figure 8a), owing to the relative strength of the 2005 year class.

Cod >45 cm long (mainly 2-year-olds and older) were most abundant at the more offshore tows on the hard ground in the southern part of the survey area in 2005–2007, but closer inshore towards the south in 2008, and more evenly spread over the hard ground from 2009 to 2011 (Figure 2, bottom row).

Cod catches on the soft ground were patchy and often very small. The small offshore patch of hard ground in the northeast part of the survey area had a catch rate of cod similar to that on the surrounding soft ground.

Comparison of cod distribution patterns between FSP surveys in 2003 and 2004 with those in 2005–2011 is restricted largely to the coastal area of hard ground area, where most of the Whitby Jet otter trawl tows in 2003 and 2004 were carried out (Figure 3). The 2005–2011 surveys yielded more complete coverage of the hard ground, but all surveys show the best overall catch rates of cod at stations close to the coast.

A statistical analysis of the impact of soft vs. hard grounds on catch rates of cod using identical gear configuration, based on data from this FSP survey time-series (2003–2008), was included in an EU project on joint data collection between scientists and the fishing industry (Darby *et al.*, 2009). That project concluded that catches of cod on soft ground are, generally, significantly less than recorded on hard ground, but that there is no difference between trends on the hard and soft grounds.

#### HADDOCK

The distribution of haddock in the FSP surveys has been quite different from that of cod, with more patchy and often very low catch rates on the inshore hard ground, and consistently better catch rates on the offshore soft and hard grounds (Figure 4). Although there were fewer offshore tows using the Whiby Jet trawl in 2003 and 2004, a generally

similar pattern to that of 2005–2011 is evident. The increased abundance of small haddock in 2006 also coincided with an extension of the distribution into the coastal hard ground, but catch rates remained low at the tows closest to the coast. In 2007–2011 the distribution had become more offshore again.

## WHITING

Catch rates of whiting were relatively high during all surveys from 2005 to 2009 and in 2011, but not in 2010. The distribution pattern in 2005 was similar to that of cod, with catch rates best on the inshore hard ground (Figure 5). From 2006 to 2008 and in 2011, the whiting were more spread out over the survey area, but in 2009 the best catch rates were again on inshore hard ground, as in 2005. In 2010, lower catch rates were recorded, and they were similar on the inshore hard ground and the soft ground farthest from the coast. The numbers of whiting caught in 2003 and 2004 were much smaller than in subsequent years, and were highest on some of the hard-ground tows close to the coast.

## LEMON SOLE AND PLAICE

Lemon sole and plaice were in the top seven most abundant species in the total survey catch (by weight) in the 2005–2011 surveys, and were widespread across the survey area, but with no particular centre of distribution (Figures 6 and 7), although larger numbers of lemon sole were caught on inshore hard ground in the central to southern areas in the years 2008–2011. There was a tendency for the catch rates to be relatively low in the northwestern part of the survey area for both species and in the inshore southeastern part for plaice during all surveys

### *Length and age compositions*

## COD

The average length frequencies of cod (in numbers caught per hour towed) in the FSP surveys in 2003–2011 have typically shown a dominance of fish ~30–45 cm long (Figure 8a). A mode of 0-group cod <20 cm long was evident in 2005. Catch rates of cod >30 cm were better on the hard ground than on the soft ground in the 2005–2011 surveys (Figure 8b).

The survey in 2003 indicated a dominance of 2-year-olds (2001 year class), whereas subsequent surveys were dominated by 1-year-olds, particularly that of 2006 (Figure 9, Table 3). A relatively strong 2005 year class of cod is indicated by the elevated catch rates of 0-group fish in 2005, 1-group fish in 2006, and 2-group fish in 2007. Overall, the catch rates in 2011 were about average for the series in terms of both total numbers and total weight (Tables 3 and 6).

## HADDOCK

Until 2009, length compositions of haddock were dominated by fish of the 2005 year class, but the 2009 year class has shifted the distribution from a peak at >35 cm in 2009 to one at <30 cm in 2010 and around 35 cm in 2011 (Figure 10a). The general shape of the length compositions was similar on both hard ground and soft ground in the years 2005–2007, with more haddock on soft ground, but length compositions shifted towards larger haddock

on the hard ground compared with soft ground in 2008–2009, indicating that larger fish were more abundant on hard ground and smaller fish on soft ground (Figure 10b). In 2010 and 2011, more haddock were once again found on the soft ground.

The 1999 year class of haddock was strongly represented as 5-year-olds in 2004, 6-year-olds in 2005, and as fish 7+ years old in 2006 and 2007, but almost disappeared after 2007 (Figure 11, Table 4). The most prominent signal, however, is the strong 2005 year class of haddock, indicated by very high catch rates of 1-year-olds in 2006, 2-year-olds in 2007, 3 year-olds in 2008, 4 year-olds in 2009 and 5 year-olds in 2010. This year class was also present (in small numbers) as 0-group fish during the 2005 survey. A strong 2009 year class, first indicated by elevated levels of 1-year-olds in 2010, has now been confirmed by high levels of 2-year-olds in 2011. Total catch rates of haddock (kg per h) in this short FSP time-series were lowest in 2003 and highest in 2011 (Table 6).

## WHITING

Until 2007, the length compositions of whiting in FSP surveys always showed the same length mode, with a peak around 30 cm, but this mode shifted to the left with a peak around 25 cm in 2008 as a result of the 2007 year class, and shifted to >30 cm in 2010 (Figure 12a). The distribution in 2011 is broader than in other years, but with a peak once more around 30 cm. Both the length composition and overall catch rate of whiting were similar on the hard and soft ground in 2006, 2007 and 2010 (Figure 12b). In 2005, catch rates on the hard ground were much higher than on the soft ground, although this finding is strongly influenced by two very large catches on hard ground (Figure 5). Catch rates were higher on soft ground in 2008, but higher on the hard ground in 2009 (as in 2005). The general shape of the length compositions was similar for the two ground types, except in 2011 where larger fish appeared to be more abundant on hard ground, and smaller fish on soft ground (Figure 12b).

The age composition of whiting shows a consistent progression of modes following the interannual variation in recruitment (Figure 13, Table 5). Catches in 2004 showed a substantial contribution of whiting 3–5 years old (the 1999–2001 year classes). These were also evident as 4–6-year-old fish in 2005, 5 years and older fish in 2006, 6 years and older fish in 2007, and fish 7+ years old in the years 2008–2010 (Figure 13, Table 5). The notable increase in catch rates since 2005 (Table 6) is due in large measure to the occurrence of these year classes of whiting as older fish. A prominent feature in recent surveys is the high catch rates of 1-year-old fish in 2008 and 2-year old fish in 2009, and 4-year old fish in 2011, although catch rates of 3-year-old fish were appreciably lower in 2010 (Figure 13, Table 5); these indicate that the 2007 year class has been strong in the survey area. Therefore, although the overall catch rates by numbers and weight declined over the period 2005–2007 as the older whiting were removed by fishing and natural mortality, they increased again in 2008 and 2009 with the enhanced contribution of the 2007 year class, and again in 2011 following lower levels in 2010 (Table 6).

**Table 3.** Summary of mean catch rates of cod (number caught per hour), by age class and FSP survey.

(a) Mean number per hour

Year	Age 0	age 1	age 2	age 3	age 4	age 5	TOTAL
2003	0.00	24.48	38.00	0.50	0.46	0.15	63.6
2004	0.00	21.87	5.87	3.06	1.00	0.00	31.8
2005	2.65	23.69	6.81	0.96	0.12	0.00	34.2
2006	0.29	54.44	9.36	1.10	0.59	0.06	65.8
2007	0.00	22.00	18.29	1.75	0.00	0.00	42.0
2008	0.01	16.04	9.07	1.95	0.09	0.00	27.2
2009	0.63	34.11	11.45	0.87	0.08	0.03	47.2
2010	0.00	29.68	7.23	0.68	0.26	0.09	37.9
2011	0.00	28.60	12.87	1.14	0.14	0.02	42.8

(b) Percentage

Year	Age 0	age 1	age 2	age 3	age 4	age 5	TOTAL
2003	0.0	38.5	59.8	0.8	0.7	0.2	100
2004	0.0	68.8	18.5	9.6	3.1	0.0	100
2005	7.7	69.2	19.9	2.8	0.4	0.0	100
2006	0.4	82.7	14.2	1.7	0.9	0.1	100
2007	0.0	52.3	43.5	4.2	0.0	0.0	100
2008	0.0	59.0	33.4	7.2	0.3	0.0	100
2009	1.3	72.3	24.3	1.8	0.2	0.1	100
2010	0.0	78.2	19.1	1.8	0.7	0.2	100
2011	0.0	66.9	30.1	2.7	0.3	0.1	100

**Table 4.** Summary of mean catch rates of haddock (number caught per hour), by age class and FSP survey.

(a) Mean number per hour

Year	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7+	Total
2004	0.0	1.1	12.8	0.0	3.0	25.9	0.3	0.0	43
2005	1.8	12.3	9.0	14.6	3.6	2.8	31.3	0.0	76
2006	0.3	159.8	10.7	12.1	5.4	1.7	5.4	3.7	199
2007	0.0	13.0	137.5	6.4	0.8	1.6	0.1	4.6	164
2008	0.3	5.9	16.8	75.0	2.6	1.9	0.4	0.1	103
2009	0.1	3.7	7.5	25.0	27.7	0.2	0.3	0.2	65
2010	0.1	52.4	9.2	6.1	7.7	17.9	2.1	0.9	96
2011	0.0	9.3	123.0	16.0	6.1	12.0	8.1	0.3	175

(b) Percentage

Year	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7+	Total
2004	0.0	2.6	29.6	0.0	7.0	60.1	0.7	0.0	100
2005	2.4	16.3	11.9	19.4	4.8	3.8	41.4	0.0	100
2006	0.1	80.3	5.4	6.1	2.7	0.9	2.7	1.9	100
2007	0.0	8.0	83.9	3.9	0.5	1.0	0.0	2.8	100
2008	0.3	5.8	16.3	72.8	2.5	1.8	0.3	0.1	100
2009	0.2	5.7	11.6	38.6	42.8	0.4	0.5	0.3	100
2010	0.1	54.3	9.6	6.3	8.0	18.6	2.1	1.0	100
2011	0.0	5.3	70.4	9.1	3.5	6.9	4.6	0.2	100

**Table 5.** Summary of mean catch rates of whiting (number caught per hour), by age class and FSP survey.

(a) Mean number per hour									
Year	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7+	Total
2004	0.0	2.5	14.1	26.7	16.4	9.9	3.2	1.3	74
2005	2.4	26.7	19.9	31.0	166.5	109.9	55.6	24.0	436
2006	0.1	31.3	48.1	17.5	11.6	97.0	45.4	42.7	294
2007	0.0	21.1	32.2	55.7	5.4	11.6	53.4	39.0	218
2008	0.7	159.8	59.3	36.1	30.8	2.9	4.6	20.8	315
2009	0.4	55.8	254.1	79.2	39.9	19.0	0.8	15.6	465
2010	0.0	24.3	32.6	67.0	38.8	18.2	5.5	10.2	197
2011	0.0	78.5	71.1	57.7	117.7	25.6	16.7	3.2	370

(b) Percentage									
Year	age 0	age 1	age 2	age 3	age 4	age 5	age 6	age 7+	Total
2004	0.0	3.3	19.0	36.1	22.2	13.3	4.3	1.7	100
2005	0.5	6.1	4.6	7.1	38.2	25.2	12.7	5.5	100
2006	0.0	10.7	16.4	6.0	3.9	33.0	15.4	14.6	100
2007	0.0	9.6	14.7	25.5	2.5	5.3	24.5	17.8	100
2008	0.2	50.7	18.8	11.5	9.8	0.9	1.5	6.6	100
2009	0.1	12.0	54.7	17.0	8.6	4.1	0.2	3.4	100
2010	0.0	12.3	16.6	34.1	19.7	9.3	2.8	5.2	100
2011	0.0	21.2	19.2	15.6	31.8	6.9	4.5	0.9	100

**Table 6.** Summary of mean numbers and weight caught per hour, for all size classes of cod, haddock and whiting during the 2003–2011 FSP surveys.

(a) Numbers per hour										
	2003	2004	2005	2006	2007	2008	2009	2010	2011	
Cod	64	32	34	66	42	27	47	38	43	
Haddock	34	43	76	199	164	103	65	96	175	
Whiting	88	74	436	294	218	315	465	197	370	

(b) kg per hour										
	2003	2004	2005	2006	2007	2008	2009	2010	2011	
Cod	53	27	23	38	31	25	32	28	36	
Haddock	18	23	36	58	58	46	33	36	82	
Whiting	19	16	101	66	53	59	97	45	82	

### *Linkages between species*

Catch rates of cod, haddock and whiting are patchy, and can vary considerably over relatively small distances. Plots of the catch rate of one species against that of another therefore show no relationship at the scale of individual tows (Figure 14).

The distribution maps for cod and haddock (Figures 2–4) clearly show that cod and haddock off the NE coast have different distribution patterns at a larger scale than the distance between tows. Vessels targeting haddock (or other species) on the soft-ground stations offshore during autumn would have lower catch rates of cod than those fishing on the hard ground closer to the coast.

In contrast to haddock, the larger-scale distribution of whiting has generally been similar to that of cod during the NE cod FSP surveys (Figures 2, 3 and 5). Any vessels targeting whiting on the inshore hard-ground stations would be likely to take a bycatch of cod unless

they were specifically able to target whiting in very restricted localities where cod were not present at the time.

### *Comparison with ICES results*

The population of cod in the survey area has primarily been 1- and 2-year-olds, with some 3- and 4-year-olds (Figure 9). Older fish have been scarce. The relative strength of recent year classes of cod, as indicated by the time-series of FSP catch rates of 1-year-olds, has been similar to the trends given by the most recent ICES assessment (ICES–WGNSSK, 2011; Figure 15), arguably showing closer agreement than the 1-group indices for the whole North Sea from the ICES International Bottom Trawl Survey (IBTS) programme (ICES–WGNSSK, 2011), but year-class signals are divergent for all indices since the 2007 year class. All series indicate that the 2006 and 2007 year classes are roughly the same size and about half as abundant as the relatively strong 2005 year class. The “Codwatch” FSP project ([www.cefas.co.uk/fsp](http://www.cefas.co.uk/fsp)) mapped the distribution of young cod of the 2005–2008 year classes using a fisher self-sampling scheme, and from a comparison of data for 1-year-olds in Q1 of 2007, 2008 and 2009, suggested that the 2006, 2007 and 2008 year classes of cod may all have been of comparable strength (Large *et al.*, 2009), and not particularly strong. The 2009 year-class peak in the ICES assessment, also reflected in the IBTS Q1 survey, is not evident in the FSP survey.

Haddock are widely distributed over the northern North Sea, and the FSP survey area covers only a small part of the range of the stock. It is possible that haddock become abundant off the NE coast of England when strong year classes are formed and that the geographic range of the stock expands as a consequence. Strong recruitment events should therefore show up prominently in the FSP data, and this is confirmed in Figure 15 for the strong 2005 and 2009 year classes. FSP results are consistent with those of the ICES assessment, indicating a series of poor recruitments following 2005, with stronger recruitment again in 2009, which was subsequently followed by poor recruitment in 2010 (ICES–WGNSSK, 2011).

For whiting, all series (ICES assessment, FSP survey, IBTS quarters 1 and 3) indicate that the 2003–2006 year classes were weak, and information available for the 2002 year class indicates that it too was weak. These weak year classes follow several comparatively strong ones around the years 1998–2001 (ICES–WGNSSK, 2011). This explains the dominance of older whiting in the FSP catches (Figure 13). The ICES assessment and FSP survey both indicate a strong 2007 year class relative to the preceding weak ones, but there is less agreement with the IBTS surveys.

The ICES assessment indicates a decline in spawning-stock biomass of whiting in the North Sea as a whole prior to the arrival of the 2007 year class (ICES–WGNSSK, 2011), whereas the FSP NE coast survey and English fishery catch rates on the NE coast indicate an increase in the abundance of older whiting since 2005 (Tables 5 and 6). This is suggestive of a localised aggregation of adult whiting along the NE coast. The results of the time-series of annual North Sea Commission Fisheries Partnership Stock Surveys, giving fishers’ perceptions of relative trends in abundance of commercial fish species in different parts of the North Sea, also demonstrated that the trend of increasing whiting abundance prior to the arrival of the 2007 year class was a phenomenon restricted to the NE coast area and the southern North Sea (Laurenson, 2008).

## Discussion

The NE cod FSP project provides an intensive survey of a distinct fishing ground that covers a relatively small part of the overall distribution of cod, whiting and haddock in the North Sea. However, the area is of considerable importance for fishers working out of ports on the NE coast of England, and who are affected by management decisions made in the context of the entire North Sea fishery. The NSCFP stock survey (Laurenson, 2008; Napier, 2010), as well as data from large-scale trawl surveys using research vessels, show regional differences in trends in fish abundance, particularly for whiting. This can lead to localized problems in managing mixed fisheries. Locally intensive trawl surveys, as carried out by this FSP project, using fishing gears typical of the fisheries, can provide valuable information on changes in abundance, distribution and species mixing affecting distinct, but localized, sectors of the fishing industry.

The 2005–2007 charter of *Emulator* and 2008–2011 charter of *Abbie Lee* specifically address the establishment of time-series data on abundance, age composition and distribution of cod and whiting off the NE coast of England, as well as providing data on other important species such as haddock. Similar FSP surveys of NE coast cod were carried out in 2003 and 2004 using the Whitby Jet otter trawl (Armstrong *et al.*, 2004; Cotter *et al.*, 2004). However, those projects had competing objectives, including comparison of catches using different gears and demonstration of day–night differences in catch rate. The focus on the survey element in the years 2005–2011 allowed greater coverage of the fishing grounds off the NE coast, and this proved very successful in providing the most comprehensive set of data obtained so far on distribution, abundance and population structure of cod, whiting and haddock throughout the survey area.

The survey was originally designed to provide a compromise between the scientific requirement to provide full coverage of the potential habitats for cod off the NE coast, and industry's desire to demonstrate catch rates and catch compositions on the main fishing grounds. This was achieved by a two-stage design consisting of a broad geographic spread of tows (two per 10' latitude  $\times$  20' longitude rectangle in the 2008–2011 surveys), and an additional tow in each rectangle in areas of hard ground identified by the vessel owner during the charter of *Emulator* as being the main habitat of cod in this region of the North Sea.

Some of the features of the cod, haddock and whiting populations given by ICES data for the North Sea as a whole are reflected in these FSP results for the NE coast. These include the relatively abundant 2005 year classes of cod and haddock, the large but declining contribution to catches of the 1999 year class of haddock since 2004, and more recently the stronger year classes of whiting in 2007 and haddock in 2009 relative to the preceding weak ones.

The indications of very poor recruitment of whiting from the 2002–2006 year classes has been reflected by a dominance of older whiting in the FSP catches until 2007. The increased abundance of whiting off the NE coast since 2005 has been a particularly strong signal, and it appears to reflect a localised aggregation of older whiting from the 2001 and earlier year classes along the NE coast, despite an apparent decline in abundance of adult whiting in the North Sea as a whole prior to the arrival of the 2007 year class. It has been inevitable that vessels targeting other demersal species in the area covered by the FSP

survey have taken large bycatches of whiting, which has led to quota-uptake problems since 2005. The 2007 year class was abundant in the survey area in 2008 and 2009, and again in 2011, with increased catch rates at age 1 in 2008, age 2 in 2009, and age 4 in 2011, but catch rates at age 3 in 2010 were rather lower than expected given the previous and subsequent strong presence of this year class; this finding may be coincident with industry reports of up to a dozen French vessels operating off Flamborough Head targeting whiting throughout summer 2010.

Cod taken during the FSP surveys have been dominated by young fish 1–3 years old, which are likely to be mainly immature. The owner of the *Emulator* advised in 2006 that catches of cod >4 years old are more likely to be taken farther offshore than 50 miles. The main catches of big cod taken by Grimsby pair-teams during the 1970s, 1980s and 1990s were taken well offshore, implying that the current NE coast FSP survey area is mainly a juvenile area for cod.

Immature cod up to 3 years old mostly do not participate in spawning migrations, so are likely to remain in and around the hard ground throughout the year, to feed. Seasonal feeding aggregations can be found, for example, on patches of autumn-spawning herring. Subsequent dispersal of cod may reduce the catch rates at such feeding “hotspots”, but it is likely that immature fish then redistribute within the FSP survey area, with relatively few moving long distances away from the area.

Cod have been maturing at progressively smaller sizes in the North Sea, and Yoneda and Wright (2004) showed that 75% of cod caught in Scottish inshore waters of the North Sea in the early 2000s were mature at a length of 50 cm. This implies that some cod along the east coast of the UK are now mature at 2 years of age and that a large proportion of 3-year-olds are mature. A significant portion of the 2005 year class of cod may therefore have migrated to offshore spawning sites, reducing their availability to inshore fishing vessels. This is a possible cause of the diminished contribution of the 2005 year class to FSP catches from 2008 on.

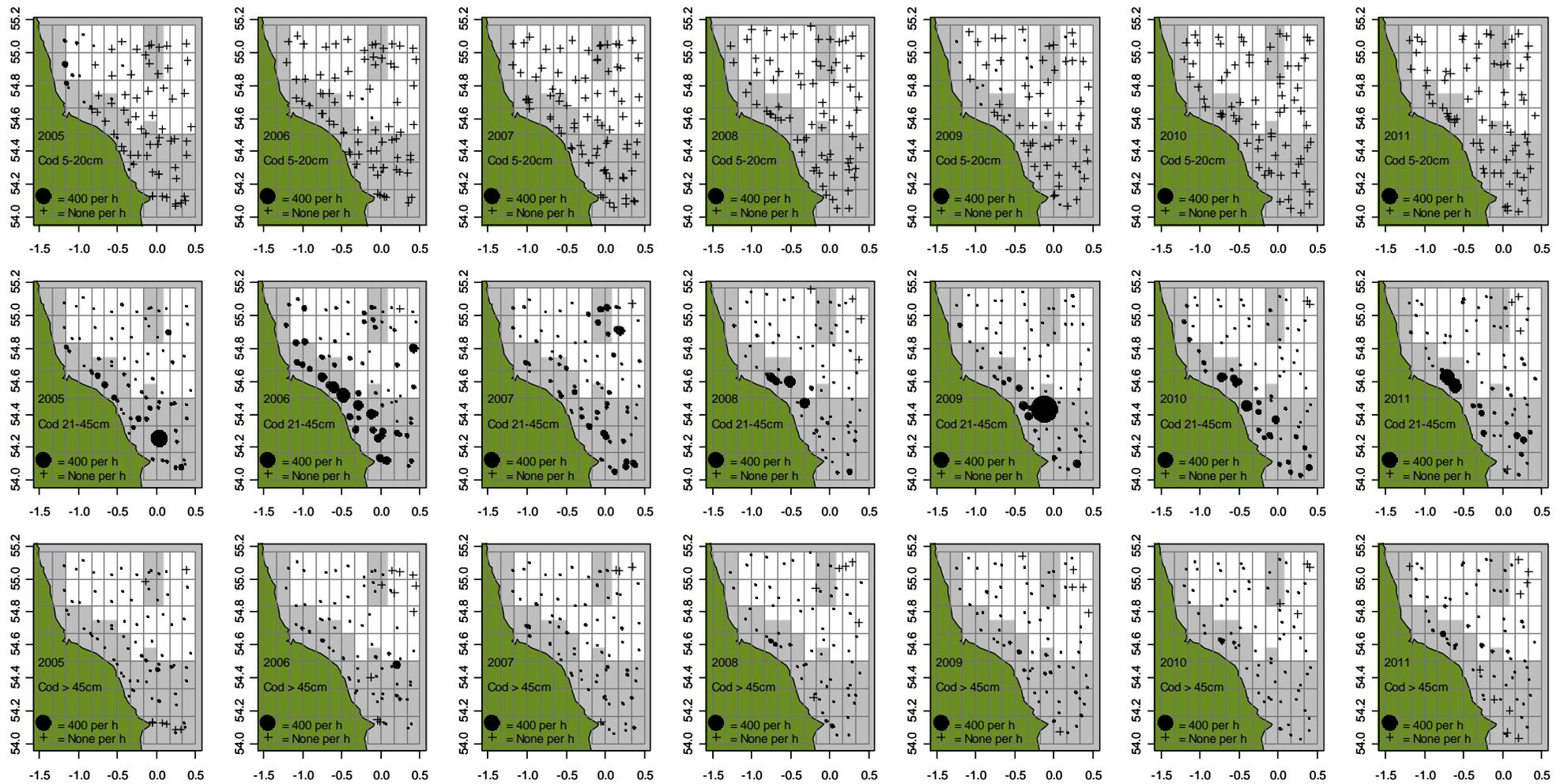
Of particular interest for implementation of management measures is how the coastal fisheries off the NE coast will be affected in the coming year by recent changes in year-class strength of the fish. The relative strength of the 2005 year class of cod led to a marked increase in availability of cod along the NE coast, causing quota-uptake and discarding problems, but that year class now no longer features in FSP catches. Although the ICES assessment estimates the 2009 year class of cod to be almost as strong as the 2005 year class, this has not been seen in the FSP survey results, which indicates that the 2008–2010 year classes were of a similar size, but smaller than the 2005 year class.

## **Acknowledgements**

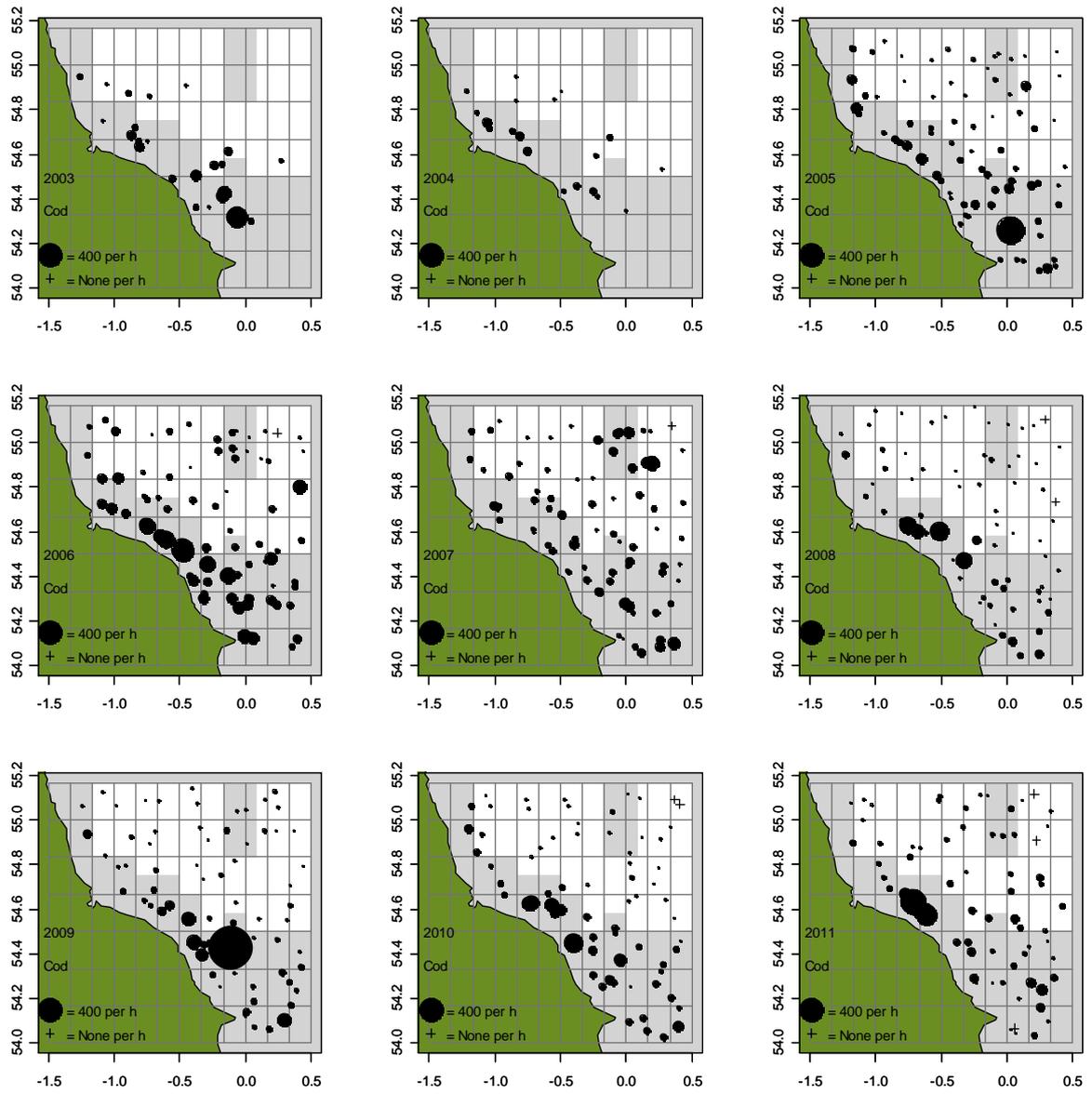
Skipper John Hall and the crew of the *Abbie Lee* are warmly thanked for their help, advice and willing cooperation throughout this project. All Cefas staff involved in data and otolith processing, and in project administration and quality assurance, are thanked for their valuable contribution to the success of this project, which was funded by Defra. Thanks are also due to Andy Payne for reviewing the report.

## References

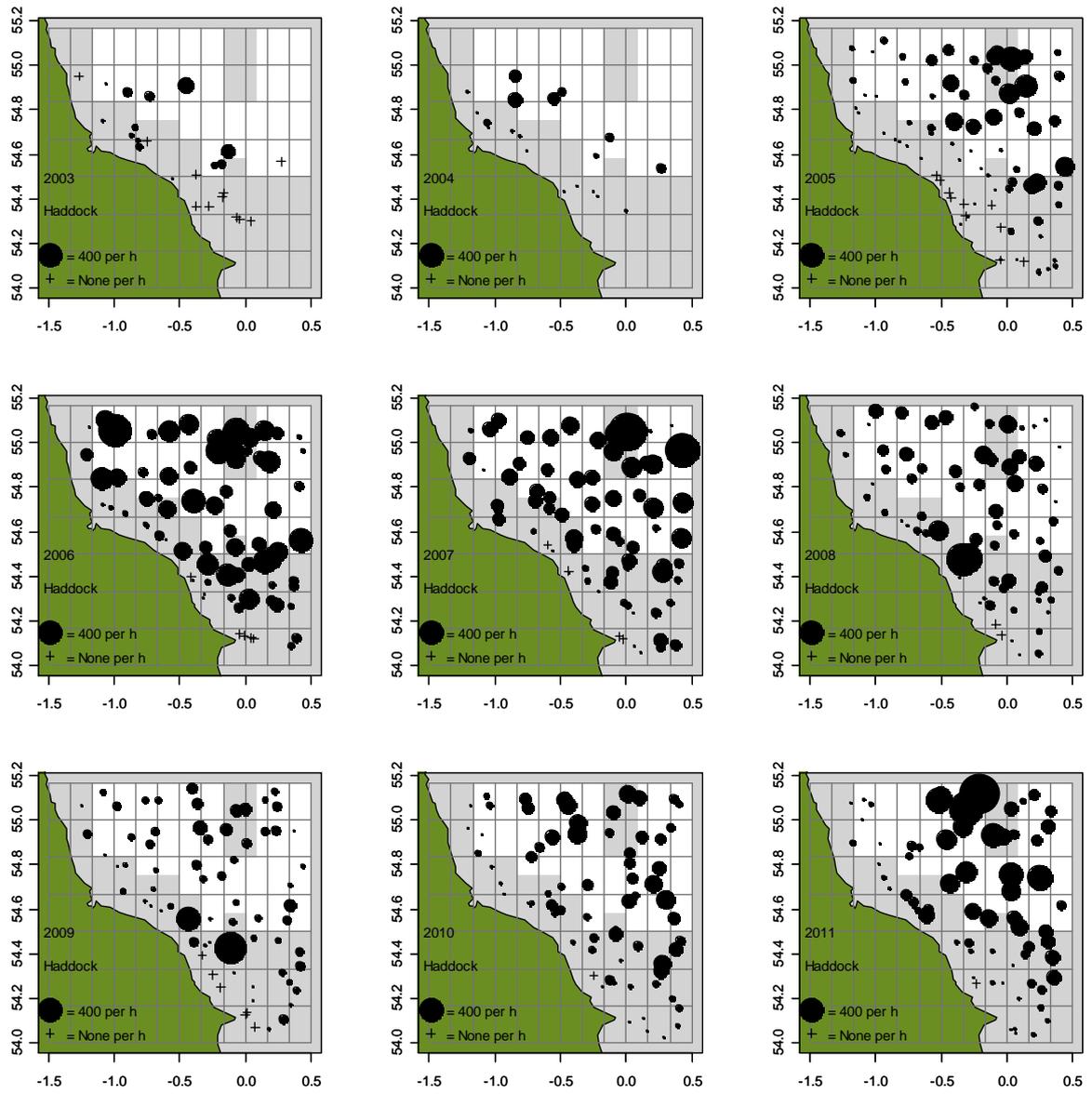
- Armstrong, M., Cotter, J., Dann, J., Garrod, C., Mainprize, R., Bevan, D., Malone, D. and Whittaker, C. 2004. Programme 1: North East Cod. Fisheries Science Partnership 2004/05 Final Report. 35 pp. [www.cefas.co.uk/fsp](http://www.cefas.co.uk/fsp).
- Armstrong, M., Dann, J., Shaw, S., Bush, R. and Whittaker, C. 2005. Programme 1: North East Cod. Fisheries Science Partnership 2005/06 Final Report. 34 pp. [www.cefas.co.uk/fsp](http://www.cefas.co.uk/fsp)
- Cotter, J., Bannister, C., Mainprize, R., Boon, T. and Mills, C. 2004. Catches of cod and other species along the English NE coast by FV *Abbie Lee*, FV *Emulator*, and by the English Groundfish Survey, autumn 2003. Fisheries Science Partnership 2003/04 Final Report. [www.cefas.co.uk/fsp](http://www.cefas.co.uk/fsp).
- Darby, C., Parker-Humphreys, M. and De Oliveira, J. 2009. Section 2.3.4. Analysis of hard and soft ground survey catches based on the UK North East Coast Cod Survey. Report 4 of Lot 7: Joint data collection between the fishing sector and the scientific community in the North Sea. Reference: SI2.464218. Pages 61–76. In: Studies and Pilot projects for carrying out the Common Fisheries Policy. Cooperation to Develop Fisheries Information from the North Sea. The European Commission Directorate-General for the Fisheries and Maritime Affairs: 150 pp. [Available online: [http://ec.europa.eu/fisheries/publications/studies/cooperation-to-develop-fisheries-info-from-north-sea\\_en.pdf](http://ec.europa.eu/fisheries/publications/studies/cooperation-to-develop-fisheries-info-from-north-sea_en.pdf). Accessed 9 January 2010.]
- ICES–WGNSSK. 2006. Report of the ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak. ICES Document CM 2006/ACFM: 09.
- ICES-WGNSSK. 2011. Report of the Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK), 4-10 May 2011, ICES Headquarters, Copenhagen. ICES CM 2011/ACOM:13. 1174 pp.
- Large, P., Brown, M., South, A., Robinson, P. and Hale, N. 2009. Programme 18: North Sea Codwatch. Fisheries Science Partnership 2007/09 Final Report. 37 pp. [www.cefas.co.uk/fsp](http://www.cefas.co.uk/fsp)
- Laurenson, C. 2008. North Sea Stock Survey 2008. NAFC Marine Centre, Shetland, UK: 113 pp.
- Napier, I. R. 2010. Fishers' North Sea stock survey 2010. NAFC Marine Centre, Shetland, Scotland: 120pp. [Accessed online, 17/05/2011: [www.nsss.eu](http://www.nsss.eu)]
- Yoneda, M. and Wright, P.J. 2004. Temporal and spatial variation in reproductive investment of Atlantic cod *Gadus morhua* in the northern North Sea and Scottish West Coast. Marine Ecology Progress Series 276: 237–248.



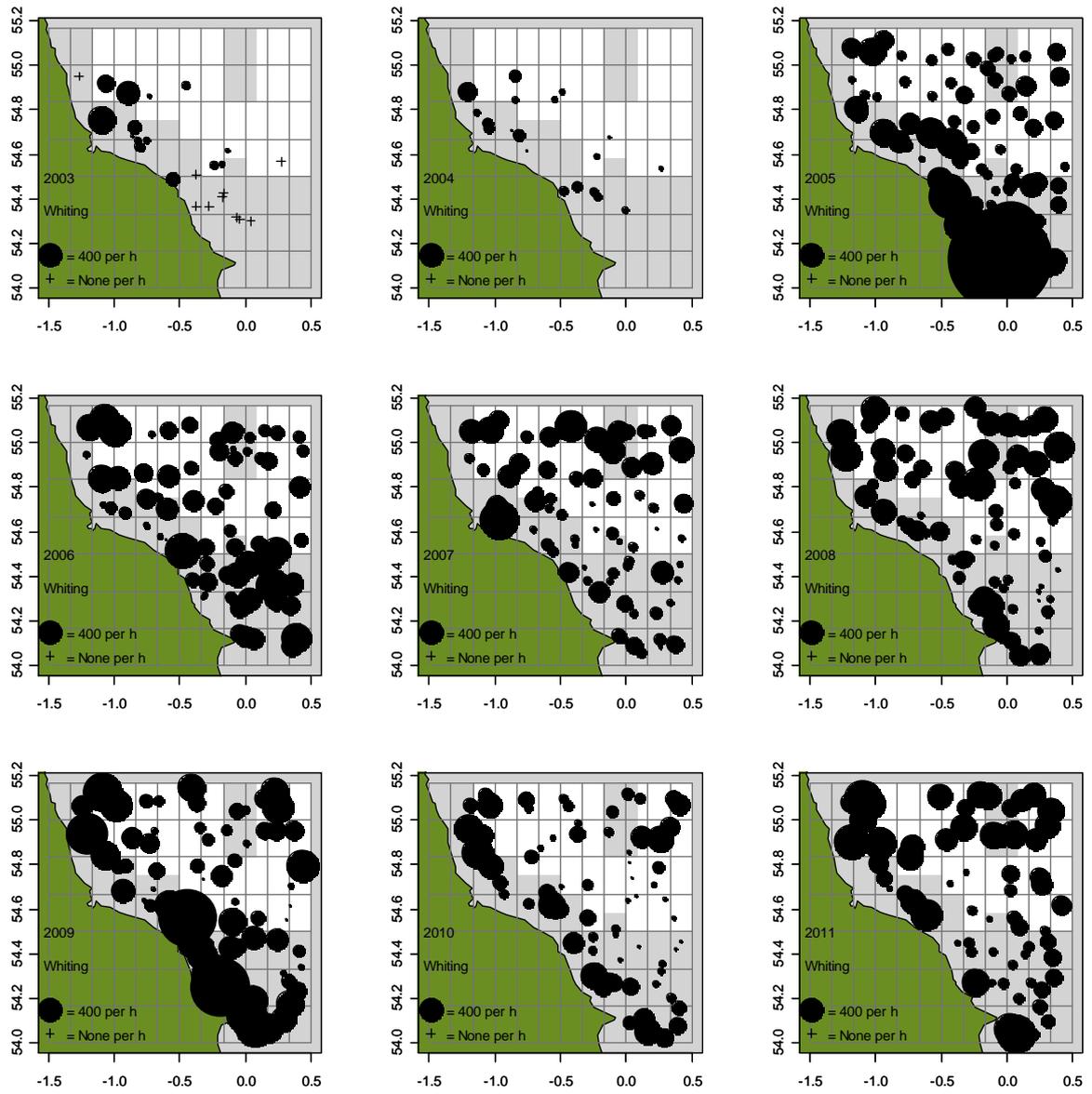
**Figure 2** Distribution patterns of cod in three length ranges, 2005–2011. Sizes of spots (surface area) are proportional to the numbers caught per hour. Crosses indicate station positions. Same scale for all plots. Shaded areas represent “hard ground”.



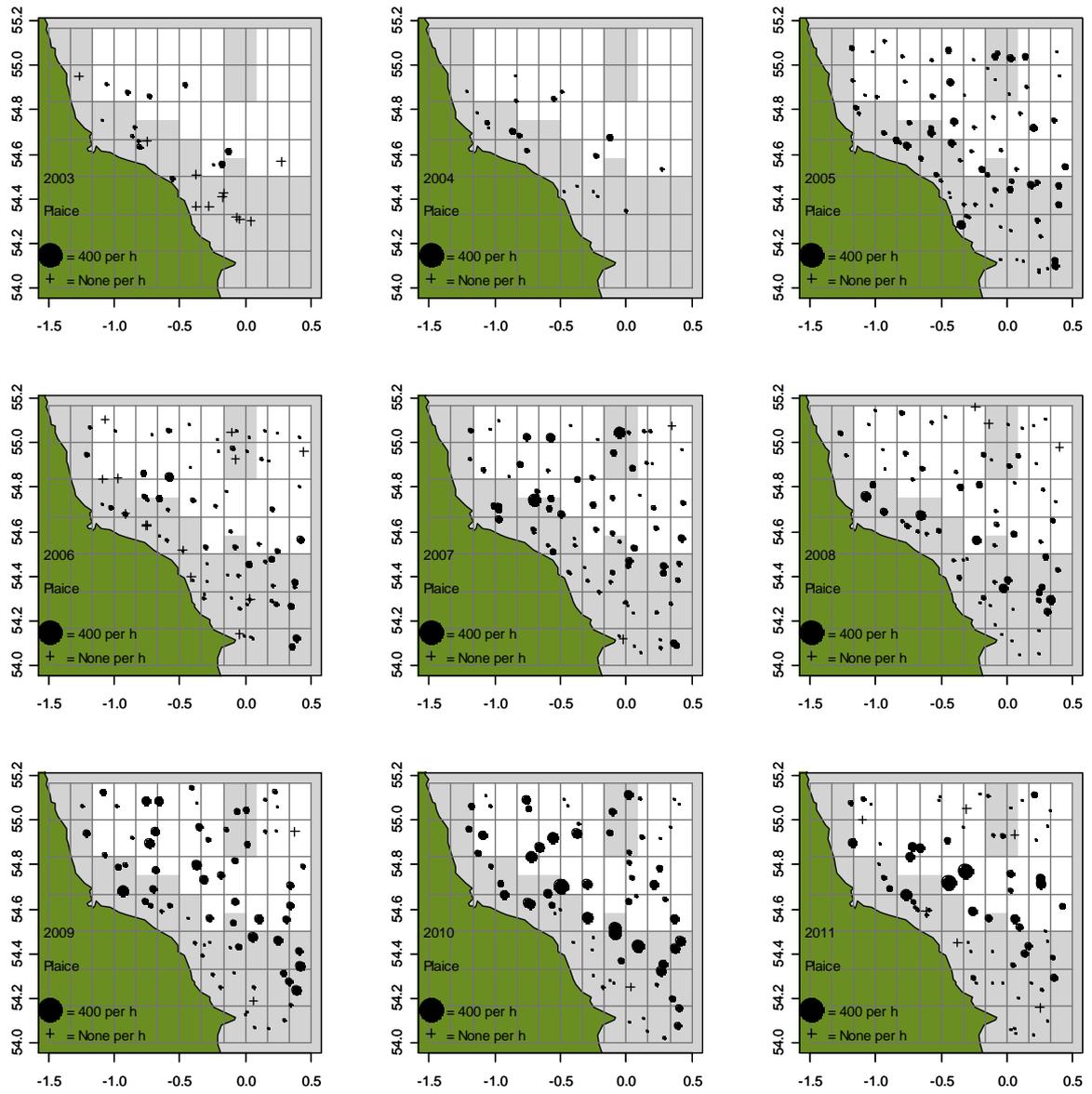
**Figure 3** Distribution patterns of cod (all lengths) in the 2003–2011 NE cod FSP surveys. Sizes of spots (area) are proportional to numbers caught per hour. Crosses indicate station positions. Same scale for all plots. Shaded areas represent “hard ground”.



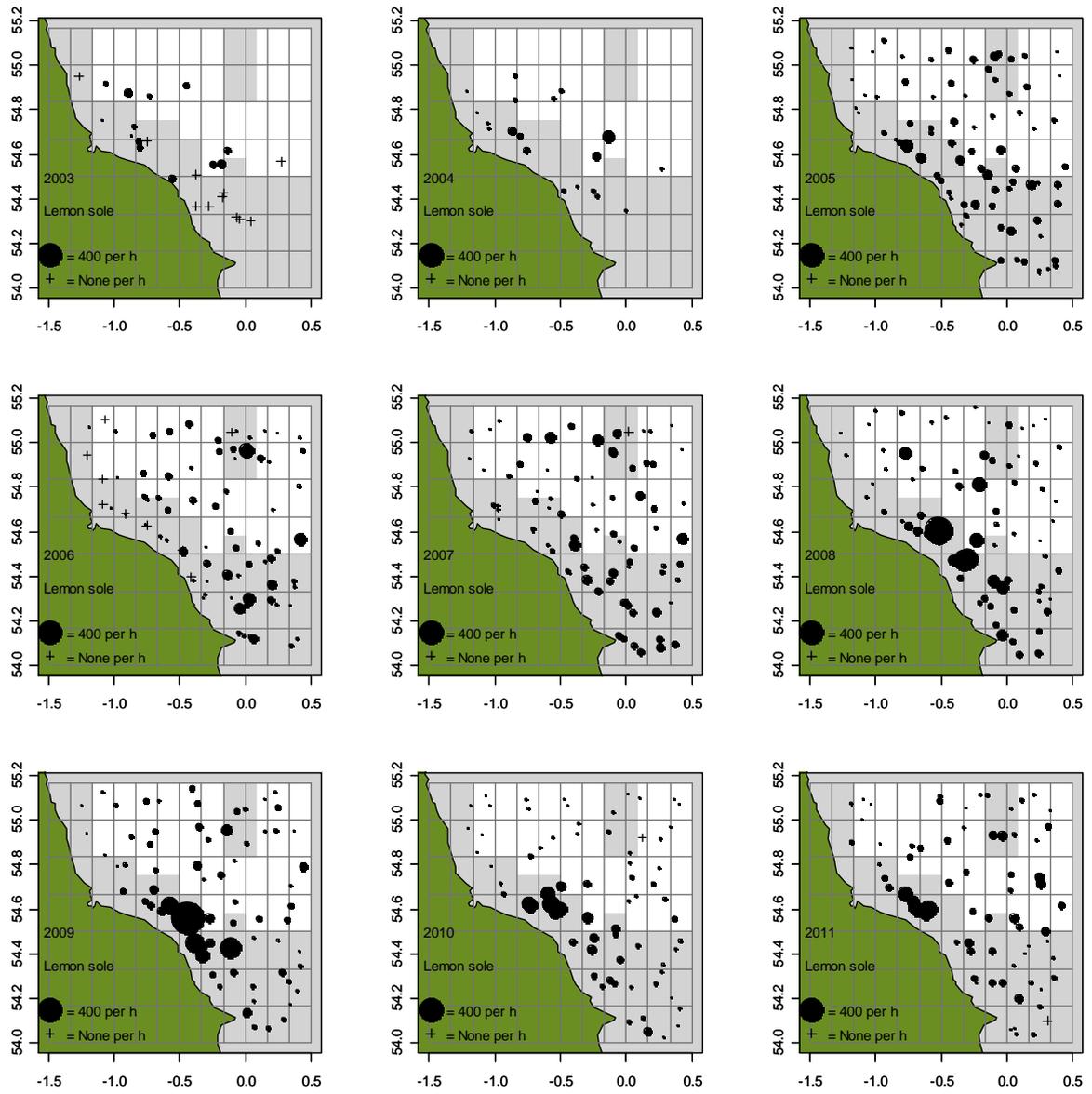
**Figure 4** Distribution patterns of haddock (all lengths) in the 2003–2011 NE cod FSP surveys. Sizes of spots (area) are proportional to numbers caught per hour. Crosses indicate station positions. Same scale for all plots. Shaded areas represent “hard ground”.



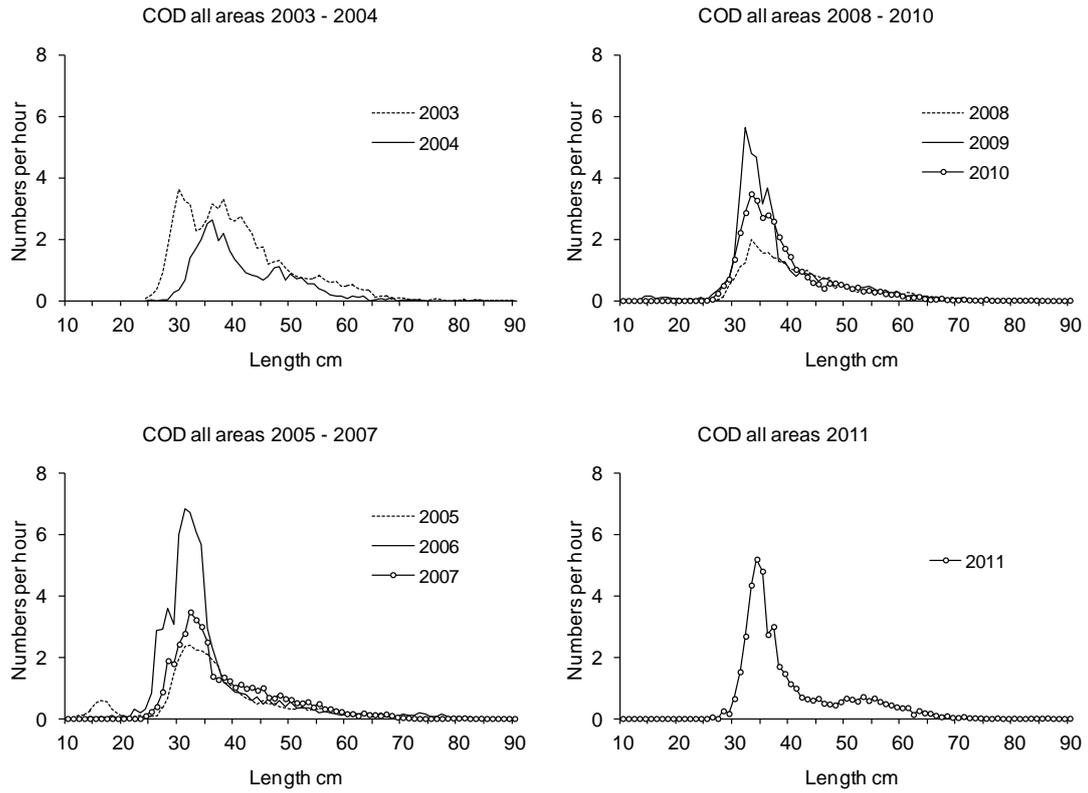
**Figure 5** Distribution patterns of whiting (all lengths) in the 2003–2011 NE cod FSP surveys. Sizes of spots (area) are proportional to numbers caught per hour. Crosses indicate station positions. Same scale for all four plots. Shaded areas represent “hard ground”.



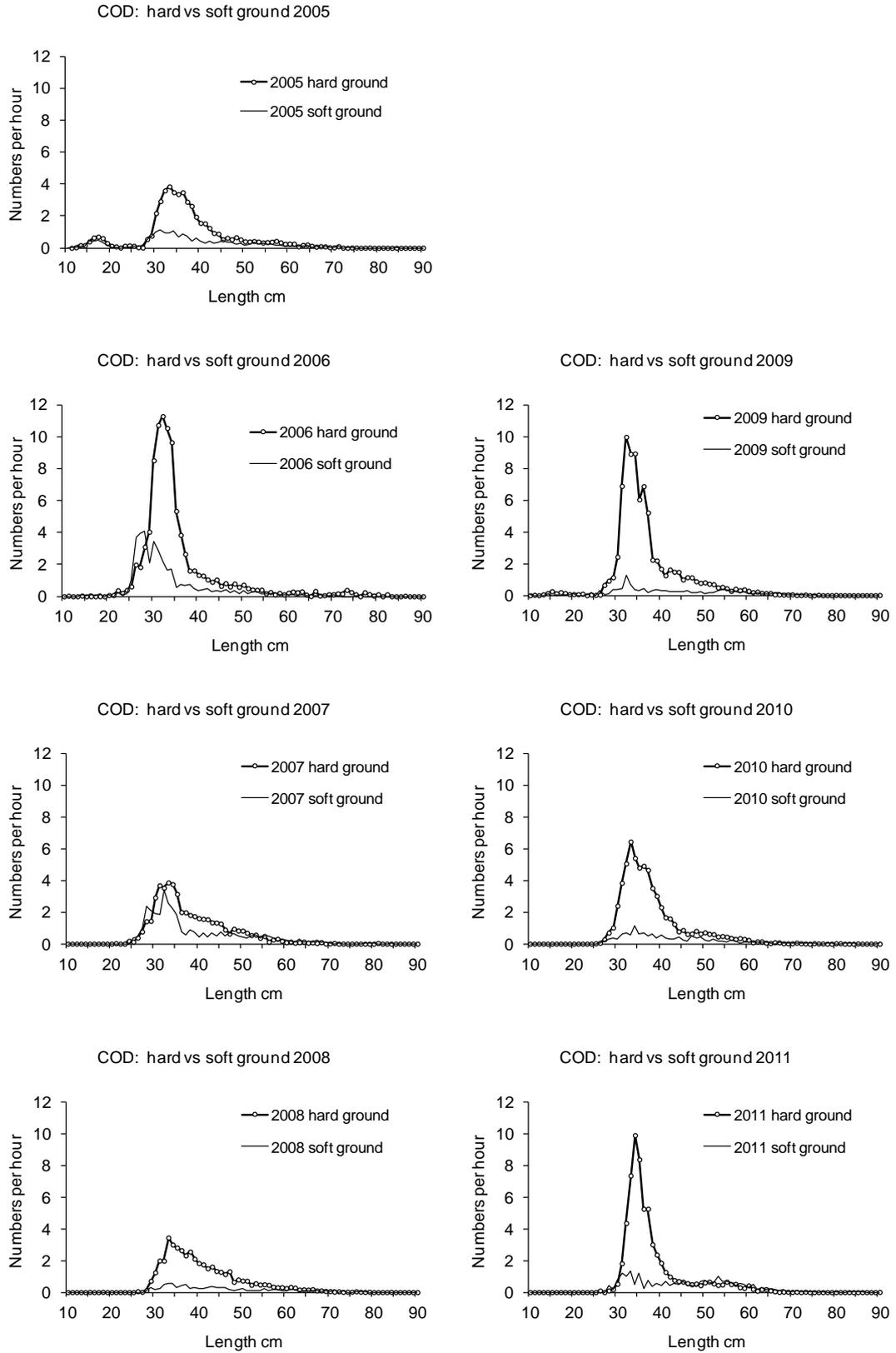
**Figure 6** Distribution patterns of plaice (all lengths) in the 2003–2011 NE cod FSP surveys. Sizes of spots (area) are proportional to numbers caught per hour. Crosses indicate station positions. Same scale for all plots. Shaded areas represent “hard ground”.



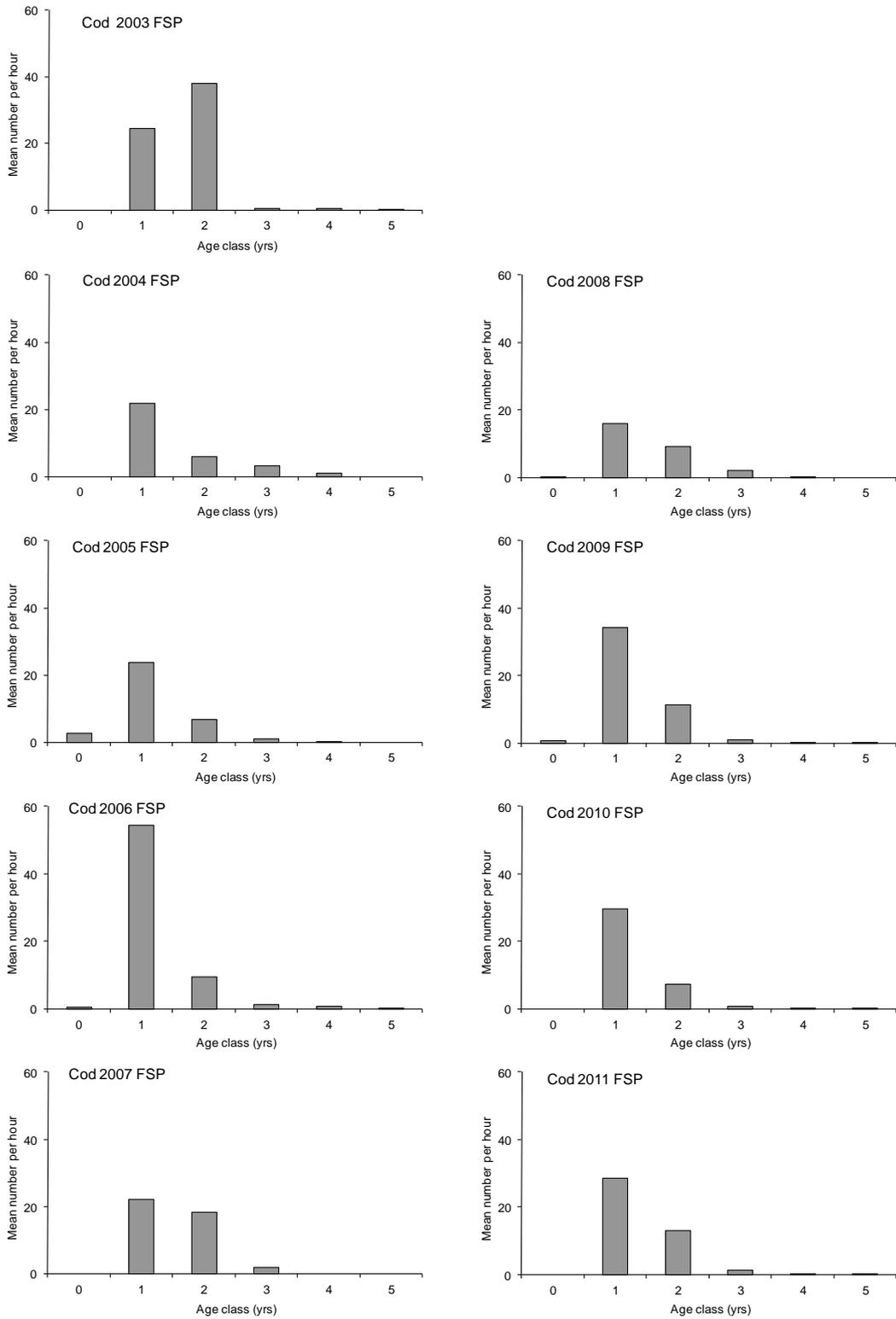
**Figure 7** Distribution patterns of lemon sole (all lengths) in the 2003–2011 NE cod FSP surveys. Sizes of spots (area) are proportional to numbers caught per hour. Crosses indicate station positions. Same scale for all plots. Shaded areas represent “hard ground”.



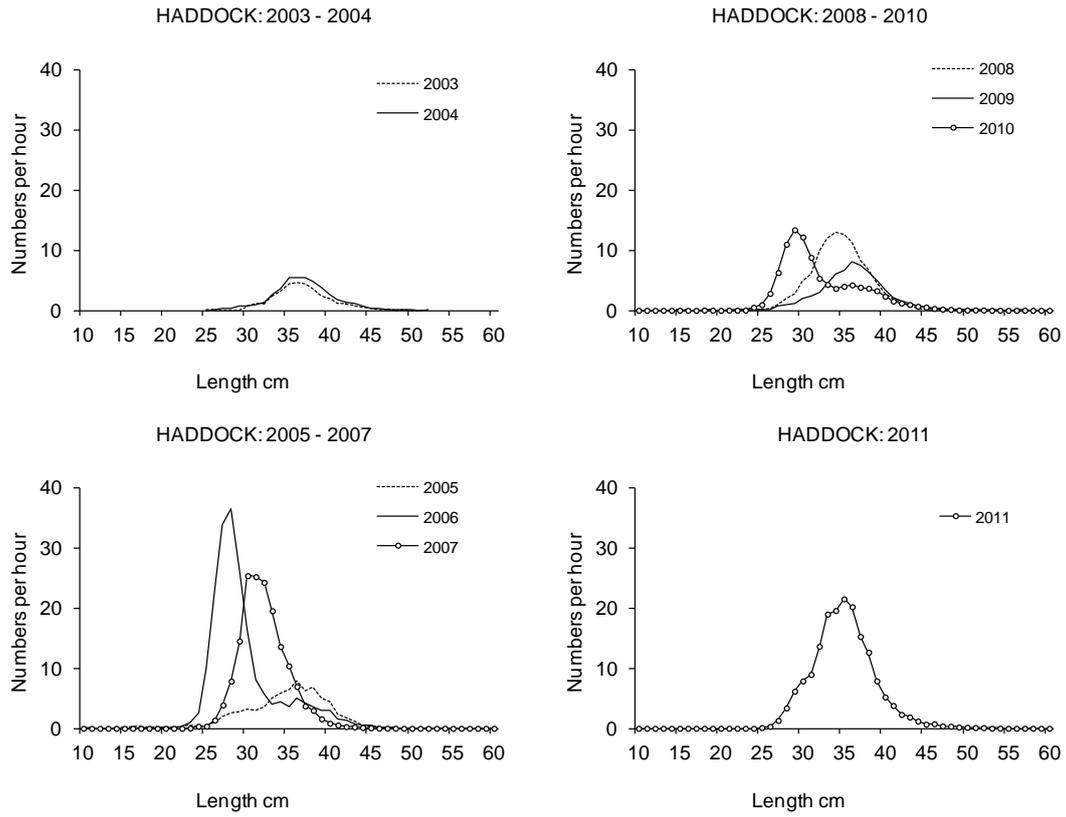
**Figure 8a** Mean length frequencies of cod during the NE cod FSP surveys (numbers per hour), for all areas combined in 2003–2004 and 2005–2007, 2008–2010 and 2011.



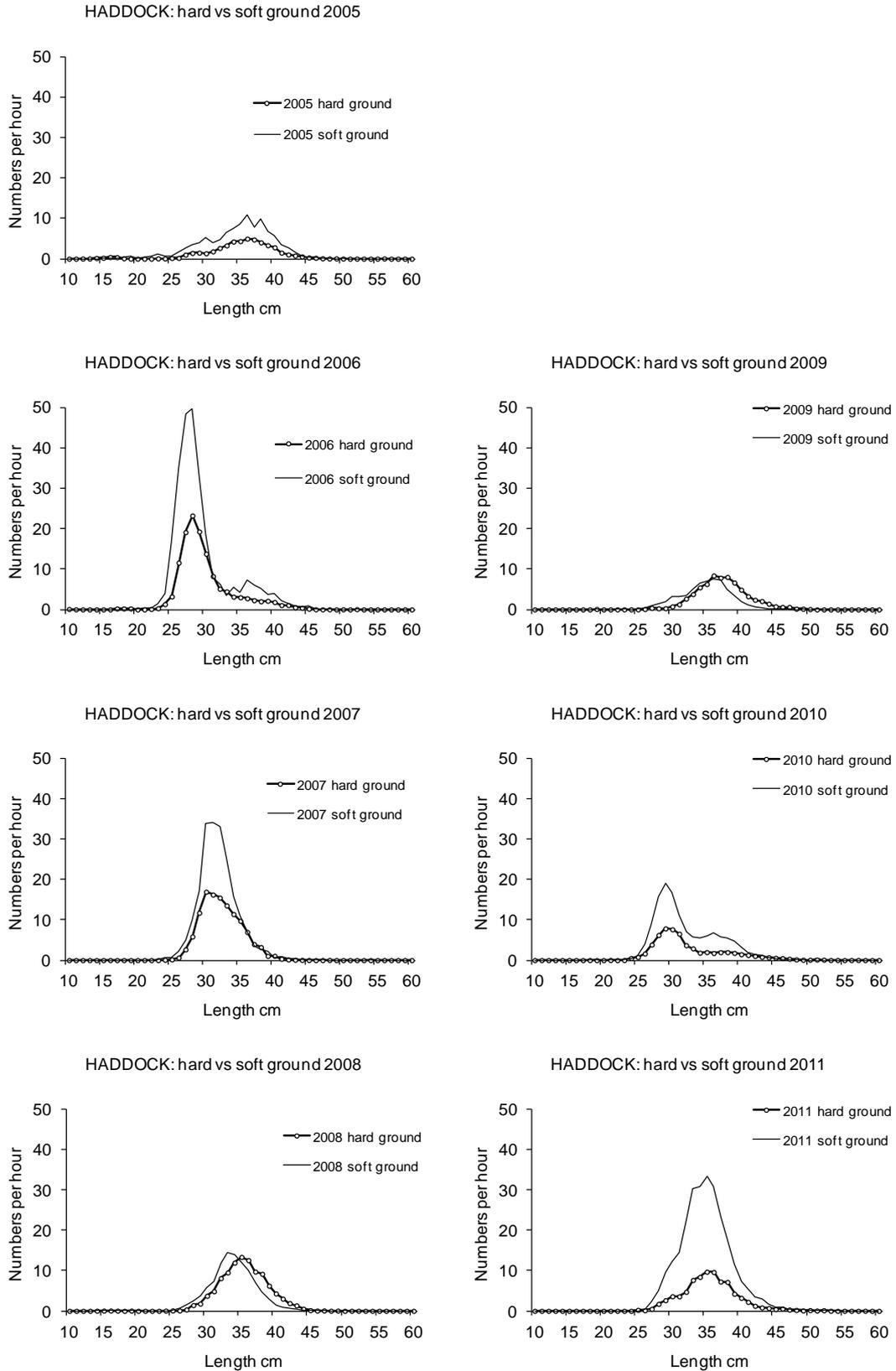
**Figure 8b** Mean length frequencies of cod during the NE cod FSP surveys (numbers per hour), showing comparisons between hard-ground and soft-ground tows in the years 2005–2011 (see Figure 1 for ground types).



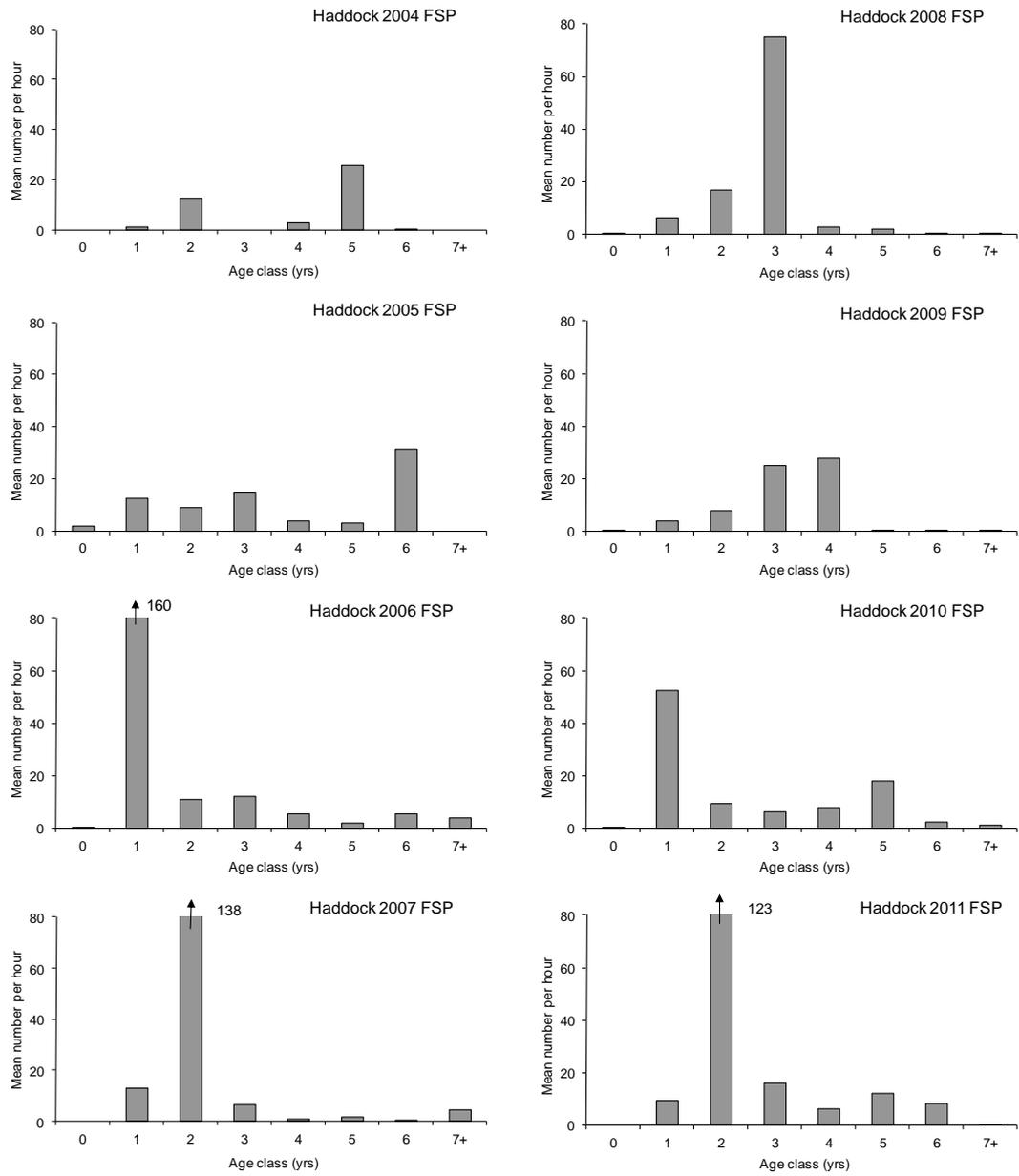
**Figure 9** Mean catch rates of cod during the 2003–2011 FSP surveys, by age class (all areas combined).



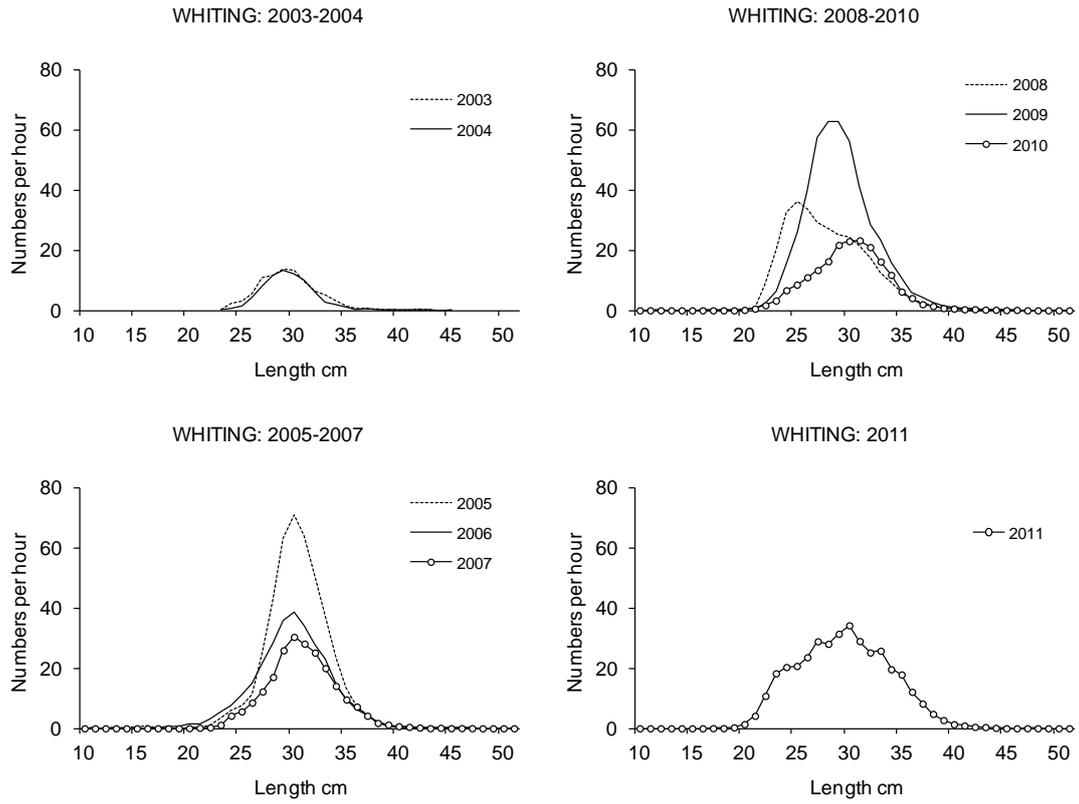
**Figure 10a** Mean length frequencies of haddock during the NE cod FSP surveys (numbers per hour), for all areas combined in 2003–2004, 2005–2007, 2008–2010 and 2011.



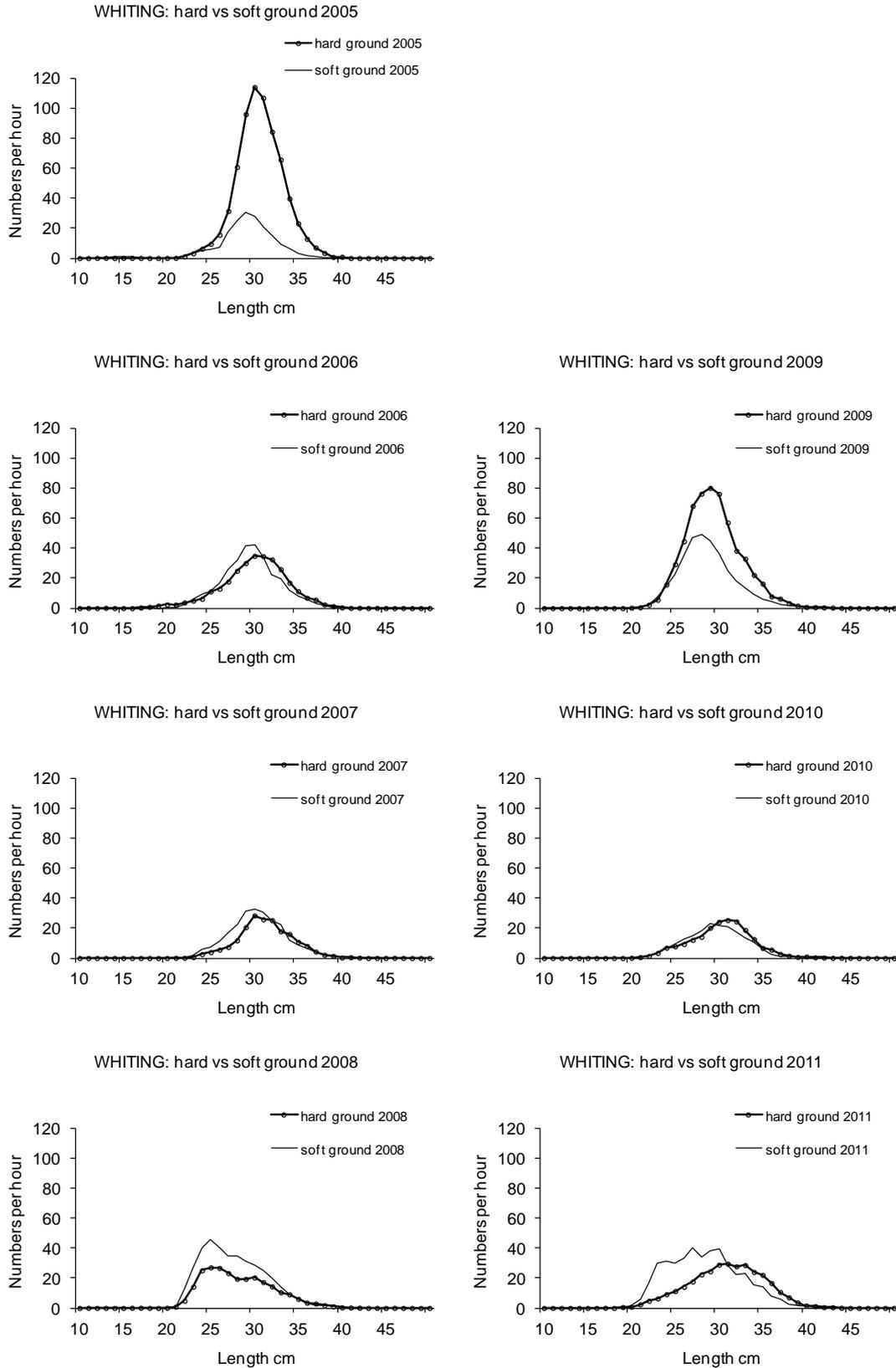
**Figure 10b** Mean length frequencies of haddock during the NE cod FSP surveys (numbers per hour), showing comparisons between hard-ground and soft-ground tows, 2005–2011 (see Figure 1 for ground types).



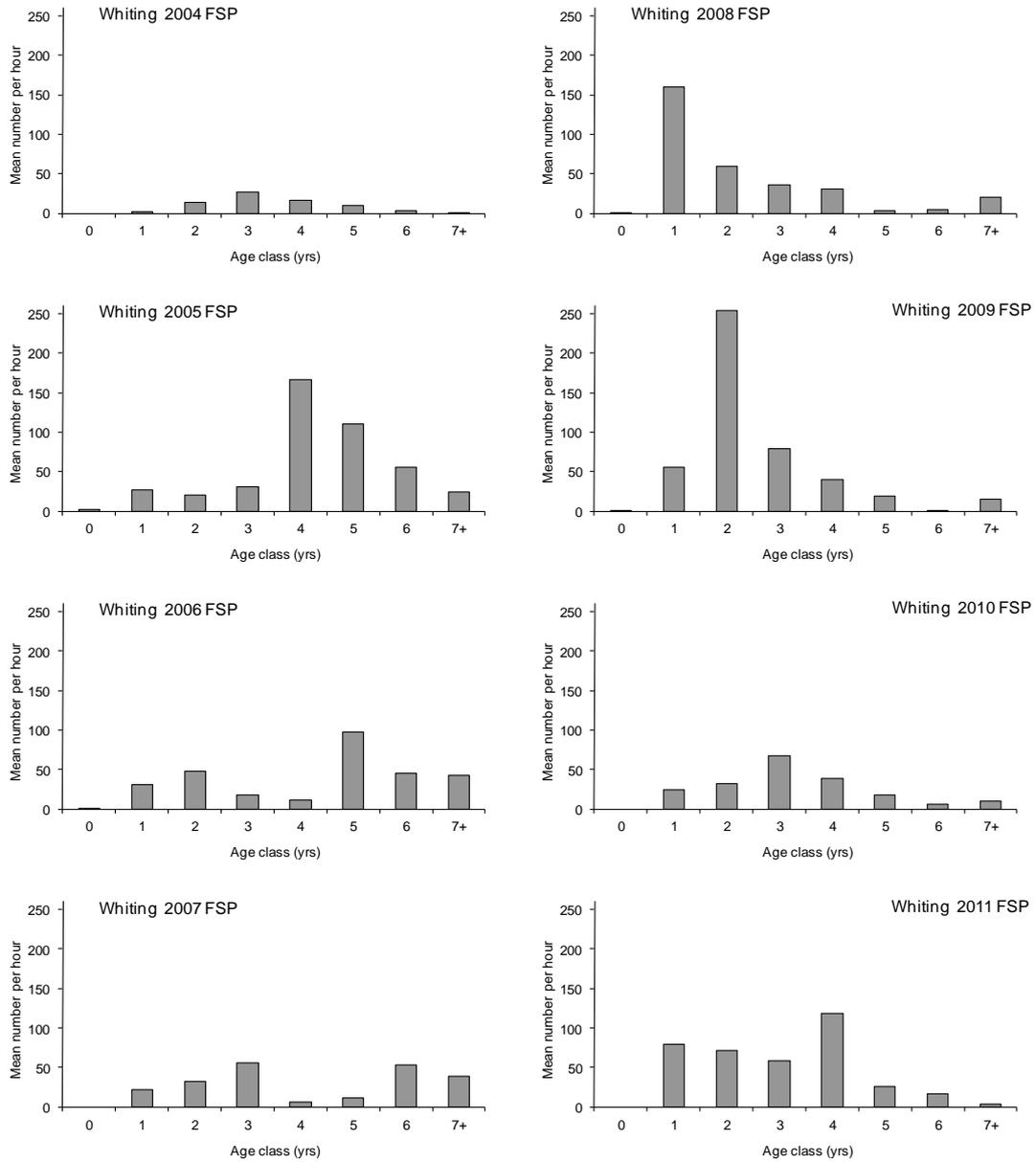
**Figure 11** Mean catch rates of haddock during the 2004–2011 FSP surveys, by age class (note the truncation of the 1-group in 2006 and the 2-group in 2007 and 2011).



**Figure 12a** Mean length frequencies of whiting during the NE cod FSP surveys (numbers per hour), for all areas combined in 2003–2004, 2005–2007, 2008–2010 and 2011.

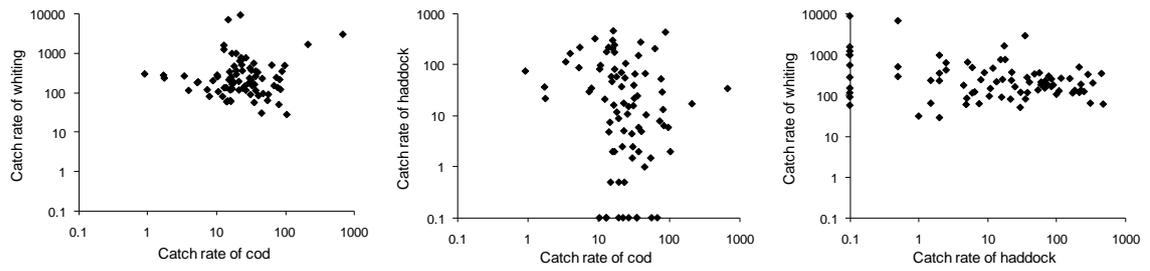


**Figure 12b** Mean length frequencies of whiting during the NE cod FSP surveys (numbers per hour), showing comparisons between hard-ground and soft-ground tows in the years 2005–2011 (see Figure 1 for ground types).

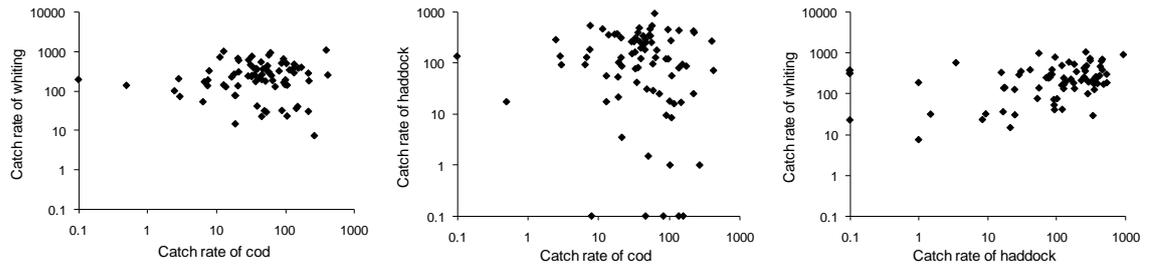


**Figure 13** Mean catch rates of whiting during the 2004–2011 FSP surveys, by age class.

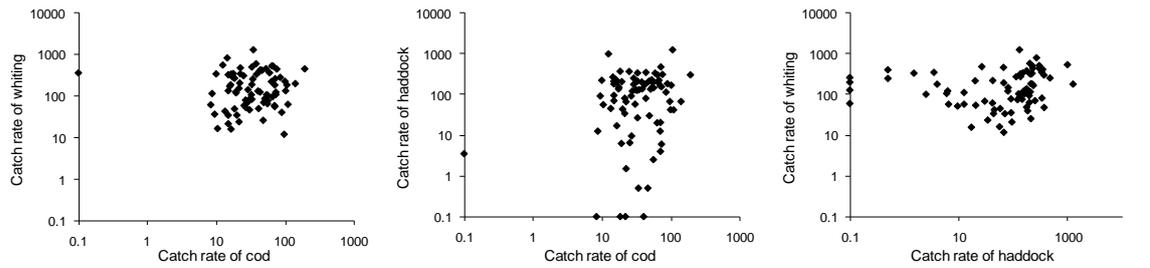
(a) 2005 FSP



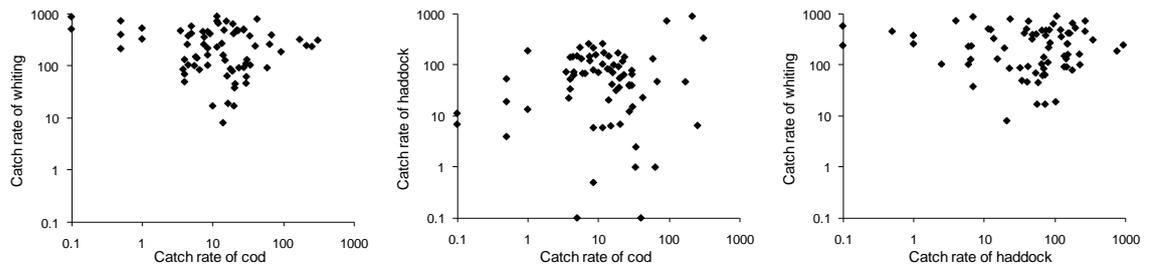
(b) 2006 FSP



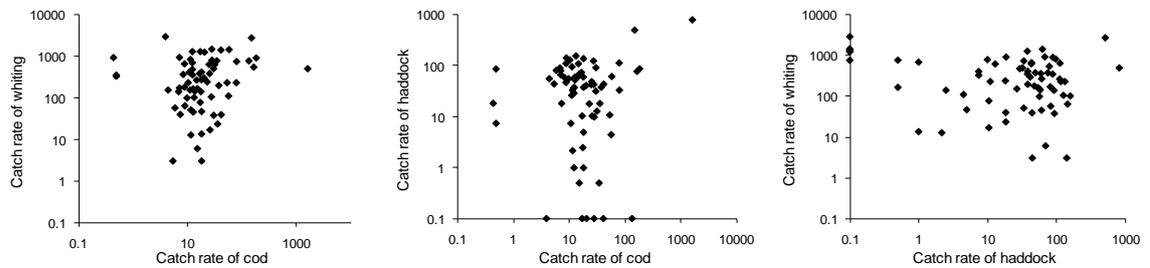
(c) 2007 FSP



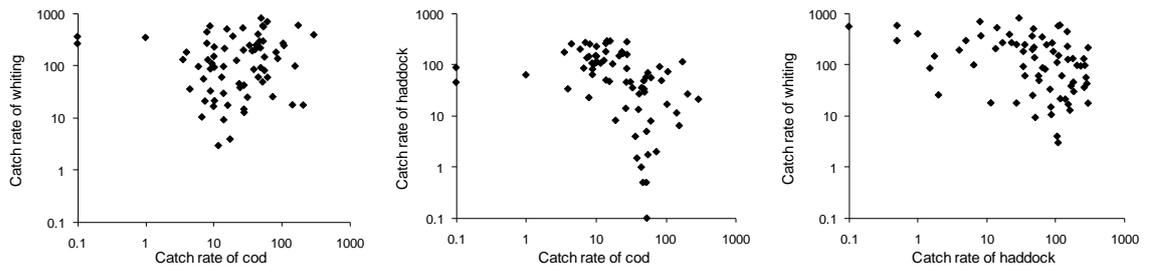
(d) 2008 FSP



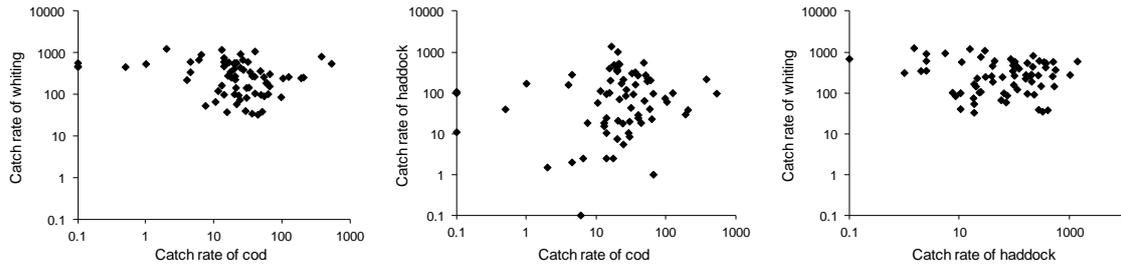
(e) 2009 FSP



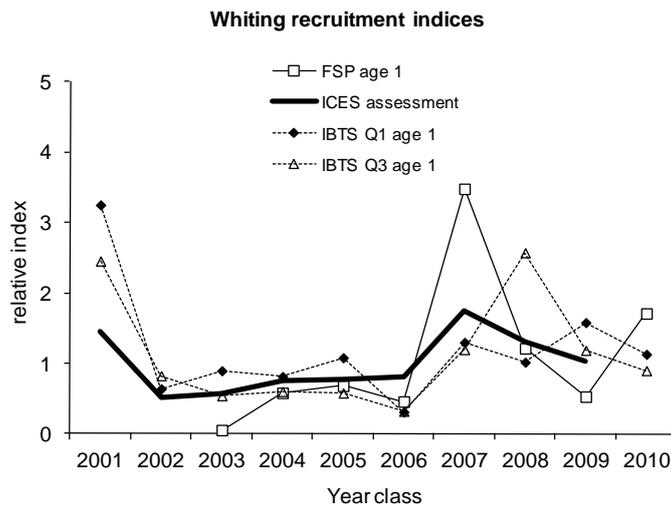
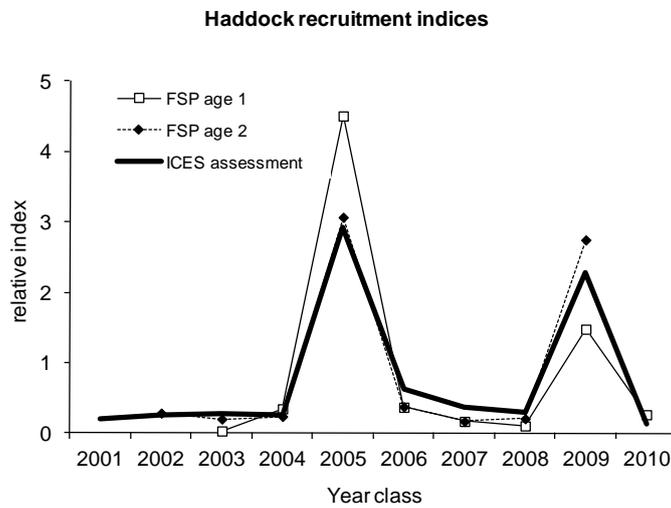
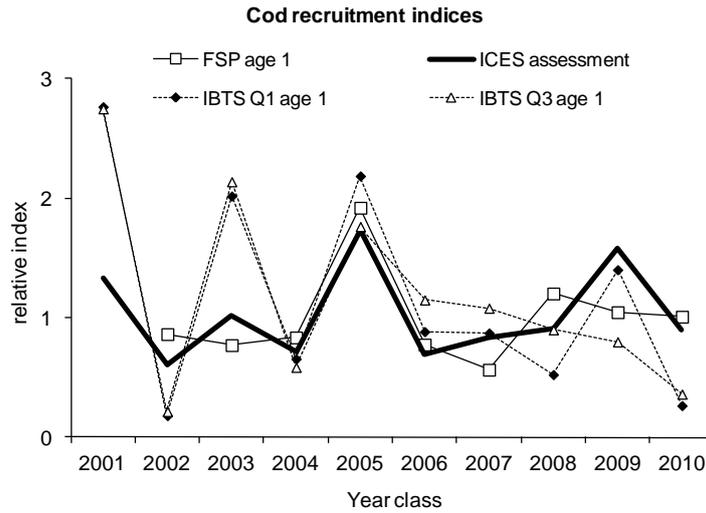
(f) 2010 FSP



(g) 2011 FSP



**Figure 14** Relationships between the catch rates of cod, whiting and haddock, by tow, during the 2005–2011 FSP surveys. Note the logarithmic scales on the axes.



**Figure 15** Relative strengths of recent year classes of cod, haddock and whiting as indicated by the most recent ICES assessment (ICES–WGNSSK, 2011) and by the FSP NE cod survey indices at age 1 (cod and whiting) and ages 1 and 2 (haddock). The ICES International Bottom Trawl survey indices (Q1 and Q3) for cod and whiting at age 1 are also shown. All indices have been standardised to the average for years common to all series for each species.

## **Appendix 1: Detailed operation plan**

### **VESSEL**

FV Abbie Lee (WY211)  
Skipper: John Hall

### **OBSERVER**

John Hingley

### **DEPARTURE DATE AND LOCATION**

3 October 2011, Whitby

### **OBJECTIVE**

To repeat the survey of NE coast cod carried out in 2005-2010 in order to provide information on distribution, relative abundance and size/age composition of cod and whiting, and the catch compositions throughout the survey area.

### **FISHING GEAR**

The fishing gear must be a Whitby Jet whitefish otter trawl of type, dimensions, construction, rigging and fishing characteristics as close as possible to gear used in previous FSP surveys of NE cod. (Gear details in tender document). Codend mesh size will be 80mm.

### **AREA OF OPERATION and TOW POSITIONS**

Fishing operations will be carried out on fishing grounds between the latitudes 54° N and 55° 10' N to the West of 30' E (See attached chart).

The tows will be spread out over the area to provide information on catch-rate, size/age composition and species catch composition from as many different locations as possible within the area where the fishery takes place, and not necessarily at identical locations to tows made in the previous FSP trips.

Annex 1 shows the survey area divided into 10-minute (longitude) x 20-minute (latitude) rectangles. To obtain as much information as possible from the core fishing areas, whilst ensuring that there is enough information from surrounding areas to allow the distribution pattern to be adequately mapped, the survey will be designed as follows. Two areas are defined:

1. a “core” area of rectangles covering harder seabed types, with potentially the highest catch rates of cod, where 3 tows per rectangle will be carried out, and
2. a surrounding area of softer seabed in which catch-rates of cod are expected to be lower than in the core area, and where 2 tows will be carried out per rectangle.

The numbers of tows per rectangle are indicated in Annex 1. The tows in each rectangle should cover different parts of the rectangle to ensure good coverage in each rectangle. This is particularly important because rectangles are now larger than in FSP surveys prior to 2008.

## **PERIOD OF SURVEY**

The vessel will depart at 8am on Monday 3 October 2011. The duration of the trip will be 20 continuous days with up to 2 days during this period in port to land fish and refuel.

## **WORKING PATTERN**

- Tow duration: 2 hours on average.
- The observer, with help from crew, must have adequate time to carry out the scientific work on a catch before the next catch is brought on board.
- The survey will take place during day and night.
- The observer must have sufficient rest periods (up to 8 hours per day in one or two periods).
- All tows will form part of the survey and must be sampled by the observer as per the sampling requirements.
- The crew should be available to help the observer

It is expected that around 70 tows will be carried out over 18 days of fishing, depending on weather.

## **SORTING AND RECORDING THE CATCH**

It is important that the catches of cod, haddock, whiting and other commercial species are quantified as accurately as possible. The crew will be required to assist in sorting the catch as required by the observer and preparing any fish for sale. Standard Cefas methods for sorting and measuring commercial fish catches at sea will be carried out. The entire catch should be available to the observer for sampling, and none discarded without being recorded. Generally the catch will be sorted into three general categories:

1. Large and rare fish e.g. congers and skates, which may be landed or discarded but which can all be counted and measured (i.e. raising factor of 1.0).
2. The retained catch of other individuals of commercial species. The observer must be able to record the total number of boxes or baskets of retained fish of each species from each tow, and will carry out a length measure on either the whole catch (raising factor = 1.0) or a known sample of the catch (raising factor > 1.0).
3. Discarded fish of commercial and non-commercial species, other than those in category (1). It is vitally important that the total quantity of discarded fish is known, and that the observer can obtain a representative, random sample to be sorted to species and length measures carried out. This is best achieved by basketing up all the discarded fish, counting the baskets and taking a random

sample of baskets for sorting and measuring. The raising factor is the total number of baskets of discarded fish divided by the number of baskets taken at random for sorting and measuring.

The observer will collect samples of cod, haddock and whiting for age determination, and will remove both otoliths where possible and record the cruise reference, tow number, species, fish length, and (if possible) sex. Target numbers of otoliths will be:

Cod: 400 otoliths  
Haddock: 200 otoliths  
Whiting: 200 otoliths

These are to be spread out over the entire area. Collections should be made across the length range at each tow to avoid over-sampling of large or small fish in different areas (i.e. avoid over-sampling of large or small fish in some areas to make up otolith quotas). For cod, the sampling should aim for at least 5 otoliths per 1-cm length class, but no more than 3 otoliths per length class per station. For haddock and whiting, at least 5 otoliths per 1-cm length class are to be collected, but no more than 3 otoliths per station.

The observer will maintain an otolith tally.

#### **DATA TO BE RECORDED AND SUPPLIED BY SKIPPER**

The observer will provide recording sheets on which the skipper will record the following details for each tow:

Date  
Tow number  
Shooting and hauling times  
Shooting and hauling positions (latitude and longitude)  
Time and position at any significant change in tow direction  
Other relevant information e.g. tidal state, weather conditions, seabed type (hard or soft).

The skipper should provide full details of the gear and rigging. At the end of the survey, the skipper should provide an electronic copy of the tow tracks from the plotter.

It should be noted that 95% of the total agreed price (including VAT) will be paid on completion of the vessel hire and submission of landings / sales notes to Cefas. The submission of landings / sales notes to Cefas is a new requirement from 2011.

#### **DATA TO BE RECORDED BY OBSERVER**

The observer must ensure that all catch composition, length frequencies and raising factors are fully and correctly entered on the recording sheets, and that all bridge log sheets and biological sampling sheets are collated at the end of each sampling day. Any significant deviations from the survey plan should be reported to Cefas by the observer.

## CRUISE REPORT

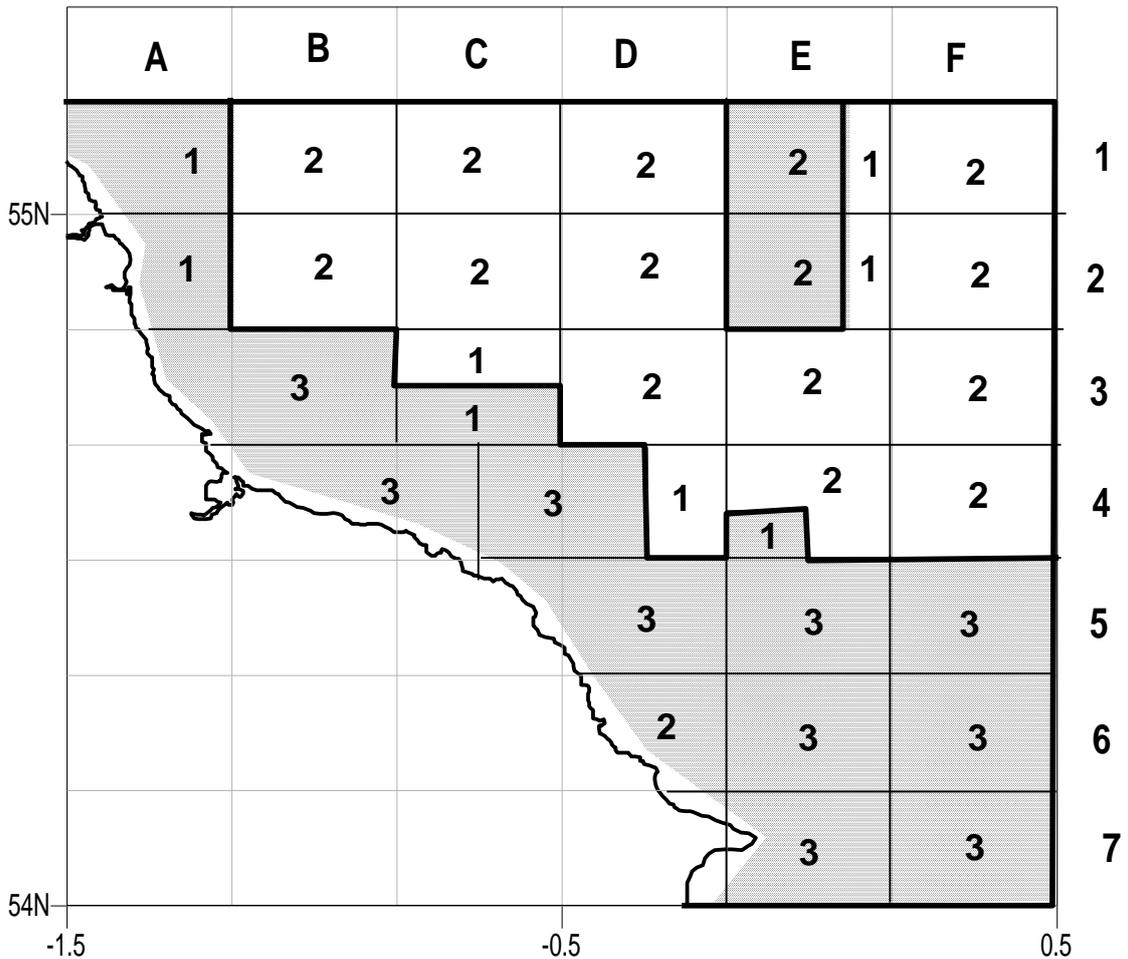
The observers will maintain a diary of activities, including an electronic copy where possible, and a draft cruise report in standard Cefas format will be prepared for submission to Cefas immediately after the cruise. The cruise narrative should be written at sea and read and agreed by the skipper (report will bear the sentence “seen in draft by skipper”).

Signed:

.....signed John Hall.....(skipper) September 2011....(date)

.....signed José De Oliveira.....(CEFAS) September 2011....(date)

**Annex 1:** Map of the area within which sampling will be required, together with number of tows per rectangle. Shaded areas are mostly hard ground. Plan is based on tows carried out in 2005-2007 NE cod survey, but with larger rectangles than previously used (10×20 min long-lat instead of 10×10), as implemented during the 2008-2010 NE cod surveys.



## **Appendix 2: Skippers Report: *Abbie Lee* CEFAS Northeast England Survey October 2010**

*(Box references e.g. AB3 refer to grid reference on Detailed Operation Plan, A box reference refers to a box that falls entirely within the reference, but where there is more than 1 possible box linked to the reference, additional information is provided to distinguish them; e.g. C3-d "down" distinguished from C3-u "up". Similarly -l is "left", -r is "right").*

Commencing 3<sup>rd</sup> October 2011

### **General comments**

Tows 1-3, 5-7 Boxes CD4, CD5.

Towed four hauls. Very good signs of mixed fish on hard ground consisting of cod, haddock and whiting. Very fresh weather.

Tows 4, 8-9 Boxes BC4.

Not very good fishing. Broken ground. A lot of queens.

Tows 10-13 Boxes C3-d, AB3.

Towed north. Fishing a bit better for codling on milder ground.

Tow 14-19 Boxes A2, B2, B1, A1

Towed into deeper water. Mixed fish with prawns and herring.

Tows 20-22 Boxes C3-u, C2

Towed onto ground. A lot better fish. More signs of codlings.

Tows 23-26 Boxes D4, E4-dl, E4-ur

Towed into deeper water. A lot better showing of haddock.

Tows 27-29, 32 Boxes F4, E3

Very hard ground. A good showing of mixed fish.

Tow 30-31, 33-34 Boxes D3, F3

Hard ground to soft. Very good showing of mixed fish again.

Tow 35-42 Boxes D6, E6, F7

Very poor fishing on broken ground. Nothing but bust-up scallops.

Tow 43-45 Boxes E7

There were better signs of whiting, squid and lobsters. Had to get where I could for pots.

Tow 46-50 Boxes D2, E2-l, E2-r

There was a very good showing of haddocks.

Tow 51-54 Boxes F2, F1

These sectors were very bad. Only whiting and herring in deeper water.

Tow 58-59 Box D1

Very good for haddock. Still in deep water, broken ground.

Tow 60-61 Boxes C1

This sector still showing haddock a lot further in.

Tow 62-70 Boxes F6, F5, E5

These sectors did not show very good signs at all, but it was mixed fish.

## More detailed tow-by-tow comments

tow	date shot	Box ref	Box class	Tow validity	Detailed Comments
1	03-Oct-11	CD4	IH	Y	Towed with ebb, hard ground, good signs of mixed fish
2	03-Oct-11	CD4	IH	Y	Towed into ebb, hard ground, mixed fish again
3	03-Oct-11	CD4	IH	Y	Towed afore tide, hard ground, mixed again
4	03-Oct-11	BC4	IH	Y	Towed into tide, same results, mixed fish on hard ground
5	04-Oct-11	CD5	IH	Y	Towed with flood, hard ground, cod end out
6	04-Oct-11	CD5	IH	Y	Towed into tide then afore it, hard ground, mixed fish
7	04-Oct-11	CD5	IH	Y	Towed with EBB, hard ground, mixed fish and a lot of queens
8	06-Oct-11	BC4	IH	Y	Towed into tide, hard ground, mixed fish again, had to go in with hydraulic trouble
9	09-Oct-11	BC4	IH	Y	Towed with ebb on hard ground, mixed fish
10	09-Oct-11	C3-d	IH	Y	Towed out across tide, hard ground, good fish
11	09-Oct-11	AB3	IH	Y	Towed in west across tide, very hard, mixed fish
12	09-Oct-11	AB3	IH	Y	Towed north with ebb, milder ground, mixed again
13	09-Oct-11	AB3	IH	Y	Towed in west-northwest, mild ground, mixed fish
14	10-Oct-11	A2	IH	Y	Towed with ebb on mild ground, a lot more whiting
15	10-Oct-11	B2	S	Y	Towed out across tide again, deep water, not very good
16	10-Oct-11	B1	S	Y	Towed into flood, deep water, only result was herring
17	10-Oct-11	B1	S	Y	Towed in west across tide, mild ground, mixed fish
18	10-Oct-11	A1	IH	Y	Towed in across tide, mild ground, poor fishing
19	11-Oct-11	B2	S	Y	Towed up southeast into tide, mild ground, mixed fish
20	11-Oct-11	C3-u	S	Y	Towed southeast again into the tide, hard ground, better fish
21	11-Oct-11	C2	S	Y	Towed north into tide, broken ground, poor fishing
22	11-Oct-11	C2	S	Y	Towed back in onto harder ground, better fish
23	12-Oct-11	D4	S	Y	Towed southeast into tide, hard ground, better mixed fish
24	12-Oct-11	E4-dl	IH	Y	Towed southeast again into tide, better signs of haddock
25	12-Oct-11	E4-ur	S	Y	Towed across tide, then afore it, hard ground , mixed fish
26	12-Oct-11	E4-ur	S	Y	Towed up and off with flood, hard ground into soft, a good showing of haddock
27	13-Oct-11	F4	S	Y	Towed out onto hard ground, mixed fish
28	13-Oct-11	F4	S	Y	Towed onto harder ground, mixed fish
29	13-Oct-11	E3	S	Y	Towed in west onto ground, good pickings of good fish
30	13-Oct-11	D3	S	Y	Towed off from hard onto soft, with ebb, good showing of haddock
31	16-Oct-11	D3	S	Y	Towed easterly across ground, mixed fish again
32	16-Oct-11	E3	S	Y	Towed out east again, deep water across tide, mixed fish again
33	16-Oct-11	F3	S	Y	Towed out across tide again, soft onto hard then soft, mixed fish
34	16-Oct-11	F3	S	Y	Towed in across tide again, harder ground, not so good in the dark
35	17-Oct-11	D6	IH	Y	Towed south with flood, not very good, mild ground
36	20-Oct-11	D6	IH	Y	Towed south with flood, broken ground, only whiting
37	20-Oct-11	E6	IH	Y	Towed across tide, mild ground, poor fish
38	20-Oct-11	E6	IH	Y	Towed into ebb, broken ground, poor again
39	20-Oct-11	E6	IH	Y	Towed easterly across tide, poor results, grounds having been towed to death with scallopers
40	20-Oct-11	F7	IH	Y	Towed out easterly again across tide, mild ground, poor fishing
41	21-Oct-11	F7	IH	Y	Towed into ebb tide and southerly wind, broken ground, poor fishing
42	21-Oct-11	F7	IH	Y	Towed into ebb tide, broken ground, poor again
43	21-Oct-11	E7	IH	Y	Towed in then down into tide, hard ground, more whiting
44	21-Oct-11	E7	IH	Y	Towed with flood, then back down into it, whiting again, towing where I can get in
45	21-Oct-11	E7	IH	Y	Towed into ebb, then turned round with ebb, broken ground, just whiting
46	27-Oct-11	D2	S	Y	Towed down and out with ebb, hard ground, mixed fish
47	27-Oct-11	D2	S	Y	Towed out into ebb tide, hard onto soft, mixed fish, mostly haddock
48	27-Oct-11	E2-1	OH	Y	Towed with flood into deeper water, mixed fish again
49	12-Oct-11	E2-1	OH	Y	Towed North with ebb, broken ground, mixed fish

tow	date shot	Box ref	Box class	Tow validity	Detailed Comments
50	27-Oct-11	E2-r	S	Y	Towed into ebb, hard ground, mixed fish
51	28-Oct-11	F2	S	Y	Towed into flood, hard ground, not very good
52	28-Oct-11	F2	S	Y	Towed out to dab hole, deep water, nothing but a herring, same every year
53	28-Oct-11	F1	S	Y	Towed down NW with ebb tide, deep water, soft, whiting and herring
54	28-Oct-11	F1	S	Y	Towed down into flood, deep water, poor again
55	28-Oct-11	E1-r	S	Y	Towed with flood onto broken ground, very poor fishing
56	28-Oct-11	E1-l	OH	Y	Towed into ebb, shallower water, broken ground, poor fishing again
57	29-Oct-11	E1-l	OH	Y	Towed North into flood, deep water, more haddock.
58	29-Oct-11	D1	S	Y	Towed South and in with flood, near pipe, good haul of haddock.
59	29-Oct-11	D1	S	Y	Towed south with ebb, mild ground, haddock again, towed half hour longer to clear fish
60	29-Oct-11	C1	S	Y	Towed North with ebb, deep water, mild ground, mixed fish, poor weather
61	29-Oct-11	C1	S	Y	Towed south with flood onto hard ground, more haddock again, very poor weather, still whitby jet
62	31-Oct-11	F6	IH	Y	Towed south into ebb tide, hard ground, poor fishing
63	31-Oct-11	F6	IH	Y	Towed SE into ebb, hard ground, poor fishing again
64	31-Oct-11	F6	IH	Y	Towed with tide ebb, then into flood, hard ground, mixed fish
65	31-Oct-11	F5	IH	Y	Towed into flood tide, hard ground, mixed fish
66	31-Oct-11	F5	IH	Y	Towed north into flood, hard ground, poor fishing, weather poor
67	01-Nov-11	F5	IH	Y	Towed into flood tide onto hard ground, not very good
68	01-Nov-11	E5	IH	Y	Towed up south with flood, hard ground, poor fishing
69	01-Nov-11	E5	IH	Y	Towed NW with ebb, hard ground, no fish
70	01-Nov-11	E5	IH	Y	Towed NW with ebb tide, hard ground, poor fishing

## Concluding remarks

The project overall has gone ok. We have struggled with weather and a lot of pots in the water this year. Nobody has taken them in because they have no fish to catch. There has been a very good showing of haddock and whiting. I would like to thank the two Cefas lads, John and Frank, for doing a good job to get done with the weather at times.

John Hall

Skipper FV Abbie Lee  
November 2011

**Appendix 3 Table 1. FSP NE cod survey, 2010. Shooting and hauling details.**

tow	ICES		Date shot	time shot	shot		shot longitude	shot EW	date haul	time haul	haul		haul longitude	haul EW	duration h		
	rect	rect			latitude	longitude					latitude	longitude					
1	38E9	38E9	03-Oct-11	10:30	54	32.0	0	35.0	W	03-Oct-11	12:30	54	37.0	0	39.0	W	2.00
2	38E9	38E9	03-Oct-11	13:00	54	37.0	0	39.0	W	03-Oct-11	15:00	54	34.0	0	35.0	W	2.00
3	38E9	38E9	03-Oct-11	15:30	54	34.0	0	34.0	W	03-Oct-11	17:30	54	38.0	0	37.0	W	2.00
4	38E9	38E9	03-Oct-11	19:10	54	34.0	0	41.0	W	03-Oct-11	21:15	54	38.0	0	41.0	W	2.08
5	37E9	37E9	04-Oct-11	06:30	54	30.0	0	26.0	W	04-Oct-11	08:30	54	24.0	0	19.0	W	2.00
6	37E9	37E9	04-Oct-11	09:15	54	23.0	0	17.0	W	04-Oct-11	11:15	54	26.0	0	16.0	W	2.00
7	37E9	37E9	04-Oct-11	11:45	54	27.0	0	16.0	W	04-Oct-11	13:45	54	27.0	0	19.0	W	2.00
8	38E9	38E9	06-Oct-11	07:30	54	35.0	0	40.0	W	06-Oct-11	09:30	54	41.0	0	45.0	W	2.00
9	38E9	38E9	09-Oct-11	07:00	54	35.0	0	40.0	W	09-Oct-11	09:00	54	38.0	0	44.0	W	2.00
10	38E9	38E9	09-Oct-11	10:00	54	40.0	0	48.0	W	09-Oct-11	11:00	54	40.0	0	44.0	W	1.00
11	38E9	38E9	09-Oct-11	13:00	54	42.0	0	50.0	W	09-Oct-11	15:00	54	41.0	0	58.0	W	2.00
12	38E9	38E9	09-Oct-11	15:30	54	41.0	0	57.0	W	09-Oct-11	17:30	54	48.0	0	55.0	W	2.00
13	38E9	38E9	09-Oct-11	17:45	54	48.0	0	55.0	W	09-Oct-11	19:45	54	48.0	1	2.0	W	2.00
14	38E8	38E8	10-Oct-11	07:15	54	50.0	1	10.0	W	10-Oct-11	09:15	54	58.0	1	11.0	W	2.00
15	39E8	39E8	10-Oct-11	09:40	54	58.0	1	10.0	W	10-Oct-11	11:40	55	2.0	1	2.0	W	2.00
16	39E8	39E8	10-Oct-11	11:55	55	0.0	1	2.0	W	10-Oct-11	13:55	55	8.0	1	2.0	W	2.00
17	39E8	39E8	10-Oct-11	14:30	55	5.0	1	2.0	W	10-Oct-11	16:30	55	6.0	1	9.0	W	2.00
18	39E8	39E8	10-Oct-11	16:50	55	6.0	1	9.0	W	10-Oct-11	18:50	55	3.0	1	14.0	W	2.00
19	38E9	38E9	11-Oct-11	07:15	54	55.0	1	3.0	W	11-Oct-11	09:15	54	52.0	0	53.0	W	2.00
20	38E9	38E9	11-Oct-11	10:00	54	50.0	0	49.0	W	11-Oct-11	12:00	54	50.0	0	40.0	W	2.00
21	38E9	38E9	11-Oct-11	12:25	54	50.0	0	40.0	W	11-Oct-11	14:25	54	55.0	0	40.0	W	2.00
22	38E9	38E9	11-Oct-11	14:45	54	54.0	0	40.0	W	11-Oct-11	16:45	54	52.0	0	47.0	W	2.00
23	38E9	38E9	12-Oct-11	09:20	54	37.0	0	19.0	W	12-Oct-11	11:20	54	34.0	0	12.0	W	2.00
24	38E9	38E9	12-Oct-11	12:00	54	35.0	0	12.0	W	12-Oct-11	14:00	54	32.0	0	4.0	W	2.00
25	38F0	38F0	12-Oct-11	15:00	54	35.0	0	6.0	E	12-Oct-11	17:00	54	32.0	0	1.0	E	2.00
26	38F0	38F0	12-Oct-11	17:30	54	32.0	0	2.0	E	12-Oct-11	19:30	54	30.0	0	10.0	E	2.00
27	38F0	38F0	13-Oct-11	04:00	54	30.0	0	12.0	E	13-Oct-11	06:00	54	30.0	0	23.0	E	2.00
28	38F0	38F0	13-Oct-11	07:00	54	34.0	0	27.0	E	13-Oct-11	09:00	54	40.0	0	23.0	E	2.00
29	38F0	38F0	13-Oct-11	12:00	54	41.0	0	7.0	E	13-Oct-11	14:00	54	41.0	0	3.0	W	2.00
30	38E9	38E9	13-Oct-11	09:45	54	40.0	0	29.0	W	13-Oct-11	11:45	54	46.0	0	24.0	W	2.00

Appendix 3 Table 1 contd.

tow	ICES		time shot	shot				shot EW	date haul	time haul	haul				haul EW	duration h
	rect	Date shot		shot latitude	shot longitude	shot latitude	shot longitude				haul latitude	haul longitude	haul latitude	haul longitude		
31	38E9	16-Oct-11	12:10	54	46.0	0	23.0	W	16-Oct-11	14:10	54	46.0	0	14.0	W	2.00
32	38F0	16-Oct-11	15:00	54	46.0	0	5.0	W	16-Oct-11	17:00	54	45.0	0	8.0	E	2.00
33	38F0	16-Oct-11	17:45	54	45.0	0	9.0	E	16-Oct-11	19:45	54	44.0	0	21.0	E	2.00
34	38F0	16-Oct-11	20:10	54	45.0	0	21.0	E	16-Oct-11	22:10	54	40.0	0	11.0	E	2.00
35	37E9	17-Oct-11	07:00	54	19.0	0	19.0	W	17-Oct-11	09:00	54	16.0	0	11.0	W	2.00
36	37E9	20-Oct-11	09:30	54	18.0	0	18.0	W	20-Oct-11	11:30	54	14.0	0	10.0	W	2.00
37	37E9	20-Oct-11	11:45	54	14.0	0	9.0	W	20-Oct-11	13:45	54	18.0	0	4.0	W	2.00
38	37F0	20-Oct-11	14:00	54	18.0	0	4.0	W	20-Oct-11	16:00	54	14.0	0	1.0	E	2.00
39	37F0	20-Oct-11	16:25	54	14.0	0	1.0	E	20-Oct-11	18:25	54	10.0	0	10.0	E	2.00
40	37F0	20-Oct-11	18:45	54	10.0	0	10.0	E	20-Oct-11	20:45	54	9.0	0	20.0	E	2.00
41	37F0	21-Oct-11	05:00	54	8.0	0	20.0	E	21-Oct-11	07:00	54	4.0	0	17.0	E	2.00
42	37F0	21-Oct-11	07:30	54	4.0	0	16.0	E	21-Oct-11	09:30	54	0.0	0	9.0	E	2.00
43	37F0	21-Oct-11	09:30	54	2.0	0	8.0	E	21-Oct-11	11:30	54	3.0	0	0.0	E	2.00
44	37F0	21-Oct-11	11:50	54	3.0	0	1.0	E	21-Oct-11	13:50	54	4.0	0	3.0	E	2.00
45	37F0	21-Oct-11	14:00	54	4.0	0	3.0	E	21-Oct-11	16:00	54	4.0	0	4.0	E	2.00
46	38E9	27-Oct-11	09:30	54	52.0	0	30.0	W	27-Oct-11	11:30	54	57.0	0	25.0	W	2.00
47	38E9	27-Oct-11	11:55	54	58.0	0	24.0	W	27-Oct-11	13:55	54	58.0	0	16.0	W	2.00
48	38E9	27-Oct-11	14:50	54	59.0	0	10.0	W	27-Oct-11	16:50	54	53.0	0	3.0	W	2.00
49	38F0	12-Oct-11	17:20	54	53.0	0	3.0	W	12-Oct-11	19:25	54	58.0	0	0.0	W	2.08
50	38F0	27-Oct-11	19:50	54	58.0	0	0.0	E	27-Oct-11	21:50	54	54.0	0	7.0	E	2.00
51	38F0	28-Oct-11	06:00	54	52.0	0	14.0	E	28-Oct-11	08:00	54	57.0	0	13.0	E	2.00
52	39F0	28-Oct-11	08:30	54	57.0	0	14.0	E	28-Oct-11	10:30	55	0.0	0	24.0	E	2.00
53	39F0	28-Oct-11	10:50	55	0.0	0	24.0	E	28-Oct-11	12:50	55	5.0	0	16.0	E	2.00
54	39F0	28-Oct-11	13:15	55	5.0	0	16.0	E	28-Oct-11	15:15	55	9.0	0	9.0	E	2.00
55	39F0	28-Oct-11	15:40	55	8.0	0	9.0	E	28-Oct-11	17:40	55	2.0	0	5.0	E	2.00
56	39E9	28-Oct-11	18:10	55	1.0	0	30.0	E	28-Oct-11	20:10	55	5.0	0	1.0	W	2.00
57	39E9	29-Oct-11	05:00	55	4.0	0	8.0	W	29-Oct-11	07:00	55	9.0	0	10.0	W	2.00
58	39E9	29-Oct-11	07:30	55	9.0	0	10.0	W	29-Oct-11	09:30	55	5.0	0	14.0	W	2.00
59	39E9	29-Oct-11	10:00	55	5.0	0	14.0	W	29-Oct-11	12:30	55	1.0	0	23.0	W	2.50
60	39E9	29-Oct-11	13:45	55	3.0	0	30.0	W	29-Oct-11	15:45	55	9.0	0	31.0	W	2.00

**Appendix 3 Table 1 contd.**

tow	ICES		Date shot	time shot	shot				date haul	time haul	haul				duration h		
	rect				shot latitude	shot longitude	EW	haul latitude			haul longitude	EW					
61	39E9		29-Oct-11	16:30	55	8.0	0	30.0	W	29-Oct-11	18:30	55	2.0	0	32.0	W	2.00
62	37F0		31-Oct-11	10:00	54	18.0	0	10.0	E	31-Oct-11	12:00	54	14.0	0	12.0	E	2.00
63	37F0		31-Oct-11	12:20	54	15.0	0	12.0	E	31-Oct-11	14:20	54	14.0	0	20.0	E	2.00
64	37F0		31-Oct-11	14:50	54	15.0	0	20.0	E	31-Oct-11	16:50	54	20.0	0	23.0	E	2.00
65	37F0		31-Oct-11	17:30	54	21.0	0	22.0	E	31-Oct-11	19:30	54	25.0	0	20.0	E	2.00
66	38F0		31-Oct-11	19:50	54	25.0	0	21.0	E	31-Oct-11	21:50	54	30.0	0	17.0	E	2.00
67	37F0		01-Nov-11	05:00	54	24.0	0	11.0	E	01-Nov-11	07:00	54	28.0	0	9.0	E	2.00
68	37F0		01-Nov-11	07:30	54	27.0	0	9.0	E	01-Nov-11	09:30	54	21.0	0	7.0	E	2.00
69	37E9		01-Nov-11	09:55	54	20.0	0	7.0	E	01-Nov-11	11:55	54	22.0	0	1.0	W	2.00
70	37E9		01-Nov-11	12:30	54	22.0	0	2.0	W	01-Nov-11	14:30	54	27.0	0	11.0	W	2.00

**Appendix 3 Table 2.** Total numbers of fish caught per tow for selected species (those with the highest weight retained; data for other species are on the Cefas FSP database). Key for species code is at end of table.

tow	HAD	WHG	COD	LEM	DAB	GUG	PLE	BIB	HER	SQC	MAC	MON	HKE	HOM	GAG	SDR	LIN	THR	GUR	BLL
1	437	1650	758	272	170	18	27	3		128	8								5	
2	77	520	412	162	168			167		88	5					1				
3	194	317	131	505	338	45	31		224		36		2							
4	62	520	396	328	190	12	20	19		26							15		8	
5	37	66	88	54	70	26				23	2		1	1						
6	46	207	125	91	570	135	7	660		52									15	
7	129	198	98	146	240	14	5	76	20	27										
8	195	1114	1065	258	371	14	50	931		32				7					7	
9	49	214	80	335	89	111	26	22		124	1		1	4			2		2	
10	100	267	125	184	58		107	6		86	2	1		2					48	
11	21	81	58	88	6		56					1	1						1	1
12	42	460	41	81	24	13	40	7	2	16		1		1		2			1	
13	5	706	35	19	22		16		4	26			5							
14	58	2195	80	49	48	9	133			26			9	7		2		2		1
15	5	1228	28	13	8	1				7			3	18						
16	49	1537	28	10	26	1	13		1888	7	6		4	10						
17	31	2408	26	8	9		47		72	1	16	3	7	3			1			
18	4	695	9	33	47	6	52			10	11		2	2						
19	11	1895	49	7	15		5				3	1	4	38			1		2	1
20	87	1227	63	61	112	109	128	8		9	30	4	2			4				3
21	115	134	21	57	70	52	118	8		7	28	2		8		3				1
22	189	960	28	44	48	128	122	28		2	8	1		16		2				
23	455	183	109	76	245	131	150	1		12	26	1					1			
24	551	78	102	107	291	76	94	21		24		1	3	52			1		8	
25	411	382	120	154	568	360	132			15									8	
26	541	544	79	92	108	586	113			11			1			1		3		1
27	343	192	46	150	178	42	16			1	15		4			1	2	2	3	
28	187	696	68	86	690	640	60	220			1	2	1			3	1		1	2
29	610	296	65	46	148	77	40	5				1					2			
30	649	70	73	104	260	46	405			5		1	4							

**Appendix 3 Table 2 contd.**

tow	HAD	WHG	COD	LEM	DAB	GUG	PLE	BIB	HER	SQC	MAC	MON	HKE	HOM	GAG	SDR	LIN	THR	GUR	BLL
31	805	76	31	63	68	20	364				4	1	7			1				
32	986	515	36	77	54	44	94		10			1				1				
33	1112	740	96	184	588	116	138	40												
34	242	792	54	188	330	16	183	12				1				2				2
35	2	624	132	71	32		45			28										
36		1376	12	16	98	10	12	2		2			1							
37	37	108	15	110	96	37	3	200		28	1									
38	15	205	40	89	71		2	92	20	53	17								42	
39	21	200	28	125	26	13	1	227	35	28			8							
40	81	378	117	43	108	112		132	8	8			3							
41	37	333	26			60	5			54	1		2						1	
42	40	290	60	50	290		10	30												
43	3	2538	4	23	3	11	8	12		26			4	10	2			2		
44	5	1839	13	17	13	11	2			33										
45	22	1156		14	14	31	3	728		37		1	16							
46	737	850	40	72	8	156	68	30		5	20	1				1		1		
47	686	1155	40	32		48	17		10	3	60	1			1	1				
48	1010	1168	43	134		110	27	40	10	1	70				1					
49	447	922	51	164	124	92	52	30										2		
50	171	1375	53	35	140	14				2		1								
51	215	929		29	10	180	2													
52	342	1092	2	64	14	276	3		112	1			5							
53	203	1180	31	9		172	3		100	1		1	4							
54	198	960		20	110	192	61		90				2							
55	80	926	1	34	16	188	8	8	48	4	8									
56	323	558	73	30	16	136	8	24												2
57	565	1230	9	39	80	126	28	20		1										
58	2788	1196	33	22	20	159	5					2								
59	2558	696	51	16	24					3		3	5							
60	752	1083	40	44	16	92	10			9	76		1							

**Appendix 3 Table 2 contd.**

tow	HAD	WHG	COD	LEM	DAB	GUG	PLE	BIB	HER	SQC	MAC	MON	HKE	HOM	GAG	SDR	LIN	THR	GUR	BLL
61	1056	292	42	58	48	111	14				9	1					1			
62	148	174	194	34			4	1184		43			2							
63	121	494	206	6	144	95	21	8		26			2							
64	391	530	108	48	90	286	95			9										
65	407	570	32	19	118	85	52	16		7		1								
66	319	450	8	8	12	34	11			2									1	
67	225	245	23	11	46	138	88						4			1		2		
68	141	118	43	8	30	93	89	9		12	6		3	3		4		1		13
69	17	168	60	30	244	48	36			46			3	4						1
70	36	150	48	112	168	15	2	469		70										

**Key to species codes:**

HAD	Haddock	GUG	Grey gurnard	MAC	Mackerel	SDR	Spotted ray
WHG	Whiting	PLE	Plaice	MON	Anglerfish	LIN	Ling
COD	Cod	BIB	Bib	HKE	Hake	THR	Thornback ray
LEM	Lemon sole	HER	Herring	HOM	Horse mackerel	GUR	Red gurnard
DAB	Dab	SQC	Common squids	GAG	Tope shark	BLL	Brill