FOREWIND

DOGGER BANK
TEESSIDE A & B

March
2014

Environmental Statement Chapter 13 Appendix E Pelagic Fish Survey Report

Application Reference 6.13.5

Dogger Bank Offshore Wind Farm

Pelagic Fish Survey

14th to 28th September 2011

Undertaken by
Brown and May Marine Ltd

Ref	Issue Date	Issue Type	Author	Checked	Approved
DBPS01	12/09/12	FINAL	AWG/PJM	LS/SX	SJA

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1.0 Summary

1.1 Pelagic Trawl

A total of 11 species were caught during the survey. Overall, sprat (*Sprattus sprattus*) was the most abundant species caught, and was found only in transects A, C and D. Mackerel (*Scomber scombrus*) was the most abundant species in transect A and B. In transect C, *S. sprattus* was the most prevalent species, and whiting (*Merlangius merlangus)* was the dominant species in transect D.

The highest catch rate of all species combined, was recorded at station PT19, followed by PT15, both of which were located in transect C. At station PT19, *S. sprattus* accounted for the majority of the catch whereas at PT15, herring (*Clupea harengus)* represented the highest proportion of the catch. Overall the total catch rate was highest in transect C, followed by transect D, with considerably lower catch rates recorded for transects A and B.

Five species with a defined minimum landing size (MLS) were caught. Most of the *S. scombrus* caught in all transects were below the MLS. *C. harengus* were found only in transects B and C, most of which were below the MLS. The majority of *M. merlangus* caught were also below the set MLS and were only found in transects C and D. Only one anchovy (*Engraulis encrasicolus*) was caught in transect A, and four haddock (*Melanogrammus aeglefinus*) were caught in transect D, all of which were above the set MLS.

Cefas were unable to determine the sex of all of the *S. sprattus* caught, or the sex of a number of immature fish of other species. A greater proportion of female *S. scombrus* were caught in transect A, whereas in transects B, C and D, the sex ratio was approximately 50:50. Most of the sexed *C. harengus,* found in transect C, were identified as female, as were the majority of grey gurnard (*Eutrigla gurnardus*) and *M. merlangus* caught in transects C and D.

M. merlangus, caught only in transects C and D, and *S. scombrus*, found in all transects, were predominantly immature. A greater proportion of *E. gurnardus* found in transect C were maturing females, whereas in transect D, most were identified as immature.

1.2 Herring (*C. harengus)*

The majority of the *C. harengus* were caught in transect C, at stations PT15 and PT19, with catch rates of 17,460.4 individuals/hr and 14,145.6/hr, respectively. Only one individual was caught in transect B at station PT10.

Cefas were unable to confidently determine the sex of a number of immature individuals, therefore the majority of the total catch were unsexed.

Most of the *C. harengus* caught were 'virgin', the highest numbers of which were caught at stations PT15 and PT19 in transect C. All *C. harengus* caught at stations PT14 to PT22 in transect C were 'virgin'. 'Early ripening' and 'ripening' individuals were caught only at stations PT10, in transect B, and PT24, in transect C. One 'late ripening' female was caught at station PT24 in transect C.

Studies into the distribution of *C. harengus* in the North Sea have concluded that larger spawning aggregations form when temperatures are between 11.0°C and 14.0°C. (Maravelias & Reid, 1995; Maravelias, 1997; Maravelias & Reid, 1997). The average temperature across the survey area (transects A to D) was 13.7 ^{o}C, which falls within the temperature ranges stated above.

Larger spawning aggregations of *C. harengus* have been observed when salinities were above 35.0‰ (Maravelias & Reid, 1995; Maravelias, 1997; Maravelias & Reid, 1997). The average salinity over the survey area was 35.7‰, which is within the expected range for spawning aggregations.

No spawning *C. harengus* were found during the survey. The majority of *C. harengus* caught were 'virgin', suggesting that within the sampling area, spawning was not occurring at the time of the survey. Furthermore, the absence of 'spent' fish suggests that spawning may not have occurred in a short period prior to the survey.

2.0 Introduction

The following report details the findings of the September 2011 pelagic fish characterisation survey, undertaken in the vicinity of the Tranche A and along the proposed export cable corridor between the 14th and 28th September 2011.

The survey methodology, vessel and sampling gear were agreed in consultation with Cefas and the Marine Management Organisation (MMO). A dispensation from the MMO for the Provisions of Council Regulation 850/98 to catch and retain undersize fish for scientific research and 43/2009 specifically related to days at sea was obtained prior to commencement of this survey. A summary of the Health and Safety performance of the survey is provided in Appendix 1.

The main aim of the survey was to assess whether *C. harengus* is currently using the historic spawning grounds of the Dogger Bank. In addition, the survey was aimed at providing site specific information to identify the principal pelagic species present in Tranche A and their relative abundance.

3.0 Herring (*C. harengus*) Spawning Grounds

There are considered to be three discrete *C. harengus* spawning stocks in the North Sea: the Buchan stock which spawns in the Orkney and Shetland area and off the Scottish east coast (July to September); the Banks or central North Sea stock which spawns off the northeast coast of England (August to October); and the Downs stock which spawns in the Southern Bight and eastern English Channel (November to February; Cefas, 2009). The stock relevant to the proposed Dogger Bank offshore wind farm is the Banks or central North Sea stock. This group spawns off the northeast coast of England and derives its name from their former spawning grounds around the western edge of the Dogger Bank (Figure 3.1). *C. harengus* deposit their eggs masses on gravel and maerl habitats where there is a low proportion of fine sediment and well oxygenated water, therefore spawning is spatially constrained (Nash *et al*., 2009; Ellis *et al*., 2012). Spawning grounds tend to be well defined, although the intensity of spawning can vary over time (Ellis *et a*l., 2012).

Studies suggest that the Banks spawning ground on parts of the Dogger Bank is a historic (no longer active) spawning ground, having no, or very little spawning activity, and spawning is now confined to small areas along the English east coast (Ellis *et al.,* 2012). This is supported by ichthyoplankton surveys from 1972 (International Herring Larval Survey; IHLS), which have not found *C. harengus* larvae on the Dogger Bank spawning grounds (Nichols & Brander, 1989; ICES, 2008a; ICES, 2008b; Schmidt *et al.*, 2009; ICES 2010). The historical and active North Sea *C. harengus* autumn spawning grounds, as defined by Schmidt *et al.* (2009) are shown in Figure 3.2 and Figure 3.3.

Since the collapse of the North Sea *C. harengus* autumn spawning stock in the 1970's the distribution of spawning grounds is considered to have become more limited. Whilst the assessment by Schmidt *et al.* (2009) of the relative distribution of newly hatched larvae suggests that stock recovery was widespread by the late 1990s, some spawning sites have yet to be re-colonised. An example of this is the Dogger Bank, historically one of the main spawning sites of the Banks stock where no larvae have been recently caught. It should be noted, however, that while the Dogger Bank zone may be

sited within a historic spawning site, the export cable route will potentially pass through potential *C. harengus* spawning grounds, nearer to the coast.

Temperature is considered a factor influencing the timing of *C. harengus* spawning, with warmer temperatures giving rise to early spawning and cooler temperatures delaying spawning (Lambert, 1987). *C. harengus* are known to form spawning aggregations and the results of studies on the distribution of *C. harengus* in the northern North Sea in relation to oceanographic conditions found the presence of large *C. harengus* aggregations associated with surface temperatures between 11.0°C and 12.5°C and to a lesser extent, around 14.0°C (Maravelias & Reid, 1997; Maravelias, 1997; Maravelias & Reid, 1995). The same studies found *C. harengus* to be abundant in areas of high surface salinity (>34.8‰.), with the largest aggregations found in waters with a surface salinity greater than 35‰.

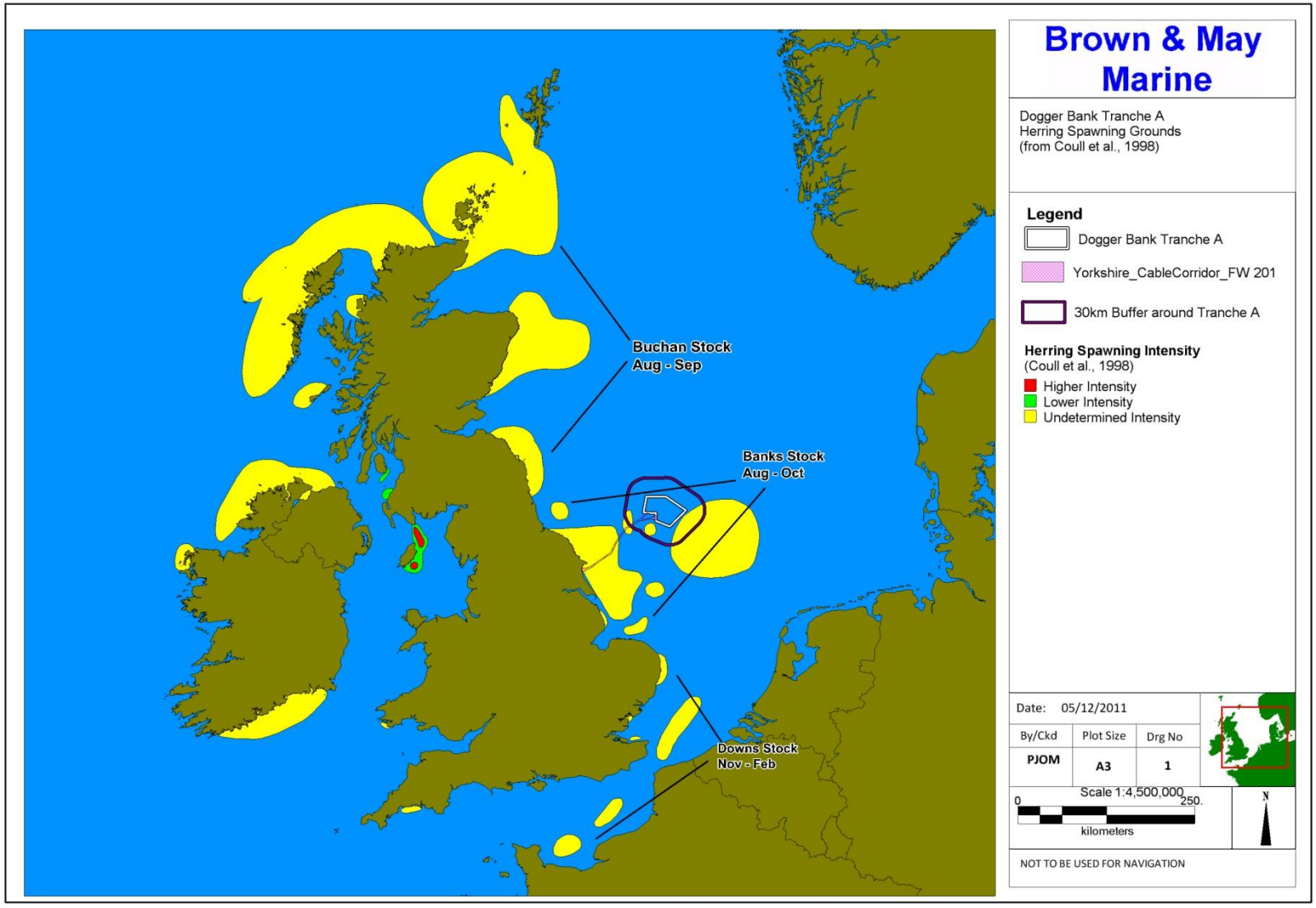


Figure 3.1 Spawning Grounds and Periods of North Sea Herring as Defined by Coull *et al.* (1998)

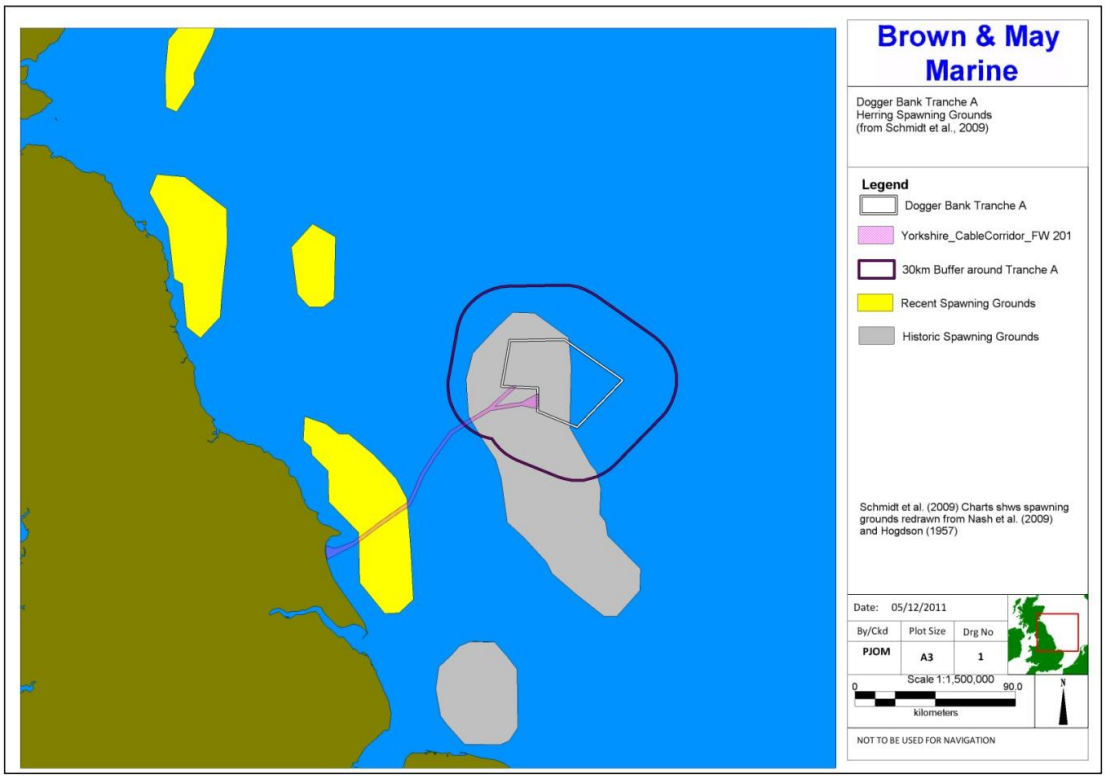


Figure 3.2 Historic and Recent Herring (*C. harengus*) Spawning Grounds as defined by Schmidt *et al.* (2009)

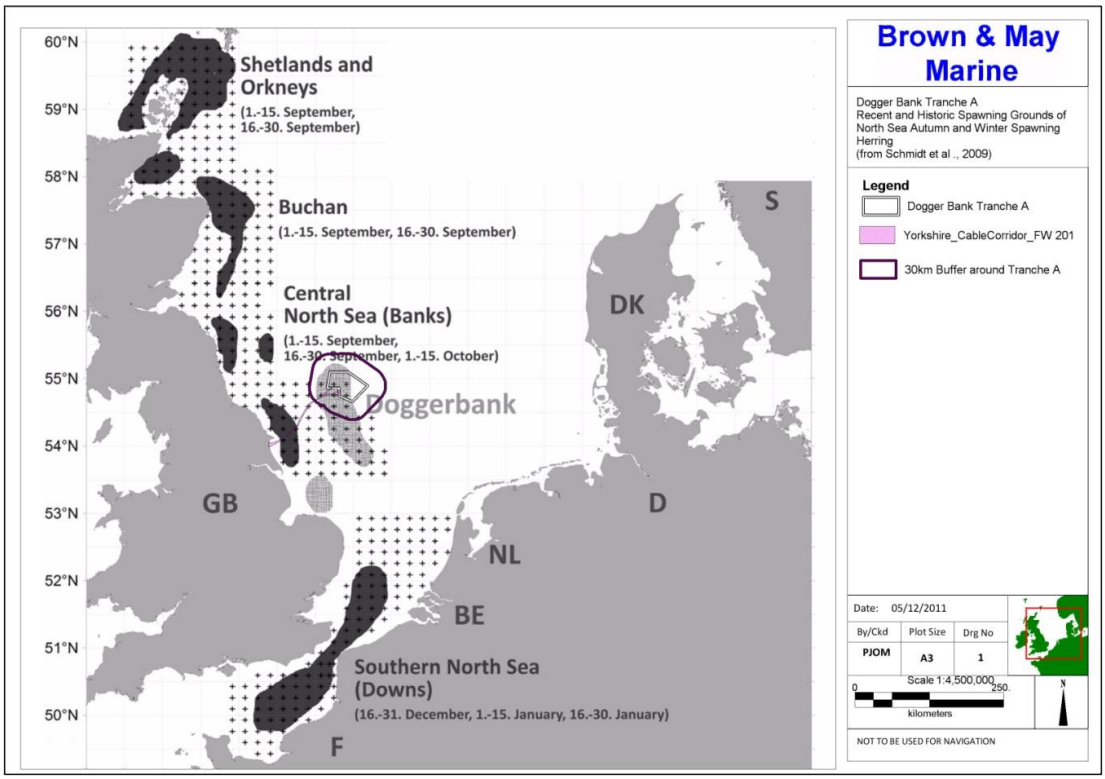


Figure 3.3 Recent (dark grey) and Historic (light grey) Spawning Grounds of North Sea Autumn and Winter Spawning Herring (*C. harengus*; sampling periods in brackets) from Schmidt *et al.* (2009). Small Crosses Indicate the Station Grid of the International Herring Larval Survey (IHLS). Spawning Grounds are Redrawn from Nash *et al.* (2009) and Hodgson (1957).

4.0 Scope of Works

The proposed scope of works for the September 2011 pelagic fish characterisation survey are detailed below and illustrated in Figure 4.1 overleaf.

- **Pelagic Trawl**
  - A predetermined search pattern covering *C. harengus* spawning grounds as described by Coull *et al.* (1998) was undertaken. Along the prescribed search pattern 37 blind tows of approximately 20 minutes duration were completed. In addition, if the echo sounder showed marks characteristic of pelagic shoals additional trawls were carried out at such locations

- **Pelagic Trawl Sample Analysis (excluding *C. harengus*)**
  - Number of individuals and catch rates by species
  - Average length and length distribution by species
    - Finfish & sharks: individual lengths (nearest cm below)
    - Rays: individual lengths and wing-width (nearest cm below)
  - Sex ratio by species
  - Spawning condition
    - Finfish species (except *S. scombrus*): Cefas Standard Maturity Key - Five Stage
    - *S. scombrus*: Cefas Maturity Key – Six Stage
    - Ray and shark species: Cefas Standard Elasmobranch Maturity Key- Four Stage

- **Pelagic Trawl Sample Analysis (*C. harengus* only)**
  - Number of individuals and catch rates
  - Average length and length distribution (nearest ½ cm below)
  - Sex ratio
  - Spawning condition
    - Cefas Maturity Key – Nine Stage
  - Conductivity-Temperature-Depth (CTD) profile at every third station (weather permitting)

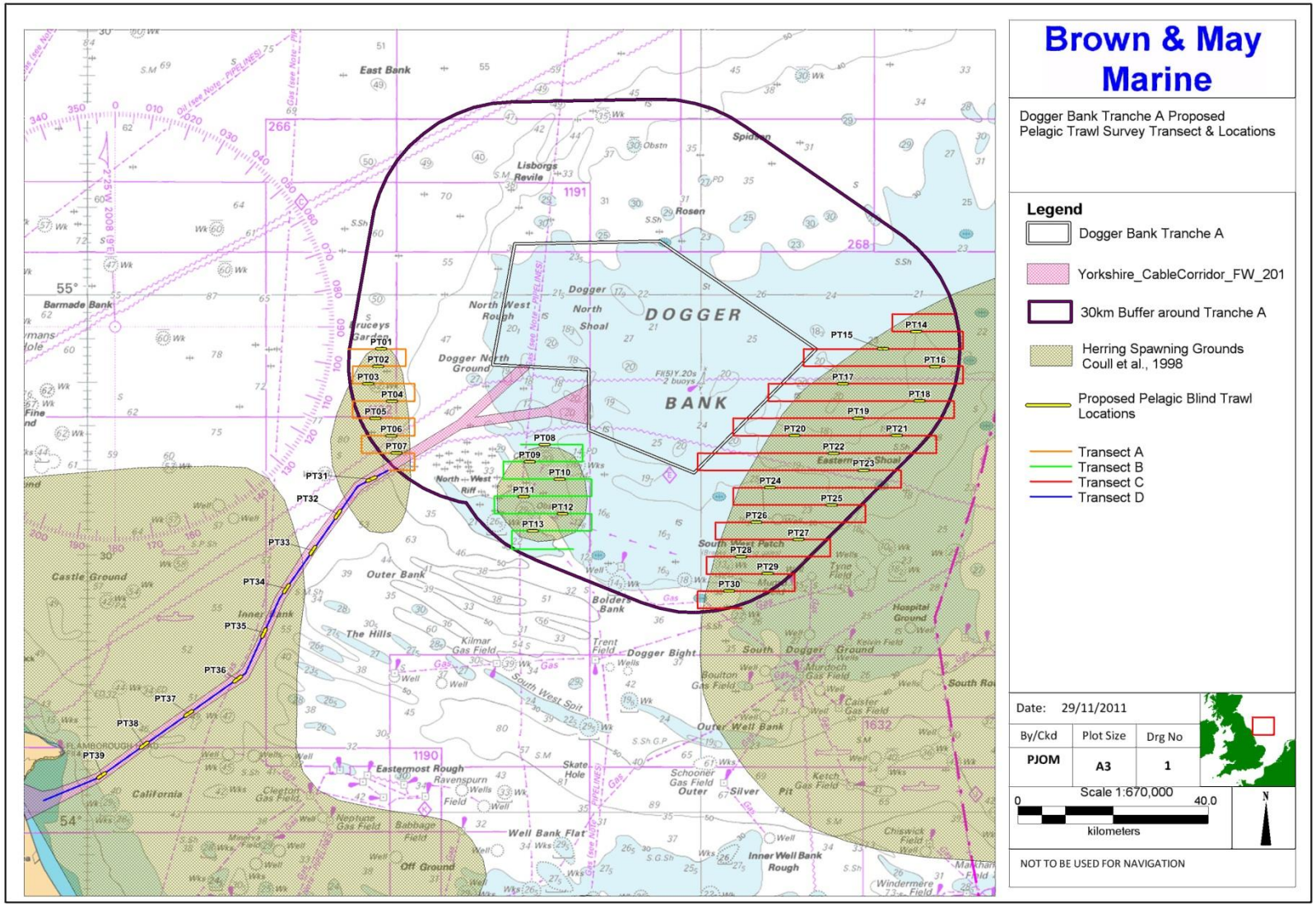


Figure 4.1 Pelagic Survey Search Pattern and Proposed Trawl Locations by Sampling Area (transects A to D)

5.0 Methodology

5.1 Survey Vessel

The vessel chartered for the survey (Figure 5.1), the "Jubilee Spirit", is a Grimsby-based commercial trawler whose skipper has experience of fishing on the Dogger Bank and of undertaking pelagic surveys. The specifications of the vessel are given below in Table 5.1.

Figure 5.1 Survey Vessel "Jubilee Spirit"

Table 5.1 Survey Vessel Specifications

Survey Vessel Specifications	
Length	21.2m
Beam	6.9m
Draft	2.3m
Main engine	Caterpillar Type 340TA 475 BHP
Gearbox	Hydraulic 6: reduction
Propeller	4 Blade Manganese Bronze Fixed Pitch 1.7m diameter
GPS	2-Furuno GP80
Plotters	Sodena Plotter with Electronic Charts
Sounder	Furuno Daylight Viewing

5.2 Sampling Gears

5.2.1 Standard Pelagic Trawl

A standard pelagic trawl with an 18mm cod-end was used for sampling Figure 5.2, the specifications of which are given in Table 5.2.

Figure 5.2 Pelagic Trawl Used

Table 5.2 Pelagic Trawl Specifications

Pelagic Trawl Specifications	
Towing warp	Steel 18mm main with 20mm extension
Depth: payout ratio	approx. 1.8:1
Bridles	54.86m, 3 combination bridles
Trawl doors	84” Perfect (500kg per door)
Distance between the doors	36.58m
Net	Millionaire trawl net with 18mm cod-end
Ground line length	45.72m, 28mm combination rope
Estimated headline height	9.14 – 12.80m

5.3 Positioning and Navigation

The position of the vessel was tracked at all times using a Garmin GPSMap 278 with an EGNOS differential connected to an external Garmin GA30 antenna. Trawl start times and positions were taken when the winch stopped paying out the gear. Similarly, trawl end times and positions were taken when hauling of the gear commenced.

5.4 Sampling Operations

The survey was undertaken from the 14th to the 28th September 2011. A summarised log of events is given in 5.3 below.

It should be noted that an additional trawl was undertaken between stations PT21 and PT22, labelled PT21a, when several marks characteristic of *C. harengus* were observed on the vessels echo sounder. When large marks were observed during the tow at PT20, the duration was shortened in order to prevent an unnecessarily large catch.

Station PT26 was omitted due to poor weather conditions at sea.

5.3 Summarised Log of Events

Wednesday 14th September 2011
Mobilise survey in Grimsby
Steam to survey site
Overnight at sea
Thursday 15th September 2011
Begin steaming transect C
Pelagic Trawls: PT14
Small marks during PT14
Overnight at sea
Friday 16th September 2011
Continue steaming transect C
Pelagic Trawls: PT15, PT16, PT17
Deploy CTD probe at PT16
Marks during PT15 and PT16
Overnight at sea
Saturday 17th September 2011
Continue steaming transect C
Pelagic Trawls: PT18, PT19, PT20, PT21
Deploy CTD probe at PT20
PT20 tow shortened to 6 minutes due to large marks on echo sounder
Marks observed on sounder during PT21
Overnight at sea
Sunday 18th September 2011
Continue steaming transect C
Pelagic Trawls: PT21a (additional trawl), PT22, PT23
Deploy CTD probe at PT22
Generator broke down, return to Grimsby
Overnight at sea

Monday 19th September 2011
Arrive into Grimsby
Unload samples, load van, load fish boxes onto vessel
Overnight in Grimsby
Tuesday 20th September 2011
Generator repaired in Grimsby
Return to survey site
Overnight at sea
Wednesday 21st September 2011
Continue steaming transect C
Pelagic Trawls: PT30, PT29, PT28
Deploy CTD probe at PT28
Overnight at sea
Thursday 22nd September 2011
Continue steaming transect C
Pelagic Trawls: PT27, PT25, PT24
Deploy CTD probe at PT24
PT26 omitted due to poor weather conditions
Steam overnight to transect B
Overnight at sea
Friday 23rd September 2011
Begin steaming transect B
Pelagic Trawls: PT08, PT09, PT10, PT11, PT12
Deploy CTD probe at PT12
Overnight at sea
Saturday 24th September 2011
Continue steaming transect B and begin steaming transect A
Pelagic Trawls: PT13, PT01, PT02
Overnight at sea
Sunday 25th September 2011
Continue steaming transect A
Pelagic Trawls: PT03, PT04, PT05, PT06, PT07
Deploy CTD probe at PT03, PT06
Mark observed during PT06
Overnight at sea
Monday 26th September 2011
Begin steaming transect D
Pelagic Trawls: PT31, PT32, PT33, PT34, PT35, PT36
Deploy CTD probe at PT32, PT35
Marks observed when approaching PT33 therefore trawl shot early
Overnight at sea
Tuesday 27th September 2011
Continue steaming transect D
Pelagic Trawls: PT37
Deploy CTD probe at PT37
Steam to Grimsby
Overnight at sea

Wednesday 28th September 2011
Arrive into Grimsby
Demobilise survey and return to office
Store samples

5.5 Pelagic Trawl Sampling

The whole catch from each trawl was retained where practicable. Sub-sampling occurred when large homogenous samples were obtained. The samples were then boxed, labelled, photographed, iced and stored at +2°C before transportation to Cefas (Lowestoft) for analysis in the middle and at the end of the survey, in line with the agreed scope of works.

The sex, length (nearest cm below) and spawning condition of each individual was analysed using the standard five stage maturity key for most finfish species (Table 5.4) and an additional six stage maturity key was used for *S. scombrus*, given in Table 5.5.

The sex, length (nearest ½ cm below) and spawning condition of each individual *C. harengus* was analysed using the nine stage maturity key shown in Table 5.6.

The start and end times, co-ordinates and duration of each pelagic trawl are given in Table 5.7 (transects A, B, C and D are highlighted orange, green, red and blue respectively). The pelagic trawl tracks are illustrated in Figure 5.3.

A conductivity – temperature – depth (CTD) probe was used to record temperature and salinity depth profiles at every third pelagic trawl location (weather permitting). The times, co-ordinates, depths and locations of each deployment of the CTD probe are given in Table 5.8 and illustrated in Figure 5.3.

For the purposes of data analysis, catch rates have been calculated to allow for quantitative comparisons to be made between the numbers of individuals caught per hour at each station (see section 6.1).

Table 5.4 Cefas Standard Finfish Maturity Key

Maturity Stage	Male	Female
I Immature	Roundfish - Testes very thin ribbon lying along an unbranched blood vessel. Flatfish - Testes tight up against back of gut cavity and very small, not usually larger than 10mm x 2mm. No sign of development.	Roundfish - Ovaries small, elongated, whitish, translucent. Flatfish - Ovaries small, ovary wall thin and easily broken, internally yellowish-orange. No sign of development.
M Maturing	Colour is progressing towards creamy white and the testes are filling more of the body cavity. Roundfish – may be many lobed. Flatfish – at latest phase the testes can become bulbous.	Eggs are beginning to develop. Roundfish – the ovaries are filling more and more of the body cavity. Flatfish – ovaries are extending down the side of the body of the fish. There are no signs of hyaline eggs.
H Hyaline	No equivalent stage.	Hyaline eggs present, one or many. Ovaries will not run, even under moderate pressure
R Running	Will extrude sperm under light pressure to advanced stage of extruding sperm freely with some sperm still in the gonad. Flatfish – sperm evident in ducts.	Will extrude eggs under light pressure to advanced stage of extruding eggs freely with some eggs still in the gonad.
S Spent	Testes shrunken with little sperm in the gonads but often some in the gonoducts which can be extruded under light pressure. The gonad can shrink back to very small size. Flatfish gonad becomes knobbly.	Ovaries shrunken with few residual eggs and slime. Ovaries become tighter, no sign of egg development.

Table 5.5 Mackerel (*S. scombrus*) Maturity Key

Maturity Stage	Male	Female
1 Virgin	Testes small pale, flattened and translucent. No sign of development.	Ovaries small, wine red and clear. Torpedo shaped. No sign of development.
2 Early Ripening	Testes occupying ¼ to ¾ body cavity, off-white, no milt running.	Ovaries occupying ¼ to ¾ body cavity. Opaque eggs visible, giving pale pink to yellowish colouration. Largest eggs without oil globule.
3 Late Ripening / Partly Spent (early)	Testes occupying 3/5 to almost filling body cavity. Creamy white in colour.	Ovaries occupying 3/5 to almost filling body cavity. Yellow to orange in colour. Largest eggs may have oil globule.
4 Ripe	Testes filling body cavity. Milt freely running.	Ovaries size variable from a full to ¼. Characterised by externally visible hyaline eggs, no matter how few or early the stage of hydration. Ovaries with hyaline eggs only in the lumen are not included.
5 Partly Spent (late)	Testes occupying ¾ to <¼ of body cavity, with freely running milt and shrivelled at anal end.	Ovaries occupying ¾ to <¼ of body cavity. Slacker than stage 3 and often blood shot.
6 Spent/Recovering Spent	Testes occupying ¼ or less of body cavity. Opaque with brownish tint and no trace of milt.	Ovaries occupying ¼ or less of body cavity. Reddish and often murky in appearance, sometimes with a scattering or patch of opaque eggs.

Table 5.6 Herring (*C. harengus*) Maturity Key

Maturity Stage	Male	Female
1 Virgin	Testes whitish or grey brown.	Ovaries small, thread like, wine red in colour.
2 Late Virgin	Testes now 3-8 mm in breadth, reddish grey in colour.	Ovaries bright red colour, eggs not visible to naked eye but can be seen under magnification.
3 Early Ripening	Testes occupying ½ of ventral cavity, reddish grey to greyish in colour.	Ovaries occupying ½ of ventral cavity, orange in colour and 1-2 cm in breadth. Eggs small and visible to the naked eye.
4 Ripening	Testes almost as long as body cavity, whitish in colour.	Ovaries almost as long as body cavity, orange to pale yellow in colour.
5 Late Ripening	Testes filling body cavity and are milk white in colour. Sperm can be extruded by pressure.	Ovaries filling body cavity and are yellowish in colour. Eggs large round with some transparent.
6 Ripe	Testes white and sperm flows freely.	Eggs transparent and flow freely.
7.1 Early Spent	Testes baggy and bloodshot, may contain remains of sperm.	Ovaries baggy and bloodshot, empty or containing only a few residual eggs.
7.2 Late Spent	Testes reddish grey or greyish. Firmer and slightly larger than virgin stage. No milt present.	Ovaries colourless or wine red coloured. Firmer and slightly larger than virgin stage. No residual eggs.
8 Recovering Spent	Testes firm and larger than stage 2.	Ovaries firm and larger than stage 2. Eggs not visible to naked eye. Wine red colour. Walls of gonad striated, blood vessels prominent.

Table 5.7 Start and End Times, Co-ordinates and Duration of each Pelagic Trawl

Station	Date	Start				End				Duration (mm:ss)
		Time (GMT)	UTM31N		Depth (m)	Time (GMT)	UTM31N		Depth (m)	
			Latitude	Longitude			Latitude	Longitude		
PT01	24/09/2011	12:31:20	6,084,994.3	370,086.8	61.9	12:52:08	6,085,197.7	368,054.7	61.2	20:48
PT02		14:58:48	6,081,588.8	368,698.6	62.3	15:18:58	6,081,588.0	367,155.3	63.2	20:10
PT03	25/09/2011	06:39:07	6,078,114.1	365,442.8	65.0	06:59:14	6,078,327.8	367,177.6	62.5	20:07
PT04		09:26:05	6,074,178.2	371,315.3	57.5	09:46:07	6,074,454.0	369,371.3	56.4	20:02
PT05		11:51:43	6,070,166.3	366,900.6	72.0	12:11:42	6,069,985.8	368,643.0	65.2	19:59
PT06		14:16:43	6,066,402.7	371,408.5	58.4	14:36:45	6,066,333.1	369,943.8	65.4	20:02
PT07		16:44:49	6,062,827.1	370,960.6	56.4	17:04:50	6,062,796.3	372,901.9	48.9	20:01
PT08	23/09/2011	06:43:49	6,064,036.7	402,368.8	25.2	07:03:55	6,063,952.5	404,162.5	22.2	20:06
PT09		09:07:42	6,060,603.7	400,620.4	32.7	09:27:45	6,060,978.7	398,866.1	30.1	20:03
PT10		11:28:50	6,056,382.5	405,447.9	26.6	11:48:57	6,056,133.4	407,601.3	23.1	20:07
PT11		14:12:50	6,052,942.4	399,193.1	33.2	14:32:53	6,053,146.9	397,686.8	33.4	20:03
PT12		16:45:44	6,049,147.0	405,718.1	27.0	17:05:47	6,049,262.4	407,818.2	33.6	20:03
PT13	24/09/2011	06:35:41	6,045,714.1	400,444.2	34.3	06:55:45	6,046,054.9	398,475.8	32.1	20:04
PT14	15/09/2011	15:16:45	6,086,661.3	477,999.9	25.2	15:36:51	6,086,104.4	476,476.8	25.2	20:06
PT15	16/09/2011	06:45:02	6,083,291.0	474,676.2	24.8	07:05:03	6,083,244.0	472,988.7	25.7	20:01
PT16		10:52:19	6,079,746.0	483,256.3	20.8	11:12:22	6,079,779.2	485,153.8	21.0	20:03
PT17		14:24:14	6,076,207.8	464,787.4	23.9	14:44:20	6,076,301.7	462,655.4	23.5	20:06
PT18	17/09/2011	06:37:23	6,072,450.0	481,684.2	21.0	06:57:34	6,072,803.4	483,806.6	21.1	20:11
PT19		10:09:02	6,068,801.0	470,271.7	23.5	10:29:05	6,069,036.0	468,959.7	23.1	20:03
PT20		14:47:53	6,065,159.5	455,091.1	19.7	14:54:01	6,065,182.4	455,555.1	20.4	06:08
PT21		16:50:04	6,064,788.9	474,404.0	20.6	17:10:19	6,064,761.8	476,147.2	20.4	20:15
PT21A	18/09/2011	07:14:07	6,063,015.3	485,217.1	20.0	07:34:14	6,061,163.4	485,245.4	19.5	20:07
PT22		09:38:58	6,061,111.2	464,424.4	21.1	09:59:08	6,061,082.8	462,803.6	21.5	20:10
PT23		15:14:56	6,057,362.5	468,087.0	20.0	15:34:56	6,057,209.0	469,496.5	19.9	20:00
PT24	22/09/2011	17:15:52	6,053,688.1	449,743.4	25.0	17:35:55	6,053,696.9	451,583.0	24.4	20:03
PT25		13:40:45	6,050,253.4	464,529.6	21.7	14:00:45	6,050,556.2	463,218.0	23.1	20:00
PT26		Omitted due to poor weather conditions								
PT27		07:35:28	6,042,998.3	456,884.2	19.7	07:55:28	6,043,331.7	455,156.3	19.5	20:00
PT28	21/09/2011	15:40:50	6,039,100.6	444,249.6	17.5	16:00:52	6,039,106.4	442,776.9	18.0	20:02
PT29		12:30:19	6,035,551.6	450,394.1	18.0	12:50:21	6,035,967.4	449,076.0	19.1	20:02
PT30		10:04:10	6,031,835.6	440,182.7	33.8	10:24:17	6,032,005.5	442,132.0	32.7	20:07
PT31	26/09/2011	06:49:21	6,058,098.3	367,336.1	58.4	07:09:21	6,057,375.2	366,123.2	60.5	20:00
PT32		09:01:01	6,051,012.5	359,573.0	62.8	09:21:12	6,049,928.7	358,840.8	63.2	20:11
PT33		10:48:07	6,046,313.1	356,197.8	63.2	11:08:08	6,045,266.3	354,713.1	61.7	20:01
PT34		12:36:20	6,035,200.2	348,474.3	60.1	12:56:20	6,033,442.0	347,367.0	65.8	20:00
PT35		14:32:23	6,024,870.0	342,330.5	67.6	14:52:24	6,023,090.1	341,257.2	63.7	20:01
PT36		16:07:08	6,015,619.8	337,380.4	65.2	16:27:09	6,014,415.8	336,102.0	67.0	20:01
PT37	27/09/2011	07:50:41	6,009,087.1	326,479.1	57.5	08:10:45	6,008,743.5	324,887.0	57.2	20:04

Table 5.8 Times, Co-ordinates and Depths of Deployment of CTD Probe

Station	Date	Probe			
		Time (GMT)	UTM31N		Depth (m)
			Latitude	Longitude	
PT03	25/09/2011	07:01:36	6,078,407.9	367,265.1	62.1
PT06		15:07:51	6,066,512.3	368,031.4	65.6
PT12	23/09/2011	17:08:02	6,049,279.0	407,958.7	33.2
PT16	16/09/2011	11:14:16	6,079,810.3	485,226.8	20.8
PT20	17/09/2011	15:03:14	6,065,474.8	455,915.1	20.6
PT22	18/09/2011	10:01:10	6,061,067.7	462,736.4	21.3
PT24	22/09/2011	17:39:46	6,053,718.1	451,798.4	24.8
PT28	21/09/2011	16:06:03	6,039,247.0	442,602.1	17.8
PT32	26/09/2011	09:23:52	6,049,915.6	358,789.4	63.0
PT35		14:54:41	6,022,946.3	341,243.0	65.2
PT37	27/09/2011	08:13:02	6,008,796.1	324,766.5	56.8

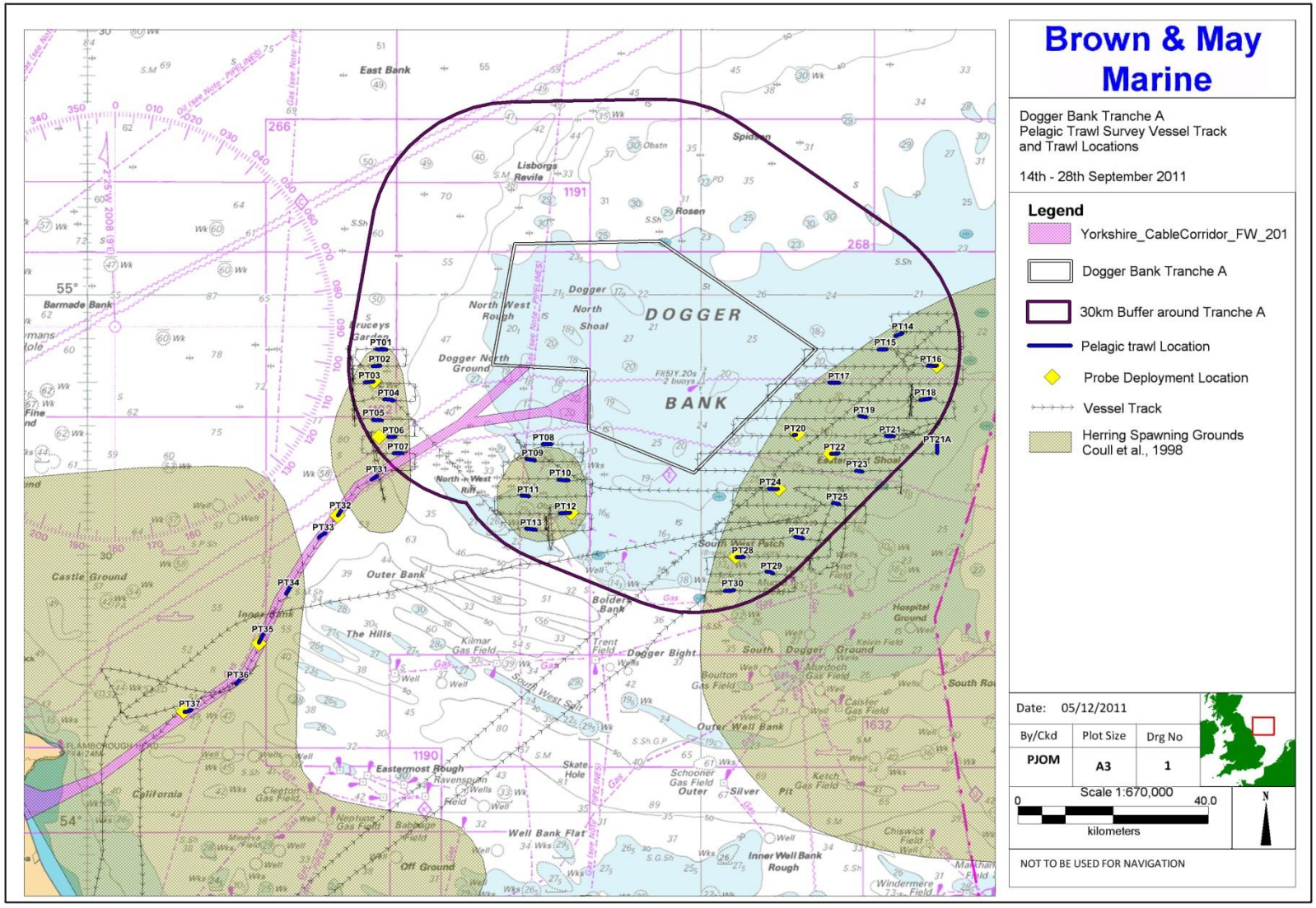


Figure 5.3 Pelagic Trawl Tow Tracks and CTD Probe Deployment Locations

6.0 Pelagic Trawl Results

6.1 Catch Rates and Species Distribution

The total number of individuals caught and the catch rate (number of individuals caught per hour) for fish species caught by sampling area (transects A to D) are given in Table 6.1 below. The catch rate by species and sampling area is illustrated in Figure 6.1 and the catch rate by species and station is given in Figure 6.2 to Figure 6.5.

A total of 11 species were caught. Overall, *S. sprattus* was the most abundant species caught with 32,049 individuals (2,636.8 individuals/hr). *S. scombrus* was the most abundant species in transect A (158.6/hr) and B (36.9/hr). In transect C, *S. sprattus* was the most prevalent species (5,873.0/hr), and *M. merlangus* was dominant (1,061.4/hr) in transect D.

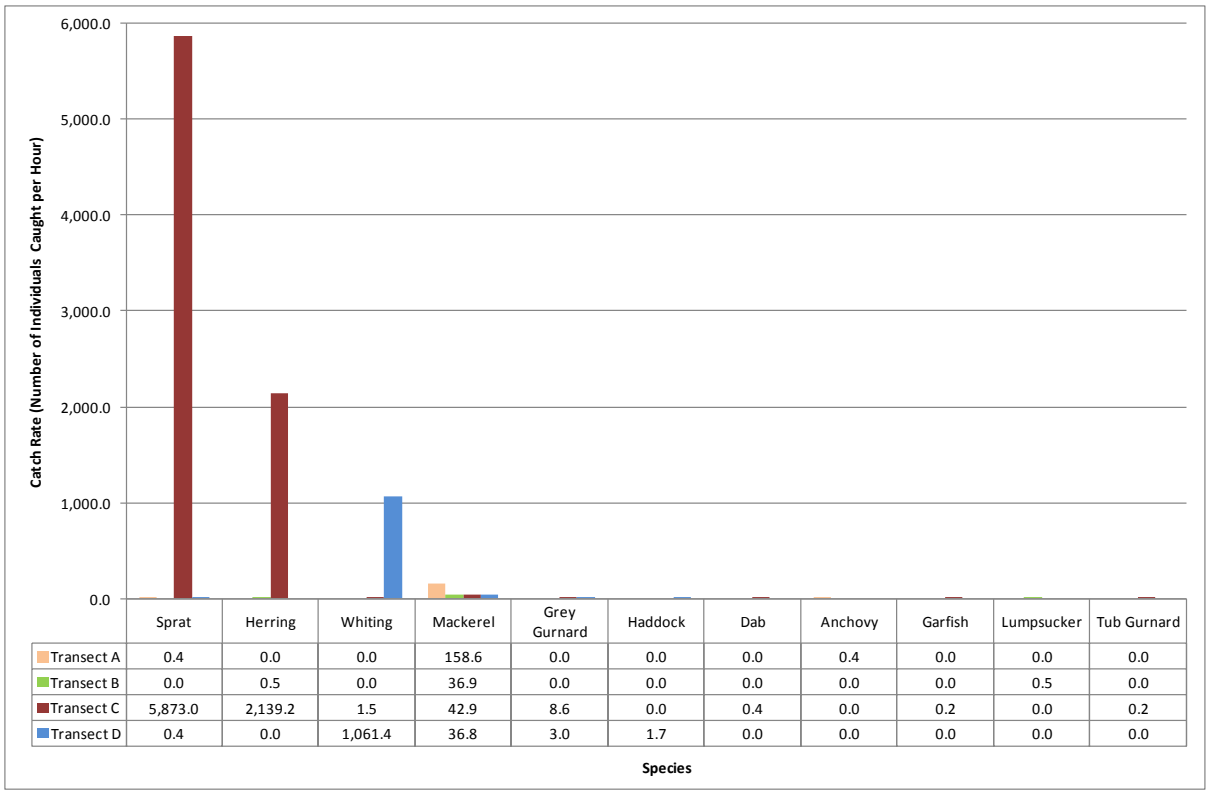
The greatest total catch rate was recorded at station PT19 (94,994.5/hr) followed by PT15 (26,303.1/hr) both of which are found in transect C. At station PT19, *S. sprattus* accounted for the majority of the catch (85.1%) whereas at PT15, *C. harengus* represented the larger proportion of the catch (66.4%).

Overall, the total catch rate was highest in transect C (8,065.9/hr), followed by transect D (1,103.3/hr). Considerably lower catch rates were recorded for transects A and B (159.4/hr and 37.9/hr respectively).

It should be noted that while an additional trawl was undertaken (PT21a), as several pelagic shoal marks were observed. The catch at station PT21a was predominantly *S. sprattus* (CR; 1,161.5/hr) although *C. harengus* (CR; 266.7/hr) and *S. scombrus* (CR; 71.1/hr) were present (Figure 6.4).

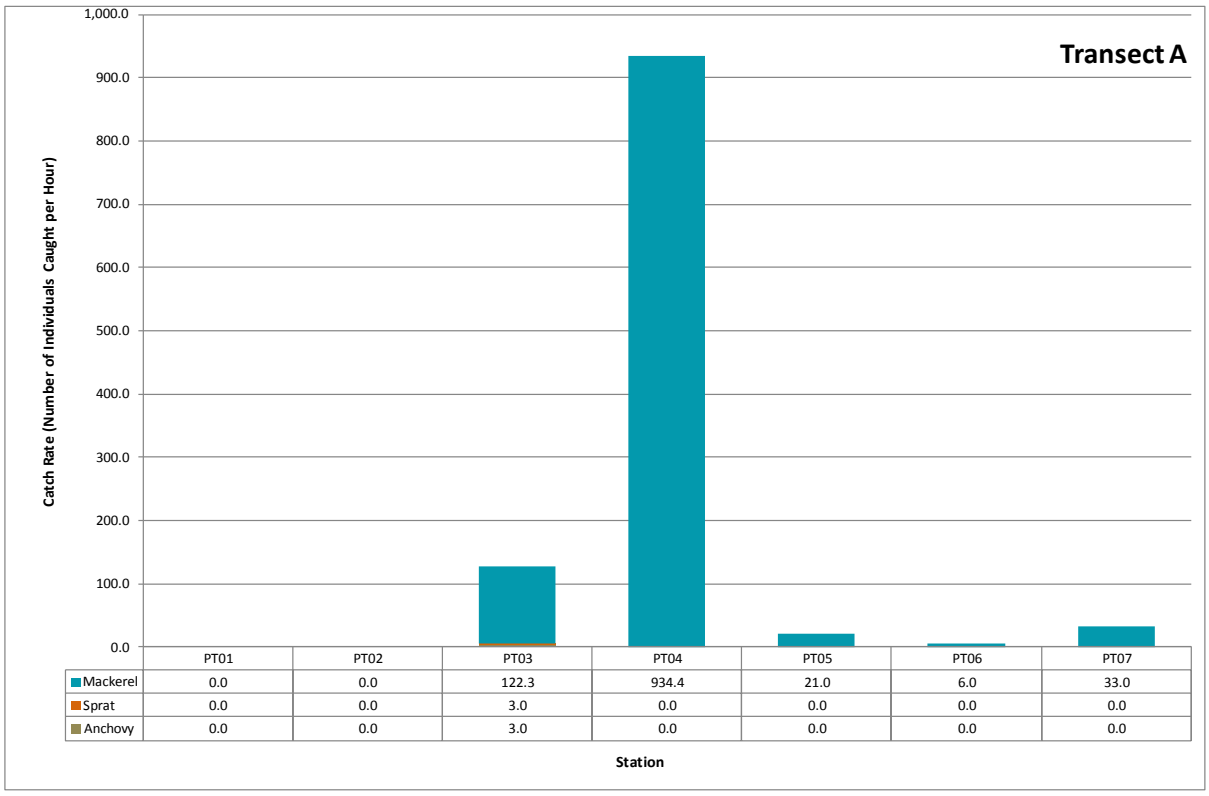
Table 6.1 Total Numbers of Individuals Caught and Catch Rate by Species and Sampling Area

Species		Number of Individuals Caught					Catch Rate (Number of Individuals Caught per Hour)			
		Transect				Total	Transect			
Common Name	Scientific Name	A	B	C	D		A	B	C	D
Sprat	*Sprattus sprattus*	1	0	32,047	1	32,049	0.4	0.0	5,873.0	0.4
Herring	*Clupea harengus*	0	1	11,673	0	11,674	0.0	0.5	2,139.2	0.0
Whiting	*Merlangius merlangus*	0	0	8	2,482	2,490	0.0	0.0	1.5	1,061.4
Mackerel	*Scomber scombrus*	373	74	234	86	767	158.6	36.9	42.9	36.8
Grey Gurnard	*Eutrigla gurnardus*	0	0	47	7	54	0.0	0.0	8.6	3.0
Haddock	*Melanogrammus aeglefinus*	0	0	0	4	4	0.0	0.0	0.0	1.7
Dab	*Limanda limanda*	0	0	2	0	2	0.0	0.0	0.4	0.0
Anchovy	*Engraulis encrasicolus*	1	0	0	0	1	0.4	0.0	0.0	0.0
Garfish	*Belone belone*	0	0	1	0	1	0.0	0.0	0.2	0.0
Lumpsucker	*Cyclopterus lumpus*	0	1	0	0	1	0.0	0.5	0.0	0.0
Tub Gurnard	*Trigla lucerna*	0	0	1	0	1	0.0	0.0	0.2	0.0



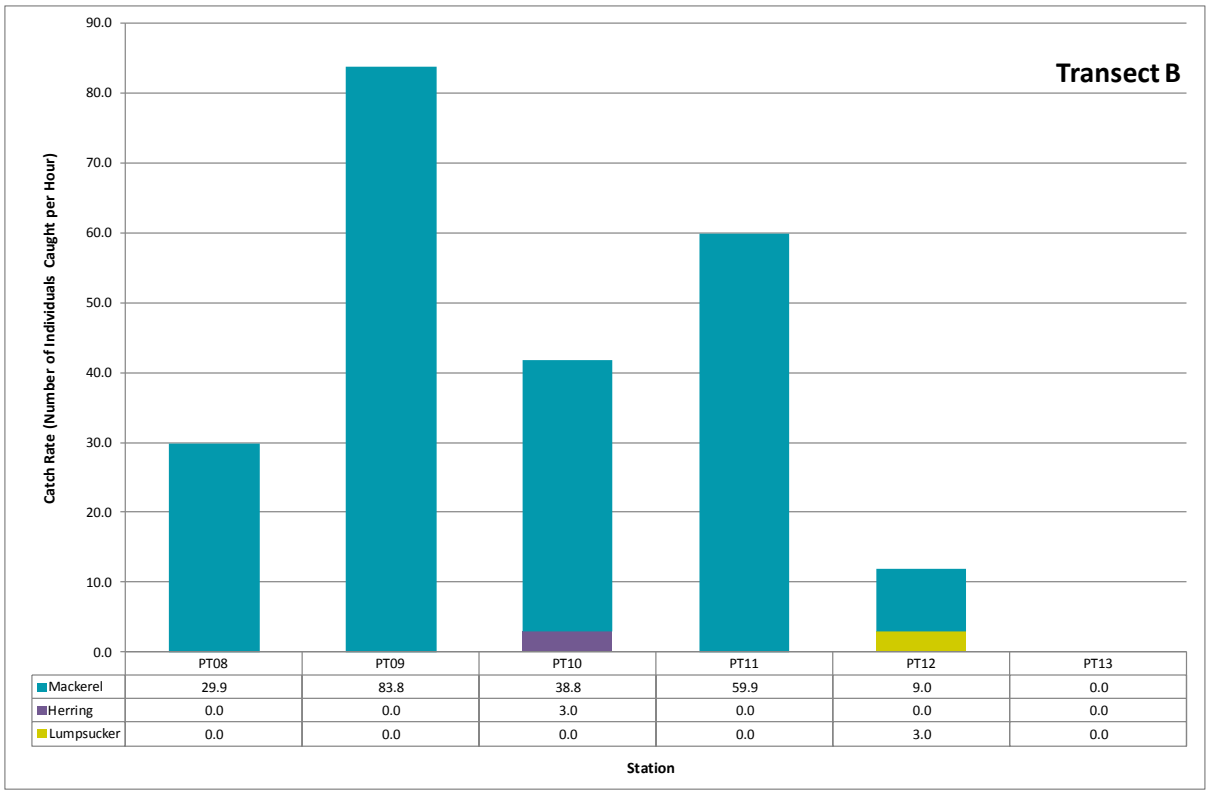
	Sprat	Herring	Whiting	Mackerel	Grey Gurnard	Haddock	Dab	Anchovy	Garfish	Lumpsucker	Tub Gurnard
Transect A	0.4	0.0	0.0	158.6	0.0	0.0	0.0	0.4	0.0	0.0	0.0
Transect B	0.0	0.5	0.0	36.9	0.0	0.0	0.0	0.0	0.0	0.5	0.0
Transect C	5,873.0	2,139.2	1.5	42.9	8.6	0.0	0.4	0.0	0.2	0.0	0.2
Transect D	0.4	0.0	1,061.4	36.8	3.0	1.7	0.0	0.0	0.0	0.0	0.0

Figure 6.1 Catch Rates by Species and Sampling Area



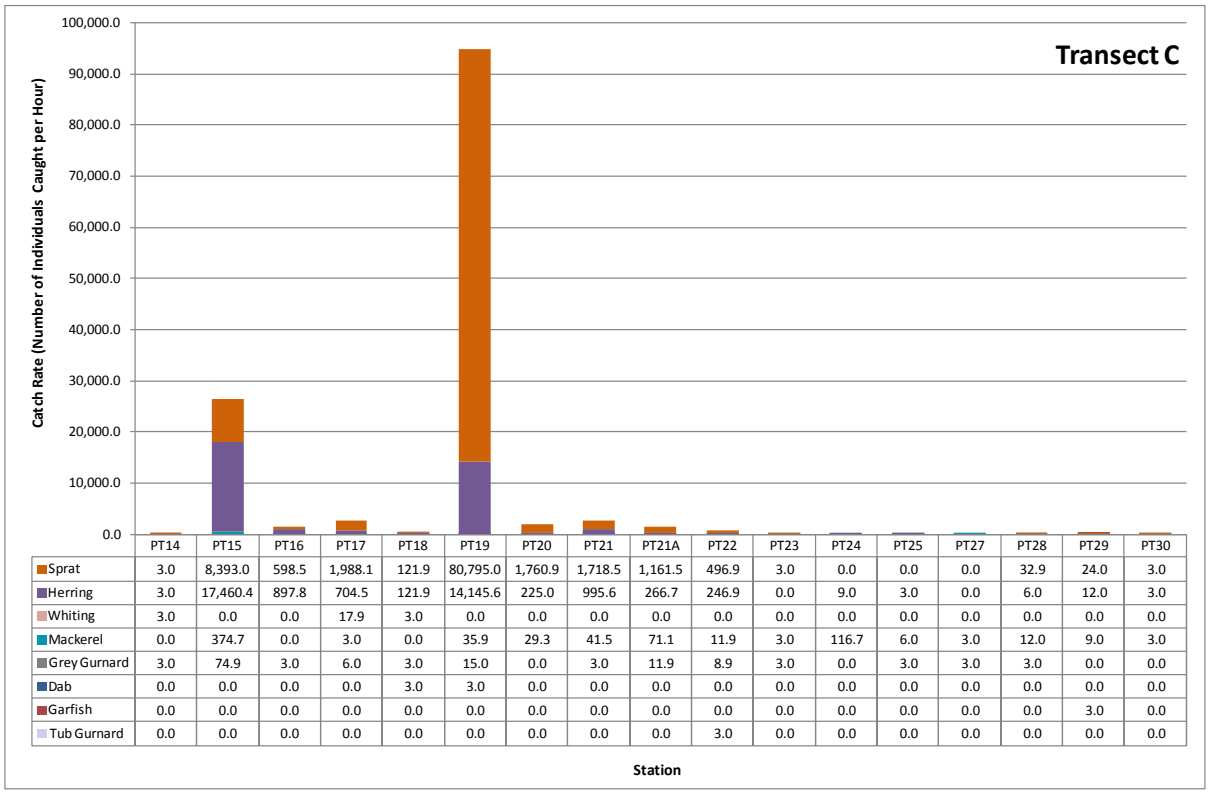
	PT01	PT02	PT03	PT04	PT05	PT06	PT07
Mackerel	0.0	0.0	122.3	934.4	21.0	6.0	33.0
Sprat	0.0	0.0	3.0	0.0	0.0	0.0	0.0
Anchovy	0.0	0.0	3.0	0.0	0.0	0.0	0.0

Figure 6.2 Catch Rate by Species and Station in Transect A



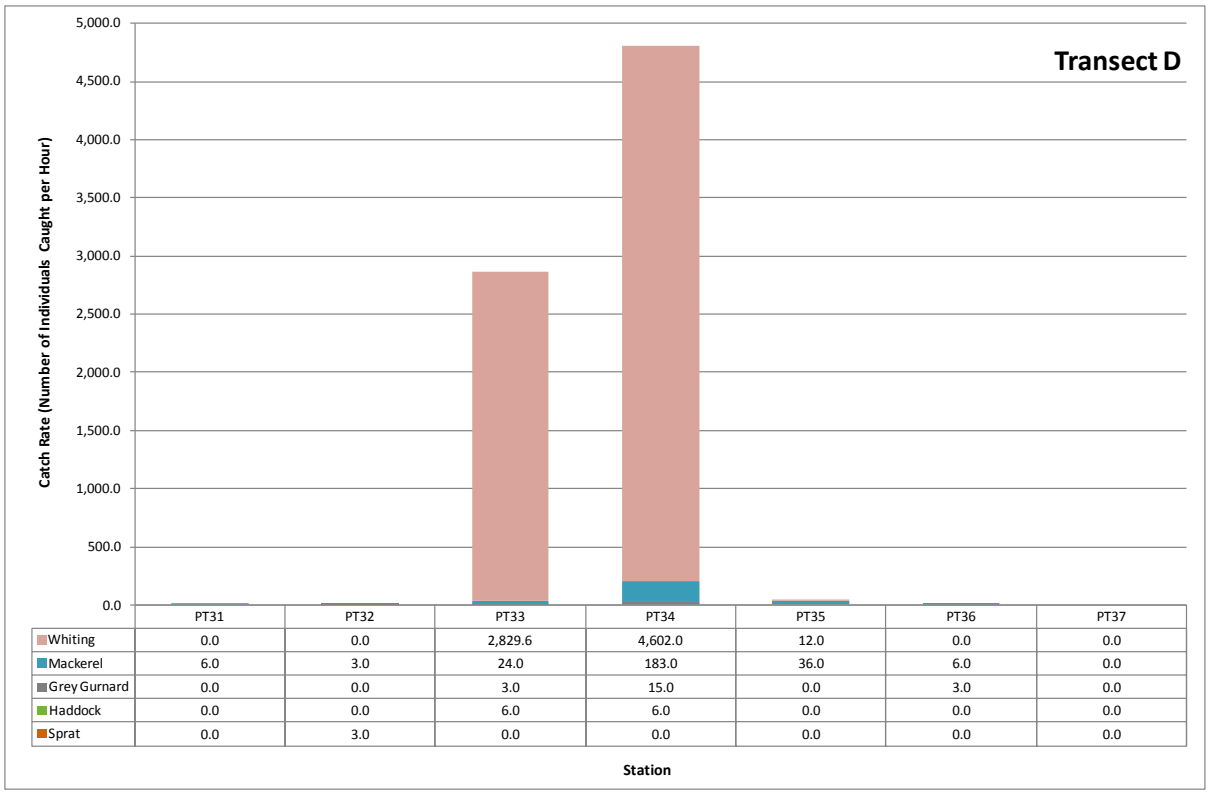
	PT08	PT09	PT10	PT11	PT12	PT13
Mackerel	29.9	83.8	38.8	59.9	9.0	0.0
Herring	0.0	0.0	3.0	0.0	0.0	0.0
Lumpsucker	0.0	0.0	0.0	0.0	3.0	0.0

Figure 6.3 Catch Rate by Species and Station in Transect B



	PT14	PT15	PT16	PT17	PT18	PT19	PT20	PT21	PT21A	PT22	PT23	PT24	PT25	PT27	PT28	PT29	PT30
Sprat	3.0	8,393.0	598.5	1,988.1	121.9	80,795.0	1,760.9	1,718.5	1,161.5	496.9	3.0	0.0	0.0	0.0	32.9	24.0	3.0
Herring	3.0	17,460.4	897.8	704.5	121.9	14,145.6	225.0	995.6	266.7	246.9	0.0	9.0	3.0	0.0	6.0	12.0	3.0
Whiting	3.0	0.0	0.0	17.9	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Mackerel	0.0	374.7	0.0	3.0	0.0	35.9	29.3	41.5	71.1	11.9	3.0	116.7	6.0	3.0	12.0	9.0	3.0
Grey Gurnard	3.0	74.9	3.0	6.0	3.0	15.0	0.0	3.0	11.9	8.9	3.0	0.0	3.0	3.0	3.0	0.0	0.0
Dab	0.0	0.0	0.0	0.0	3.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Garfish	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0
Tub Gurnard	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 6.4 Catch Rate by Species and Station in Transect C



	PT31	PT32	PT33	PT34	PT35	PT36	PT37
Whiting	0.0	0.0	2,829.6	4,602.0	12.0	0.0	0.0
Mackerel	6.0	3.0	24.0	183.0	36.0	6.0	0.0
Grey Gurnard	0.0	0.0	3.0	15.0	0.0	3.0	0.0
Haddock	0.0	0.0	6.0	6.0	0.0	0.0	0.0
Sprat	0.0	3.0	0.0	0.0	0.0	0.0	0.0

Figure 6.5 Catch Rate by Species and Station in Transect D

6.2 Length Distributions

The average length (cm) by sampling area (transects A to D) and length range by species, is given below in Table 6.2.

The length distributions of the most abundant species caught during the survey (>50 individuals), expressed as the catch rate (number of individuals caught per hour) by length interval (cm) and by transect, are shown in Figure 6.6 to Figure 6.9. The length distribution of *C. harengus* is analysed separately in section 7.0.

Table 6.2 Average Length and Length Ranges of the Most Abundant Species Caught by Sampling Area

Species		Average Length (cm)				Length Range (cm)	
		Transect					
Common Name	Scientific Name	A	B	C	D	Min.	Max.
Sprat	*Sprattus sprattus*	12.5	0.0	12.1	13.0	10.5	15.5
Herring	*Clupea harengus*	0.0	21.0	16.5	0.0	5.0	25.5
Whiting	*Merlangius merlangus*	0.0	0.0	19.8	22.0	17.0	39.0
Mackerel	*Scomber scombrus*	24.1	22.9	24.6	24.0	16.0	36.0
Grey Gurnard	*Eutrigla gurnardus*	0.0	0.0	24.4	19.1	13.0	29.0
Haddock	*Melanogrammus aeglefinus*	0.0	0.0	0.0	33.0	31.0	34.0
Dab	*Limanda limanda*	0.0	0.0	20.5	0.0	19.0	22.0
Anchovy	*Engraulis encrasicolus*	17.5	0.0	0.0	0.0	17.5	17.5
Garfish	*Belone belone*	0.0	0.0	59.0	0.0	59.0	59.0
Lumpsucker	*Cyclopterus lumpus*	0.0	8.0	0.0	0.0	8.0	8.0
Tub Gurnard	*Trigla lucerna*	0.0	0.0	29.0	0.0	29.0	29.0

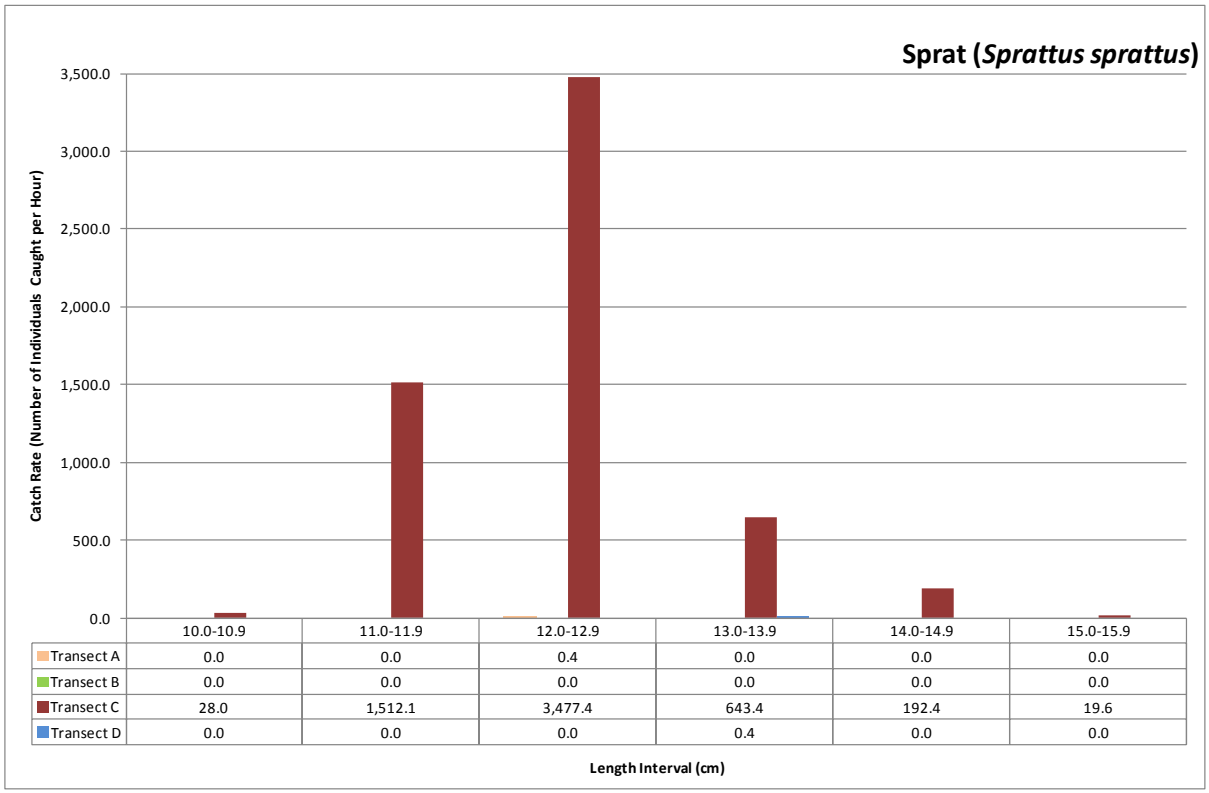
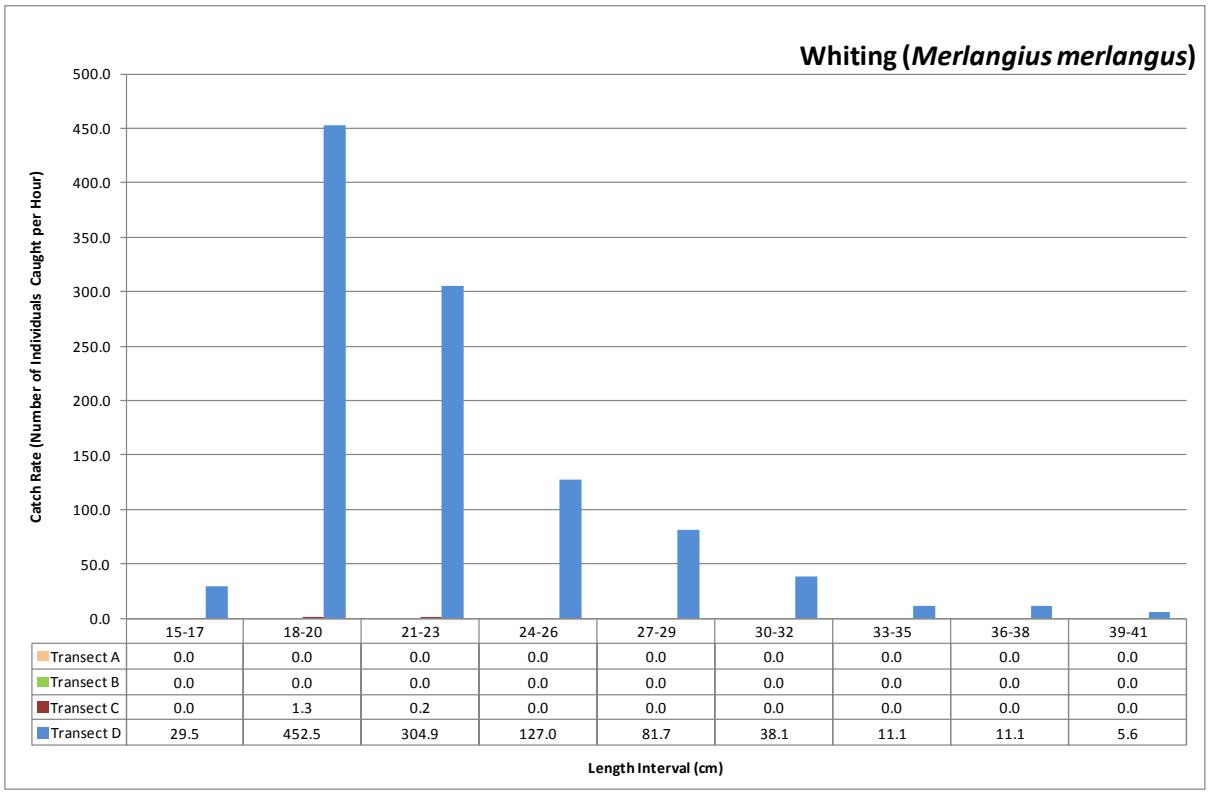
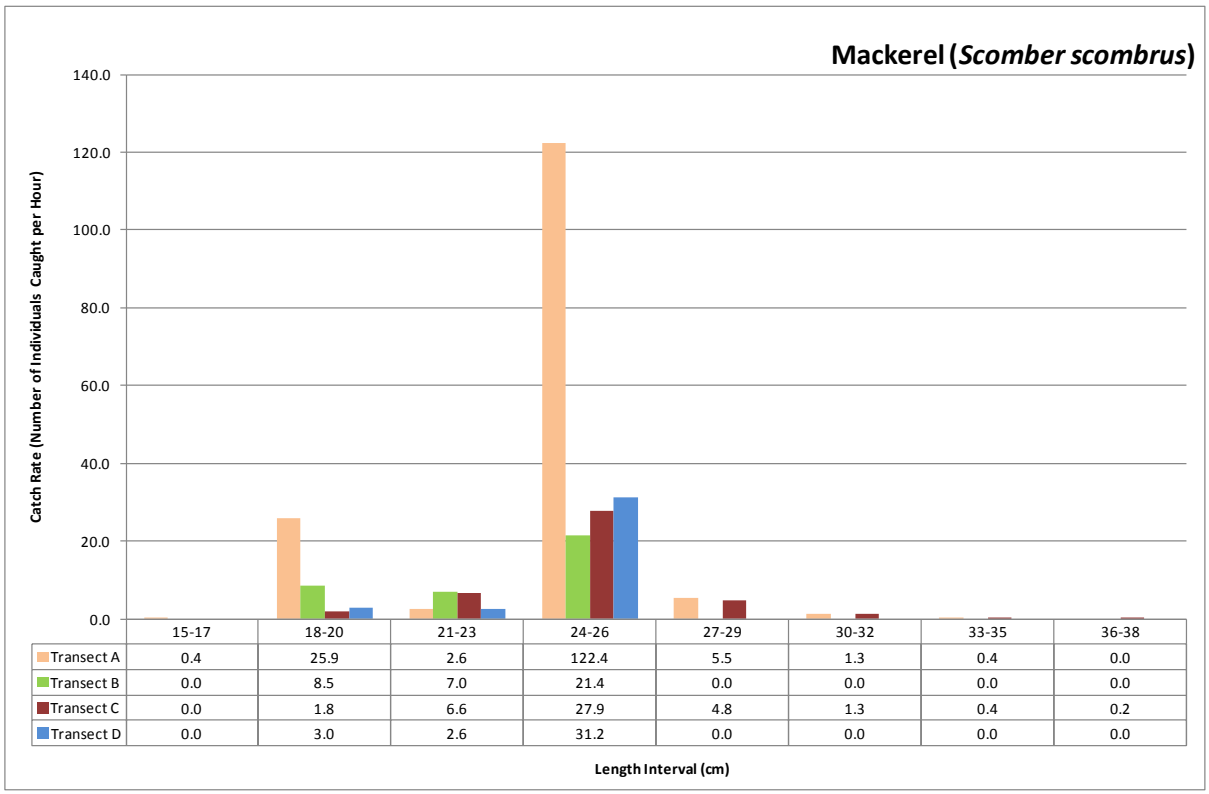


Figure 6.6 Sprat (*S. sprattus*) Length Distribution by Sampling Area



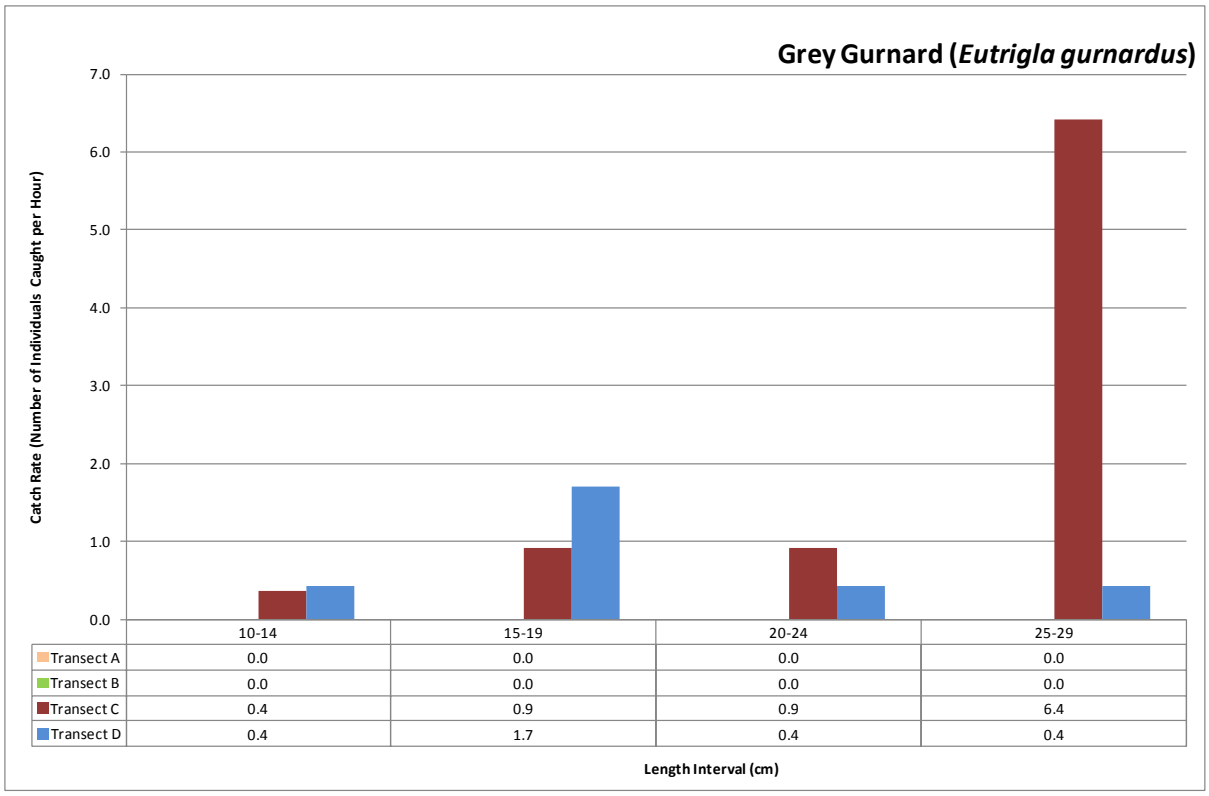
	15-17	18-20	21-23	24-26	27-29	30-32	33-35	36-38	39-41
Transect A	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transect B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Transect C	0.0	1.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Transect D	29.5	452.5	304.9	127.0	81.7	38.1	11.1	11.1	5.6

Figure 6.7 Whiting (*M. merlangus*) Length Distribution by Sampling Area



	15-17	18-20	21-23	24-26	27-29	30-32	33-35	36-38
Transect A	0.4	25.9	2.6	122.4	5.5	1.3	0.4	0.0
Transect B	0.0	8.5	7.0	21.4	0.0	0.0	0.0	0.0
Transect C	0.0	1.8	6.6	27.9	4.8	1.3	0.4	0.2
Transect D	0.0	3.0	2.6	31.2	0.0	0.0	0.0	0.0

Figure 6.8 Mackerel (*S. scombrus*) Length Distribution by Sampling Area



	10-14	15-19	20-24	25-29
Transect A	0.0	0.0	0.0	0.0
Transect B	0.0	0.0	0.0	0.0
Transect C	0.4	0.9	0.9	6.4
Transect D	0.4	1.7	0.4	0.4

Figure 6.9 Grey Gurnard (*E. gurnardus*) Length Distribution by Sampling Area

6.3 Minimum Landing Sizes (MLS)

Minimum landing sizes (MLS) for fish and shellfish species are set by the European Commission (EC) under Regulation No. 850/98 (Annex XII). The planned Dogger Bank offshore wind farm is an area subject to the MLS regulations set by the EC.

Table 6.3 shows the five species caught for which a MLS has been set, and denotes their presence or absence by sampling area (transects A to D).

Table 6.3 MLS Set by EC

Species		EU MLS (cm)	Presence			
			Transect			
Common Name	Scientific Name		A	B	C	D
Herring	*Clupea harengus*	20	-	✓	✓	-
Whiting	*Merlangius merlangus*	27	-	-	✓	✓
Mackerel	*Scomber scombrus*	30	✓	✓	✓	✓
Haddock	*Melanogrammus aeglefinus*	30	-	-	-	✓
Anchovy	*Engraulis encrasicolus*	12	✓	-	-	-

The percentage of individuals caught above and below their set MLS, by species and sampling area (transects A to D) are given in Figure 6.10 to Figure 6.13.

Most of the *C. harengus* found in transect C were below the MLS (99.7%), whereas only one *C. harengus* was caught in transect B and was above the MLS.

M. merlangus were found only in transects C and D, the majority of which were below the MLS (100.0% and 86.1% respectively).

Most of the *S. scombrus,* caught in all transects (A, 98.9%; B, 100.0%; C, 95.7 %; D, 100.0 %), were below the set MLS.

Four *M. aeglefinus* were found in transect D, all of which were above the set MLS.

Only one *E. encrasicolus* was caught, found in transect A, and was above the set MLS.

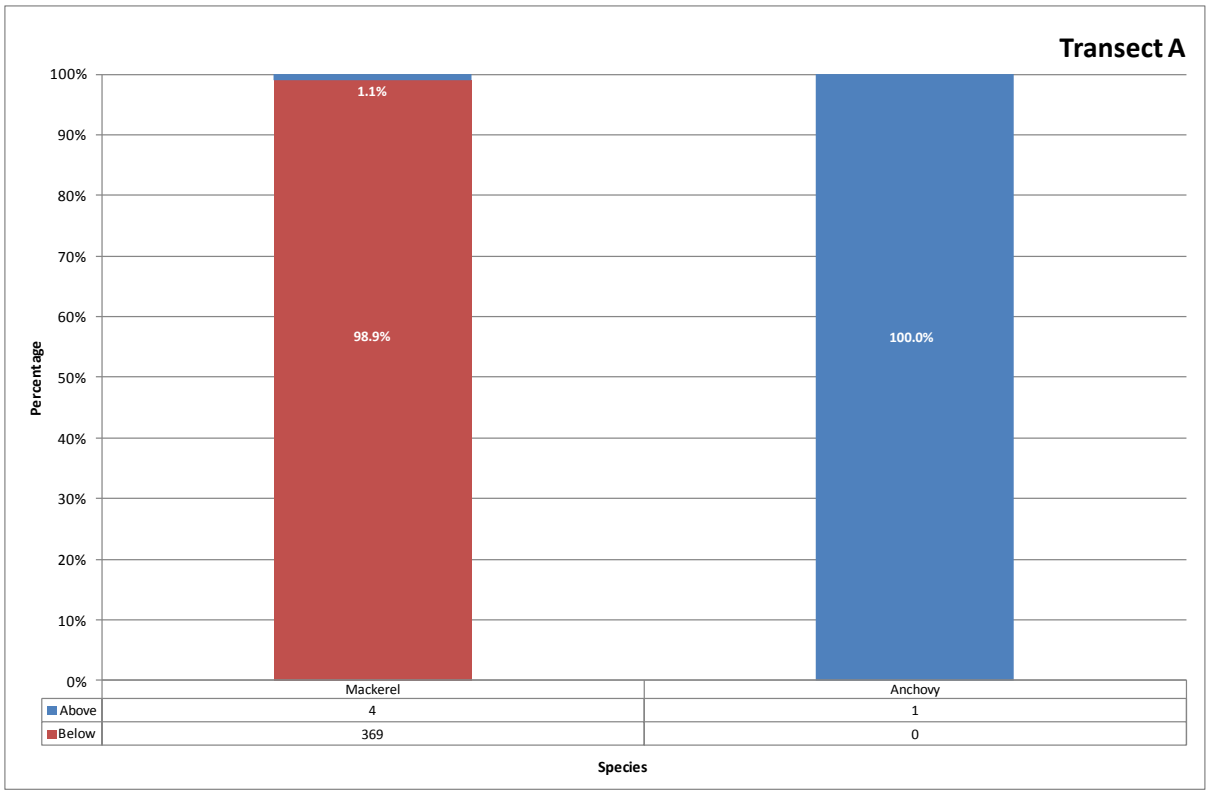


Figure 6.10 Percentage of the Catch Above and Below the MLS by Species in Transect A

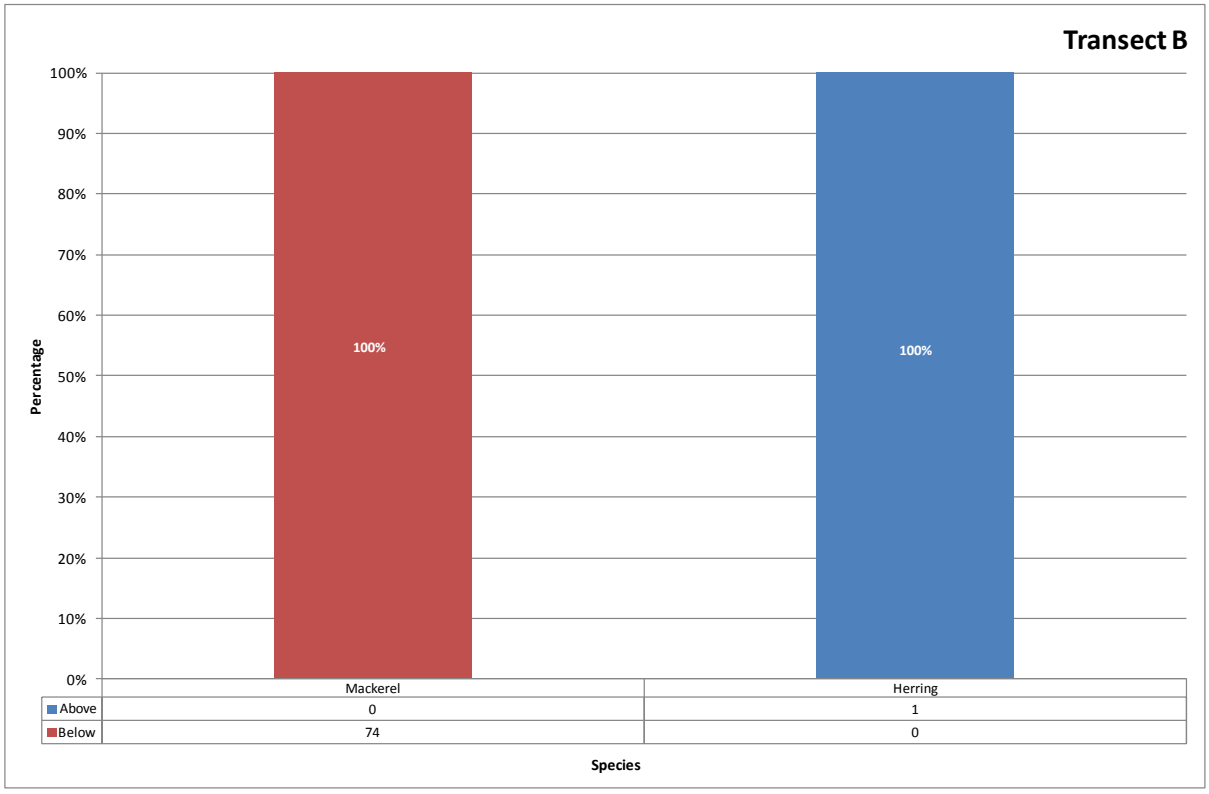


Figure 6.11 Percentage of the Catch Above and Below the MLS by Species in Transect B

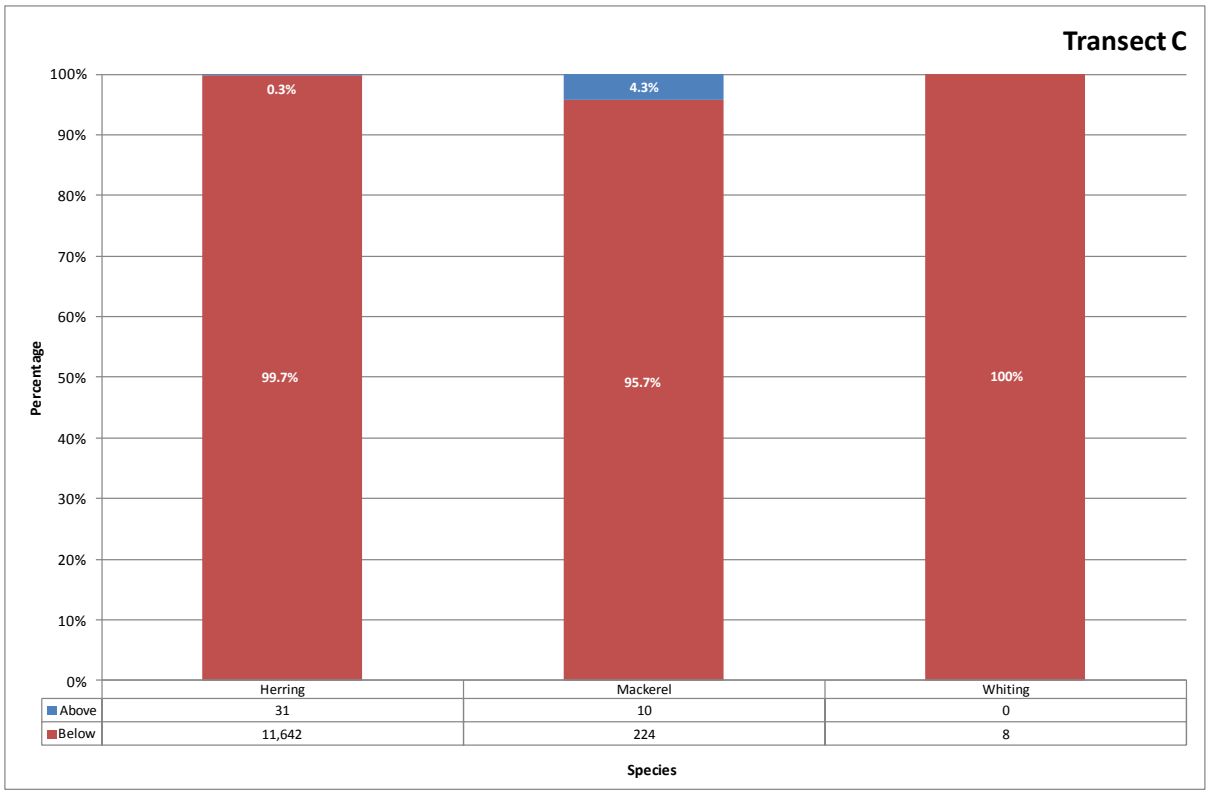


Figure 6.12 Percentage of the Catch Above and Below the MLS by Species in Transect C

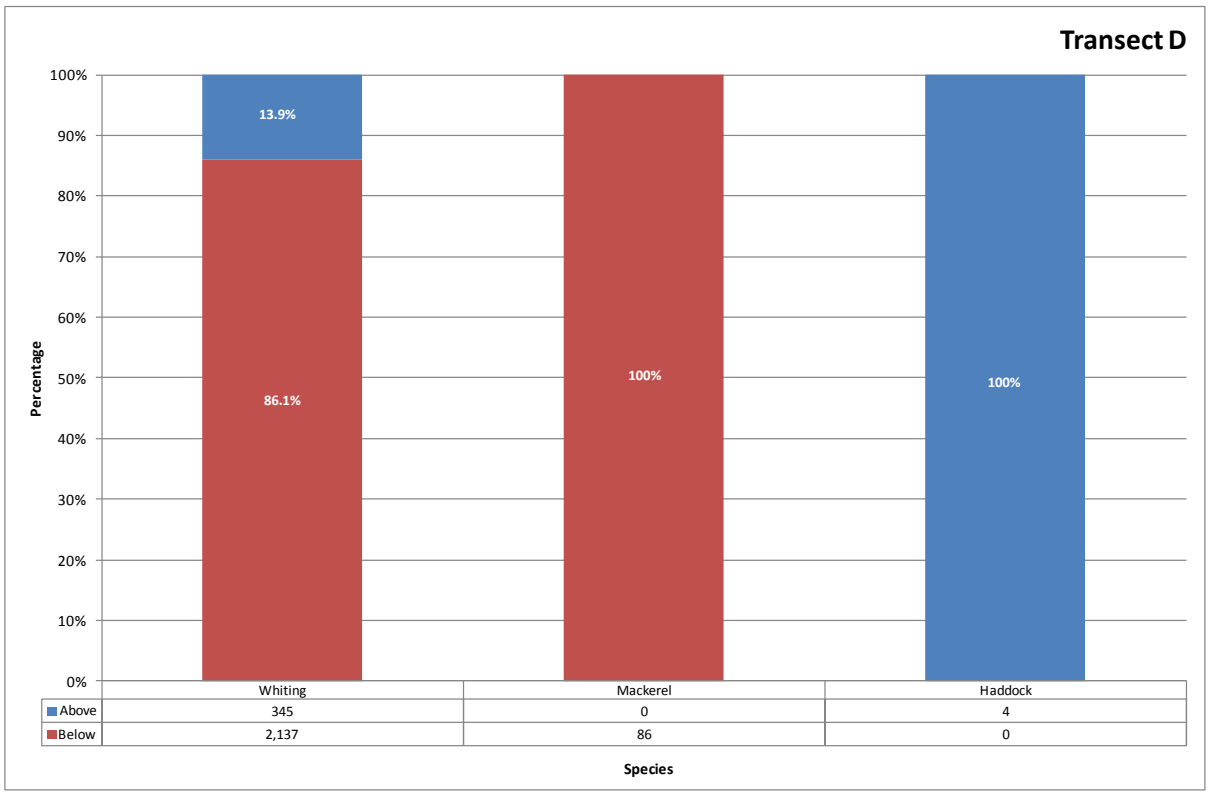


Figure 6.13 Percentage of the Catch Above and Below the MLS by Species in Transect D

6.4 Sex Ratios

The sex ratios of the five most abundant species caught (>50 individuals), by sampling area (transects A to D) are given in Figure 6.14 to Figure 6.17. It should be noted that Cefas were unable to confidently determine the sex of a number of immature individuals. All of the *S. sprattus* caught were unsexed due to their small size, and have therefore been excluded from the charts below.

A greater proportion of the *S. scombrus* caught in transect A were female (45.3%), whereas in transects B, C and D the sex ratio was approximately 50:50.

Only one male *C. harengus* was caught in transect B, whereas in transect C, a larger proportion of the *C. harengus* were identified as female.

The majority of *E. gurnardus* caught in transects C and D were female (78.7% and 57.1% respectively).

Only female *M. merlangus* were identified in transect C (25.0%), and a greater proportion of those found in transect D were also female (41.5%).

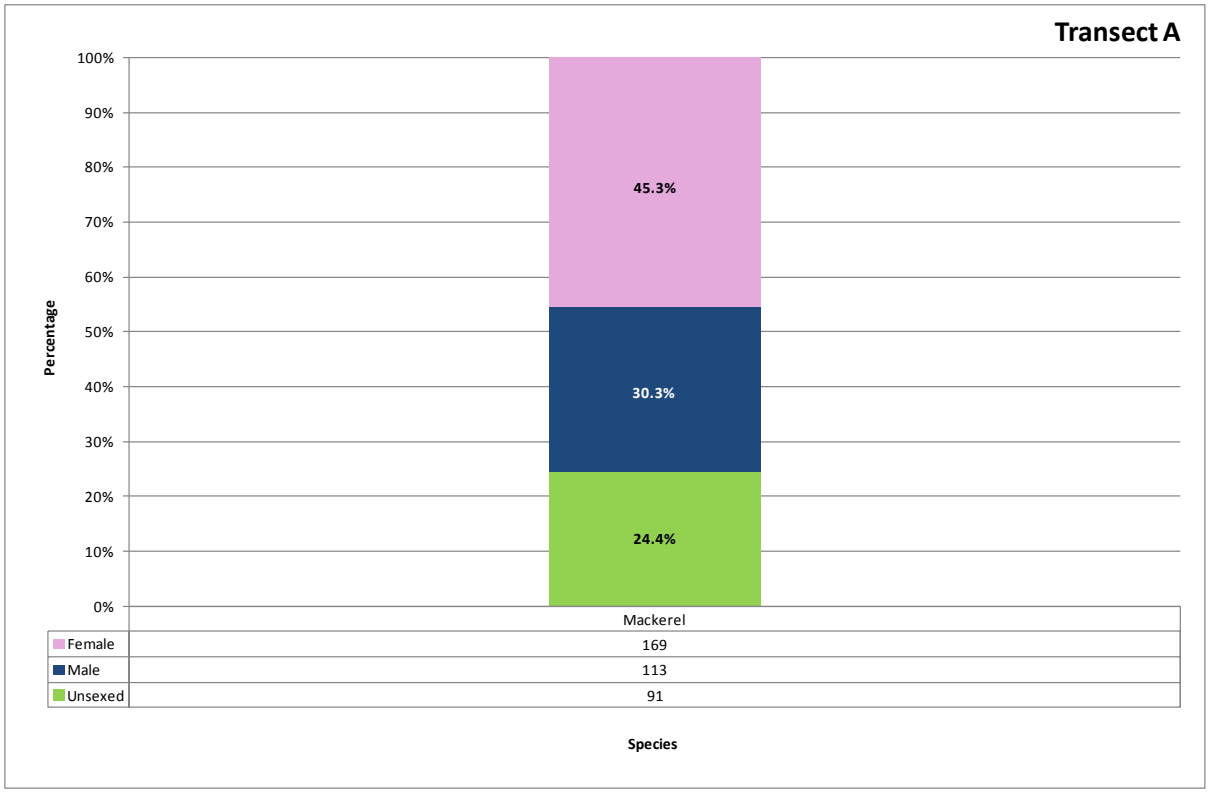


Figure 6.14 Sex Ratio by Species in Transect A

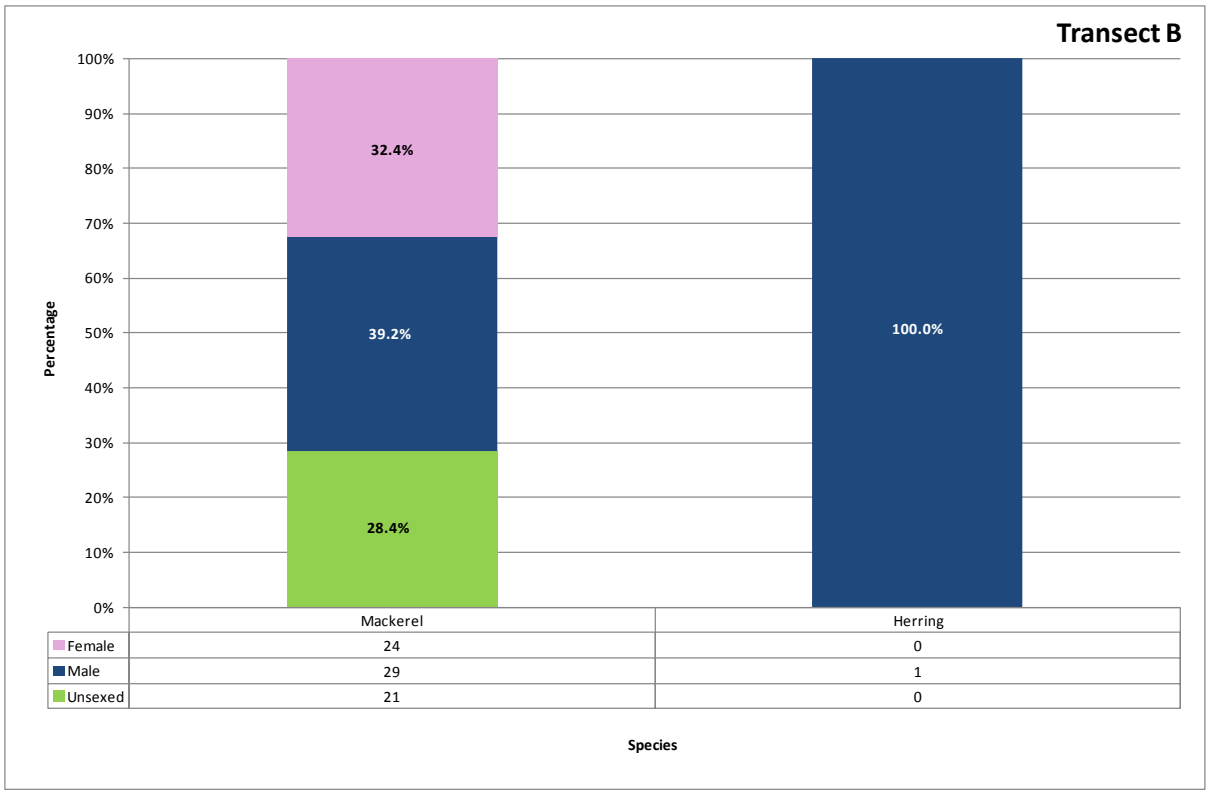


Figure 6.15 Sex Ratio by Species in Transect B

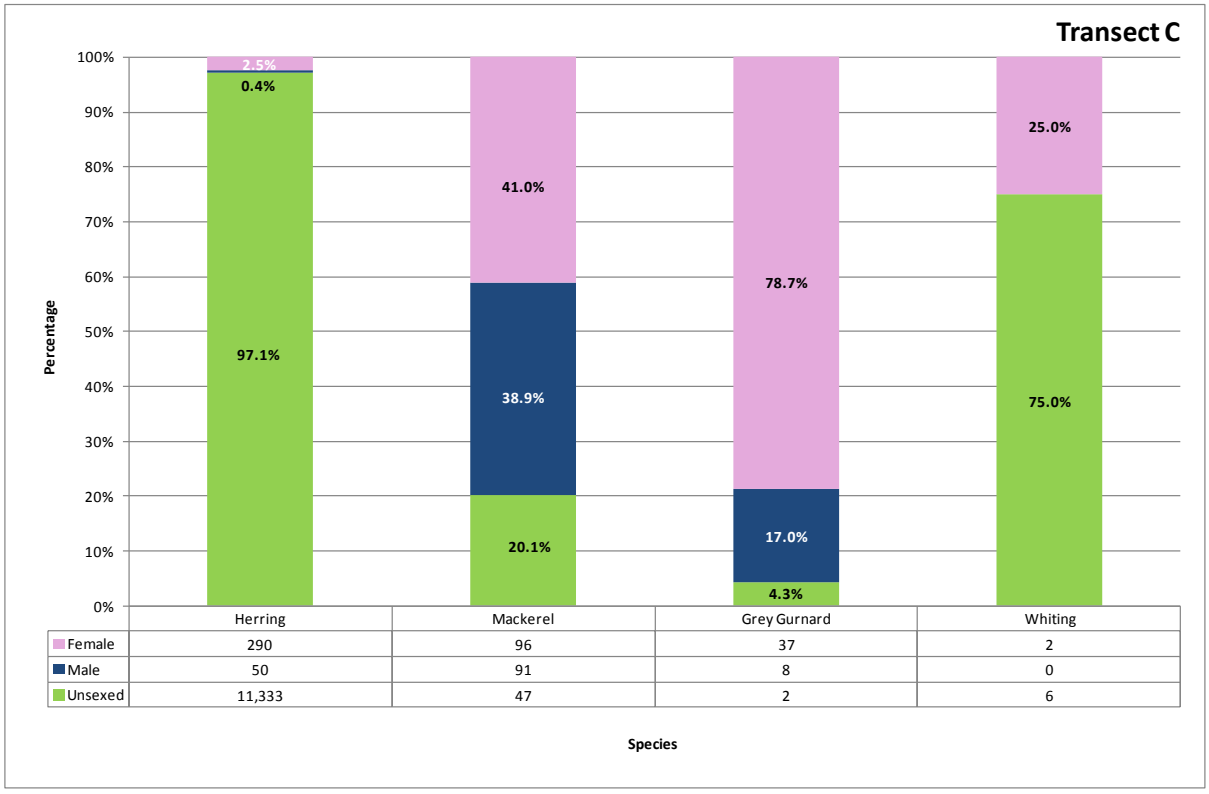


Figure 6.16 Sex Ratio by Species in Transect C

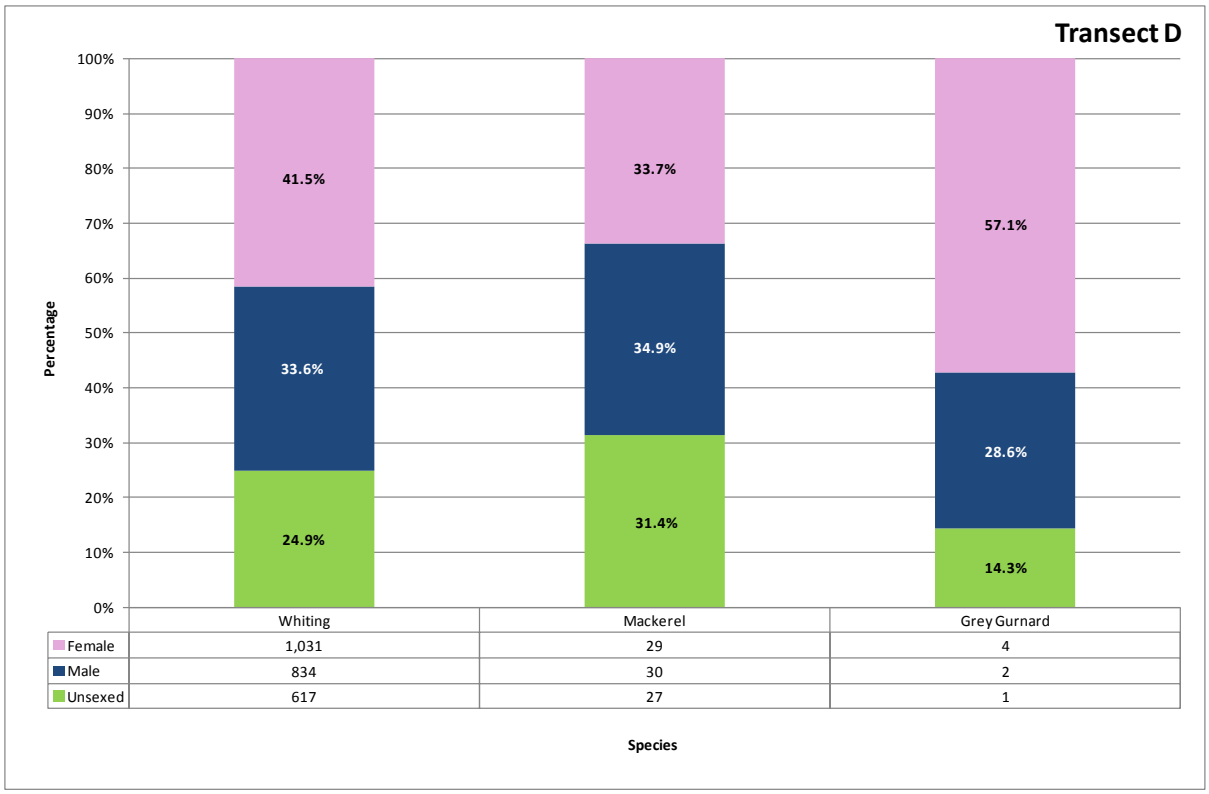


Figure 6.17 Sex Ratio by Species in Transect D

6.5 Spawning Condition

The spawning condition, sex and length range (nearest cm below) of the most abundant species (>50 individuals) caught during the survey are given in Table 6.4 to Table 6.6. Where a stage of maturity was not recorded for a species it has not been included in the following tables.

It should be noted that Cefas were unable to confidently determine the sex of a number of immature fish, or the maturity of all of the *S. sprattus* caught. *S. sprattus* have therefore been excluded from the following tables. *C. harengus* will be discussed separately in section 7.0.

M. merlangus were caught only in transects C and D, most of which were immature (82.9%), with lengths ranging from 17cm to 29cm.

The majority of *S. scombrus* caught over transects A to D were immature (86.6%) with lengths ranging from 16cm to 30cm.

E. gurnardus were found only in transects C and D. In transect C, maturing female fish contributed the greatest percentage (48.1%) whereas in transect D, most of the individuals were identified as immature (85.7%). Length ranges varied from 13cm to 25cm for immature fish and 19cm to 26cm for maturing individuals.

Table 6.4 Whiting *(M. merlangus)* Spawning Condition

Whiting									
Sex	Maturity	Individuals Caught				Total	% of Total Catch	Length Range (cm)	
		Transect							
		A	B	C	D			Min.	Max.
Female	Immature	0	0	2	739	741	29.8%	17	27
	Spent	0	0	0	292	292	11.7%	23	39
Male	Immature	0	0	0	700	700	28.1%	17	29
	Spent	0	0	0	134	134	5.4%	23	31
Unsexed	Immature	0	0	6	617	623	25.0%	17	24

Table 6.5 Mackerel (*S. scombrus*) Spawning Condition

Mackerel									
Sex	Maturity	Individuals Caught				Total	% of Total Catch	Length Range (cm)	
		Transect							
		A	B	C	D			Min.	Max.
Female	1 - Virgin	129	21	63	29	242	31.6%	19	30
	2 – Early Ripening	0	0	1	0	1	0.1%	25	25
	6 – Spent/Recovering Spent	40	3	33	0	76	9.9%	25	36
Male	1 - Virgin	102	21	84	30	237	30.9%	18	27
	6 – Spent/Recovering Spent	11	8	7	0	26	3.4%	23	35
Unsexed	1 - Virgin	91	21	46	27	185	24.1%	16	25

Table 6.6 Grey Gurnard (*E. gurnardus*) Spawning Condition

Grey Gurnard									
Sex	Maturity	Individuals Caught				Total	% of Total Catch	Length Range (cm)	
		Transect							
		A	B	C	D			Min.	Max.
Female	Immature	0	0	4	2	6	11.1%	16	25
	Maturing	0	0	26	0	26	48.1%	19	26
	Spent	0	0	7	2	9	16.7%	24	29
Male	Immature	0	0	4	2	6	11.1%	16	24
	Maturing	0	0	1	0	1	1.9%	20	20
	Spent	0	0	3	0	3	5.6%	24	27
Unsexed	Immature	0	0	2	1	3	5.6%	13	14

7.0 Herring (*C. harengus*) Results

7.1 Number of Individuals and Catch Rates

The total number of *C. harengus* caught and the catch rate (number of individuals caught per hour) by station is given in Table 7.1 (green and red stations represent transects B and C respectively). Figure 7.1 presents the catch rate by station (green and red boxes correspond to transects B and C respectively).

The tow tracks for each station and the catch rate (number of individuals caught per hour) of *C. harengus* caught is illustrated in Figure 7.2.

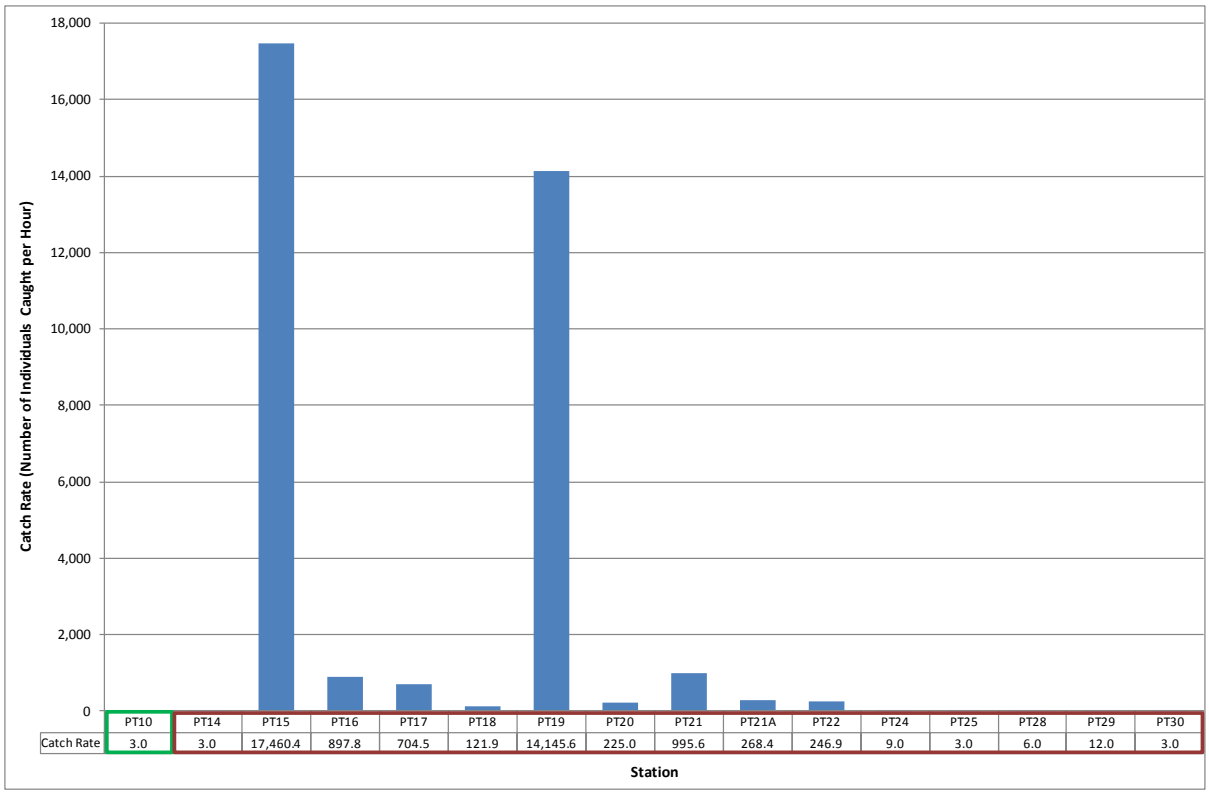
As mentioned previously, one additional trawl was undertaken between stations PT21 and PT22, labelled PT21a, when several marks characteristic of *C. harengus* were observed on the vessels echo sounder, however, the catch at PT21a was predominantly *S. sprattus*.

C. harengus were found only in transects B and C. The majority of *C. harengus* were caught in transect C (11,673), at stations PT15 (5,825) and PT19 (4,727), with catch rates of 17,460.4/hr and 14,145.6/hr at these stations, respectively.

Only one individual was caught in transect B at station PT10.

Table 7.1 Number of Individuals, Percentage of Total Catch and Catch Rate per Station

Station	Number of individuals Caught	% of Total Catch	Catch Rate (Number of Individuals Caught per Hour)
PT10	1	0.01%	3.0
PT14	1	0.01%	3.0
PT15	5,825	49.90%	17,460.4
PT16	300	2.57%	897.8
PT17	236	2.02%	704.5
PT18	41	0.35%	121.9
PT19	4,727	40.49%	14,145.6
PT20	23	0.20%	225.0
PT21	336	2.88%	995.6
PT21A	90	0.77%	268.4
PT22	83	0.71%	246.9
PT24	3	0.03%	9.0
PT25	1	0.01%	3.0
PT28	2	0.02%	6.0
PT29	4	0.03%	12.0
PT30	1	0.01%	3.0
Total	11,674		



	PT10	PT14	PT15	PT16	PT17	PT18	PT19	PT20	PT21	PT21A	PT22	PT24	PT25	PT28	PT29	PT30
Catch Rate	3.0	3.0	17,460.4	897.8	704.5	121.9	14,145.6	225.0	995.6	268.4	246.9	9.0	3.0	6.0	12.0	3.0

Figure 7.1 Herring (*C. harengus*) Catch Rates by Station and Sampling Area

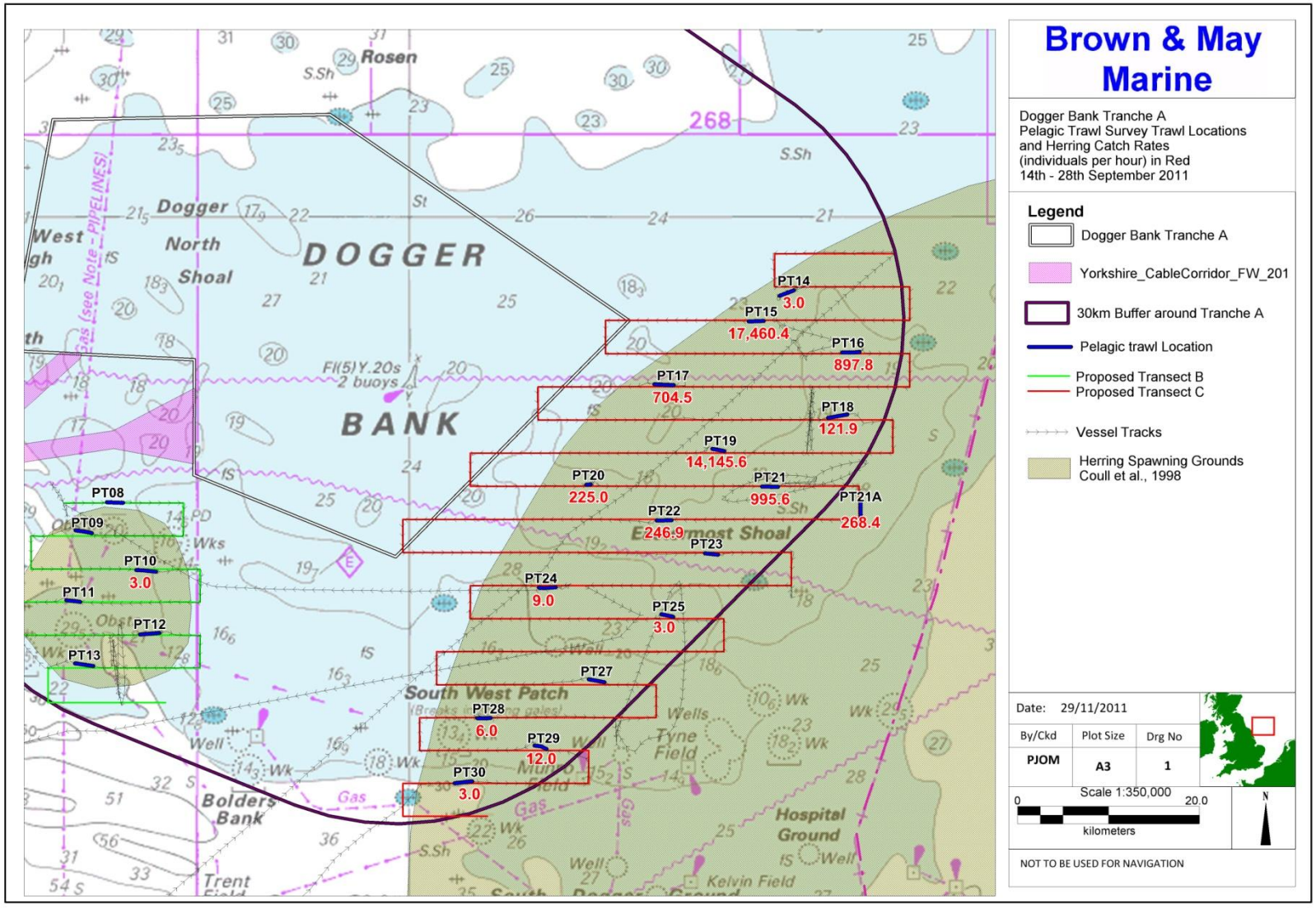
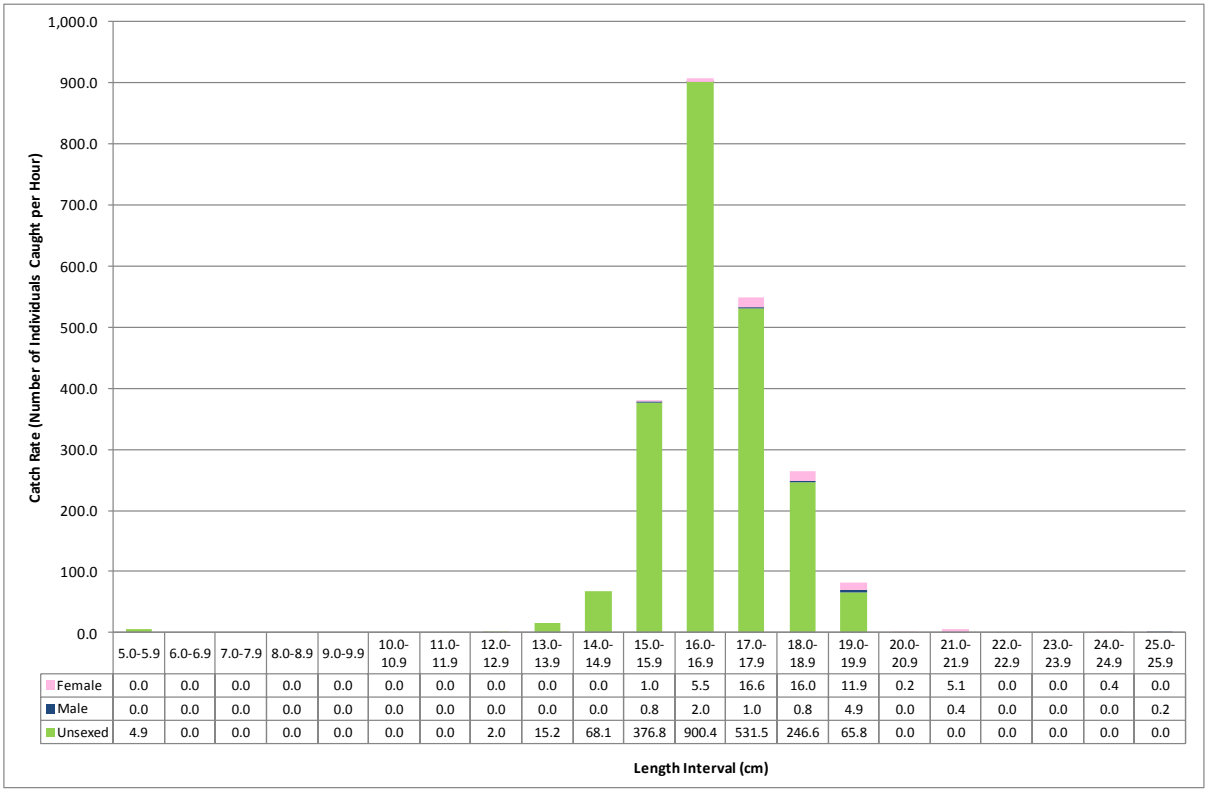


Figure 7.2 Catch Rate (Number of Individuals Caught per Hour; in red) of Herring (*C. harengus*) by Sampling Station

7.2 Length Distribution

The length distributions of *C. harengus,* expressed as the catch rate (number of individuals caught per hour) by length (nearest ½ cm), and sex for all stations, is shown in Figure 7.3. It should be noted that Cefas were unable to confidently determine the sex of a number of 'virgin' *C. harengus* and as such they have been categorised as 'unsexed'.

The greatest number of *C. harengus* were unsexed virgin fish and were between 16.0 and 16.9 cm in length (900.4/hr), followed by 17.0 to 17.9cm (531.5/hr). Most of the females caught were between 17.0 and 19.9cm and the majority of the males were found with lengths ranging from 15.0 to 20.0cm.



	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9	19.0-19.9	20.0-20.9	21.0-21.9	22.0-22.9	23.0-23.9	24.0-24.9	25.0-25.9
Female	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	5.5	16.6	16.0	11.9	0.2	5.1	0.0	0.0	0.4	0.0
Male	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	2.0	1.0	0.8	4.9	0.0	0.4	0.0	0.0	0.0	0.2
Unsexed	4.9	0.0	0.0	0.0	0.0	0.0	0.0	2.0	15.2	68.1	376.8	900.4	531.5	246.6	65.8	0.0	0.0	0.0	0.0	0.0	0.0

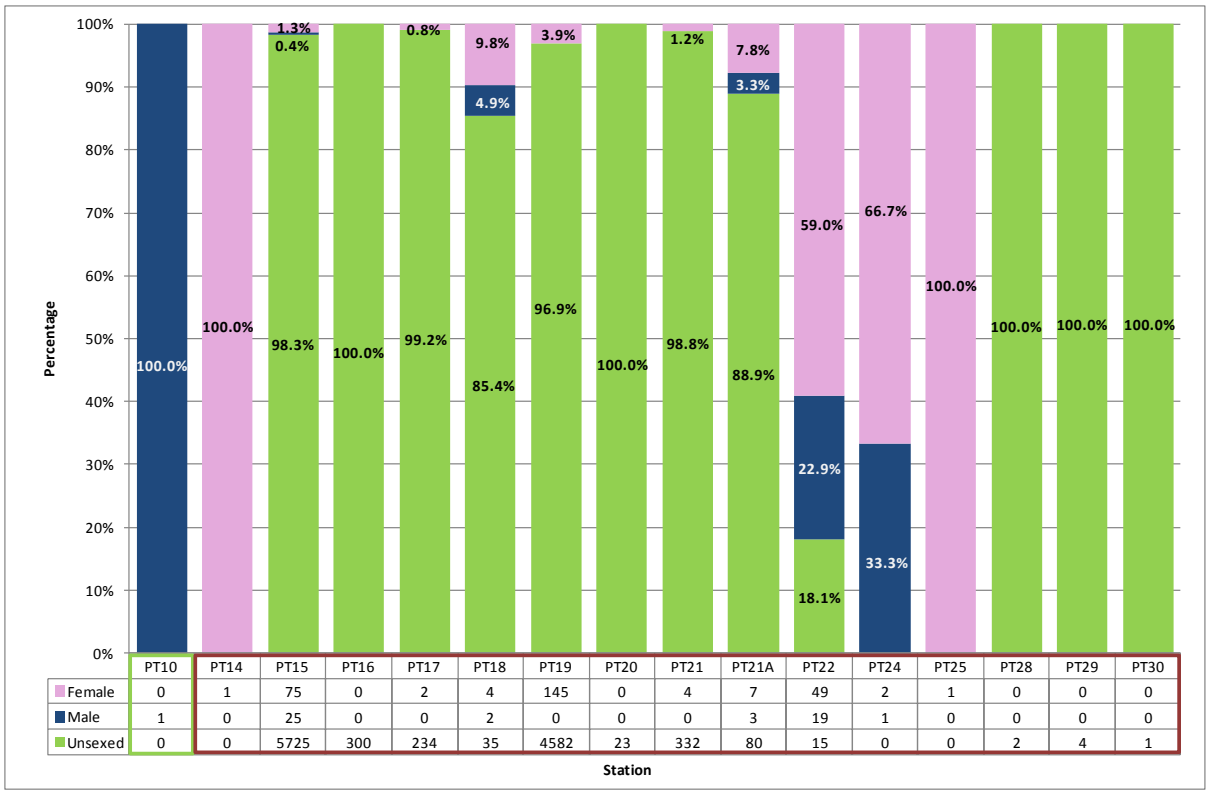
Figure 7.3 Herring (*C. harengus)* Length Distribution by Sex (all Stations)

7.3 Sex ratio

The sex ratio of *C. harengus* as a percentage by station and sampling area (transects A to D) is given in Figure 7.4 (green and red boxes denote transects B and C, respectively). It should be noted that Cefas were unable to confidently determine the sex of a number of 'virgin' *C. harengus* and as such they have been categorised as 'unsexed'.

The majority of individuals from the total catch were unsexed 'virgin' fish (97.1%), followed by females (2.5%) and then males (0.4%).

The greatest number of females were found at station PT19 (145) and the most males were found in PT15 (25), both of which are found in transect C.



	PT10	PT14	PT15	PT16	PT17	PT18	PT19	PT20	PT21	PT21A	PT22	PT24	PT25	PT28	PT29	PT30
Female	0	1	75	0	2	4	145	0	4	7	49	2	1	0	0	0
Male	1	0	25	0	0	2	0	0	0	3	19	1	0	0	0	0
Unsexed	0	0	5725	300	234	35	4582	23	332	80	15	0	0	2	4	1

Figure 7.4 Herring (*C. harengus)* Sex Ratio as a Percentage by Station and Sampling Area

7.4 Spawning Condition

The spawning condition, sex and length range (nearest cm below) of *C. harengus* caught during the survey are given in Table 7.2. The number of *C. harengus* caught by spawning condition, sampling station and sampling area (transects A to D) is shown in Figure 7.5 (green and red boxes represent transects B and C). Figure 7.6 presents the percentage distribution by spawning condition and station. It should be noted that Cefas were unable to confidently determine the sex of a number of 'virgin' *C. harengus*.

The *C. harengus* caught were predominantly 'virgin', most of which were caught at stations PT15 (5,825) and PT19 (4,727), in transect C. All *C. harengus* caught at stations PT14 to PT22 in transect C were 'virgin'. 'Early ripening' and 'ripening' individuals were only caught at stations PT10, in transect B, and PT24 (transect C). The only 'late ripening' fish was caught at station PT24 in transect C. 'Virgin' *C. harengus* comprised 99.95% of the catch. The very low numbers of individuals in other spawning conditions cannot be considered as indicative of spawning events having occurred.

Table 7.2 Herring (*C. harengus*) Spawning Condition

Herring									
Sex	Maturity	Individuals Caught				Total	% of Total Catch	Length Range (cm)	
		Transect							
		A	B	C	D			Min.	Max.
Female	1 - Virgin	0	0	287	0	287	2.46%	15	21.5
	3 - Early Ripening	0	0	1	0	1	0.01%	21.5	21.5
	4 - Ripening	0	0	1	0	1	0.01%	24	24
	5 - Late Ripening	0	0	1	0	1	0.01%	24.5	24.5
Male	1 - Virgin	0	0	49	0	49	0.42%	15.5	21.5
	3 - Early Ripening	0	1	0	0	1	0.01%	21	21
	4 - Ripening	0	0	1	0	1	0.01%	25.5	25.5
Unknown	1 - Virgin	0	0	11,333	0	11,333	97.08%	5	19.5

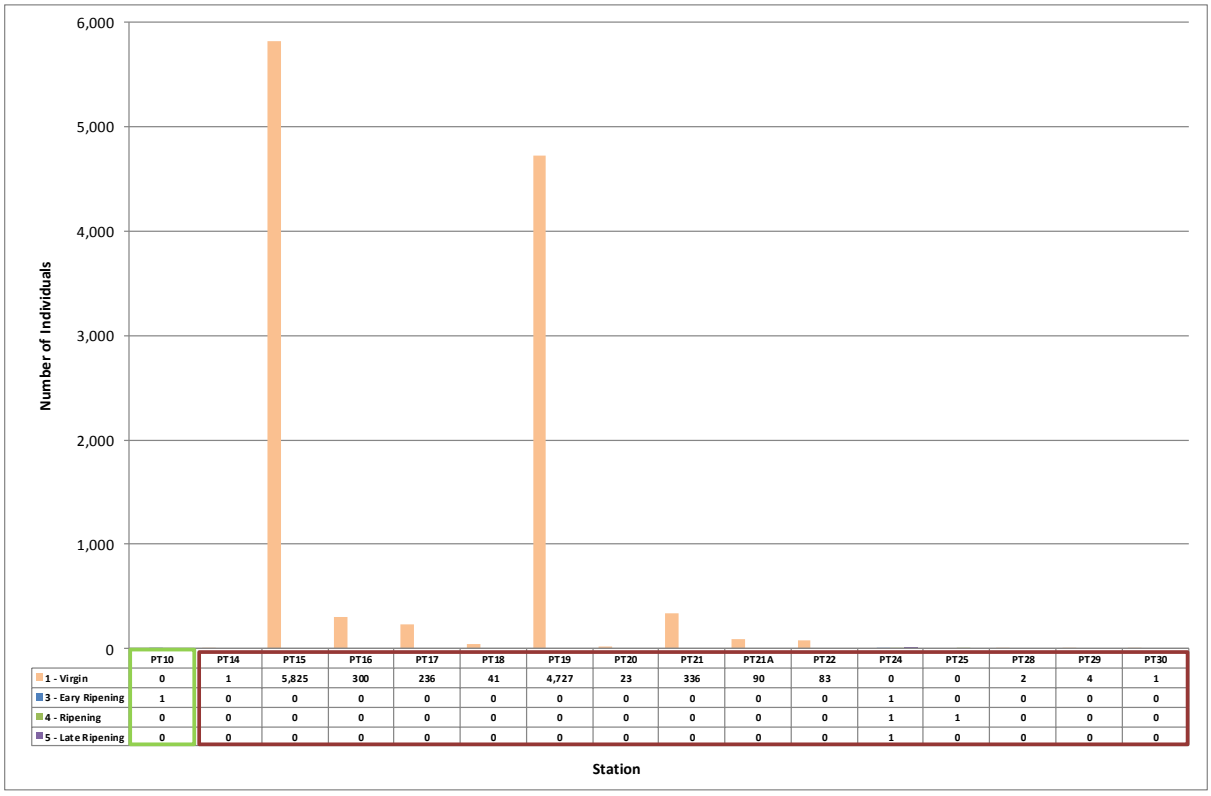


Figure 7.5 Herring (*C. harengus)* Spawning Condition by Station and Sampling Area

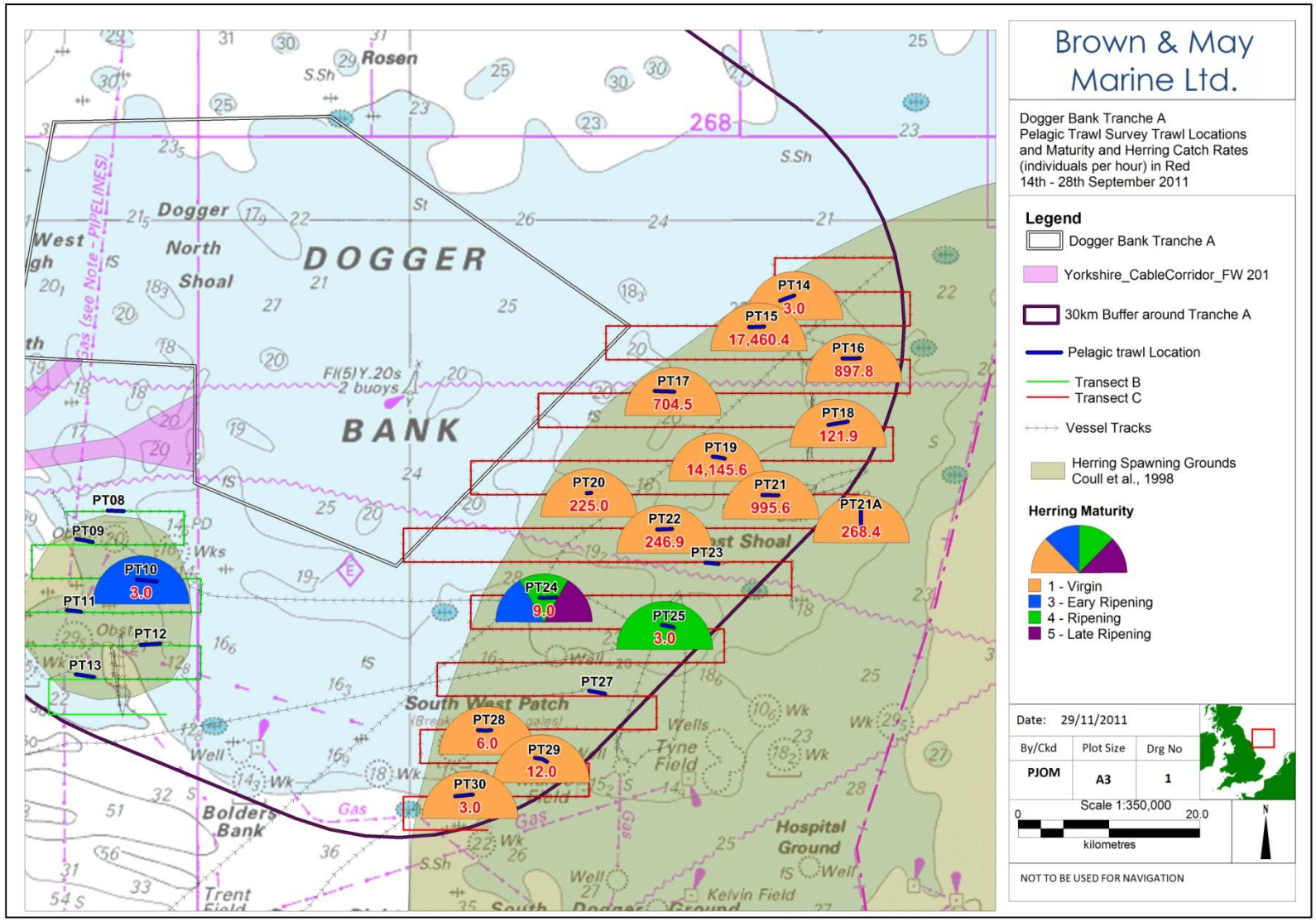


Figure 7.6 Herring (*C. harengus*) Catch Rate (in red) and Percentage Distribution by Spawning Condition by Station

8.0 Temperature and Salinity

8.1 Temperature

As previously mentioned in section 3.0, *C. harengus* are known to form spawning aggregations and temperature is considered a factor influencing the timing of *C. harengus* spawning. Larger spawning *C. harengus* aggregations were observed when sea surface temperatures (SSTs) were between 11.0°C and 14.0°C (Maravelias & Reid, 1995; Maravelias, 1997; Maravelias & Reid, 1997).

The minimum, maximum and average temperature recorded at every third station is given by sampling area (transects A to D) in Table 8.1.

The depth profile of the average temperature by sampling area (transects A to D) is given in Figure 8.1.

The temperature ranged from 12.7°C to 14.6°C across all stations with the average temperature varying between 13.2°C and 14.3°C.

Table 8.1 Minimum, Maximum and Average Temperature by Sampling Area

Transect	Minimum Temperature (°C)	Maximum Temperature (°C)	Average Temperature (°C)
Transect A	13.4	13.6	13.5
Transect B	13.4	13.8	13.7
Transect C	12.8	14.6	14.3
Transect D	12.7	13.4	13.2

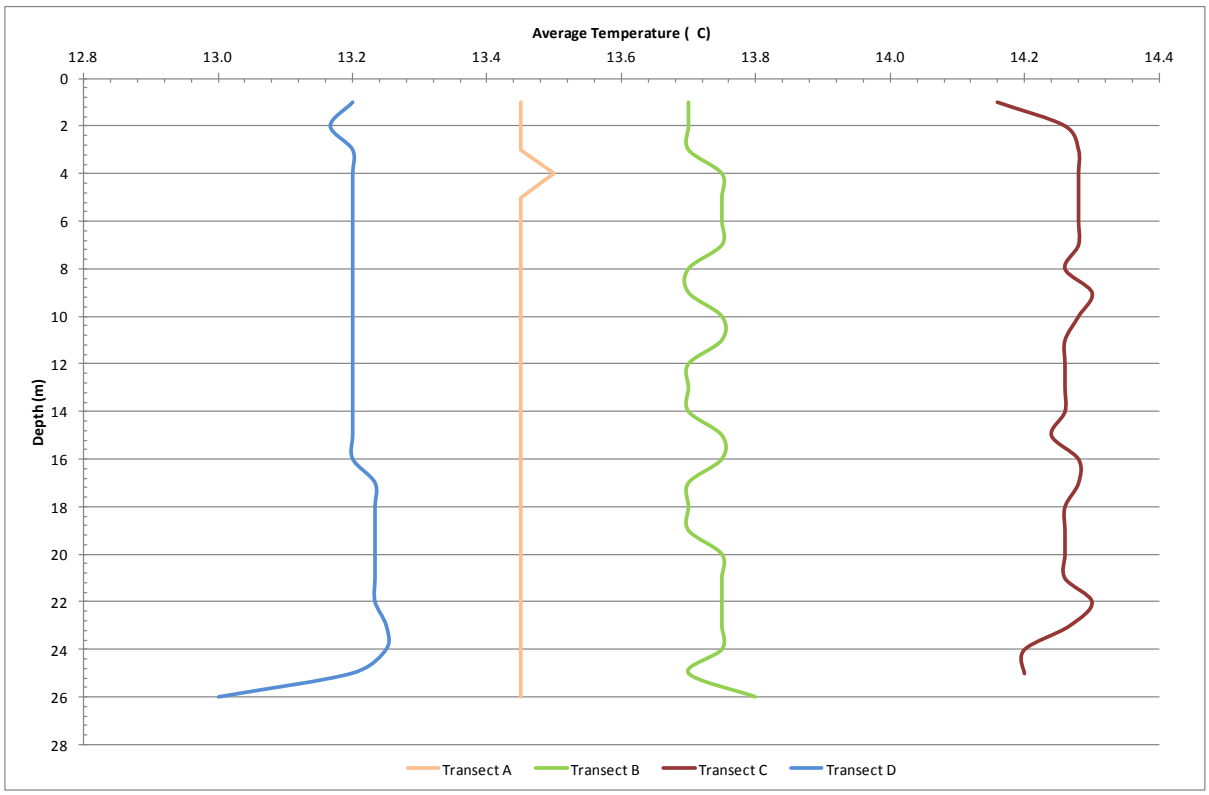


Figure 8.1 Average Temperature Depth Profile by Sampling Area

8.2 Salinity

Studies have found spawning aggregations of *C. harengus* to be abundant in areas of high salinities (>34.5‰), with the largest spawning aggregations found in waters with salinities greater than 35.0‰ (Maravelias & Reid, 1995; Maravelias, 1997; Maravelias & Reid, 1997).

The minimum, maximum and average salinity recorded at every third station is given by sampling area (transects A to D) in Table 8.2. The depth profile of the average salinity by sampling area is given in Figure 8.2.

The salinity ranged from 35.5‰ to 36.0‰ across all sampling areas with the average salinity ranging between 35.6‰ and 35.9‰.

Table 8.2 Minimum, Maximum and Average Salinity by Sampling Area

Transect	Minimum Salinity (‰)	Maximum Salinity (‰)	Average Salinity (‰)
Transect A	35.6	36.0	35.9
Transect B	35.7	35.8	35.8
Transect C	35.6	35.7	35.6
Transect D	35.5	35.8	35.6

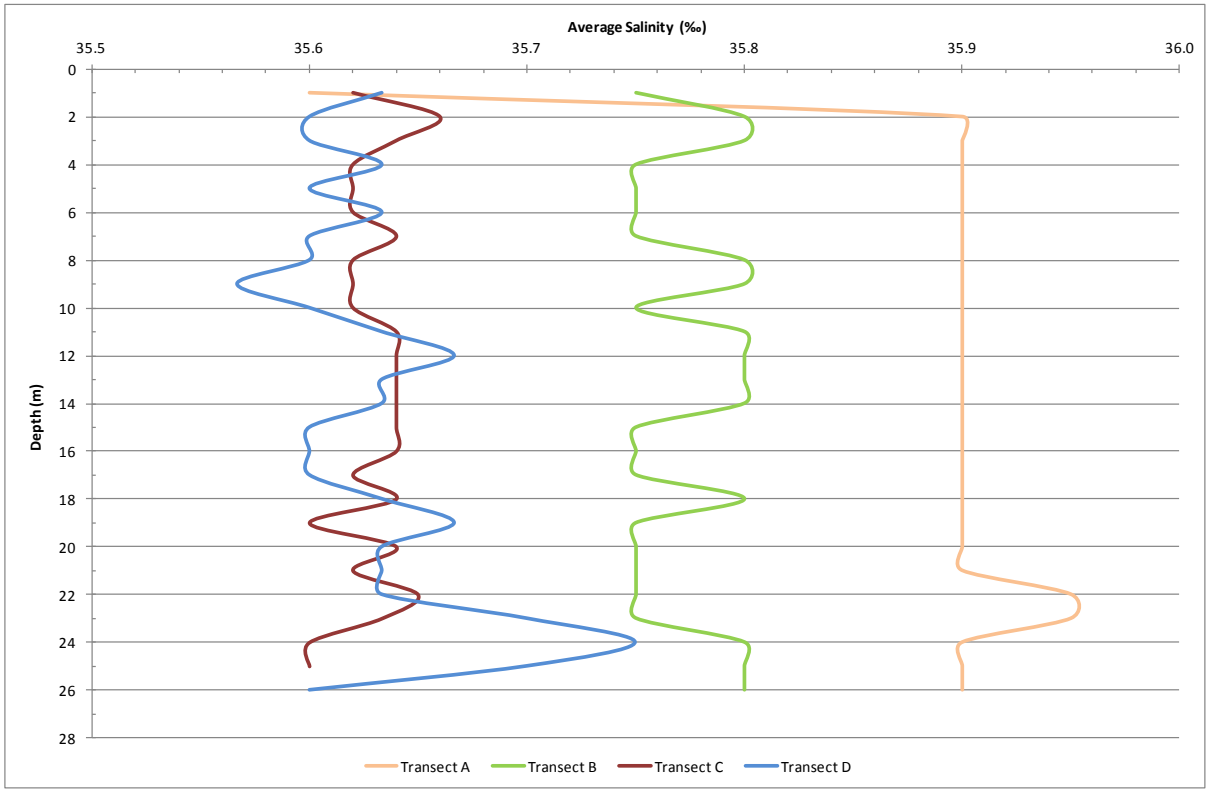


Figure 8.2 Average Salinity Depth Profile by Sampling Area

9.0 Conclusion

C. harengus were caught in transects B and C during the survey, with the majority of fish caught in transect C, on the western section of the Dogger Bank.

The survey was carried out during the *C. harengus* spawning season for the Banks stock and the temperatures and salinities, recorded during the survey, corresponded with those found when large spawning aggregations occur.

Most of the *C. harengus* caught in the historic spawning grounds were 'virgin' fish, suggesting that within the sampling area, spawning was not occurring during the time of the survey. Furthermore, the absence of 'spent' fish suggests that spawning may not have occurred in a short period prior to the survey.

The results of the survey are in line with findings of other surveys and studies which have indicated that the Dogger Bank is a historical spawning ground as spawning has not been found to occur in the area "*for more than 40 years after the collapse in 1967*" (Schmidt *et al.,* 2009; Petitgas *et al.*, 2010).

While spawning was considered to have occurred in the area in the past, it is possible that the stock collapse has resulted in a change in *C. harengus* spawning patterns within the North Sea (Schmidt *et al.*, 2009; BMM, 2010). The results of the survey suggest that recolonisation of the former Banks herring spawning grounds in the Dogger Bank is yet to occur.

10.0 References

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11.0 Appendix

11.1 Appendix 1 – Health and Safety

11.1.1 Personnel

Brown and May Marine (BMM) staff protocol followed the standard health and safety protocol outlined in the BMM "Offshore Operational Procedures for Surveys using Commercial Fishing Vessels".

All BMM staff have completed a Sea Survival course approved by the Maritime and Coastguard Agency, meeting the requirements laid down in: **STCW 95 Regulation VI/1 para 2.1.1 and STCW Code section A- VI/1** before boarding any vessel conducting works for the company. Employees are also required to have valid medical certificates (ENG1 or ML5), Seafish Safety Awareness, Seafish Basic First Aid and Seafish Basic Fire Fighting and Fire Prevention certificates before participating in offshore works.

11.1.2 Vessel Induction

Before boarding the survey team were shown how to safely board and disembark the vessel. Prior to departure the skipper briefed the BMM staff on the whereabouts of the safety equipment, including the life raft, emergency flares and fire extinguishers, and also the location of the emergency muster point. The safe deck areas, man-overboard procedures and emergency alarms were also discussed. The survey team were warned about the possible hazards, such as slippery decks and obstructions whilst aboard. The BMM staff were briefed about trawling operations and the need to keep clear of all winch's when operational. All hazards were assessed prior to the survey in the BMM health and safety risk assessment.

11.1.3 Daily Safety Checks

The condition of the life jackets, EPIRB's, and life raft were inspected daily. Also checked were the survey team working areas, including the fish room and the wheelhouse to ensure these areas were clear of hazards such as clutter and obstructions.

11.1.4 Post Trip Survey Review

Upon completion of the survey a "Post Trip Survey Review" was filed, see Table 11.1 below.

Table 11.1 Post Trip Survey Review

Project: Dogger Bank Pelagic September 2011	**Vessel:** Jubilee Spirit
Surveyors: Lucy Shuff, Alex Winrow-Giffin	**Skipper:** Ross Crookes
Survey Area: Dogger Bank	**Total Time at Sea:** 15 Days
Dates at Sea: 14/09/2011 - 28/09/2011	

	Comments	Actions
Did vessel comply with pre trip safety audits?	Yes	N/A
Skipper and crew attitude to safety?	Good	N/A
Vessel machinery failures?	Generator broke down 18/9/11	Returned to Grimsby for repair
Safety equipment failures?	None	N/A
Accidents?	None	N/A
Injuries?	None	N/A