FOREWIND

DOGGER BANK
TEESSIDE A & B

March
2014

Environmental Statement Chapter 13 Appendix F Sandeel Survey report

Application Reference 6.13.6

Dogger Bank Offshore Wind Farm

Tranche A & B

Sandeel Survey

22nd March to 1st April 2012

Undertaken by
Brown and May Marine Ltd

Ref	Issue Date	Issue Type	Author	Checked	Approved
DBSS01	06/09/2012	FINAL	AWG	SX/JW/LS	SJA

Contents

Figures

Tables

1.0 Summary

Sandeels are thought to be one of the most abundant fish species in the North Sea and are an important component of the food web as a source of prey for many fish, seabirds and marine mammals.

Sandeels spend most of the year buried in the sediment and only emerge into the water column briefly in winter for spawning and for an extended feeding period in spring and summer. Spawning principally takes place in December and January. After spawning they remain buried in sand until April.

Sandeel distribution is considered to be highly patchy and varies in relation to sediment type. Sandeels require a very specific substratum, favouring seabed habitats containing a high proportion of coarse sand (particle size ≥0.25 to <2mm) and low silt (particle size <0.63µm) content. They are considered to be rare in sediments where the silt content is greater than 4% and absent where it is greater than 10%.

The survey was undertaken during night hours between the 22nd March and the 1st April, when the majority of sandeels were expected to be buried in the sediment. A total of 110 stations were sampled using a modified scallop dredge, 47 of which were located in Tranche A, 20 in Tranche B and 43 at adjacent control areas.

Three species of sandeel were caught during the survey: Raitt's sandeel (*Ammodytes marinus*), smooth sandeel (*Gymnammodytes semisquamatus*) and greater sandeel (*Hyperoplus lanceolatus*). *A. marinus* was the most abundant species caught, accounting for 98.2% of the total sandeel catch.

The results of the survey indicate large aggregations of sandeels in certain well defined areas in the originally defined Dogger Bank Zone. Sandeels were caught in 100 out of 110 stations, in varying numbers, with a maximum of 674 individuals caught at a single station (SD027).

The highest abundances of sandeels were found in stations located along the western boundary of the Dogger Bank Zone. Sandeels were also found in relatively high numbers on the north-eastern border of Tranche A with Tranche B and the central eastern sections of Tranche A and Tranche B. This correlates with the distribution of Danish fishing activity.

2.0 Introduction

The following report details the findings of the sandeel survey, undertaken within and adjacent to the Tranche A and Tranche B of the planned Dogger Bank offshore wind farm between the 22nd March and 1st April 2012.

The survey methodology, vessel and sampling gear used were agreed in consultation with Cefas and the Marine Management Organisation (MMO). Marine Scotland Science (MSS) and H. Mosegaard (DTU Aqua) were also consulted when selecting the sampling gear. A dispensation from the MMO for the Provisions of Council Regulation 850/98 to catch and retain undersize fish for scientific research and 43/2012 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 aim of the survey was to provide a broad scale assessment of the sandeel distribution across Tranches A and B of the planned Dogger Bank offshore wind farm; establishing the abundance, species composition and distribution of sandeel species within the area. In addition, the survey objective was to define the east-west boundaries of the areas of high sandeel densities along the western boundary of the Dogger Bank Zone and in its central area as implied by Danish sandeel fishing activity, defined by VMS satellite tracking and by Jensen *et al*. (2011).

Sandeels require the presence of a specific substrate in which to burrow and it is understood that sandeel distribution and spawning grounds will occupy discrete patchy areas rather than be continuous throughout the Dogger Bank Zone. As such the sampling effort was primarily concentrated over known fishing grounds, with areas outside these being sampled less intensively.

3.0 Background Information

3.1 Species Overview

Sandeels are thought to be the most abundant fish species in the North Sea, in which five species of sandeel have been identified: Raitt's sandeel (*Ammodytes marinus*); greater sandeel (*Hyperoplus lanceolatus*); smooth sandeel (*Gymnammodytes semisquamatus*); lesser sandeel (*Ammodytes tobianus*) and; Corbin's sandeel (*Hyperoplus immaculatus*). Of these, *A. marinus* is considered to be the most abundant species (Heath *et al.* 2011).

Sandeels spend most of the year in the seabed, only emerging into the water column briefly in winter for spawning and for an extended feeding period in spring and summer. During this feeding period they are thought to undertake diurnal migrations of a few kilometres, moving from the seabed where they are buried at night, to deeper areas of the water column during the day to feed (Cefas, 2004; Van der Kooij *et al.,* 2008).

Sandeel distribution varies depending on sediment type, requiring seabed habitats with a high proportion of medium and coarse sands and a low silt content (see Section 3.3). Sandeel distribution is also linked to local hydrography and the higher levels of food resource for the sandeels at these locations with increased plankton abundance where fronts meet (Cefas, 2007).

Spawning principally takes place in December and January (Winslade, 1974; Gauld & Hutcheon, 1990; Bergstad *et al.* 2001). Females lay demersal eggs on the seabed and after several weeks planktonic larvae hatch, usually in February-March (Macer, 1965; Langham, 1971; Wright & Bailey, 1996). After spawning sandeels remain buried in sand until April (Winslade, 1974).

Sandeels vary in size depending on species. There is little information on sizes for specific year groups for *H. lanceolatus* and *G. semisquamatus*, but common lengths and maximum lengths are considered to be 200mm and 400mm (Muus & Dahlstrom, 1974) and 150mm and 300mm (Reay, 1986), respectively. A study by Clausen *et al*. (2006) in the northwest North Sea found that 0-group *A. marinus* were approximately 60-70mm by May, while Wanless *et al*. (2004) found that in the Firth of Forth area, 0-group *A. marinus* ranged between 20 and 80mm and the 1+group ranged from 80 and 140mm. A study in the Firth of Forth found that 0-group sandeels needed to attain a length of 75 to 80mm before being able to bury themselves in the sediment (Greenstreet *et al*., 2006). It must be emphasised that sandeel length is not a reliable indicator of age. It is not uncommon for the growth rate of the same species, from the same area to vary widely (Williams & Bedford, 1974). It should also be noted that 0-group sandeels are less likely to be caught in the sandeel dredge (Greenstreet, 2007).

On the Dogger Bank, sandeels are thought to support a large diversity and abundance of seabirds (Diesing *et al*., 2009). In addition, sandeels constitute an important prey species for a number of fish, including herring, salmon, sea trout, cod, haddock, whiting, grey gurnard, saithe, mackerel, horse mackerel and starry ray, and also for squid (Collins & Pierce, 1996; Wright & Kennedy, 1999; Mills *et al.,* 2003; ICES, 2005; Haugland *et al.,* 2006; ICES, 2006; ICES, 2008; ICES, 2009; ICES, 2010b; MSS, 2010; Walters, 2010; Walters, 2011;). Marine mammals such as common seals (Thompson *et al,.* 1991), grey seals (McConnell *et al.,* 1999), harbour porpoises (Santos *et al.,* 2005) and minke whales (Olsen & Holst, 2001; Pierce *et al.,* 2004) also prey on sandeels.

Although sandeels are preyed upon in the sediment by a number of predators, they are more commonly predated on when they are in transit, or feeding in the water column (Hobson, 1986; Furness, 2002; Van der Kooij *et al.,* 2008). It is also during this period that they are targeted by industrial fisheries (Van der Kooij *et al.,* 2008).

The Dogger Bank Zone falls within a high intensity spawning ground and a low intensity nursery ground for sandeels (Coull *et al*., 2008; Ellis *et al.,* 2010). Spawning grounds are shown in Figure 3.1 together with the results of recent egg and larval surveys, as presented in Ellis *et al.* (2010).

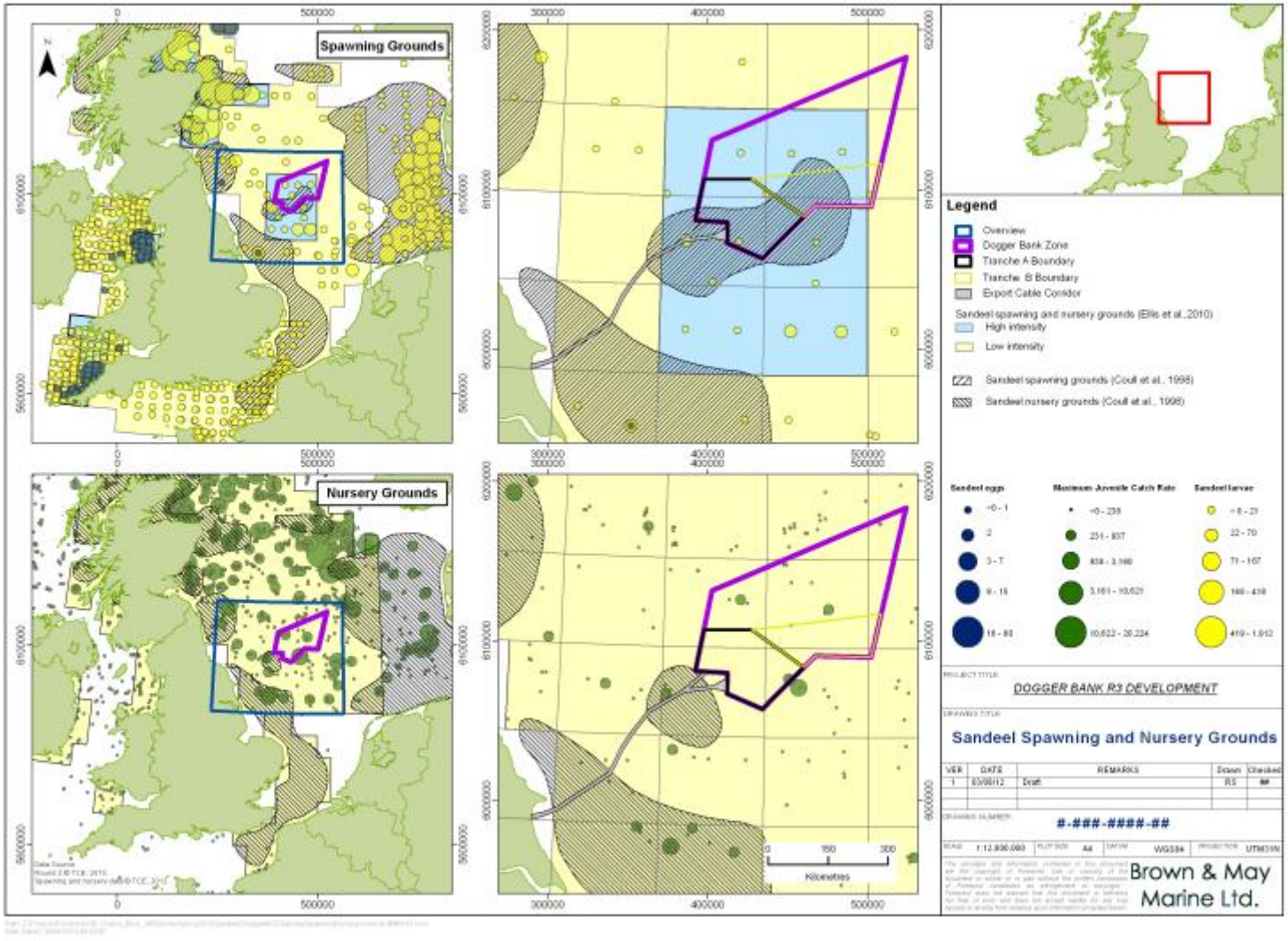


Figure 3.1 Sandeel Spawning and Nursery Grounds (Defined by Coull *et al.*, 1998 and Ellis *et al.*, 2010)

3.2 Fisheries

The International landings data by ICES rectangle show that fishing for sandeel takes place mainly during the summer months, especially throughout May, June and July, and is focused on the Dogger Bank, the Wee Bankie off Scotland, and in the central North Sea. They are taken by demersal and pelagic trawlers using fine-meshed gears with cod-ends of ≤16mm (Bell *et al*., 2004; NSRAC, 2012).

The sandeel fishery on the Dogger Bank is an important fishery and has historically been predominantly Danish, receiving the largest quota allocation for sandeels in the North Sea (167,436 tonnes in ICES Areas IIa, IIIa, IV in 2012). In recent years the annual sandeel quotas have fluctuated significantly, predominantly in response to declining populations and the secondary effect upon other species. The distribution of Danish sandeel fishing activity in the area of the Dogger Bank is illustrated by VMS satellite tracking data (average 2007 – 2011; Figure 3.2), and in a study by Jensen *et al*. (2011; Figure 3.3). The identified Danish sandeel fishing grounds are shown in Figure 3.3.

The highest fishing activity in the Dogger Bank Zone occurs along the western boundary. According to studies by Jensen (2001), van der Kooij *et al*. (2008), Jensen & Christensen (2008), Jensen *et al*. (2011), and Mosegaard pers. com. (2012), fishing patterns are thought to reflect sandeel habitat distribution.

Sandeels are largely stationary after settlement, and there are considered to be seven local sub-stocks in the North Sea. Some interchange between sub-stocks may take place during the early phases of life before settlement (ICES, 2010a). The sandeel population of the Dogger Bank is part of the Dogger Bank area sandeel sub-stock (ICES, 2010a; Figure 3.4).

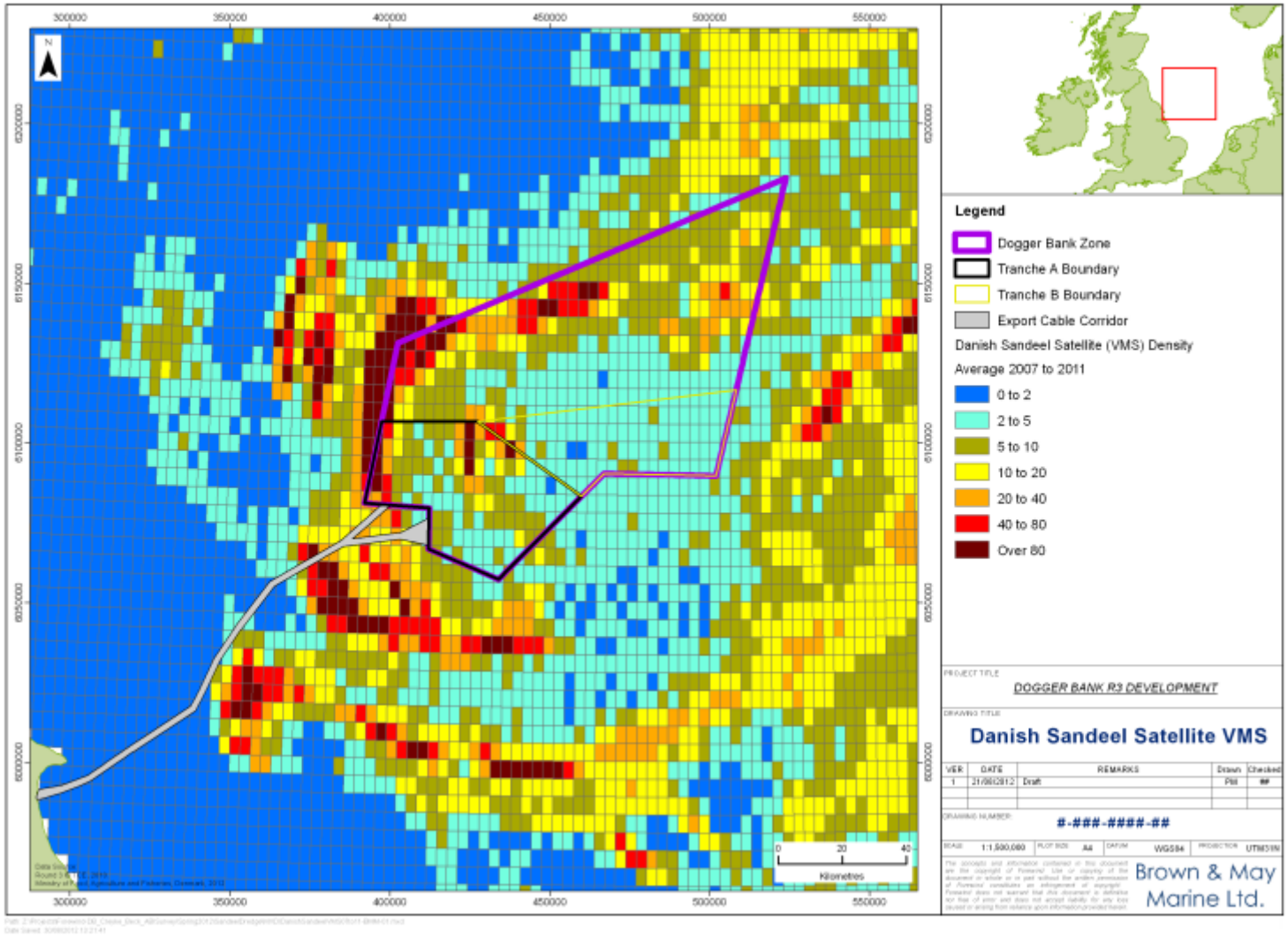


Figure 3.2 Annual Satellite Density VMS Sightings of Danish Vessels of Over-15m in Length

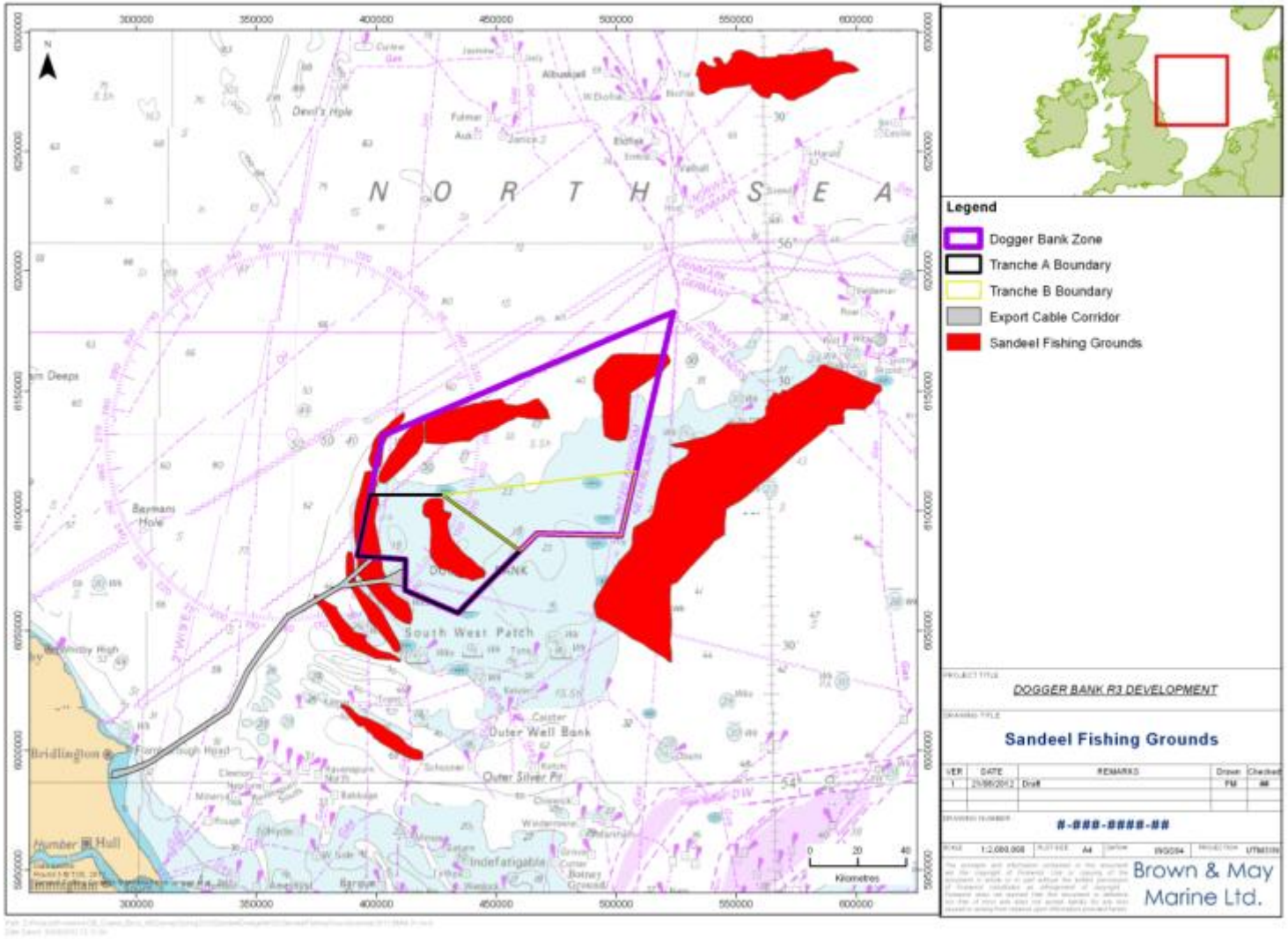


Figure 3.3 Danish Sandeel Fishing Grounds (Source: Jensen *et al.*, 2011)

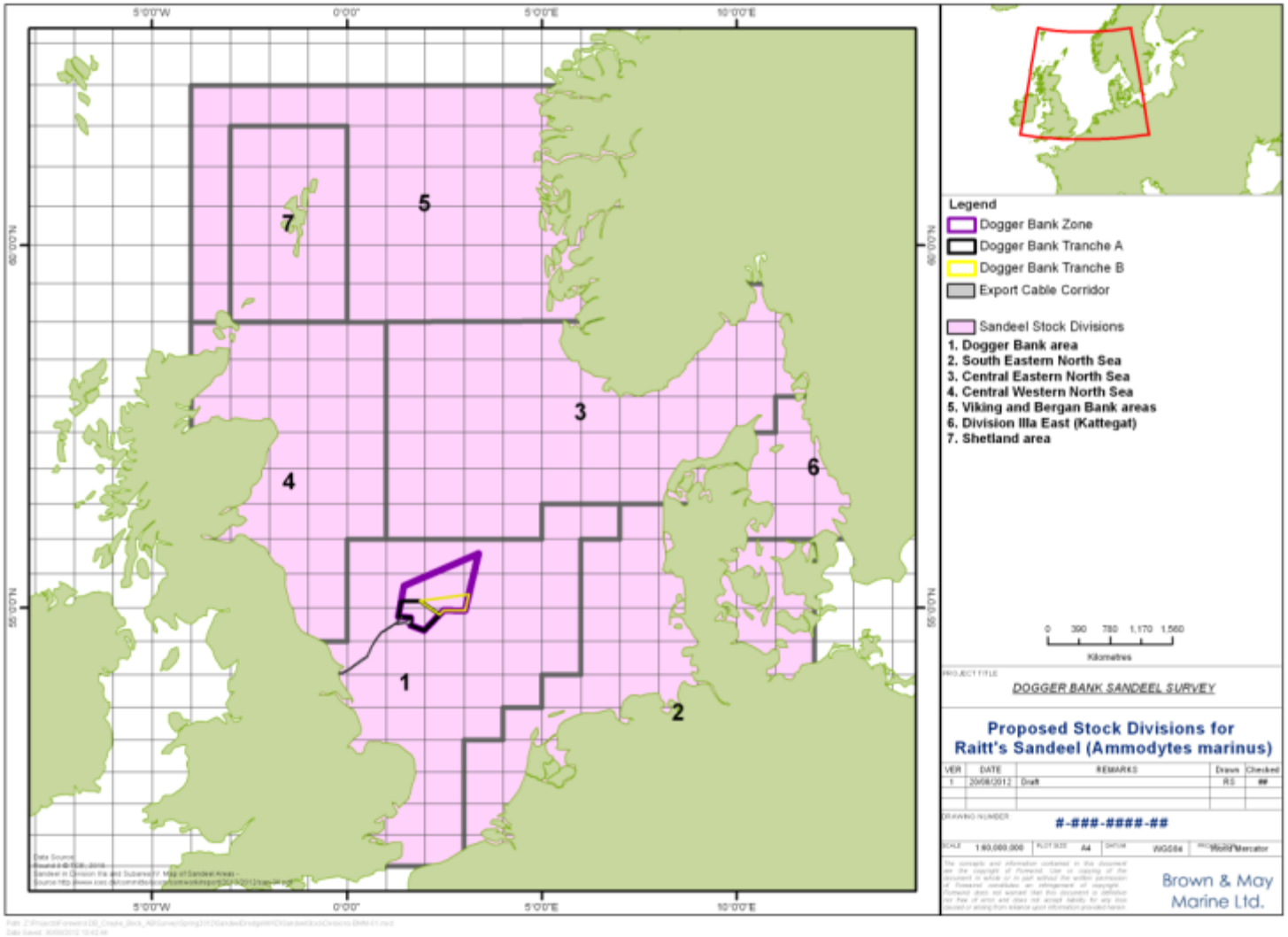


Figure 3.4 Sandeel Stock Divisions (Source: ICES, 2010a)

3.3 Sandeel Sediment Preference

Sandeel distribution is patchy and varies in relation to sediment type (Wright, 1999). Sandeels do not maintain permanent burrow openings and ventilate their gills with interstitial water. The presence of fine particles in silt rich sediments clogs gills and inhibits respiration. In addition, if the interstitial spaces between sand and gravel particles were occupied by silt particles the rate of exchange of interstitial water would be lower and oxygen supply inadequate (Holland *et al.,* 2005).

Sandeels tend to occupy areas on the sloping edges of sandbanks, showing a preference for depths of 30 to 70m, although they have been found between depths of 15 and 120m (Wright *et al.,* 1998; Greenstreet *et al.,* 2010). Holland *et al.* (2005) found that *A. marinus* require a very specific substratum, favouring seabed habitats containing a high proportion of medium and coarse sand (particle size ≥ 0.25 to < 2mm) and low silt content (Holland *et al.,* 2005). Overall, sandeels are considered to be rare in sediments where the silt content (particle size < 0.63µm) is greater than 4%, and absent where the silt content is greater than 10% (Wright *et al.,* 2000; Holland *et al.,* 2005).

The distribution of seabed sediment types, based on Folk's classification system (Folk, 1954), in the Dogger Bank, is shown in Figure 3.5. Folk's classification system groups grains into mud, sand and gravel categories on the basis of their diameter with the boundary between mud and sand size grains at 63µm and the boundary between sand and gravel size grains at 2mm. The relative proportion of the grains in the three categories is then used to describe the sediment and is displayed in a diagram commonly called a "Folk triangle" (see Figure 3.5).

Four Folk (1954) sediment categories; sand (S), slightly gravelly sand ((g)S), gravelly sand (gS) and sandy gravel (Sg), are more likely to constitute suitable sandeel habitats than those characterised by finer sediments, and are, as shown in Figure 3.5, widely distributed throughout the Dogger Bank Zone.

Particle Size Distribution (PSD) analysis of grab samples from Tranche A was undertaken by EMU Ltd (2011) and gives an indication of the areas suitability as a sandeel habitat, for the analysis of which three simplified sediment categories were created: "gravel" (≥ 2mm,) "coarse sands"(≥ 250µm to< 2mm) and "silt and fine sands"(< 250µm). Grab samples where the silt content was higher than 4% are also noted. Samples with a higher proportion of "coarse sands" are more likely to constitute suitable sandeel habitat than those with a high proportion of "silt and fine sands".

As can be seen in Figure 3.6, five stations on the western edge of the Dogger Bank Zone and a number of other stations dispersed across Tranche A had a higher proportion of "coarse sands". However, for the majority of stations sampled, the percentage contribution of "silt and fine sands" was higher than the proportion of "coarse sands". The silt content at six stations was greater than 4%, and as such was likely to represent an unsuitable habitat for sandeels.

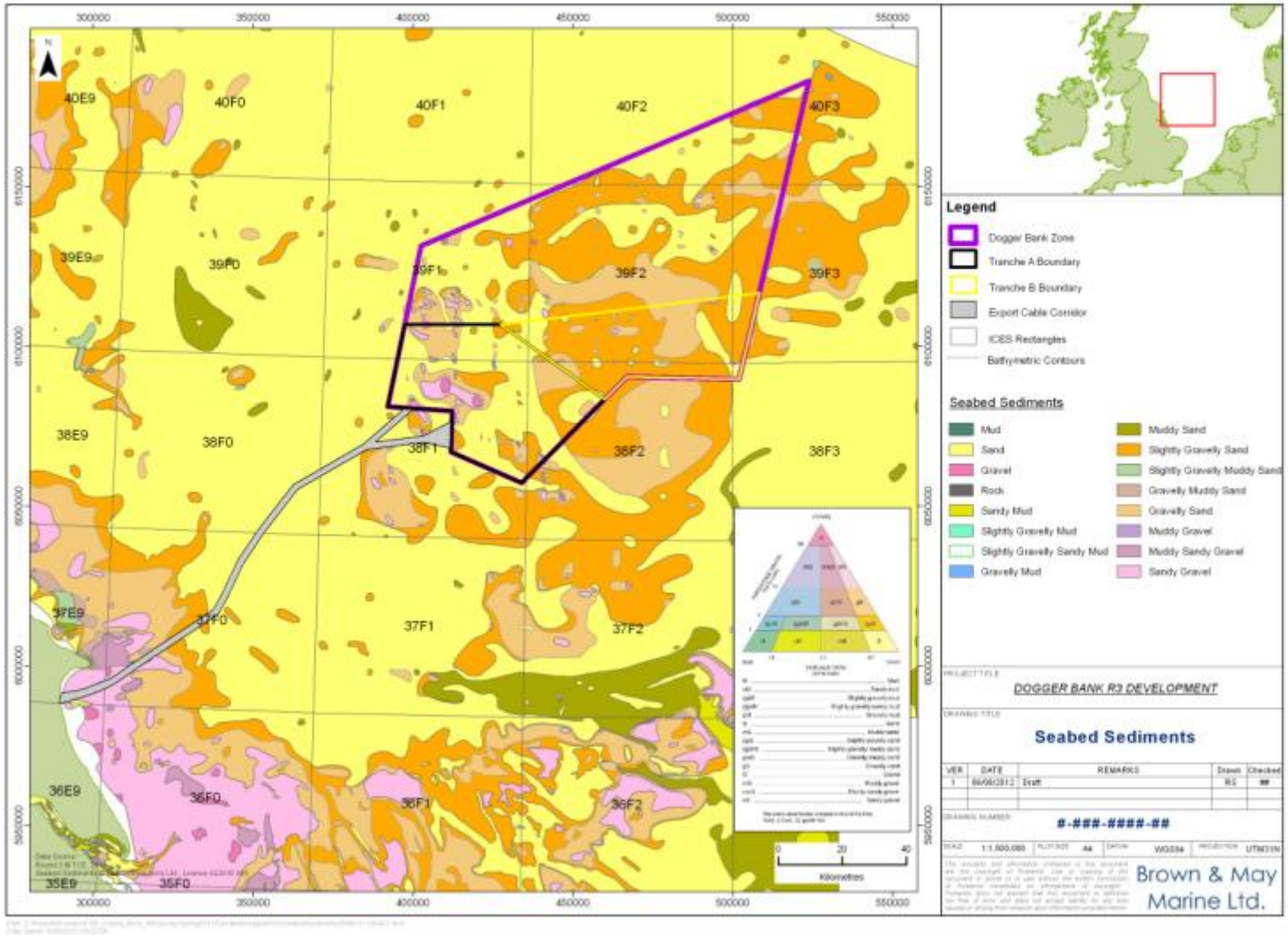


Figure 3.5 Seabed Sediments (Source: British Geological Survey)

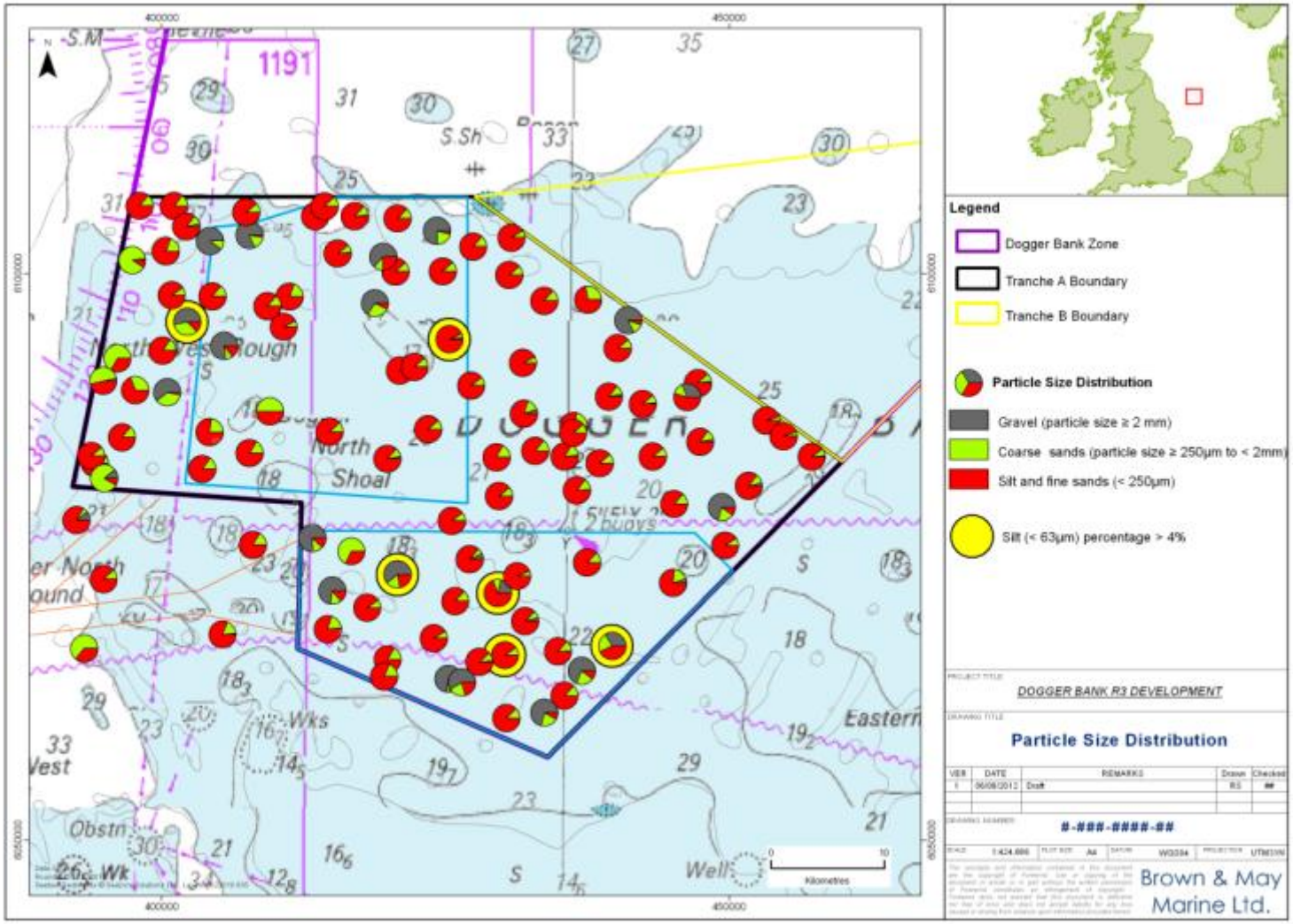


Figure 3.6 Particle Size Distribution and Sediment of Tranche A (Data source: EMU, 2011)

4.0 Scope of Works

The proposed scope of works for the March 2012 sandeel survey are detailed below and illustrated in Figure 4.1.

- **Sandeel Dredge**
  - 47 tows of approximately 250m were undertaken within Tranche A, 20 tows were undertaken in Tranche B and a further 43 control tows were undertaken in adjacent areas

- **Sandeel Dredge Sample Analysis**
  - Number of individuals, catch rates by per unit effort and per m^2 per species
  - Average length (mm) and length distribution by species
  - Average weight (g) and weight distribution by species

- **Conductivity-Temperature-Depth (CTD)**
  - Conductivity-Temperature-Depth (CTD) profile at approximately every 10^{th} station (weather permitting)

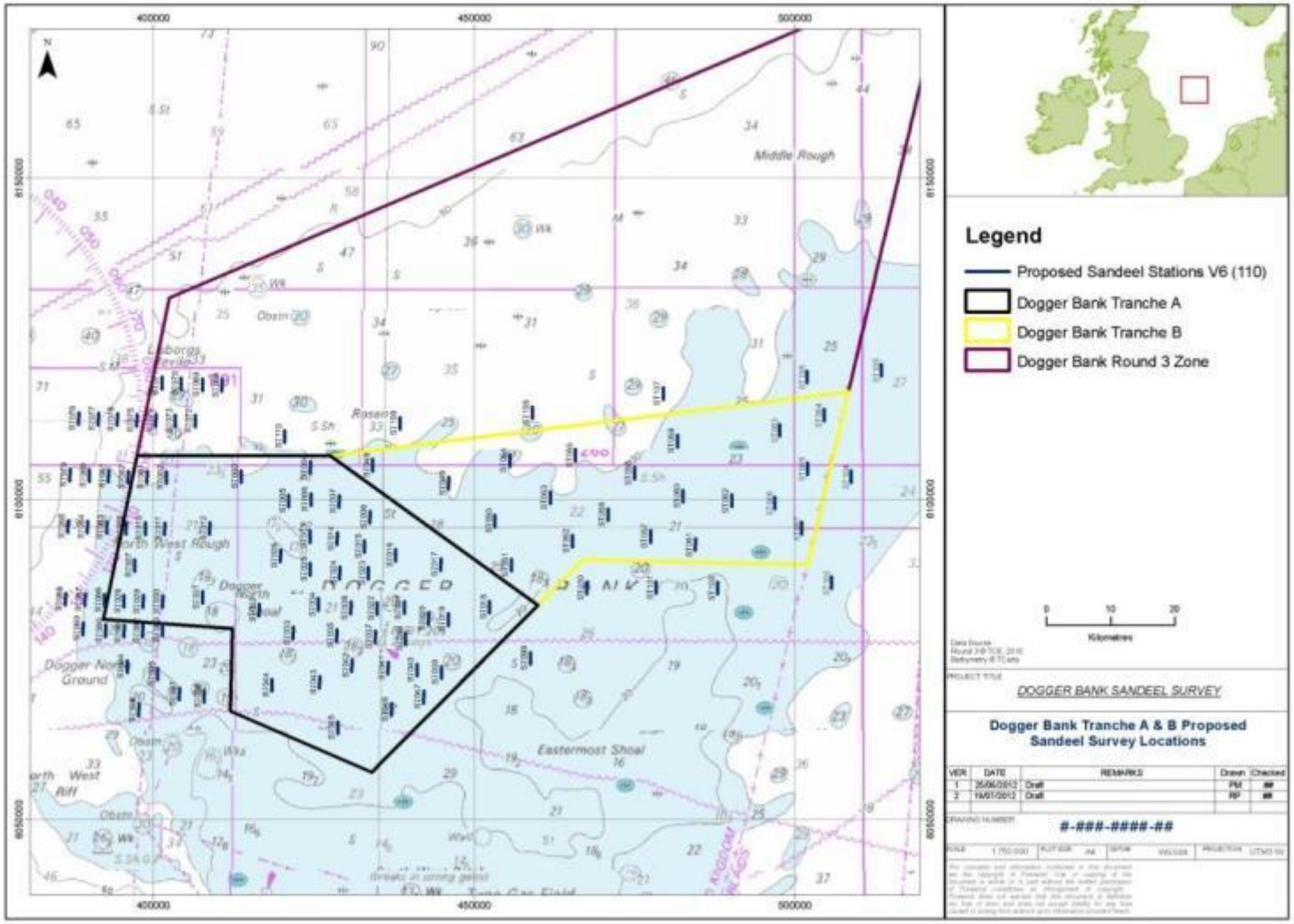


Figure 4.1 Proposed Sampling Locations

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 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 Modified 1.24m Shellfish Dredge

A modified 1.24m shellfish dredge with a fixed tooth bar (6" teeth) 10mm mesh and an 6mm mesh cod-end liner was used for sampling (Figure 5.2), the specifications of which are given in Table 5.2. The dredges, steel bellies and nets were manufactured using the specifications obtained through consultation with H. Mosegaard (DTU Aqua) and at a meeting with MSS, with the gear technician responsible for constructing the sandeel dredges used for MSS survey works.

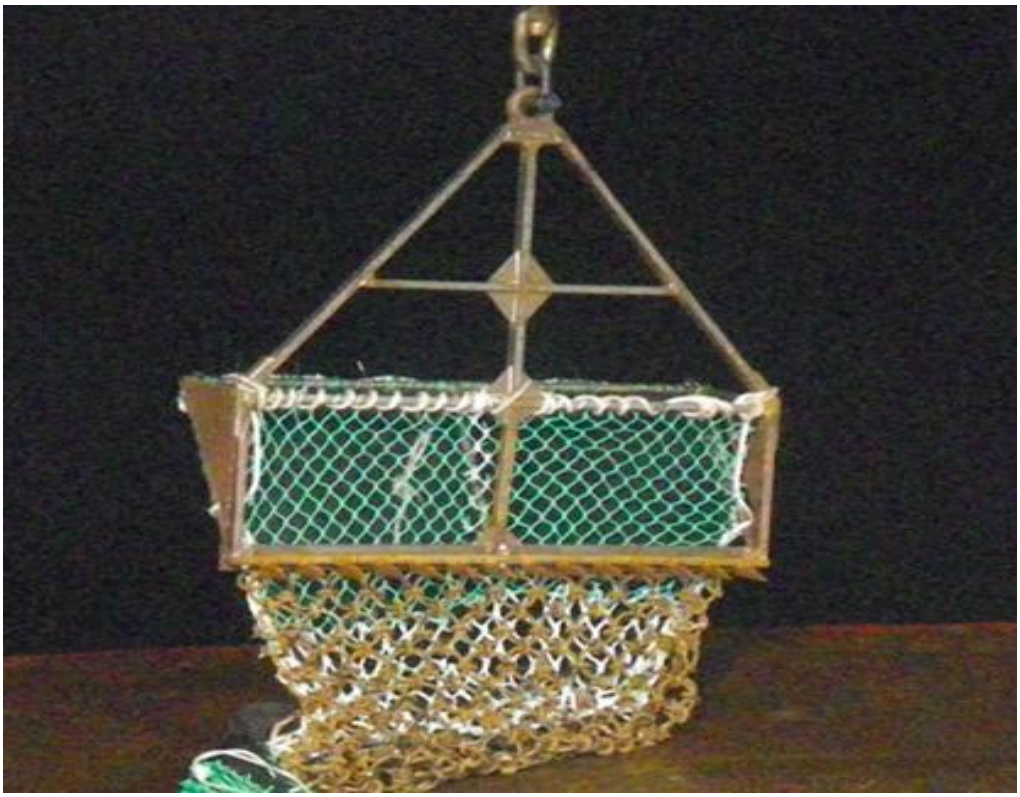


Figure 5.2 Modified 1.24m Shellfish Dredge

Table 5.2 Modified 1.24m Shellfish Dredge Specifications

Modified 1.24m Shellfish Dredge Specifications	
Towing warp	Steel 14mm main with 24mm extension
Depth: payout ratio	approx. 3/4:1
Net	10mm mesh with 6mm cod end liner and chain mat
Estimated headline height	0.5m
Dredge width	1.24m
Tooth length	6"

6.0 Sampling Operations

The survey was undertaken from 22nd March to 1st April 2012. A summarised log of events is given in Table 6.1 below.

Table 6.1 Summarised Log of Events

Thursday 22nd March 2012
HSE tour and vessel induction of new Client Representative
Mobilise survey in Scarborough
Overnight at sea
Friday 23rd March 2012
Depart Scarborough 0230 and steam to Dogger Bank
Sandeel Dredges: SD071, SD070, SD069 (repeat x 1), SD068, SD072, SD073, SD074, SD075, SD076 (repeat x 1), SD077, SD078, SD079, SD080, SD081 (repeat x 1)
CTD Probe: SD077
Sandeel Caught: SD071 (25), SD070 (28), SD069 (85), SD068 (225), SD072 (3), SD073 (190), SD074 (3), SD075 (394), SD076 (3), SD81 (37)
Overnight at sea
Saturday 24th March 2012
Sandeel Dredges: SD082, SD001, SD002, SD012, SD011, SD010, SD027 (repeat x 1), SD009, SD083, SD084, SD085, SD088, SD087, SD086, SD028, SD029
CTD Probe: SD027
Sandeel Caught: SD082 (156), SD001 (74), SD002 (5), SD012 (2), SD011 (7), SD027 (approx. 550/600), SD009 (47), SD083 (302), SD084 (4), SD086 (31), SD028 (5)
Overnight at sea
Sunday 25th March 2012
Sandeel Dredges: SD030, SD031, SD093, SD092, SD091, SD090, SD089, SD094, SD096, SD095, SD097, SD098
CTD Probe: SD030, SD095
Sandeel Caught: SD030 (79), SD031 (31), SD093 (52), SD092 (92), SD091 (220), SD090 (25), SD089 (1), SD094 (287), SD096 (70), SD095 (12), SD097 (14), SD098 (452)
Overnight at sea
Monday 26th March 2012
Sandeel Dredges: SD105, SD106, SD064, SD063, SD065, SD104, SD103, SD067, SD066, SD062
CTD Probe: SD066
Sandeel Caught: SD105 (3), SD106 (1), SD064 (2), SD063 (1), SD065 (5), SD104 (125), SD103 (223), SD067 (16), SD066 (6), SD062 (11)
Overnight at sea
Tuesday 27th March 2012
Sandeel Dredges: SD107, SD059, SD060, SD061, SD102, SD101, SD057, SD058, SD056, SD100, SD052, SD053
CTD Probe: SD056
Sandeel Caught: SD107 (41), SD059 (22), SD060 (223), SD061 (38), SD102 (44), SD101 (38), SD057 (46), SD058 (121), SD056 (22), SD100 (12), SD052 (108), SD053 (11)
Overnight at sea
Wednesday 28th March 2012
Sandeel Dredges: SD055, SD108, SD054, SD049, SD050, SD051, SD099, SD018, SD017, SD019, SD020, SD021

CTD Probe: SD017
Sandeel Caught: SD055 (1), SD108 (53), SD049 (16), SD050 (12), SD051 (3), SD099 (2), SD018 (32), SD017 (6), SD019 (30), SD020 (22), SD021 (21)
Overnight at sea
Thursday 29th March 2012
Sandeel Dredges: SD046, SD047, SD039, SD040, SD041, SD042, SD035, SD037, SD038, SD022, SD036, SD034, SD025, SD024, SD023, SD016, SD015, SD014
CTD Probe: SD035
Sandeel Caught: SD046 (3), SD047 (13), SD039 (24), SD040 (25), SD041 (35), SD035 (149), SD037 (197), SD038 (79), SD022 (14), SD036 (4), SD034 (67), SD025 (9), SD024 (14), SD023 (32), SD016 (14), SD015 (21), SD014 (30)
Overnight at sea
Friday 30th March 2012
Sandeel Dredges: SD109, SD048, SD004 (repeat x 1), D110, SD003, SD005, SD006, SD007, SD008, SD013, SD026, SD032, SD033, SD044, SD043, SD045
CTD Probe: Not deployed due to poor weather conditions
Sandeel Caught: SD109 (19), SD048 (362), SD004 (47), SD110 (60), SD003 (80), SD005 (2), SD006 (79), SD007 (62), SD008 (19), SD013 (32), SD026 (5), SD032 (2), SD033 (1), SD044 (29), SD043 (4), SD045 (1)
Overnight at sea
Saturday 31st March 2012
Return to Scarborough, arrive 2130
Overnight aboard vessel
Sunday 1st April 2012
Demobilise survey in Scarborough
Samples transported to BMM

6.1 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. Dredge start times and positions were taken when the winch stopped paying out the gear. Similarly, dredge end times and positions were taken when hauling of the gear commenced. The start and end times, co-ordinates and duration of each sandeel dredge are given in Table 6.2 (control, Tranche A and Tranche B tows are highlighted green, red and blue, respectively). The vessel tracks whilst towing the sandeel dredge are illustrated in Figure 6.1.

6.2 Sandeel Dredge Sampling

The catch from each tow was emptied into a bucket, photographed and any sandeels present were retained. The sandeels from each dredge were removed from the sample, put into a labelled polythene bag (station, date and survey type), sealed with cable ties and frozen for subsequent onshore species identification, numeration, length and biomass analysis by Jacobs Engineering Ltd. All bycatch species were identified, counted, measured and returned to the sea.

A CTD probe was used to record temperature and salinity depth profiles at approximately every tenth tow location (weather permitting). The times, co-ordinates and depths of each deployment of the CTD probe are given in Table 6.3 and illustrated in Figure 6.2.

For the purposes of data analysis, catch rates (number of individuals per hour) and densities (number of individuals per m^2) have been calculated to allow for quantitative comparisons to be made between the numbers of individuals caught at each station (see section 7.0).

Table 6.2 Start and End Times, Co-ordinates and Duration of each Sandeel Dredge

Station	Date	Start				End				Duration (mm:ss)	Length (m)
		Time (GMT)	UTM31N		Depth (m)	Time (GMT)	UTM31N		Depth (m)		
			Latitude	Longitude			Latitude	Longitude			
SD001	24/03/2012	18:57:42	6,102,374.0	398,891.9	32.3	19:01:27	6,102,455.4	399,225.0	36.9	03:45	342
SD002		19:22:23	6,102,402.1	402,054.6	37.2	19:26:48	6,102,628.7	402,246.8	33.2	04:25	297
SD003	30/03/2012	21:42:38	6,102,627.1	413,959.7	29.4	21:47:27	6,102,453.9	413,771.0	29.2	04:49	256
SD004		20:07:40	6,104,015.3	424,374.4	31.6	20:11:47	6,104,082.8	424,643.2	31.9	04:07	276
SD005		22:29:14	6,098,817.8	421,029.3	30.6	22:32:32	6,098,746.0	421,292.5	29.9	03:18	272
SD006		22:51:30	6,098,900.8	424,413.6	27.7	22:55:05	6,098,873.1	424,674.9	27.9	03:35	262
SD007		23:56:41	6,098,700.3	428,823.0	29.4	23:59:45	6,098,528.0	429,026.3	28.1	03:04	266
SD008	31/03/2012	00:52:05	6,096,340.6	433,457.3	27.7	00:54:49	6,096,230.7	433,706.0	25.2	02:44	271
SD009	25/03/2012	00:04:02	6,094,779.3	395,665.3	27.5	00:10:22	6,094,490.1	395,698.8	27.9	06:20	291
SD010	24/03/2012	21:51:06	6,094,490.4	398,652.7	34.3	21:54:50	6,094,794.8	398,578.5	34.3	03:44	313
SD011		21:23:44	6,094,245.9	401,691.3	28.8	21:27:41	6,094,559.6	401,619.4	29.2	03:57	322
SD012		20:37:58	6,094,477.5	408,707.2	33.2	20:42:02	6,094,748.7	408,573.7	32.3	04:04	302
SD013	31/03/2012	01:53:52	6,093,244.3	424,542.5	25.9	01:57:47	6,093,168.9	424,300.9	25.2	03:55	252
SD014	30/03/2012	06:13:45	6,092,870.0	428,693.7	26.6	06:19:20	6,093,080.4	428,529.7	25.7	05:35	266
SD015		05:40:14	6,091,620.2	432,945.9	25.7	05:44:13	6,091,486.6	432,710.8	25.2	03:59	270
SD016		04:57:49	6,090,159.4	437,589.4	25.2	05:01:56	6,090,232.1	437,840.9	25.5	04:07	261
SD017	29/03/2012	03:51:51	6,088,684.0	444,960.7	25.7	03:56:31	6,088,778.9	444,712.1	25.5	04:40	265
SD018		02:47:56	6,082,037.7	452,538.5	25.5	02:52:48	6,082,231.6	452,363.5	25.7	04:52	261
SD019		04:49:47	6,080,285.9	445,891.3	23.5	04:52:49	6,080,036.7	445,943.3	23.5	03:02	254
SD020		05:14:00	6,080,320.8	442,997.1	23.3	05:19:02	6,080,344.6	442,714.7	22.6	05:02	283
SD021		05:44:33	6,082,036.9	439,090.2	23.1	05:49:21	6,081,987.7	438,839.2	23.0	04:48	255
SD022	30/03/2012	01:07:15	6,081,863.6	435,103.9	23.0	01:13:20	6,081,975.9	434,870.9	23.7	06:05	258
SD023		04:19:03	6,087,500.3	433,380.4	23.3	04:23:23	6,087,440.4	433,616.1	23.9	04:20	243
SD024		03:48:02	6,087,536.9	429,013.9	24.8	03:51:37	6,087,438.8	429,270.1	22.8	03:35	274
SD025		03:12:39	6,088,048.6	424,437.2	23.3	03:17:47	6,088,302.1	424,409.5	23.3	05:08	255
SD026	31/03/2012	02:28:34	6,090,277.5	419,960.2	26.8	02:32:34	6,090,095.1	419,782.5	27.2	04:00	254
SD027	24/03/2012	22:57:20	6,088,988.3	396,986.7	27.2	23:03:44	6,088,733.7	396,925.3	26.8	06:24	262
SD028	25/03/2012	04:28:19	6,083,024.4	395,404.7	29.9	04:33:06	6,083,300.5	395,399.4	29.5	04:47	276
SD029		04:58:19	6,083,085.4	398,387.8	26.6	05:03:30	6,083,383.8	398,328.3	26.6	05:11	304
SD030		18:56:43	6,082,984.3	401,260.3	31.6	19:00:06	6,083,000.0	401,510.8	31.9	03:23	250
SD031		19:50:03	6,083,687.5	407,578.7	27.0	19:53:52	6,083,687.0	407,895.8	27.2	03:49	316
SD032	31/03/2012	03:18:39	6,081,854.4	416,442.2	27.0	03:21:51	6,081,601.3	416,346.1	27.9	03:12	270
SD033		03:57:45	6,078,235.7	421,665.7	25.9	04:01:23	6,078,065.4	421,855.1	26.3	03:38	254
SD034	30/03/2012	02:22:27	6,082,591.4	425,898.4	23.3	02:27:48	6,082,507.0	425,650.3	22.4	05:21	261
SD035	29/03/2012	22:46:47	6,077,561.6	428,586.7	27.4	22:52:55	6,077,810.0	428,505.6	27.2	06:08	261
SD036	30/03/2012	01:42:39	6,082,069.9	430,892.3	23.0	01:48:51	6,082,041.4	430,626.0	23.3	06:12	267
SD037	29/03/2012	23:43:07	6,077,519.0	434,575.4	22.8	23:46:53	6,077,393.9	434,837.5	23.3	03:46	290
SD038	30/03/2012	00:15:51	6,077,213.4	439,059.4	21.5	00:19:37	6,077,173.4	439,327.1	22.2	03:46	270
SD039	29/03/2012	20:05:57	6,071,835.2	444,849.7	23.1	20:13:12	6,072,070.7	444,969.3	23.1	07:15	264
SD040		20:44:28	6,072,427.9	441,205.3	25.0	20:49:22	6,072,297.9	440,928.3	24.1	04:54	305
SD041		21:21:34	6,072,560.6	436,585.0	27.5	21:27:32	6,072,483.3	436,346.3	27.9	05:58	250
SD042		22:04:23	6,072,975.2	431,078.2	31.0	22:09:25	6,072,919.9	430,818.9	31.7	05:02	264
SD043	31/03/2012	05:33:43	6,070,380.1	425,227.0	26.3	05:39:49	6,070,320.9	425,482.8	24.2	06:06	262
SD044		04:45:13	6,069,985.8	418,414.4	27.0	04:48:17	6,069,691.8	418,297.8	27.2	03:04	316
SD045		06:20:26	6,063,388.6	428,648.6	27.9	06:24:02	6,063,106.3	428,738.5	27.5	03:36	296
SD046	29/03/2012	18:53:34	6,066,153.5	436,851.7	34.7	18:59:26	6,066,278.9	437,060.4	34.7	05:52	243
SD047		19:32:16	6,068,107.6	441,904.7	26.6	19:36:32	6,068,137.8	442,178.2	25.9	04:16	274

Station	Date	Start				End				Duration (mm:ss)	Length (m)
		Time (GMT)	UTM31N		Depth (m)	Time (GMT)	UTM31N		Depth (m)		
			Latitude	Longitude			Latitude	Longitude			
SD048	30/03/2012	19:02:20	6,104,384.2	434,210.7	33.2	19:06:05	6,104,155.3	434,080.2	29.4	03:45	263
SD049	28/03/2012	22:10:07	6,101,489.8	446,063.8	32.5	22:14:20	6,101,440.8	445,809.7	32.5	04:13	258
SD050		23:08:03	6,095,765.5	453,128.7	30.8	23:11:48	6,095,626.9	453,351.0	30.3	03:45	261
SD051	29/03/2012	00:13:12	6,088,811.2	455,818.7	27.7	00:17:03	6,088,590.7	455,962.9	27.4	03:51	263
SD052	28/03/2012	04:53:20	6,092,316.1	465,287.6	26.4	04:57:07	6,092,578.7	465,287.4	27.0	03:47	262
SD053		05:35:26	6,099,103.7	462,033.8	30.8	05:40:25	6,099,248.7	461,825.1	30.8	04:59	254
SD054		21:04:49	6,105,157.0	455,587.7	33.8	21:08:52	6,104,905.5	455,536.1	34.3	04:03	256
SD055		18:54:26	6,105,679.1	465,836.2	34.7	18:59:20	6,105,943.4	465,837.3	36.1	04:54	264
SD056		02:52:44	6,096,599.0	470,848.6	28.5	02:57:22	6,096,320.9	470,817.9	28.3	04:38	280
SD057		00:50:38	6,093,133.1	477,424.3	25.3	00:55:03	6,093,384.7	477,545.2	25.3	04:25	279
SD058		01:58:28	6,103,025.6	474,986.5	29.9	02:03:26	6,103,271.8	474,887.5	29.9	04:58	265
SD059	27/03/2012	19:57:09	6,108,414.9	481,758.8	26.6	20:00:54	6,108,127.5	481,854.5	26.4	03:45	303
SD060		20:52:20	6,099,735.4	482,656.6	25.2	20:56:45	6,099,472.4	482,692.5	25.2	04:25	265
SD061		21:45:00	6,092,063.0	484,558.9	23.7	21:48:33	6,091,896.8	484,767.8	23.7	03:33	266
SD062		03:55:00	6,098,916.0	490,312.1	24.4	03:58:40	6,098,826.6	490,047.6	24.4	03:40	278
SD063	26/03/2012	21:58:29	6,109,836.8	497,821.8	29.7	22:03:38	6,109,755.6	497,550.0	30.1	05:09	283
SD064		21:04:37	6,112,379.4	504,505.2	29.2	21:07:58	6,112,147.4	504,662.1	29.0	03:21	280
SD065		22:49:12	6,103,994.5	501,832.6	27.2	22:53:06	6,103,791.0	502,012.0	27.2	03:54	271
SD066	27/03/2012	03:10:47	6,098,311.1	496,864.9	28.1	03:14:41	6,098,509.7	496,666.2	27.9	03:54	280
SD067		02:26:40	6,094,276.3	501,060.2	23.1	02:30:57	6,094,533.4	500,994.3	23.1	04:17	265
SD068	23/03/2012	20:18:37	6,116,913.4	410,733.8	38.7	20:23:51	6,116,992.4	411,014.7	38.9	05:14	291
SD069		19:36:59	6,116,964.6	407,563.5	36.7	19:41:23	6,116,978.0	407,302.1	36.3	04:24	261
SD070		18:46:35	6,117,076.7	404,302.6	39.8	18:51:35	6,117,051.5	404,576.2	38.3	05:00	274
SD071		18:06:21	6,116,991.3	401,476.8	44.7	18:11:44	6,117,204.7	401,325.1	45.3	05:23	261
SD072		21:31:16	6,111,268.2	406,499.9	38.7	21:35:07	6,111,570.8	406,487.3	39.6	03:51	303
SD073		22:08:51	6,111,336.5	403,279.8	35.9	22:12:32	6,111,629.7	403,263.2	36.1	03:41	293
SD074		22:43:43	6,111,098.6	400,359.1	37.4	22:47:07	6,111,404.7	400,275.2	38.3	03:24	317
SD075	24/03/2012	00:08:42	6,111,480.4	397,310.4	36.9	00:13:40	6,111,798.0	397,308.9	37.6	04:58	317
SD076		01:00:42	6,111,435.7	394,041.5	41.6	01:07:43	6,111,509.9	394,316.5	40.9	07:01	284
SD077		01:37:04	6,111,552.6	391,183.9	63.6	01:41:39	6,111,275.4	391,127.3	63.2	04:35	283
SD078		02:26:56	6,111,749.7	388,317.6	63.7	02:33:15	6,111,354.5	388,342.7	64.5	06:19	396
SD079		03:36:55	6,102,252.8	386,778.2	58.8	03:42:28	6,101,872.0	386,697.4	58.4	05:33	389
SD080		04:18:24	6,102,684.1	389,966.9	49.8	04:22:42	6,102,388.5	389,970.3	50.4	04:18	295
SD081		05:09:33	6,102,379.4	393,240.2	35.2	05:13:18	6,102,595.4	393,121.6	35.9	03:45	246
SD082		18:30:12	6,102,520.5	395,960.9	32.5	18:34:23	6,102,364.3	396,210.6	33.2	04:11	294
SD083	25/03/2012	00:38:20	6,094,744.9	392,552.8	30.6	00:43:39	6,094,470.2	392,533.6	30.3	05:19	275
SD084		01:07:20	6,094,516.1	389,703.9	40.2	01:12:03	6,094,677.5	389,387.4	41.3	04:43	354
SD085		01:36:02	6,094,939.2	386,655.4	48.2	01:41:17	6,094,673.6	386,529.4	48.6	05:15	294
SD086		03:58:09	6,083,303.0	392,349.5	30.6	04:03:45	6,083,561.6	392,316.5	30.8	05:36	260
SD087		03:25:32	6,083,288.8	389,218.4	37.2	03:31:15	6,083,570.2	389,207.9	37.2	05:43	281
SD088		02:55:12	6,083,213.6	386,314.9	42.5	02:58:53	6,082,927.2	386,297.0	42.5	03:41	287
SD089		22:52:43	6,078,866.9	388,914.5	38.0	22:59:05	6,078,600.6	388,860.2	38.0	06:22	272
SD090		22:16:01	6,078,678.4	392,477.5	29.0	22:20:36	6,078,387.3	392,460.9	29.0	04:35	291
SD091		21:43:43	6,078,684.0	395,578.4	24.4	21:50:20	6,078,496.0	395,366.7	23.5	06:37	282
SD092		21:13:42	6,078,562.4	398,417.4	29.2	21:19:30	6,078,473.7	398,138.1	28.8	05:48	292
SD093		20:47:27	6,078,758.0	401,645.5	25.9	20:53:16	6,078,669.6	401,375.3	26.1	05:49	283
SD094	26/03/2012	00:16:05	6,073,157.4	395,936.3	25.2	00:24:01	6,073,000.7	396,164.3	25.9	07:56	276
SD095		01:58:20	6,071,622.4	400,391.2	23.3	02:02:46	6,071,908.6	400,478.6	24.2	04:26	299
SD096		01:11:36	6,066,263.8	397,626.4	26.8	01:19:19	6,065,986.9	397,647.4	30.3	07:43	277
SD097		02:52:53	6,068,787.3	403,745.6	23.0	02:57:55	6,068,551.8	403,932.3	23.1	05:02	300
SD098		03:25:25	6,068,349.8	407,816.6	26.6	03:29:46	6,068,402.4	408,096.5	26.4	04:21	284
SD099	29/03/2012	01:36:17	6,074,092.8	458,775.1	23.0	01:40:31	6,073,835.7	458,847.6	23.0	04:14	267
SD100	28/03/2012	04:06:13	6,085,282.2	467,586.7	28.8	04:10:36	6,085,084.0	467,398.5	29.2	04:23	273
SD101	27/03/2012	23:56:26	6,085,246.9	478,604.1	23.0	00:00:19	6,085,303.8	478,319.9	23.1	03:53	289
SD102		22:33:39	6,085,246.5	488,048.7	22.2	22:37:17	6,085,008.0	488,160.2	22.2	03:38	263

Station	Date	Start				End				Duration (mm:ss)	Length (m)
		Time (GMT)	UTM31N		Depth (m)	Time (GMT)	UTM31N		Depth (m)		
			Latitude	Longitude			Latitude	Longitude			
SD103		01:24:13	6,086,168.7	505,706.1	23.0	01:28:26	6,085,894.3	505,691.1	23.1	04:13	275
SD104	26/03/2012	23:48:20	6,102,485.8	508,557.1	25.3	23:52:15	6,102,442.7	508,827.3	25.2	03:55	273
SD105		18:56:24	6,119,183.4	513,538.5	29.7	19:01:11	6,119,401.6	513,670.3	29.7	04:47	255
SD106		20:14:34	6,118,143.0	502,116.7	29.0	20:20:32	6,118,068.7	501,868.0	29.0	05:58	259
SD107	27/03/2012	18:58:06	6,115,202.8	479,314.2	30.6	19:02:19	6,115,478.5	479,243.6	30.6	04:13	284
SD108	28/03/2012	20:13:27	6,112,587.9	459,079.1	33.0	20:16:43	6,112,498.4	459,328.3	33.6	03:16	264
SD109	30/03/2012	18:17:13	6,110,808.9	438,256.7	39.6	18:20:37	6,110,853.9	438,517.5	38.7	03:24	264
SD110		20:50:30	6,108,463.2	420,664.2	34.1	20:55:44	6,108,651.4	420,464.8	35.4	05:14	274

Table 6.3 Deployment Times, Co-ordinates and Depth of each CTD Probe Deployment

Station	Date	CTD Probe			
		Time (GMT)	UTM31N		Depth (m)
			Latitude	Longitude	
SD017	29/03/2012	04:06:05	6,088,760.9	444,503.1	26.8
SD027	24/03/2012	23:15:44	6,088,566.3	396,897.6	26.8
SD030	25/03/2012	19:13:10	6,082,916.7	401,681.2	30.6
SD035	29/03/2012	23:01:50	6,077,749.0	428,506.5	28.1
SD056	28/03/2012	03:06:44	6,095,954.4	470,721.5	28.1
SD066	27/03/2012	03:25:35	6,098,799.4	496,319.7	27.7
SD077	24/03/2012	01:59:24	6,111,243.9	391,016.9	64.7
SD095	26/03/2012	02:15:51	6,072,303.1	400,379.5	25.2

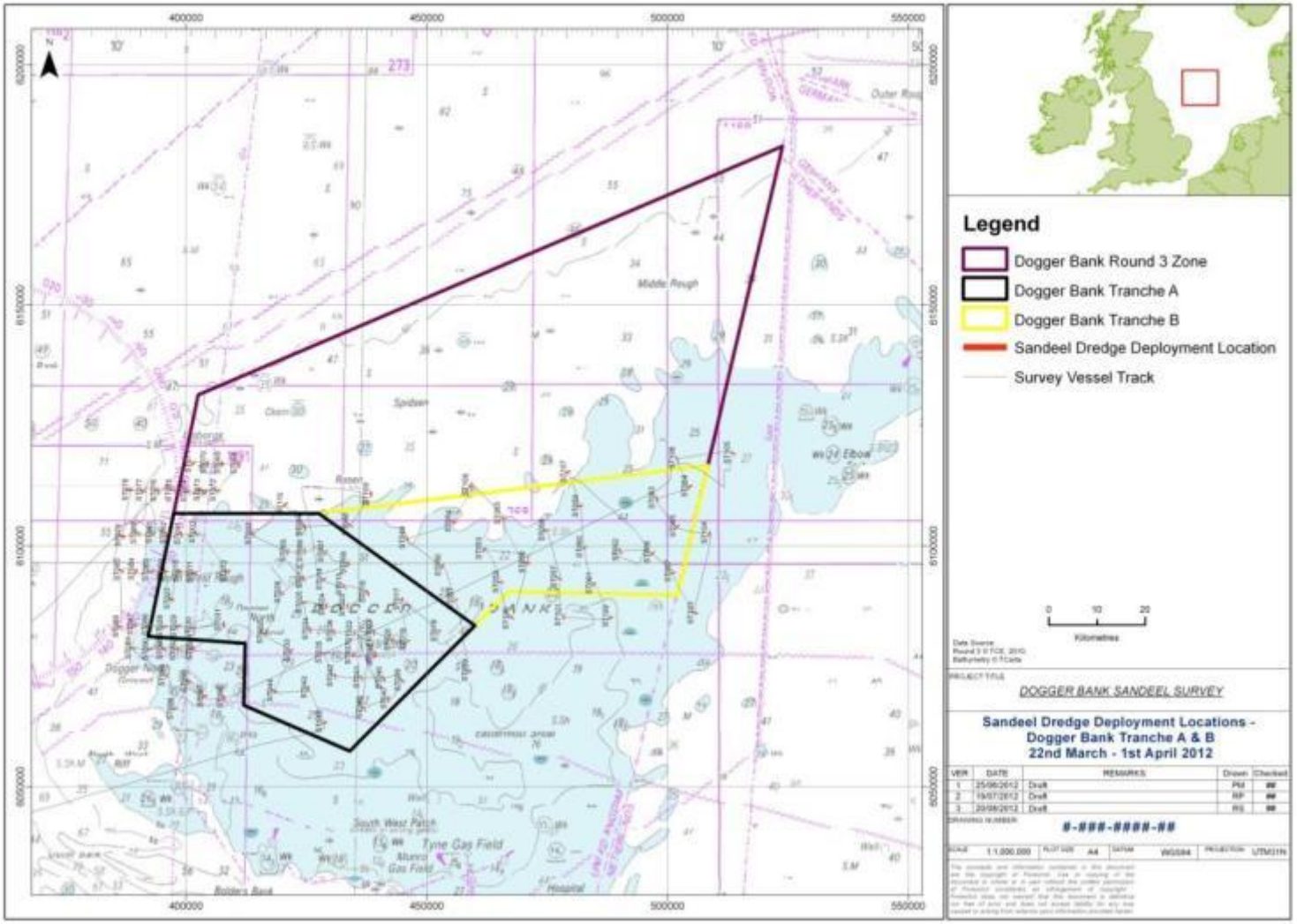


Figure 6.1 Vessel Tracks whilst Towing the Sandeel Dredge

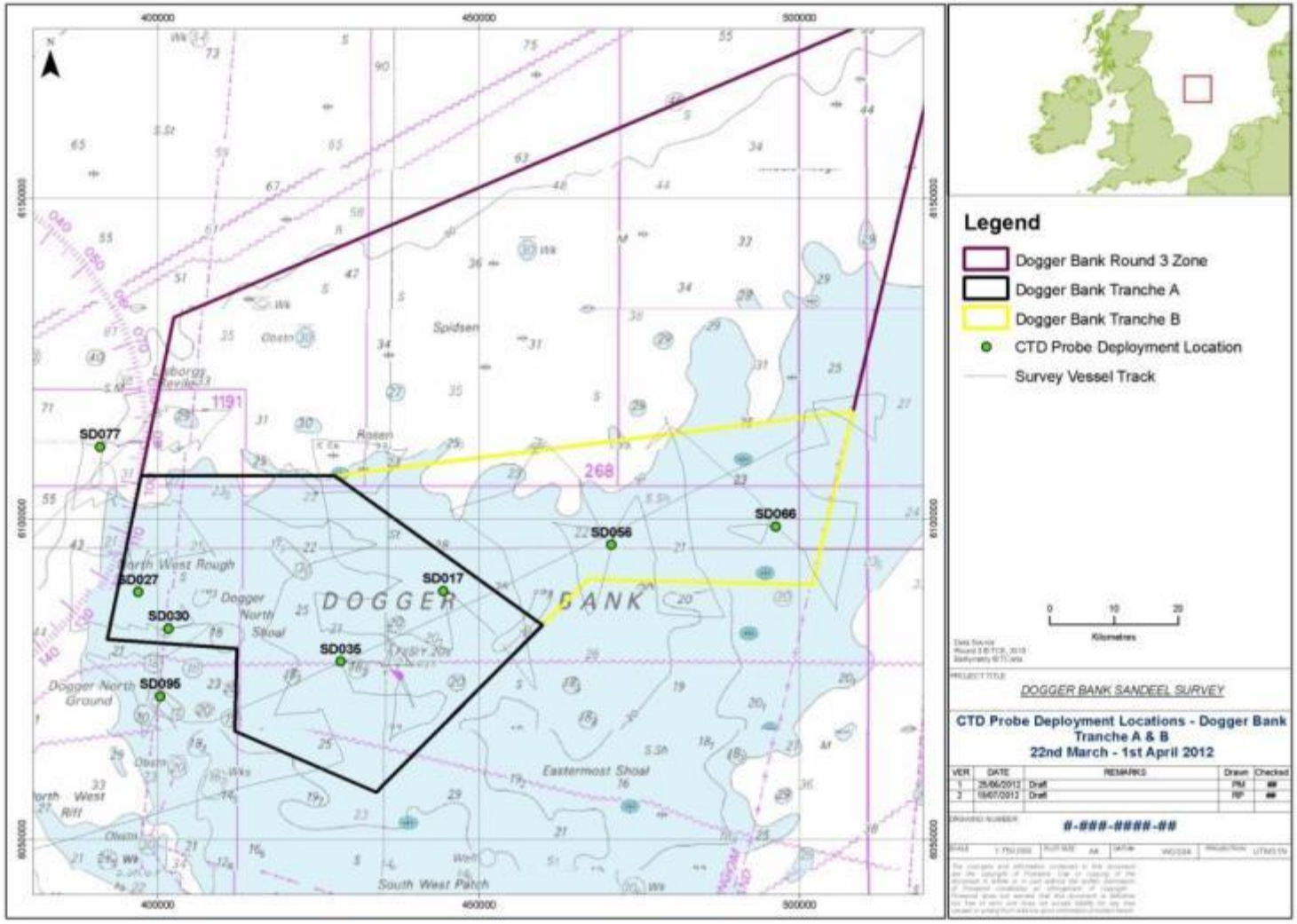


Figure 6.2 CTD Probe Deployment Locations

7.0 Sandeel Dredge Results

7.1 Sandeel Abundance and Distribution

The total number of individuals caught by species and sampling area (control, Tranche A and Tranche B) is given in Table 7.1. The catch rate (number of individuals caught per hour) and the density (number of individuals caught per m^2) by species and sampling area are given in Table 7.2. The catch rate by species and sampling area is illustrated in Figure 7.1, and the catch rate by species and station is given in Figure 7.2, Figure 7.3 and Figure 7.4 for control, Tranche A and Tranche B respectively.

The spatial distribution of sandeel species caught during the survey are shown as stacked histograms in Figure 7.5. The histogram spatial plots show the percentage distribution by catch rate of the three sandeel species, where the bar size corresponds to the catch rate i.e. larger bars indicate greater catch rates.

The total numbers of individuals caught by station, together with the catch rate and density are provided in Section 11.2. Sandeel densities for each sample were calculated dividing the total number of sandeels caught by the area swept by the dredge (dredge width; 1.24m, multiplied by tow track length in metres).

Three species of sandeels were caught during the survey: Raitt's sandeel (*Ammodytes marinus*), smooth sandeel (*Gymnammodytes semisquamatus*) and greater sandeel (*Hyperoplus lanceolatus*). Sandeels were caught in 100 out of 110 stations with a maximum of 674 individuals caught at a single station (SD027), all of which were *A. marinus*.

The most abundant species caught during the survey was *A. marinus* (6,722 individuals), accounting for 98.2% of the total sandeel catch. Over the three sampling areas, 115 *G. semisquamatus* and five *H. lanceolatus* were caught. The greatest total catch rate was recorded at station SD098 (6,496.6/hr), followed by SD027 (6,318.8/hr).

The highest density of sandeels was recorded in Tranche A for *A. marinus,* with 0.16 individuals/m^2, followed by 0.15/m^2 in Tranche B.

As shown in Figure 7.5, the highest abundances of sandeels were caught along the western boundary of the Dogger Bank Zone, with a patchy distribution of higher abundances caught throughout the rest of Tranches A and B. Overlaying the sandeel catches on the Folk's sediment chart (Figure 7.6) suggested that the sandeels caught were found more often over areas of the sediment composition "sand", which are likely to constitute suitable sandeel habitat. Sandeels were also caught over the sediment compositions "muddy sand", "slightly gravelly sand" and "sandy gravel".

The sandeel distribution and abundances during the survey corroborates with the distribution of fishing activity shown by the Danish VMS (Figure 7.7), with the larger catches found in areas of higher fishing effort. This supports previous studies which have suggested that sandeel habitat can be inferred by fishing activity. It should be noted that there will be suitable sandeel habitat patches in areas which cannot be fished efficiently (e.g. see Bergstad *et al.,* 2001).

Table 7.1 Total Numbers of Individuals Caught by Species and Sampling Area

Species		No. of Individuals Caught			
Common Name	Scientific Name	Control	Tranche A	Tranche B	Total
Raitt's Sandeel	*Ammodytes marinus*	3,334	2,382	1,006	6,722
Smooth Sandeel	*Gymnammodytes semisquamatus*	25	87	3	115
Greater Sandeel	*Hyperoplus lanceolatus*	0	5	0	5
Total		3,359	2,474	1,009	6,842

Table 7.2 Catch Rate and Density by Species and Sampling Area

Species		Catch Rate (No. of Individuals Caught per Hour)			Density (No. of Individuals Caught per m^2)		
Common Name	Scientific Name	Control	Tranche A	Tranche B	Control	Tranche A	Tranche B
Raitt's Sandeel	*Ammodytes marinus*	945.0	672.0	724.9	0.2177	0.1492	0.1503
Smooth Sandeel	*Gymnammodytes semisquamatus*	7.1	24.5	2.2	0.0016	0.0054	0.0004
Greater Sandeel	*Hyperoplus lanceolatus*	0.0	1.4	0.0	0.0000	0.0003	0.0000
Total		952.1	697.9	727.1	0.2193	0.1600	0.1508

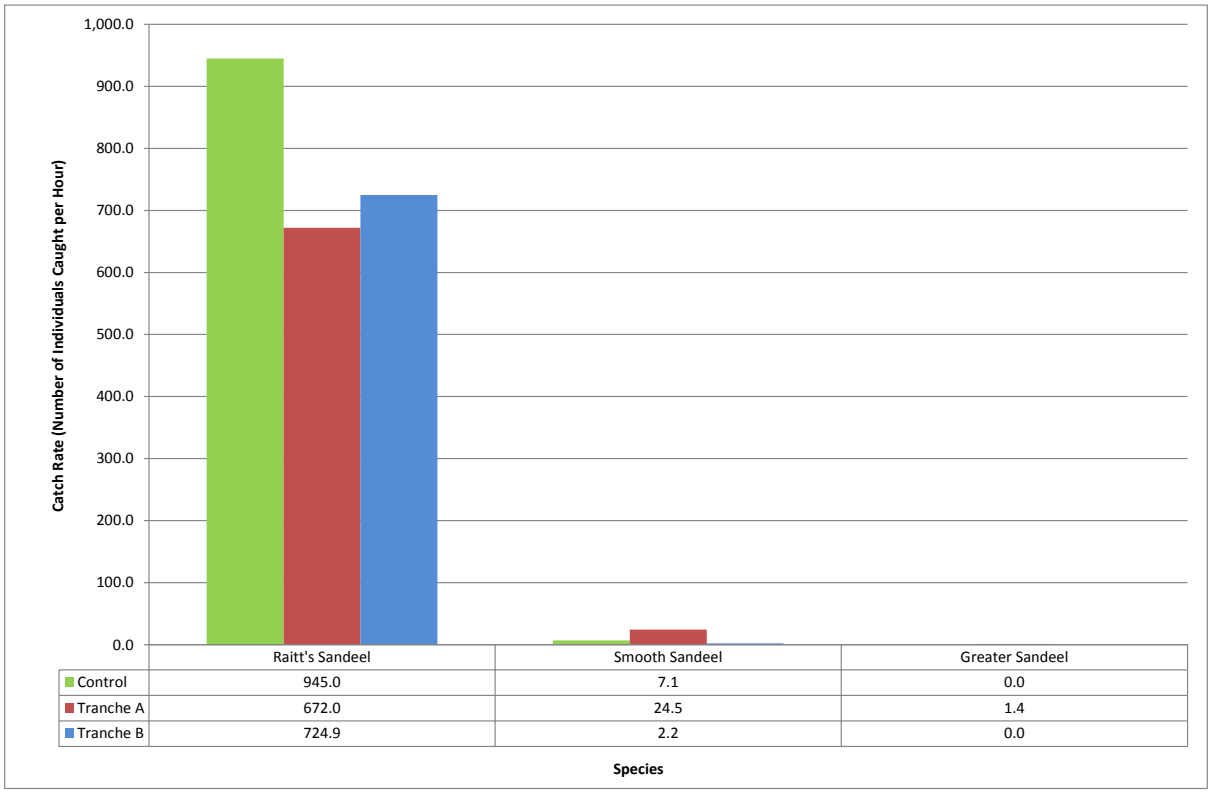
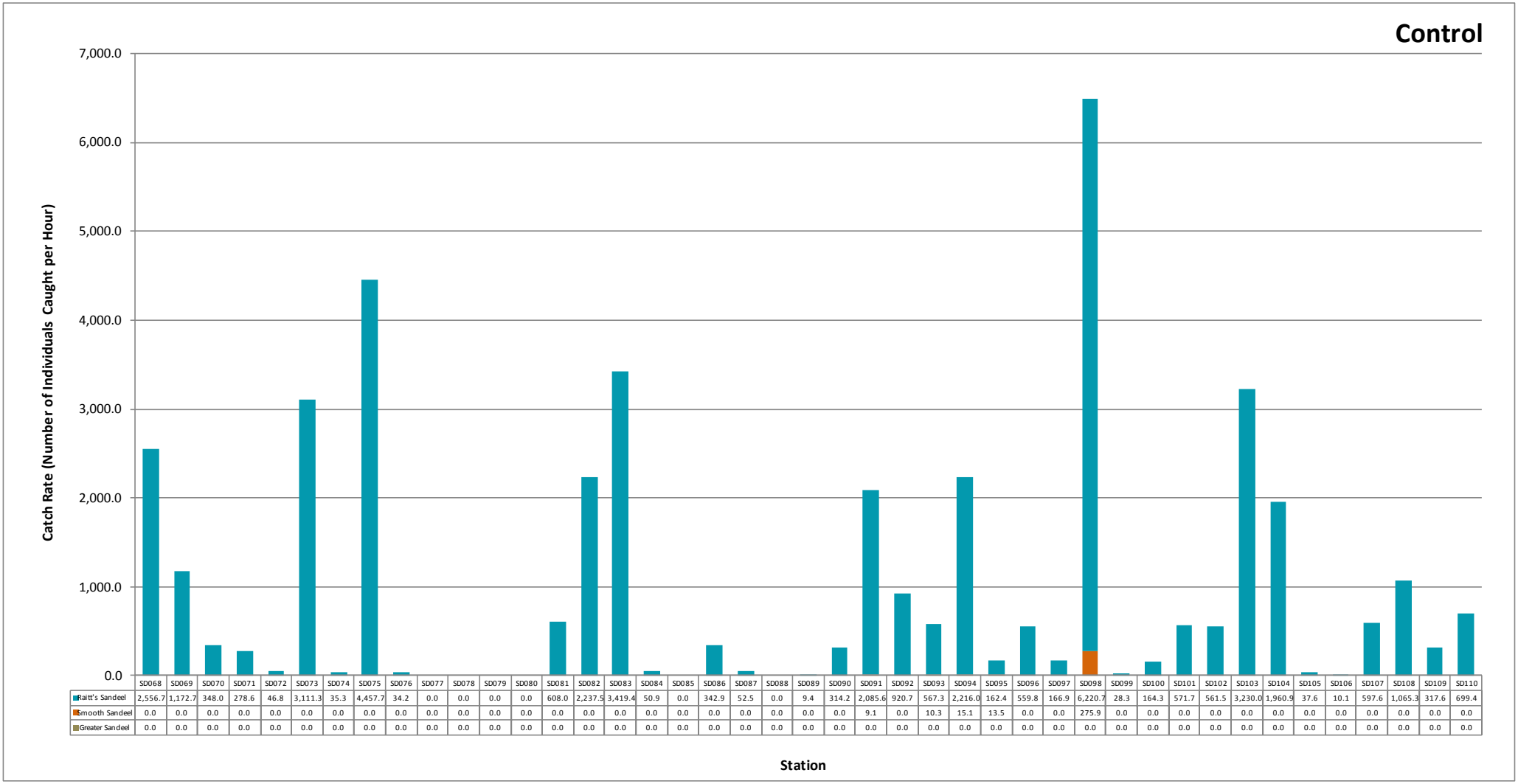
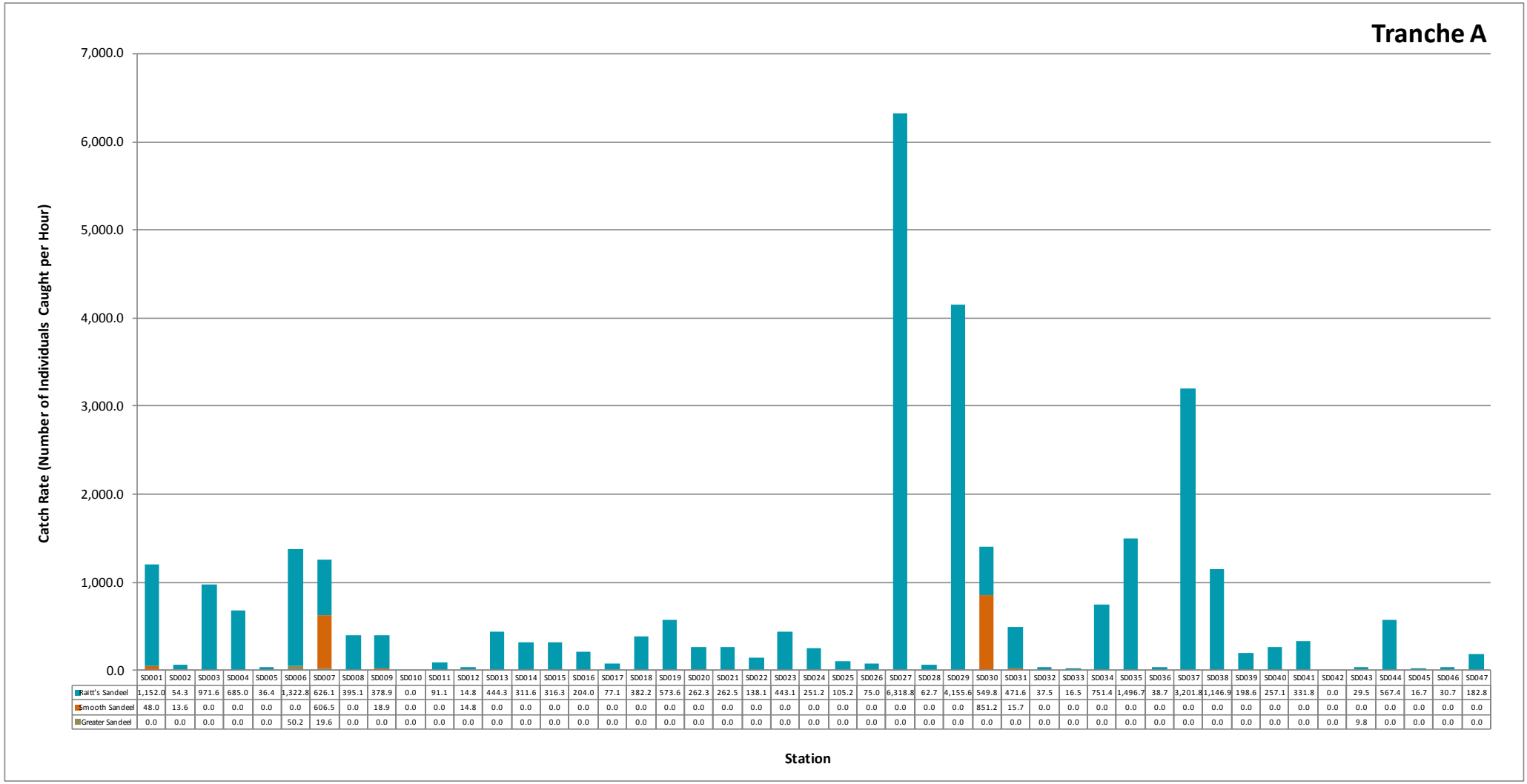


Figure 7.1 Catch Rate by Species and Sampling Area



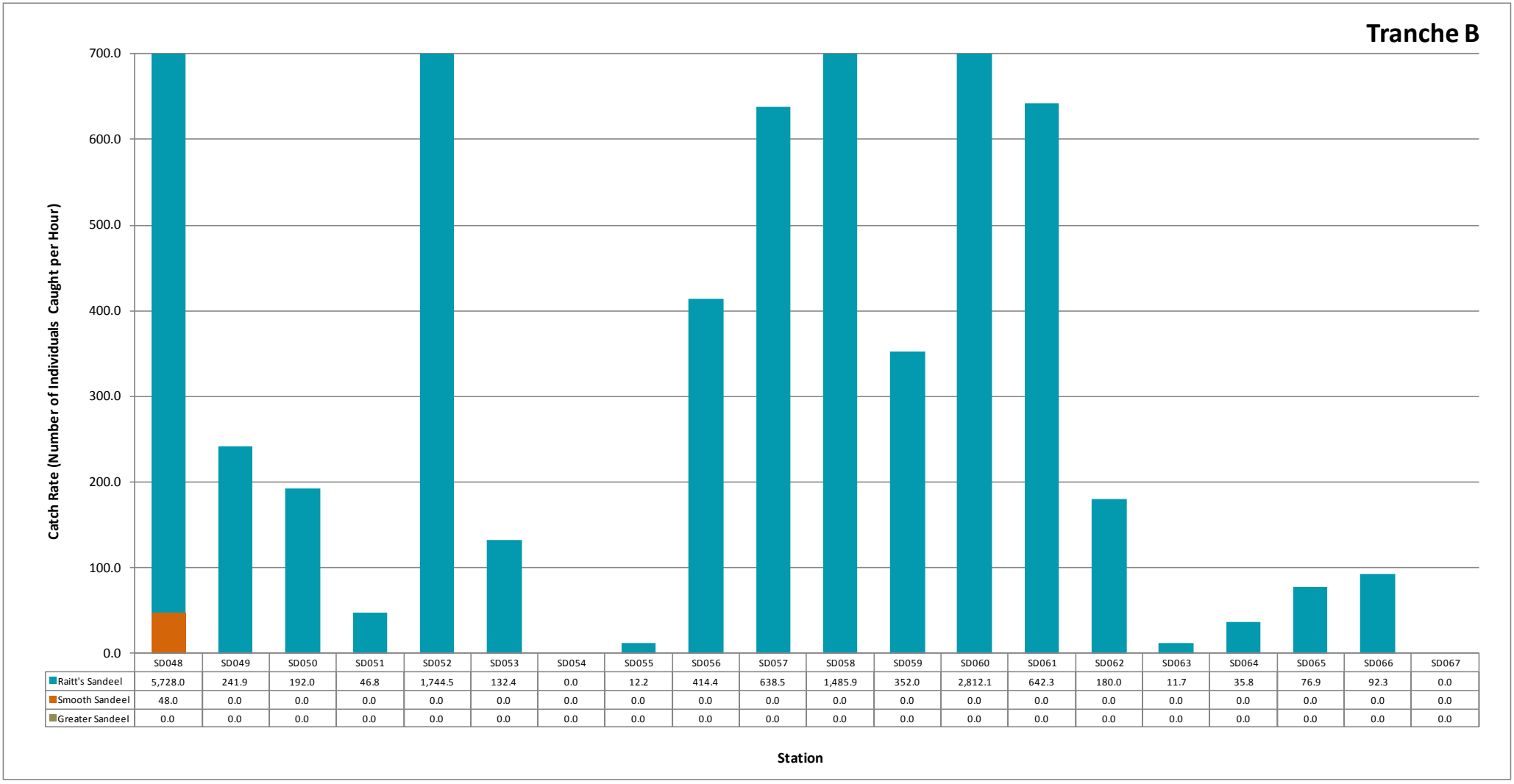
	SD068	SD069	SD070	SD071	SD072	SD073	SD074	SD075	SD076	SD077	SD078	SD079	SD080	SD081	SD082	SD083	SD084	SD085	SD086	SD087	SD088	SD089	SD090	SD091	SD092	SD093	SD094	SD095	SD096	SD097	SD098	SD099	SD100	SD101	SD102	SD103	SD104	SD105	SD106	SD107	SD108	SD109	SD110
Raitt's Sandeel	2,556.7	1,172.7	348.0	278.6	46.8	3,111.3	35.3	4,457.7	34.2	0.0	0.0	0.0	0.0	608.0	2,237.5	3,419.4	50.9	0.0	342.9	52.5	0.0	9.4	314.2	2,085.6	920.7	567.3	2,216.0	162.4	559.8	166.9	6,220.7	28.3	164.3	571.7	561.5	3,230.0	1,960.9	37.6	10.1	597.6	1,065.3	317.6	699.4
Smooth Sandeel	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	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.1	0.0	10.3	15.1	13.5	0.0	0.0	275.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Greater Sandeel	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	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	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

Figure 7.2 Catch Rate by Species and Station at the Control Stations



	SD001	SD002	SD003	SD004	SD005	SD006	SD007	SD008	SD009	SD010	SD011	SD012	SD013	SD014	SD015	SD016	SD017	SD018	SD019	SD020	SD021	SD022	SD023	SD024	SD025	SD026	SD027	SD028	SD029	SD030	SD031	SD032	SD033	SD034	SD035	SD036	SD037	SD038	SD039	SD040	SD041	SD042	SD043	SD044	SD045	SD046	SD047
Raitt's Sandeel	1,152.0	54.3	971.6	685.0	36.4	1,322.8	626.1	395.1	378.9	0.0	91.1	14.8	444.3	311.6	316.3	204.0	77.1	382.2	573.6	262.3	262.5	138.1	443.1	251.2	105.2	75.0	6,318.8	62.7	4,155.6	549.8	471.6	37.5	16.5	751.4	1,496.7	38.7	3,201.8	1,146.9	198.6	257.1	331.8	0.0	29.5	567.4	16.7	30.7	182.8
Smooth Sandeel	48.0	13.6	0.0	0.0	0.0	0.0	606.5	0.0	18.9	0.0	0.0	14.8	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	0.0	0.0	851.2	15.7	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	0.0
Greater Sandeel	0.0	0.0	0.0	0.0	0.0	50.2	19.6	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	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	0.0	0.0	0.0	0.0	0.0	9.8	0.0	0.0	0.0	0.0

Figure 7.3 Catch Rate by Species and Station in Tranche A



	SD048	SD049	SD050	SD051	SD052	SD053	SD054	SD055	SD056	SD057	SD058	SD059	SD060	SD061	SD062	SD063	SD064	SD065	SD066	SD067
Raitt's Sandeel	5,728.0	241.9	192.0	46.8	1,744.5	132.4	0.0	12.2	414.4	638.5	1,485.9	352.0	2,812.1	642.3	180.0	11.7	35.8	76.9	92.3	0.0
Smooth Sandeel	48.0	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	0.0	0.0	0.0	0.0	0.0
Greater Sandeel	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	0.0	0.0	0.0	0.0	0.0

Figure 7.4 Catch Rate by Species and Station in Tranche B

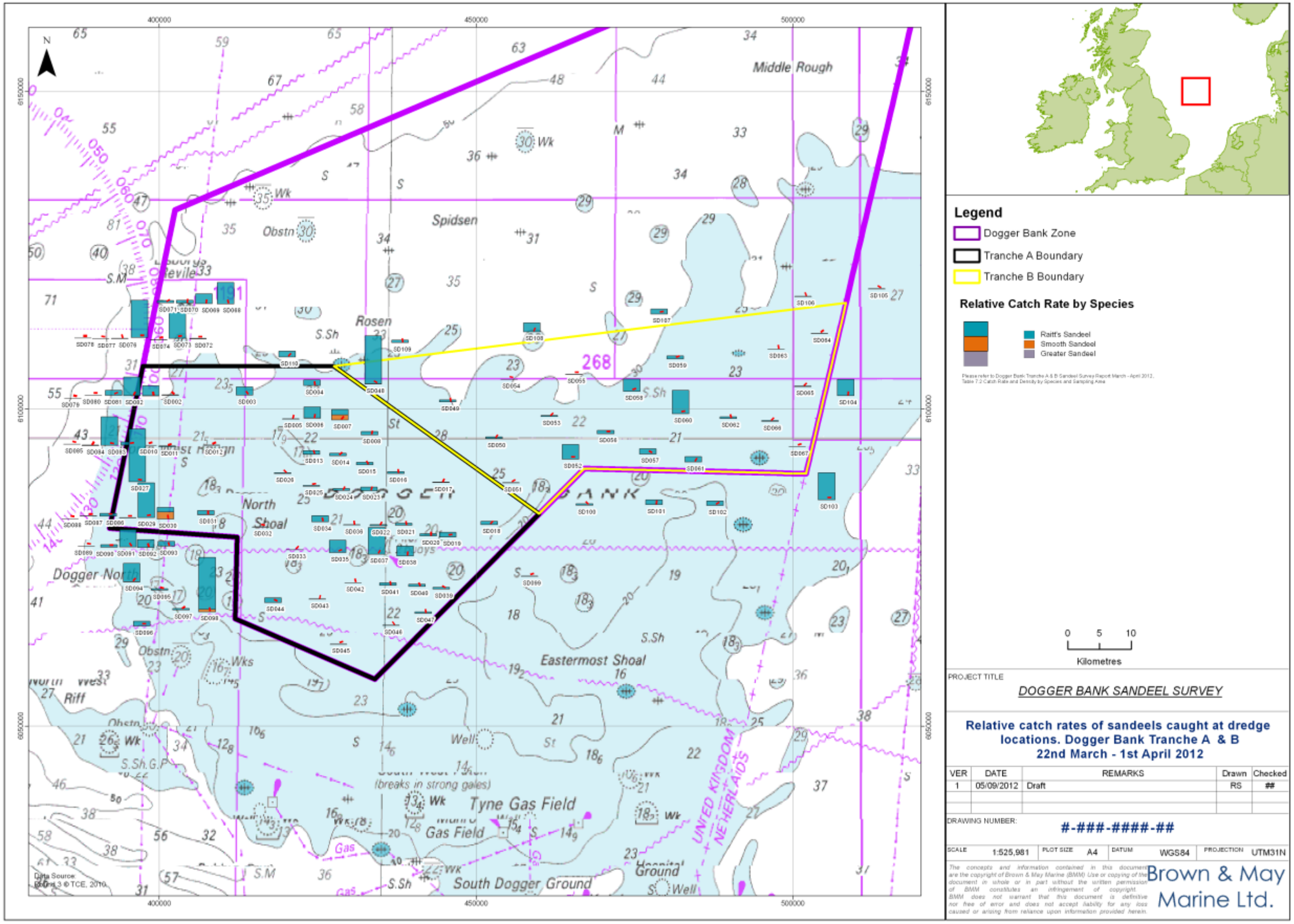


Figure 7.5 Spatial Distribution of Sandeel Species

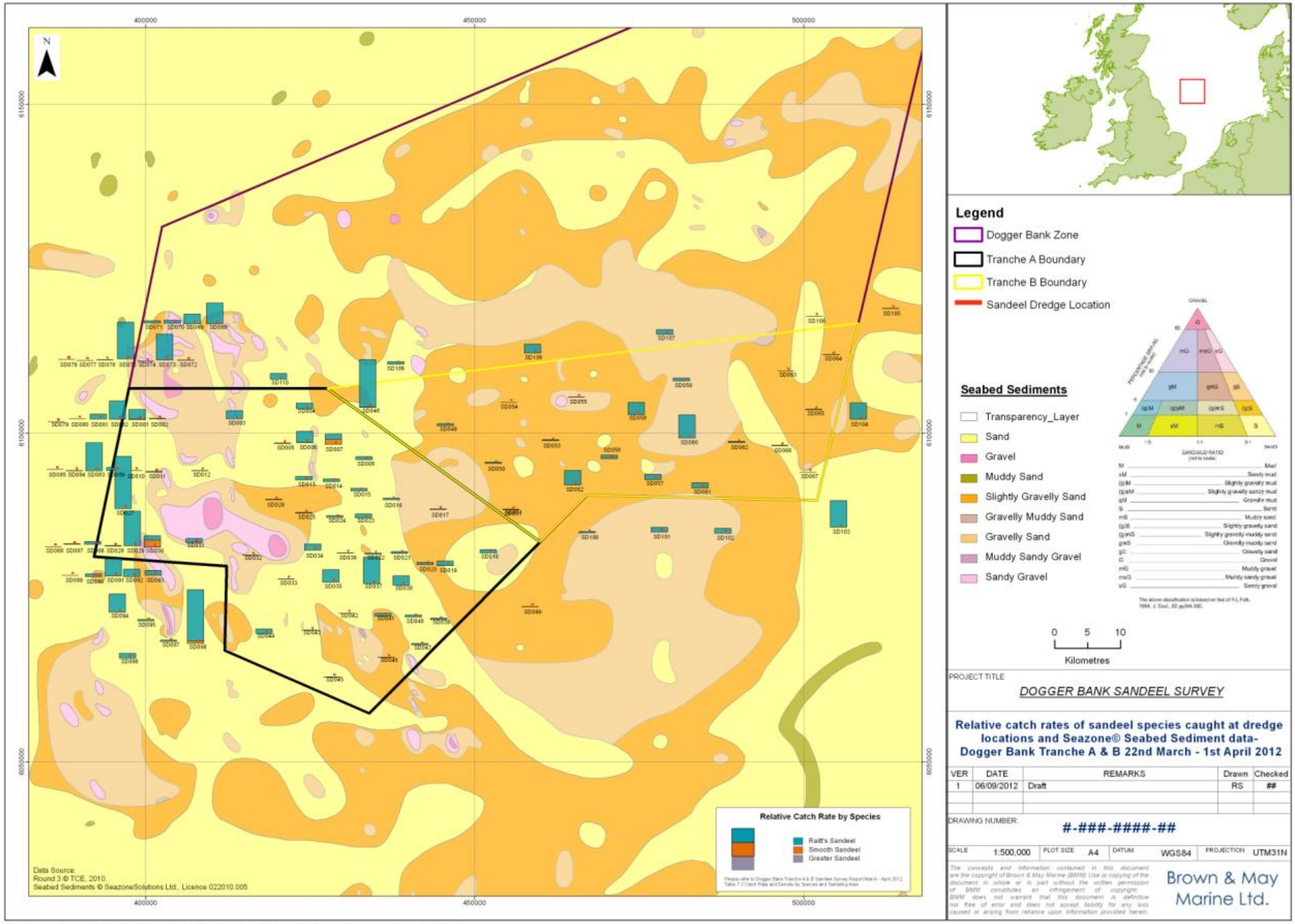


Figure 7.6 Spatial Distribution of Sandeel Species Overlaying Seabed Sediments (Source: BGS)

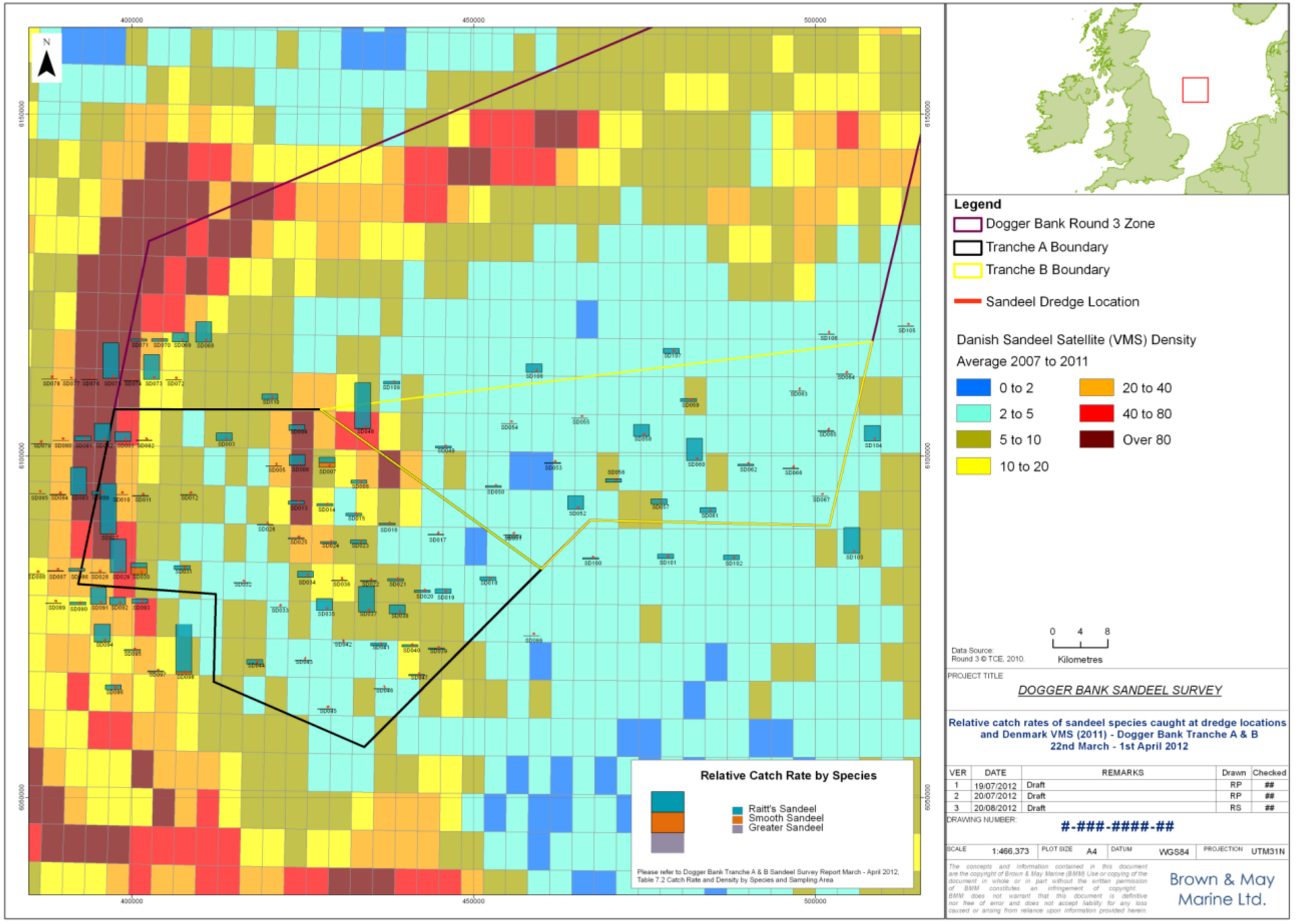


Figure 7.7 Spatial Distribution of Sandeel Species Overlaying Annual Satellite Density VMS Sightings of Danish Vessels of Over-15m

7.2 Length Distributions

The average length (mm) and length range by species and by sampling area (control, Tranche A and Tranche B) is given below in Table 7.3.

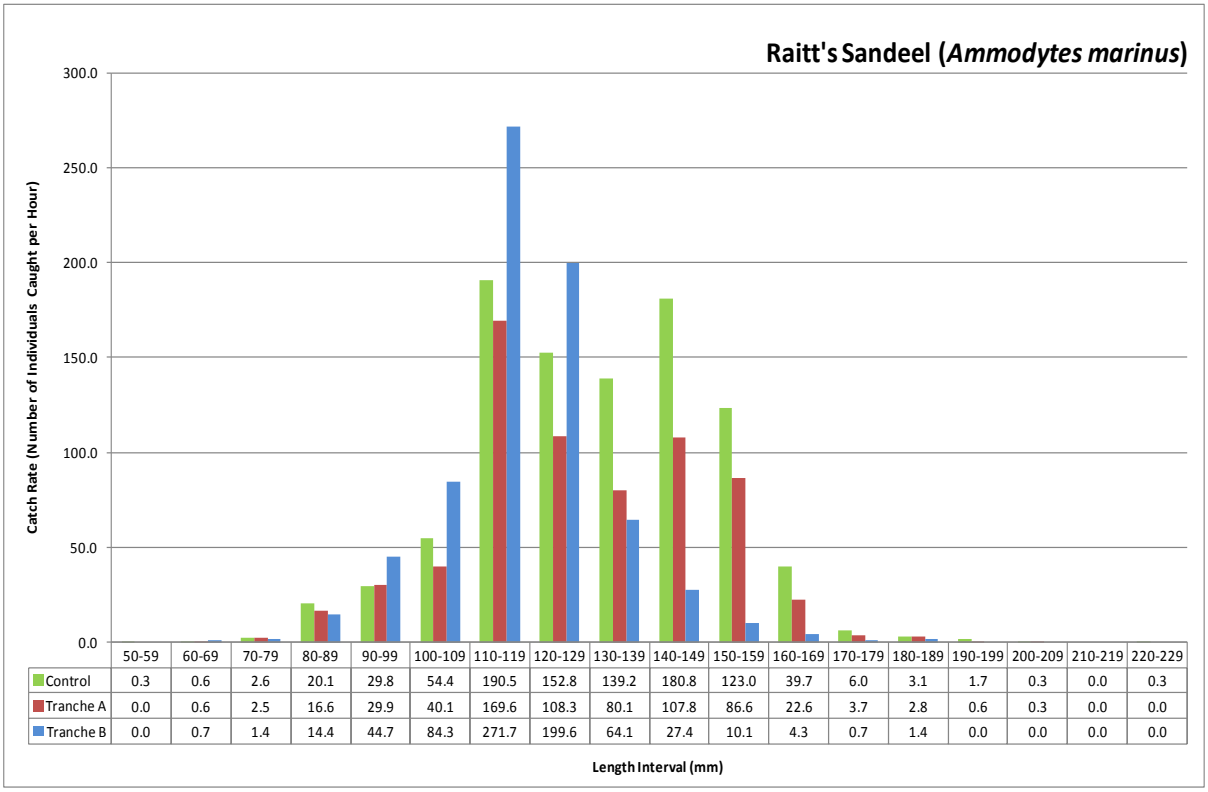
The length distributions of the three sandeel species caught during the survey, expressed as the catch rate (number of individuals caught per hour) by length (mm) and by sampling area are shown in Figure 7.8 to Figure 7.10.

The greatest numbers of *A. marinus* caught were between 110.0 and 119.0mm in length, in all three sampling areas. *G. semisquamatus* were found in their highest numbers between the lengths of 160.0 and 169.0mm. Five *H. lanceolatus* were caught in the survey with lengths ranging between 244.0 and 266.0mm.

Previous studies carried out on sandeel lengths in the Dogger Bank area (see Section 3.1) suggest that the lengths of *A. marinus* caught during the survey could be from 0-group and 1+-group year classes, with the majority likely to be found in the 1+-group. The lengths recorded in this survey for *G. semisquamatus* and *H. lanceolatus* fall within what is considered to be "common" lengths for those species.

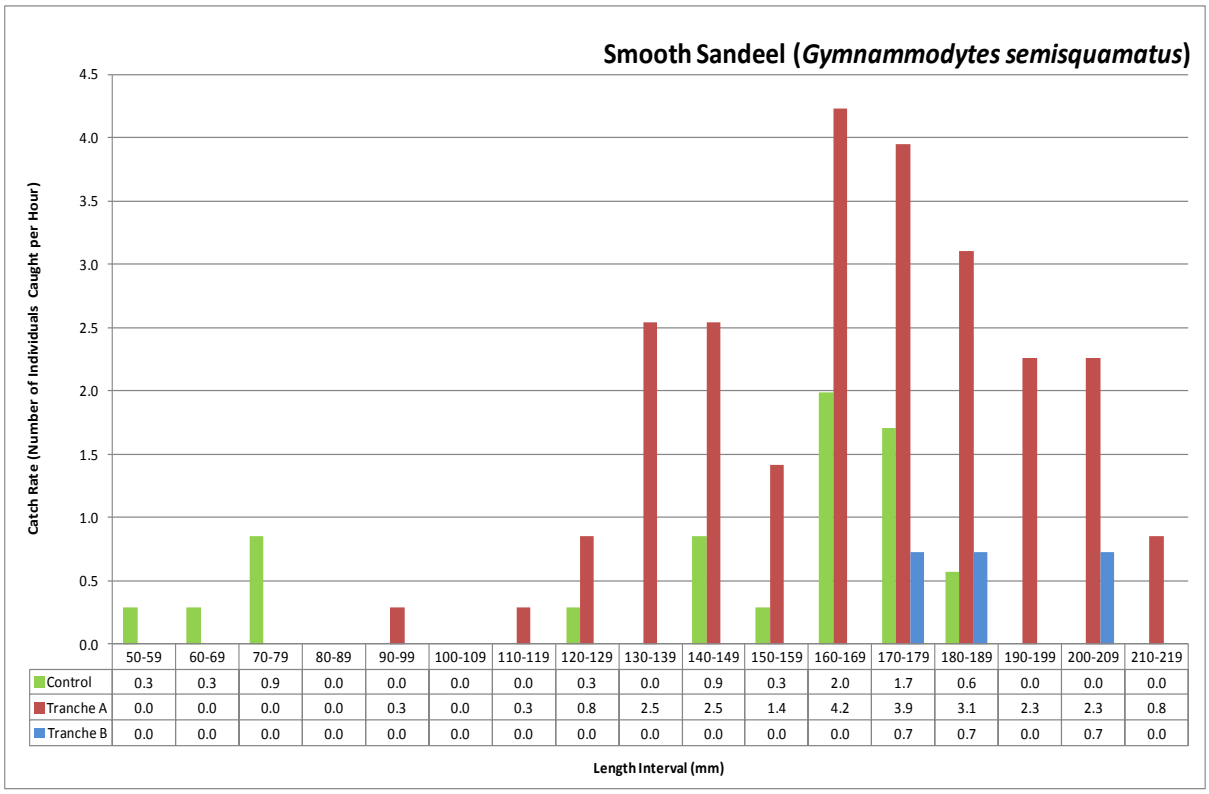
Table 7.3 Average Length and Length Ranges by Species and Sampling Area

Species		Average Length (mm)			Length Range (mm)	
Common Name	Scientific Name	Control	Tranche A	Tranche B	Min.	Max.
Raitt's Sandeel	*Ammodytes marinus*	130.8	128.4	118.0	50.0	229.0
Smooth Sandeel	*Gymnammodytes semisquamatus*	144.5	167.7	187.0	59.0	214.0
Greater Sandeel	*Hyperoplus lanceolatus*	0.0	253.2	0.0	244.0	266.0



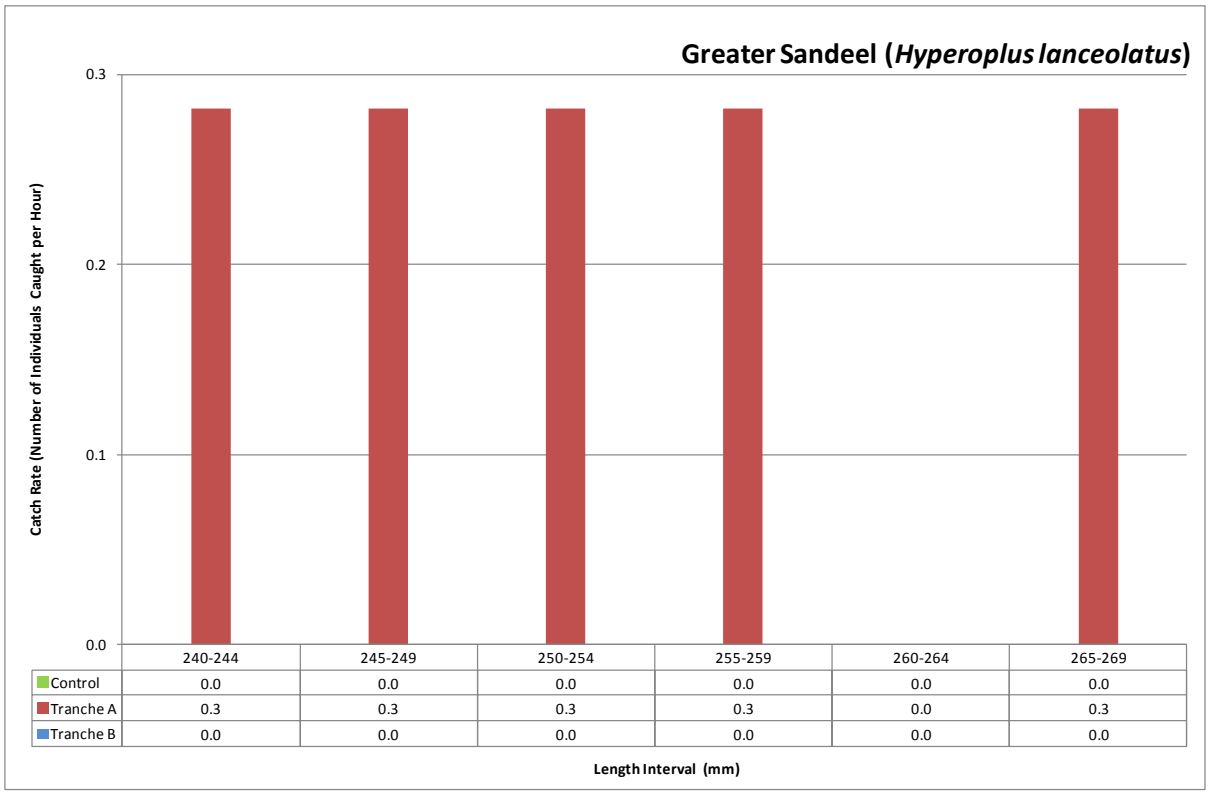
	50-59	60-69	70-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200-209	210-219	220-229
Control	0.3	0.6	2.6	20.1	29.8	54.4	190.5	152.8	139.2	180.8	123.0	39.7	6.0	3.1	1.7	0.3	0.0	0.3
Tranche A	0.0	0.6	2.5	16.6	29.9	40.1	169.6	108.3	80.1	107.8	86.6	22.6	3.7	2.8	0.6	0.3	0.0	0.0
Tranche B	0.0	0.7	1.4	14.4	44.7	84.3	271.7	199.6	64.1	27.4	10.1	4.3	0.7	1.4	0.0	0.0	0.0	0.0

Figure 7.8 Raitt's Sandeel (*A. marinus*) Length Distribution by Sampling Area



	50-59	60-69	70-79	80-89	90-99	100-109	110-119	120-129	130-139	140-149	150-159	160-169	170-179	180-189	190-199	200-209	210-219
Control	0.3	0.3	0.9	0.0	0.0	0.0	0.0	0.3	0.0	0.9	0.3	2.0	1.7	0.6	0.0	0.0	0.0
Tranche A	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.8	2.5	2.5	1.4	4.2	3.9	3.1	2.3	2.3	0.8
Tranche B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.7	0.0

Figure 7.9 Smooth Sandeel (*G. semisquamatus*) Length Distribution by Sampling Area



	240-244	245-249	250-254	255-259	260-264	265-269
Control	0.0	0.0	0.0	0.0	0.0	0.0
Tranche A	0.3	0.3	0.3	0.3	0.0	0.3
Tranche B	0.0	0.0	0.0	0.0	0.0	0.0

Figure 7.10 Greater Sandeel (*H. lanceolatus*) Length Distribution by Sampling Area

7.3 Wet (defrosted) Weight Distribution

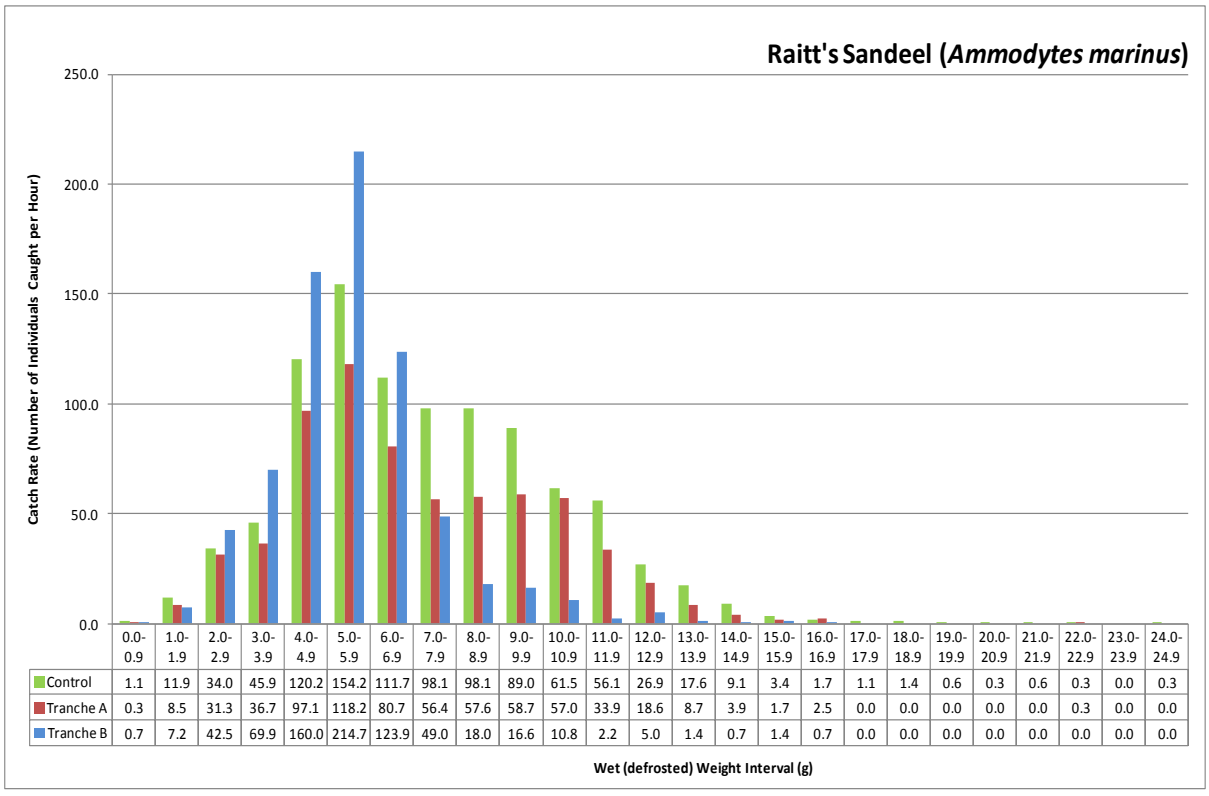
The average wet (defrosted) weight (g) and weight range, by species and sampling area (control, Tranche A and Tranche B), is given below in Table 7.4.

The weight distributions of the three sandeel species caught during the survey, expressed as the catch rate (number of individuals caught per hour) by wet (defrosted) weight (g) and by sampling area are shown in Figure 7.11 to Figure 7.13.

The greatest numbers of *A. marinus* caught in all sampling areas were between 5.0 and 5.9g in wet weight. *G. semisquamatus* were found in their highest numbers between the wet weights of 14.0 and 15.9g. Five *H. lanceolatus* were caught during the survey, with wet weights ranging from 48.0 to 65.0g.

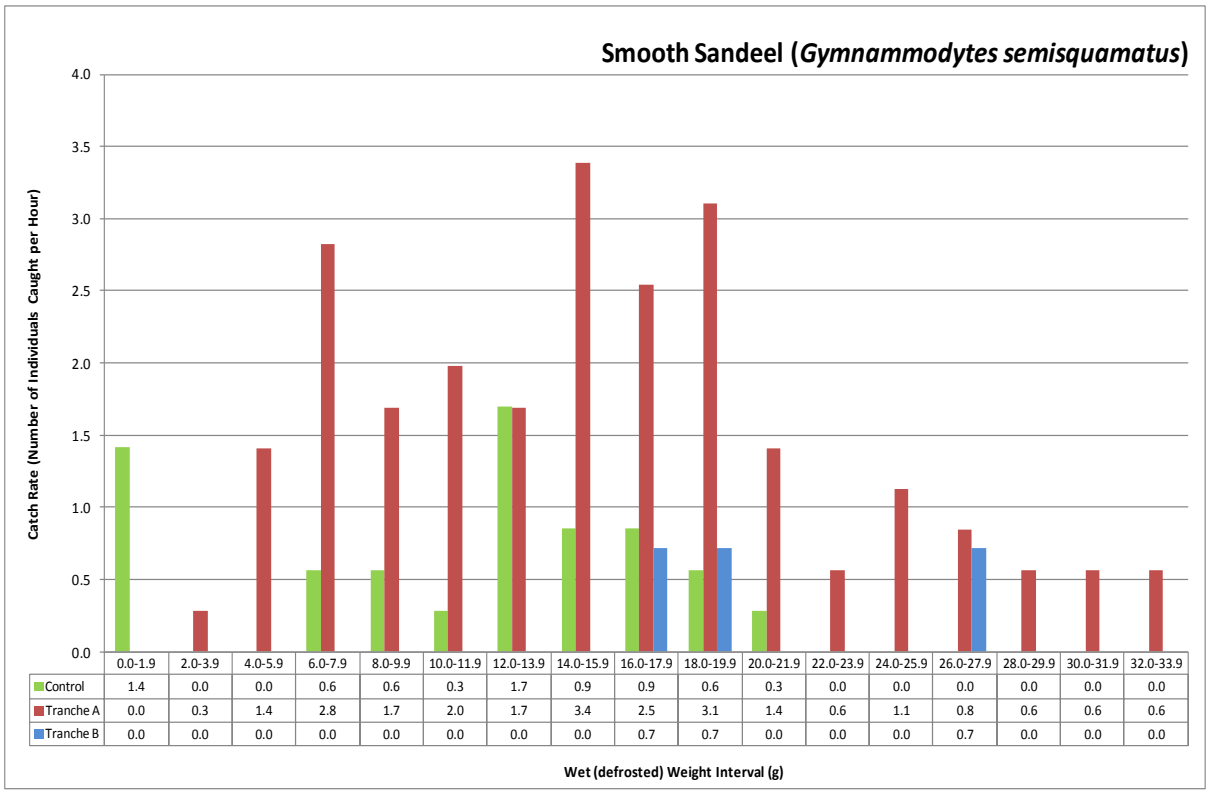
Table 7.4 Average Wet (defrosted) Weight and Weight Ranges by Species and Sampling Area

Species		Average Wet (defrosted) Weight (g)			Wet (defrosted) Weight Range (g)	
Common Name	Scientific Name	Control	Tranche A	Tranche B	Min.	Max.
Raitt's Sandeel	*Ammodytes marinus*	7.3	7.0	5.5	0.2	24.1
Smooth Sandeel	*Gymnammodytes semisquamatus*	11.2	15.6	20.6	0.4	32.9
Greater Sandeel	*Hyperoplus lanceolatus*	0.0	56.4	0.0	48.0	65.0



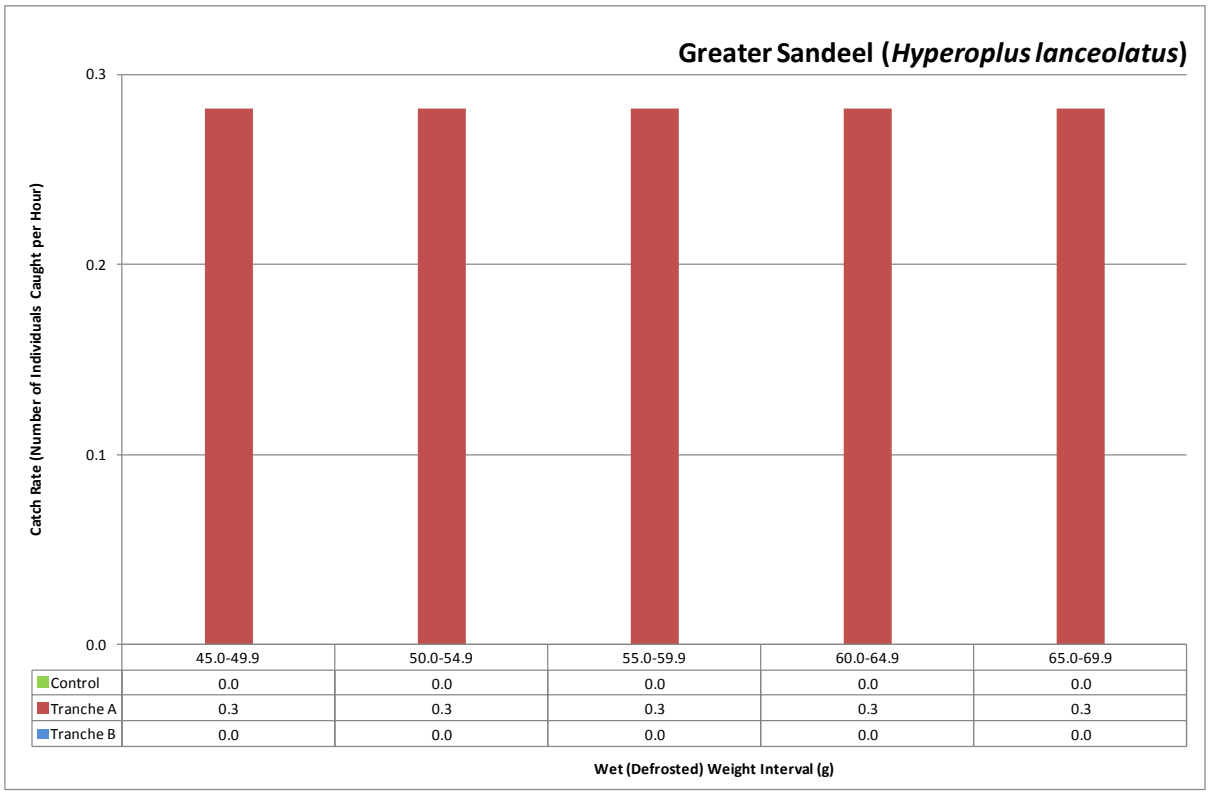
	0.0-0.9	1.0-1.9	2.0-2.9	3.0-3.9	4.0-4.9	5.0-5.9	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9	19.0-19.9	20.0-20.9	21.0-21.9	22.0-22.9	23.0-23.9	24.0-24.9
Control	1.1	11.9	34.0	45.9	120.2	154.2	111.7	98.1	98.1	89.0	61.5	56.1	26.9	17.6	9.1	3.4	1.7	1.1	1.4	0.6	0.3	0.6	0.3	0.0	0.3
Tranche A	0.3	8.5	31.3	36.7	97.1	118.2	80.7	56.4	57.6	58.7	57.0	33.9	18.6	8.7	3.9	1.7	2.5	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
Tranche B	0.7	7.2	42.5	69.9	160.0	214.7	123.9	49.0	18.0	16.6	10.8	2.2	5.0	1.4	0.7	1.4	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure 7.11 Raitt's Sandeel (*A. marinus*) Wet (defrosted) Weight Distribution by Sampling Area



	0.0-1.9	2.0-3.9	4.0-5.9	6.0-7.9	8.0-9.9	10.0-11.9	12.0-13.9	14.0-15.9	16.0-17.9	18.0-19.9	20.0-21.9	22.0-23.9	24.0-25.9	26.0-27.9	28.0-29.9	30.0-31.9	32.0-33.9
Control	1.4	0.0	0.0	0.6	0.6	0.3	1.7	0.9	0.9	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Tranche A	0.0	0.3	1.4	2.8	1.7	2.0	1.7	3.4	2.5	3.1	1.4	0.6	1.1	0.8	0.6	0.6	0.6
Tranche B	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.0	0.0	0.0	0.7	0.0	0.0	0.0

Figure 7.12 Smooth Sandeel (*G. semisquamatus*) Wet (defrosted) Weight Distribution by Sampling Area



	45.0-49.9	50.0-54.9	55.0-59.9	60.0-64.9	65.0-69.9
Control	0.0	0.0	0.0	0.0	0.0
Tranche A	0.3	0.3	0.3	0.3	0.3
Tranche B	0.0	0.0	0.0	0.0	0.0

Figure 7.13 Greater Sandeel (*H. lanceolatus*) Wet (defrosted) Weight Distribution by Sampling Area

8.0 Temperature and Salinity

8.1 Temperature

The minimum, maximum and average temperature recorded at every tenth station is given by sampling area (control, Tranche A and Tranche B) in Table 8.1. The depth profile of the average temperature by sampling area is given in Figure 8.1.

The temperature ranged from 6.9°C to 8.2°C across all stations with the average temperature varying between 7.3°C and 7.7°C.

Table 8.1 Minimum, Maximum and Average Temperature by Sampling Area

Sampling Area	Minimum Temperature (°C)	Maximum Temperature (°C)	Average Temperature (°C)
Control	7.3	7.6	7.4
Tranche A	7.3	8.2	7.7
Tranche B	6.9	8.2	7.3
Average	6.9	8.2	7.5

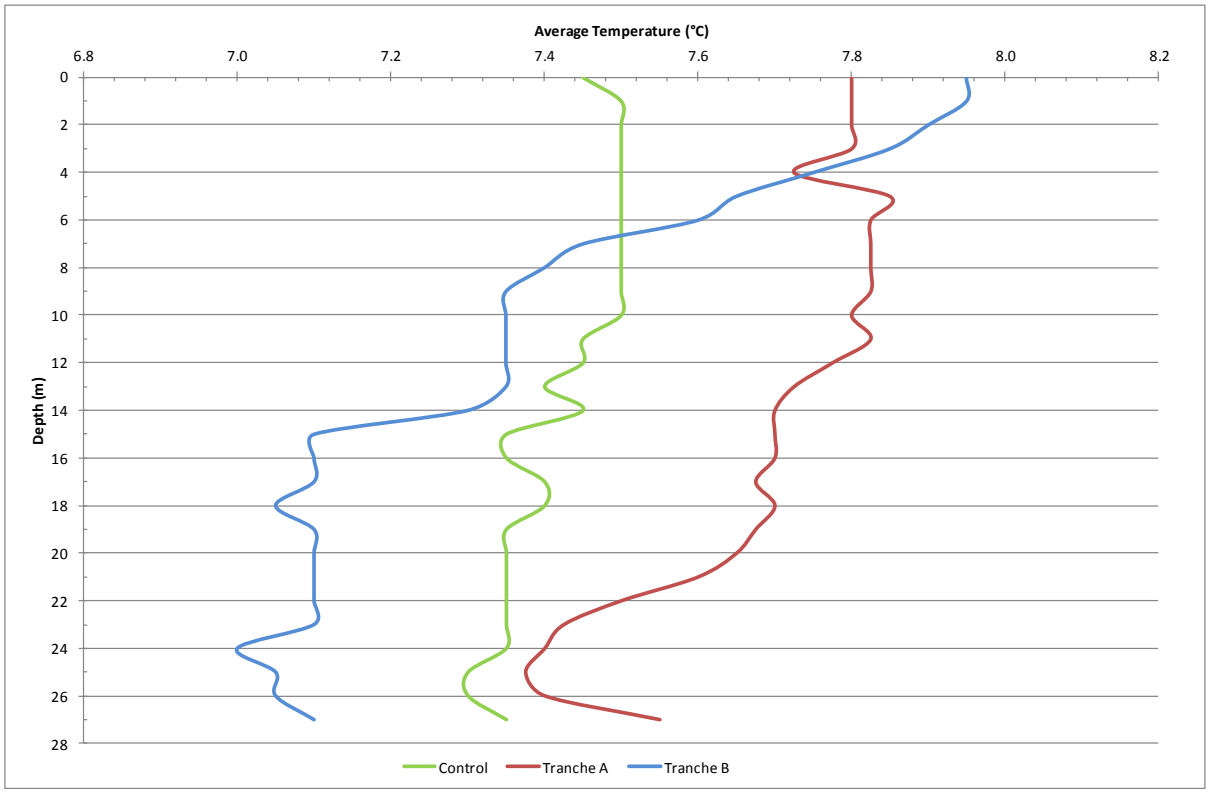


Figure 8.1 Average Temperature Depth Profile by Sampling Area

8.2 Salinity

The minimum, maximum and average salinity recorded at approximately every tenth station is given by sampling area (control, Tranche A and Tranche B) in Table 8.2. The depth profile of the average salinity by sampling area is given in Figure 8.2.

The salinity ranged from 35.9‰ to 36.4‰ across all sampling areas with the average salinity ranging between 36.0‰ and 36.1‰.

Table 8.2 Minimum, Maximum and Average Salinity by Sampling Area

Sampling Area	Minimum Salinity (‰)	Maximum Salinity (‰)	Average Salinity (‰)
Control	35.9	36.1	36.0
Tranche A	36.0	36.2	36.1
Tranche B	36.1	36.4	36.1
Average	35.9	36.4	36.1

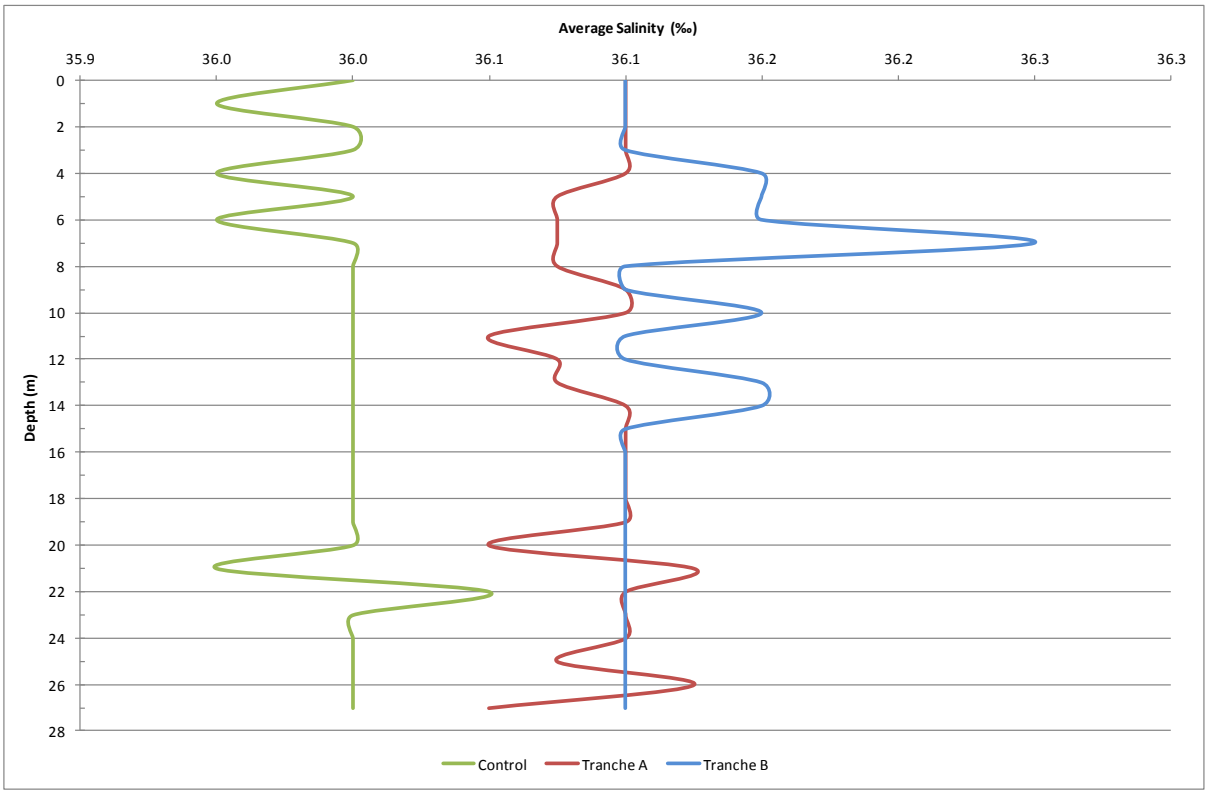


Figure 8.2 Average Salinity Depth Profile by Sampling Area

9.0 Conclusion

The survey was undertaken during night hours between the 22nd March and the 1st April, when the majority of sandeels were expected to be buried in the sediment.

Sandeels were caught in all sampling areas (control, Tranche A and Tranche B), in 100 out of 110 stations. The highest abundances of sandeels were recorded in stations from the western boundary of the Dogger Bank Zone, and to a lesser extent in the south-western section of Tranche A and the central eastern section of Tranche B. The most abundant species caught was *A. marinus,* accounting for 98.2% of the total sandeel catch.

PSD analysis carried out in Tranche A suggests that the majority of stations sampled were considered to be less suitable sandeel habitat. However, on the basis of the Folk's sediment charts, certain areas of the Dogger Bank Zone have the potential to support sandeel populations.

The distribution of sandeel abundances recorded during the survey suggest that the western boundary of the Dogger Bank Zone supports an important sandeel population, and correlates with Danish sandeel fishing activity, providing further support that fishing patterns reflect sandeel habitat distribution.

The presence of suitable sandeel habitat does not necessarily imply that sandeels will be present in a given area. Sandeel distribution is extremely patchy and even the most suitable habitats often render zero-catch samples. If it is assumed that the population is below the area's carrying capacity, it is unlikely that all of the most suitable habitat will be fully occupied by sandeels (Greenstreet, 2007).

Studies carried out in the Dogger Bank area suggest that the *A. marinus* caught during the survey were from 0-group and 1+-group year classes, with the majority likely to be found in the 1+-group. The lengths recorded for *G. semisquamatus* and *H. lanceolatus* fall within what is considered to be "common" lengths for those species.

10.0 References

Bell, E., Bannister, C., Satchel, C., Garrod, C., Boon, T. (2004) Report of Investigation into the potential whitefish by-catch in the North Sea sandeel fishery. Fisheries Science Partnership. Fisheries Management Group, Cefas, Lowerstoft, pp 1-19.

Bergstad, O. A., Hoines, A. S., Kruger-Johnsen, E. M. (2001) Spawning time, age and size at maturity, and fecundity of sandeel, Ammodytes marinus, in the north-eastern North Sea and in unfished coastal waters off Norway. Aquatic Living Resources, 14: 29-301.

CEFAS (2007) Multispecies Fisheries Management: A Comprehensive Impact Assessment of the Sand eel Fishery along the English East Coast. CEFAS Contract Report MF0323/01.

Collins, M. A. & Pierce, G. J. (1996) Size selectivity in the diet of "Loligo forbesi" (Cephalopoda: Loliginidae). Journal of the Marine Biological Association of the United Kingdom, 76, pp 1081-1090.

Clausen, L.W., Davis, C.G., Hansen, S. (2006) Report of the Sandeel Otolith Ageing Workshop, DIFRES. Ices Planning Group on Commerical Catch, discards and Biological Sampling (PGCCDBS), 17pp. Accessed March 2012: http://www.ices.dk/reports/acfm/pgccdbs/ReportSandEelAgeWK0906.pdf

Ellis, J.R., Milligan, S., Readdy, L., South, A., Taylor, N., and Brown, M. (2010) Mapping spawning and nursery areas of species to be considered in Marine Protected Areas (Marine Conservation Zones).

EMU (2011) Dogger Bank Offshore Wind Farm Benthic Ecology Characterisation Survey.

Folk, R.L. (1954) The distinction between grain size and mineral composition in sedimentary rocks. Journal of Geology, 62, 344-359.

Furness, R.W. (2002) Management implications of interactions between fisheries and sandeel-dependent seabirds and seals in the North Sea.-ICES Journal of Marine Science, 59:261-269.

Gauld, J.A., & Hutcheon, J.R. (1990) Spawning and fecundity in the lesser sandeel, Ammodytes marinus Raitt, in the northwestern North Sea. Journal of Fish Biology, 36: 611e613.

Greenstreet, S.P.R. (2007) Variation in the abundance and distribution of sandeels and clupeids in the Wee Bankie/Marr Bank region of the north-western North Sea over the period 1997 to 2003. Fisheries Research Services Internal Report No: 25/07.

Greenstreet, S.P.R., Fraser, H., Armstrong, E., Gibb, I. (2010) Monitoring the consequences of the northwestern North Sea sandeel fishery closure. Marine Scotland. Scottish Marine and Freshwater Science Volume 1(6). 34pp.

Haugland, M., Holst J.C., Holm, M. and Hansen, L.P. (2006) Feeding of Atlantic salmon *(Salmo salar L.*) post-smolts in the Northeast Atlantic. ICES J. Mar.Sci. 63(8):1488-1500.

Heath, M.R., Rasmussen, J., Bailey, M.C., Dunn, J., Fraser, J., Gallego, A., Hay, S.J., Inglis, M., Robinson, S. (2011) Larval mortality rates and population dynamics of Lesser Sandeel (*Ammodytes marinus*) in the northwestern North Sea. Journal of Marine Systems, 93: 47-57.

Hobson, E.S. (1986) Predation on the Pacific sand lance, A. hexapterus (Pisces: Ammodytidae) during the transition between day and night in southeastern Alaska. Copeia 1, 223–226.

Holland, G. J., Greenstreet, S. P. R., Gibb, I. M., Fraser, H. M., Robertson, M. R. (2005) Identifying sandeel Ammodytes marinus sediment habitat preferences in the marine environment. Marine Ecology Progress Series, 303: 269-282.

ICES (2005) Report of the Study Group on Multispecies Assessment in the North Sea (SGMSNS), 5–8 April 2005, ICES Headquarters. ICES CM 2005/D: 06. 163 pp.

ICES (2006) Report of the Study Group on Multispecies Assessments in the North Sea (SGMSNS), 20–25 February 2006, ICES Copenhagen. ICES CM 2006/RMC: 02. 75 pp. For permission to reproduce material from this publication, please apply to the General Secretary.

ICES (2008) Report of the Working Group on Multispecies Assessment Methods (WGSAM), 6–10 October 2008, ICES Headquarters, Copenhagen. ICES CM 2008/RMC:06. 113 pp.

ICES (2009) Report of the Working Group on Multispecies Assessment Methods (WGSAM), 5–9 October 2009, ICES Headquarters, Copenhagen. ICES CM 2009/RMC:10. 117 pp.

ICES (2010a) Report of the ICES Advisory Committee 2010. ICES Advice, 2010. Book 6, 309 pp.

ICES, (2010b) Report of the Herring Assessment Working Group for the Area South of 62n (HAWG), 15 - 23 March 2010, ICES Headquarters, Copenhagen, Denmark. 688 pp.

Jensen, H., Rindorf, A., Wright, P. J., Mosegaard, H. (2011) Inferring the location and scale of mixing between habitat areas of lesser sandeel through information from the fishery. ICES Journal of Marine Science 68: 43–51.

Diesing, M., Ware, S., Foster-Smith, R., Stewart, H., Long, D., Vanstaen, K., Forster, R. & Morando, A. (2009) Understanding the marine environment – seabed habitat investigations of the Dogger Bank offshore draft SAC. JNCC Peterborough. JNCC Report No. 429, 89pp.

Langham, N. P. E. (1971) The distribution and abundance of larval sand-eels (Ammodytidae) in Scottish waters. Journal of the Marine Biological Association of the United Kingdom, 51: 697e707. Cited in Jensen *et al.* 2003.

Macer, C.T. (1965) The distribution of larval sand eels (Ammodytidae) in the southern North Sea. Journal of the Marine Biological Association of the United Kingdom, 45: 187e207. Cited in Jensen *et al.* 2003.

McConnell, B., Hall A., Fedal, M. (1999) Seal Foraging and Sandeel Distribution. *In* Wright, P.J. and Kennedy, F.M., (1999).

Mills, D.H., Hadoke, G.D.F., Shelton R.G.J., Read, J.B.D. (2003) Atlantic Salmon Facts. Atlantic Salmon Trust Booklet. Prepared in 1986. Revised in 2003.

MSS, (2010) Sea trout. Marine Scotland Science online publications. Available online at: http://www.scotland.gov.uk/Topics/marine/marine-environment/species/fish/freshwater/seatrout. Accessed: 05/12/2010.

Muus, B.J. & Dahlström, P. (1974) Collins guide to the sea fishes of Britain and North-Western Europe. Collins, London, UK. 244pp.

NSRAC (2012) Fisheries management in relation to nature conservation for the combined area of 3 national Natura 2000 sites (SACs) on the Dogger Bank. Final position paper. 31pp.

Olsen, E. & Holst, J.C. (2001) A note on common minke whale (*Balaenoptera acutorostrata*) diets in the Norwegian Sea and the North Sea. *J. CETACEAN RES. MANAGE.* 3(2):179–183, 2001.

Pierce, G.J., Santos, M.B., Reid, R.J., Patterson, I.A.P., Ross, H.M. (2004) Diet of minke whales Balaenoptera acutorostrata in Scottish (UK) waters with notes on strandings of this species in Scotland 1992-2002. J. Mar. Biol. Ass. U.K. (2004), 84, 1241-1244.

Reay, P.J. (1986) Ammodytidae. p. 945-950. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen, E. Tortonese (eds.) Fishes of the north-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol. 2.

Santos, M.B., Pierce, G.J., Ieno, E.N., Addink, M., Smeenk, C., Kinze, C.C. and Sacau, M. (2005) Harbour porpoise (*Phocoena phocoena*) feeding ecology in the eastern North Sea.

Thompson, P.M., Pierce, G.J., Hislop, J.R.G., Miller, D., Diack, J.S.W. (1991) Winter foraging by common seals (Phoca vitulina) in relation to food availability in the Inner Moray Firth, N.E. Scotland.

Van der Kooij, J., Scott, B.E., Mackinson S., (2008) The effects of environmental factors on daytime sandeel distribution and abundance on the Dogger Bank. Journal of Sea Research 60 (2008) 201–209.

Walters, M., (2010) Moray Firth Sea Trout Project. Progress report February 2010.

Walters, M., (2011) Moray Firth Sea Trout Project Final Report. A summary of the projects progress, findings and next steps.

Williams T. & Bedford B.C. (1974). The use otoliths for age determination. In: T.B. Bagenal (ed.) The ageing of fish. Unwin Brothers Limited, Chessington KT9 2NY, U.K. 114-123.

Winslade, P. (1974) Behavioural studies on the lesser sandeel *Ammodytes marinus* (Raitt) III. The effect of temperature on activity and the environmental control of the annual cycle of activity. Journal of Fish Biology, 6: 587–599. doi: 10.1111/j.1095-8649.1974.tb05102.

Wright, P.J. & Bailey, M. C. (1996) Timing of hatching in Ammodytes marinus from Shetland waters and its significance to early growth and survivorship. Marine Biology, 126: 143e152. Cited in Jensen *et al.* (2003).

Wright, P.J., Pedersen, S.S., Anderson, C., Lewy, P., Proctor, R. (1998) The influence of physical factors on the distribution of lesser sandeel, Ammodytes marinus and its relevance to fishing pressure in the North Sea. ICES ASC CM/ AA: 3.

Wright P.J. (1999) Development of Survey Methods. *In* Wright, P.J. and Kennedy, F.M., (1999).

Wright, P.J. & Kennedy, F.M. (1999) Proceedings of a workshop held at FRS Marine Laboratory Aberedeen 22-24 February 1999. Fisheries Research Services Report No 12/99.

Wright, P. J., Jensen, H., Tuck, I. (2000) The influence of sediment type on the distribution of the lesser sandeel, *Ammodytes marinus*. Journal of Sea Research, 44: 243–256.

11.0 Appendices

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 Sandeel 2012	**Vessel:** Jubilee Spirit
Surveyors: Lucy Shuff, Alex Winrow-Giffin	**Skipper:** Ross Crookes
Survey Area: Dogger Bank	**Total Time at Sea:** 11 Days
Dates at Sea: 22/03/12 to 01/04/12	

	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?	Sodena plotter broke on 26/03/12	Used Decca system for remainder of survey
Safety equipment failures?	None	N/A
Accidents?	None	N/A
Injuries?	None	N/A

11.2 Appendix 2 – Sandeel Catch Data

Station	No. of Individuals				Catch Rate (No. of Individuals Caught per Hour)			Density (No. of Individuals Caught per m^2)		
	Raitt's Sandeel (*Ammodytes marinus*)	Smooth Sandeel (*Gymnammodytes semisquamatus*)	Greater Sandeel (*Hyperoplus lanceolatus*)	Total	Raitt's Sandeel (*Ammodytes marinus*)	Smooth Sandeel (*Gymnammodytes semisquamatus*)	Greater Sandeel (*Hyperoplus lanceolatus*)	Raitt's Sandeel (*Ammodytes marinus*)	Smooth Sandeel (*Gymnammodytes semisquamatus*)	Greater Sandeel (*Hyperoplus lanceolatus*)
SD001	72	3	0	75	1,152.0	48.0	0.0	0.17	0.01	0.00
SD002	4	1	0	5	54.3	13.6	0.0	0.01	0.00	0.00
SD003	78	0	0	78	971.6	0.0	0.0	0.25	0.00	0.00
SD004	47	0	0	47	685.0	0.0	0.0	0.14	0.00	0.00
SD005	2	0	0	2	36.4	0.0	0.0	0.01	0.00	0.00
SD006	79	0	3	82	1,322.8	0.0	50.2	0.24	0.00	0.01
SD007	32	31	1	64	626.1	606.5	19.6	0.10	0.09	0.00
SD008	18	0	0	18	395.1	0.0	0.0	0.05	0.00	0.00
SD009	40	2	0	42	378.9	18.9	0.0	0.11	0.01	0.00
SD010	0	0	0	0	0.0	0.0	0.0	0.00	0.00	0.00
SD011	6	0	0	6	91.1	0.0	0.0	0.02	0.00	0.00
SD012	1	1	0	2	14.8	14.8	0.0	0.00	0.00	0.00
SD013	29	0	0	29	444.3	0.0	0.0	0.09	0.00	0.00
SD014	29	0	0	29	311.6	0.0	0.0	0.09	0.00	0.00
SD015	21	0	0	21	316.3	0.0	0.0	0.06	0.00	0.00
SD016	14	0	0	14	204.0	0.0	0.0	0.04	0.00	0.00
SD017	6	0	0	6	77.1	0.0	0.0	0.02	0.00	0.00
SD018	31	0	0	31	382.2	0.0	0.0	0.10	0.00	0.00
SD019	29	0	0	29	573.6	0.0	0.0	0.09	0.00	0.00
SD020	22	0	0	22	262.3	0.0	0.0	0.06	0.00	0.00
SD021	21	0	0	21	262.5	0.0	0.0	0.07	0.00	0.00
SD022	14	0	0	14	138.1	0.0	0.0	0.04	0.00	0.00
SD023	32	0	0	32	443.1	0.0	0.0	0.11	0.00	0.00

Station	No. of Individuals				Catch Rate (No. of Individuals Caught per Hour)			Density (No. of Individuals Caught per m^2)		
	Raitt's Sandeel (*Ammodytes marinus*)	Smooth Sandeel (*Gymnammodytes semisquamatus*)	Greater Sandeel (*Hyperoplus lanceolatus*)	Total	Raitt's Sandeel (*Ammodytes marinus*)	Smooth Sandeel (*Gymnammodytes semisquamatus*)	Greater Sandeel (*Hyperoplus lanceolatus*)	Raitt's Sandeel (*Ammodytes marinus*)	Smooth Sandeel (*Gymnammodytes semisquamatus*)	Greater Sandeel (*Hyperoplus lanceolatus*)
SD024	15	0	0	15	251.2	0.0	0.0	0.04	0.00	0.00
SD025	9	0	0	9	105.2	0.0	0.0	0.03	0.00	0.00
SD026	5	0	0	5	75.0	0.0	0.0	0.02	0.00	0.00
SD027	674	0	0	674	6,318.8	0.0	0.0	2.08	0.00	0.00
SD028	5	0	0	5	62.7	0.0	0.0	0.01	0.00	0.00
SD029	359	0	0	359	4,155.6	0.0	0.0	0.95	0.00	0.00
SD030	31	48	0	79	549.8	851.2	0.0	0.10	0.15	0.00
SD031	30	1	0	31	471.6	15.7	0.0	0.08	0.00	0.00
SD032	2	0	0	2	37.5	0.0	0.0	0.01	0.00	0.00
SD033	1	0	0	1	16.5	0.0	0.0	0.00	0.00	0.00
SD034	67	0	0	67	751.4	0.0	0.0	0.21	0.00	0.00
SD035	153	0	0	153	1,496.7	0.0	0.0	0.47	0.00	0.00
SD036	4	0	0	4	38.7	0.0	0.0	0.01	0.00	0.00
SD037	201	0	0	201	3,201.8	0.0	0.0	0.56	0.00	0.00
SD038	72	0	0	72	1,146.9	0.0	0.0	0.22	0.00	0.00
SD039	24	0	0	24	198.6	0.0	0.0	0.07	0.00	0.00
SD040	21	0	0	21	257.1	0.0	0.0	0.06	0.00	0.00
SD041	33	0	0	33	331.8	0.0	0.0	0.11	0.00	0.00
SD042	0	0	0	0	0.0	0.0	0.0	0.00	0.00	0.00
SD043	3	0	1	4	29.5	0.0	9.8	0.01	0.00	0.00
SD044	29	0	0	29	567.4	0.0	0.0	0.07	0.00	0.00
SD045	1	0	0	1	16.7	0.0	0.0	0.00	0.00	0.00
SD046	3	0	0	3	30.7	0.0	0.0	0.01	0.00	0.00
SD047	13	0	0	13	182.8	0.0	0.0	0.04	0.00	0.00

Station	No. of Individuals				Catch Rate (No. of Individuals Caught per Hour)			Density (No. of Individuals Caught per m^2)		
	Raitt's Sandeel (*Ammodytes marinus*)	Smooth Sandeel (*Gymnammodytes semisquamatus*)	Greater Sandeel (*Hyperoplus lanceolatus*)	Total	Raitt's Sandeel (*Ammodytes marinus*)	Smooth Sandeel (*Gymnammodytes semisquamatus*)	Greater Sandeel (*Hyperoplus lanceolatus*)	Raitt's Sandeel (*Ammodytes marinus*)	Smooth Sandeel (*Gymnammodytes semisquamatus*)	Greater Sandeel (*Hyperoplus lanceolatus*)
SD048	358	3	0	361	5,728.0	48.0	0.0	1.10	0.01	0.00
SD049	17	0	0	17	241.9	0.0	0.0	0.05	0.00	0.00
SD050	12	0	0	12	192.0	0.0	0.0	0.04	0.00	0.00
SD051	3	0	0	3	46.8	0.0	0.0	0.01	0.00	0.00
SD052	110	0	0	110	1,744.5	0.0	0.0	0.34	0.00	0.00
SD053	11	0	0	11	132.4	0.0	0.0	0.03	0.00	0.00
SD054	0	0	0	0	0.0	0.0	0.0	0.00	0.00	0.00
SD055	1	0	0	1	12.2	0.0	0.0	0.00	0.00	0.00
SD056	32	0	0	32	414.4	0.0	0.0	0.09	0.00	0.00
SD057	47	0	0	47	638.5	0.0	0.0	0.14	0.00	0.00
SD058	123	0	0	123	1,485.9	0.0	0.0	0.37	0.00	0.00
SD059	22	0	0	22	352.0	0.0	0.0	0.06	0.00	0.00
SD060	207	0	0	207	2,812.1	0.0	0.0	0.63	0.00	0.00
SD061	38	0	0	38	642.3	0.0	0.0	0.12	0.00	0.00
SD062	11	0	0	11	180.0	0.0	0.0	0.03	0.00	0.00
SD063	1	0	0	1	11.7	0.0	0.0	0.00	0.00	0.00
SD064	2	0	0	2	35.8	0.0	0.0	0.01	0.00	0.00
SD065	5	0	0	5	76.9	0.0	0.0	0.01	0.00	0.00
SD066	6	0	0	6	92.3	0.0	0.0	0.02	0.00	0.00
SD067	0	0	0	0	0.0	0.0	0.0	0.00	0.00	0.00
SD068	223	0	0	223	2,556.7	0.0	0.0	0.62	0.00	0.00
SD069	86	0	0	86	1,172.7	0.0	0.0	0.27	0.00	0.00
SD070	29	0	0	29	348.0	0.0	0.0	0.09	0.00	0.00
SD071	25	0	0	25	278.6	0.0	0.0	0.08	0.00	0.00

Station	No. of Individuals				Catch Rate (No. of Individuals Caught per Hour)			Density (No. of Individuals Caught per m^2)		
	Raitt's Sandeel (*Ammodytes marinus*)	Smooth Sandeel (*Gymnammodytes semisquamatus*)	Greater Sandeel (*Hyperoplus lanceolatus*)	Total	Raitt's Sandeel (*Ammodytes marinus*)	Smooth Sandeel (*Gymnammodytes semisquamatus*)	Greater Sandeel (*Hyperoplus lanceolatus*)	Raitt's Sandeel (*Ammodytes marinus*)	Smooth Sandeel (*Gymnammodytes semisquamatus*)	Greater Sandeel (*Hyperoplus lanceolatus*)
SD072	3	0	0	3	46.8	0.0	0.0	0.01	0.00	0.00
SD073	191	0	0	191	3,111.3	0.0	0.0	0.52	0.00	0.00
SD074	2	0	0	2	35.3	0.0	0.0	0.01	0.00	0.00
SD075	369	0	0	369	4,457.7	0.0	0.0	0.94	0.00	0.00
SD076	4	0	0	4	34.2	0.0	0.0	0.01	0.00	0.00
SD077	0	0	0	0	0.0	0.0	0.0	0.00	0.00	0.00
SD078	0	0	0	0	0.0	0.0	0.0	0.00	0.00	0.00
SD079	0	0	0	0	0.0	0.0	0.0	0.00	0.00	0.00
SD080	0	0	0	0	0.0	0.0	0.0	0.00	0.00	0.00
SD081	38	0	0	38	608.0	0.0	0.0	0.12	0.00	0.00
SD082	156	0	0	156	2,237.5	0.0	0.0	0.43	0.00	0.00
SD083	303	0	0	303	3,419.4	0.0	0.0	0.89	0.00	0.00
SD084	4	0	0	4	50.9	0.0	0.0	0.01	0.00	0.00
SD085	0	0	0	0	0.0	0.0	0.0	0.00	0.00	0.00
SD086	32	0	0	32	342.9	0.0	0.0	0.10	0.00	0.00
SD087	5	0	0	5	52.5	0.0	0.0	0.01	0.00	0.00
SD088	0	0	0	0	0.0	0.0	0.0	0.00	0.00	0.00
SD089	1	0	0	1	9.4	0.0	0.0	0.00	0.00	0.00
SD090	24	0	0	24	314.2	0.0	0.0	0.07	0.00	0.00
SD091	230	1	0	231	2,085.6	9.1	0.0	0.66	0.00	0.00
SD092	89	0	0	89	920.7	0.0	0.0	0.25	0.00	0.00
SD093	55	1	0	56	567.3	10.3	0.0	0.16	0.00	0.00
SD094	293	2	0	295	2,216.0	15.1	0.0	0.86	0.01	0.00
SD095	12	1	0	13	162.4	13.5	0.0	0.03	0.00	0.00

Station	No. of Individuals				Catch Rate (No. of Individuals Caught per Hour)			Density (No. of Individuals Caught per m^2)		
	Raitt's Sandeel (*Ammodytes marinus*)	Smooth Sandeel (*Gymnammodytes semisquamatus*)	Greater Sandeel (*Hyperoplus lanceolatus*)	Total	Raitt's Sandeel (*Ammodytes marinus*)	Smooth Sandeel (*Gymnammodytes semisquamatus*)	Greater Sandeel (*Hyperoplus lanceolatus*)	Raitt's Sandeel (*Ammodytes marinus*)	Smooth Sandeel (*Gymnammodytes semisquamatus*)	Greater Sandeel (*Hyperoplus lanceolatus*)
SD096	72	0	0	72	559.8	0.0	0.0	0.21	0.00	0.00
SD097	14	0	0	14	166.9	0.0	0.0	0.04	0.00	0.00
SD098	451	20	0	471	6,220.7	275.9	0.0	1.28	0.06	0.00
SD099	2	0	0	2	28.3	0.0	0.0	0.01	0.00	0.00
SD100	12	0	0	12	164.3	0.0	0.0	0.04	0.00	0.00
SD101	37	0	0	37	571.7	0.0	0.0	0.10	0.00	0.00
SD102	34	0	0	34	561.5	0.0	0.0	0.10	0.00	0.00
SD103	227	0	0	227	3,230.0	0.0	0.0	0.67	0.00	0.00
SD104	128	0	0	128	1,960.9	0.0	0.0	0.38	0.00	0.00
SD105	3	0	0	3	37.6	0.0	0.0	0.01	0.00	0.00
SD106	1	0	0	1	10.1	0.0	0.0	0.00	0.00	0.00
SD107	42	0	0	42	597.6	0.0	0.0	0.12	0.00	0.00
SD108	58	0	0	58	1,065.3	0.0	0.0	0.18	0.00	0.00
SD109	18	0	0	18	317.6	0.0	0.0	0.06	0.00	0.00
SD110	61	0	0	61	699.4	0.0	0.0	0.18	0.00	0.00
Total	6,722	115	5	6,842						