moray offshore renewables ltd

Environmental Statement

Technical Appendix 4.3 C - Sandeel Survey Report

Telford, Stevenson, MacColl Wind Farms and associated Transmission Infrastructure Environmental Statement

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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.

Their distribution is 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 < 2 mm) and low silt (particle size < 0.63 µm) content. They are considered to be rare in sediments where the silt content is greater than 4 % and absent where the silt content is greater than 10 %.

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.

The survey was undertaken during night hours between the end of January and the beginning of March, when the majority of sandeels were expected to be buried in the sediment. A total of 114 stations were sampled, using two principal survey techniques: dredging and grabbing, both undertaken at night.

The results of the sandeel survey indicate an overall patchy distribution of sandeels across the MORL Zone. Sandeels were caught in only 29 out of 114 stations, in relatively low numbers, with a maximum of 40 individuals caught at a single station. Highest abundances of sandeels were recorded in dredge samples from the north eastern section of the Western Development Area (WDA) and to a lesser extent in the western section of MacColl, as well as in areas located at the border between Stevenson and Telford. Overall, sandeels appear to show a preference for sediments containing a high proportion of coarse sands and a low proportion of silt and fine sands.

Three species of sandeels (*Ammodytidae spp*.) were caught during the survey:

- Raitt's sandeel (*Ammodytes marinus*);
- Smooth sandeel (*Gymnammodytes semisquamatus*); and
- Greater sandeel (*Hyperoplus lanceolatus*).

Raitt's sandeel was the most abundant species caught, accounting for 89.8% of the total sandeel catch, with the majority (78.5%) being caught within the WDA.

The relatively low numbers of sandeels recorded in dredge samples during the survey suggest that there are not extensive areas supporting important sandeel populations in the MORL Zone. It should also be noted, that areas considered to potentially constitute suitable habitat for sandeels (those characterised by the presence of sand, slightly gravelly sand, gravelly sand and sandy gravel) are widespread throughout the Moray Firth.

2.0 Introduction

The following report details the findings of the sandeel (*Ammodytidae spp*) survey undertaken between the 30th January and 2nd March 2012 in the MORL Zone, which includes the following four development areas:

- Telford Offshore Wind Farm;
- MacColl Offshore Wind Farm;
- Stevenson Offshore Wind Farm; and
- Western Development Area.

Sandeels are understood to be a key component of the diet of many birds, such as kittiwakes, razorbills, puffins, common tern, arctic tern, European shag, great skuas and common guillemots, all known to rely on sandeels during the breeding season (Wright & Bailey 1993, Furness 1999, ICES 2006a, Wanless *et al* 1998, Wanless *et al* 1999, Wanless 2005). In the Moray Firth, Raitt's sandeel (*Ammodytus marinus)* is thought to support a large diversity and abundance of seabirds (Wright & Begg 1997). 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 as well as for squid (Wright & Kennedy 1999, ICES 2006b, ICES 2005a, ICES 2008, ICES 2010a, Walters 2010, ICES 2009, Mills *et al* 2003, MSS 2010, Walters 2011, Collins & Pierce 1996, Haugland *et al* 2006). 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.

As a consequence of the number of marine predators reliant on sandeels, concerns were raised by stakeholders in relation to the effects of the construction and operation of MORL's proposed wind farm developments on sandeel populations.

Studies in relation to sandeel abundances and distribution in the North Sea have mainly been undertaken in areas which support seabird colonies, such as the Firth of Forth, and in areas which support important commercial fisheries such as the Dogger Bank. In the light of studies linking low sandeel availability to poor breeding success of kittiwake, commercial fishing in the Firth of Forth area has been prohibited since 2000 (Heath *et al* 2011). Little information is however currently available on the distribution and abundance of sandeels in the Moray Firth. Given the lack of site specific information within the MORL Zone, the developer commissioned a sandeel survey to obtain site specific information on the abundance and distribution of sandeels across the site.

3.0 Background Information

Sandeels are probably the most abundant fish species in the North Sea and formed the largest component by weight of annual fishery landings between 1985 and 2000 (Heath *et al* 2011). They are largely stationary after settlement and there are 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 2010). The sandeel population of the Moray Firth is part of the Central Western North Sea sandeel sub-stock (ICES 2010).

Five species of sandeel (*Ammodytidae spp.*) have been identified in the North Sea:

- 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 by far the most abundant species (Heath *et al* 2011).

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

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 (Van der Kooij *et al* 2008). Spawning principally takes place in December and January (Gauld & Hutcheon 1990, Bergstad *et al* 2001, Winslade 1974). Females lay demersal eggs 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).

The MORL Zone falls within defined high intensity spawning grounds and low intensity nursery grounds for sandeels (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). In addition, Figure 3.1 shows the extent of sandeel nursery grounds and juvenile catch rates recorded in groundfish surveys (Ellis *et al* 2010).

Sandeels require a specific substrate and it is understood that sandeels' distribution and spawning grounds will occupy discrete patchy areas rather than be continuous throughout the Moray Firth and the development site.

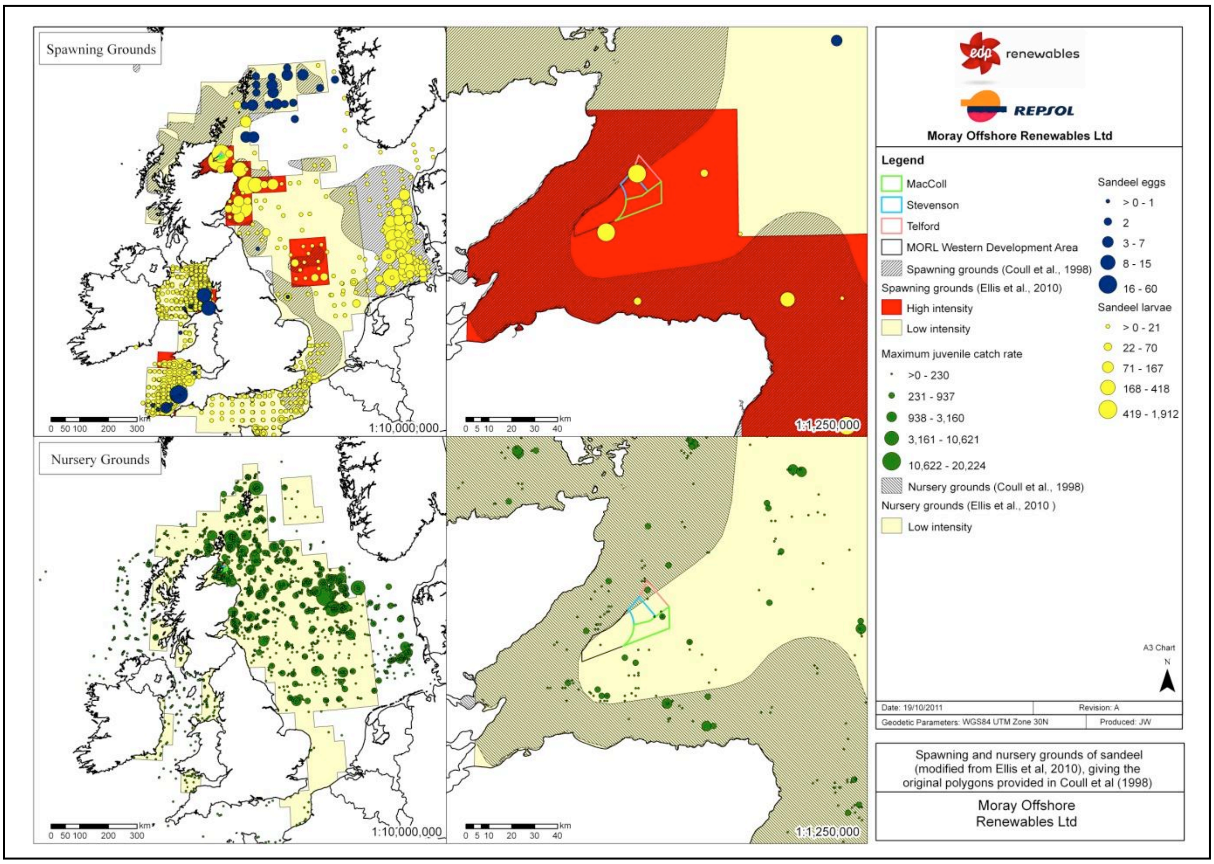


Figure 3.1 Sandeel Spawning and Nursery Grounds (Modified from Ellis *et al* 2010)

3.1 Sandeel sediment preference

Sandeel distribution is highly patchy and varies in relation to sediment type (Wright 1999). Sandeels do not maintain permanent burrow openings and have to ventilate their gills with interstitial water. The presence of fine particles of 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). They prefer depths of 30 to 70 m, although they occur between depths of 15 and 120 m (Wright *et al* 1998).

Sandeels tend to occupy areas on the sloping edges of sandbanks (Greenstreet *et al* 2010). Holland *et al* (2005) analysed 2885 grab-samples to determine sandeel (*A. marinus*) sediment preference in terms of its particle size composition and defined eight particle size classes (see Section 7.1). The results show 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 < 2 mm) and low silt content (Holland *et al* 2005). Overall, sandeels are considered to be rare in sediments where the silt content (particle size < 0.63 µm) is greater than 4 %, and absent where the silt content is greater than 10 % (Holland *et al* 2005, Wright *et al* 2000). Holland *et al* (2005) defined sediment characteristics for suitable and unsuitable habitats for sandeels. A habitat was defined as unsuitable for sandeels if all of the four sediment characteristics described below are present:

- >1% Medium Silt;
- ≤55% Medium Sand;
- >2% Coarse Silt; and

- ≤15% Coarse Sand.

Suitable habitat was only broadly defined requiring one or more of the characteristics:

- ≤1% Medium Silt;
- >55% Medium Sand;
- ≤2% Coarse Silt; and
- >15% Coarse Sand.

The distribution of seabed sediment types, based on Folk's classification system (Folk, 1954), in the Moray Firth is shown in Figure 3.2. Folk's classification system groups grains into mud, sand and gravel on the basis of their diameter with the boundary between mud and sand size grains at 63 µm and the boundary between sand and gravel size grains at 2 mm. 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 3.2).

On the basis of previous studies, which found that sandeels avoided sediments with a high silt content, the two Folk (1954) sediment categories muddy sand (mS) and slightly gravelly muddy sand ((g)mS) are considered to be unsuitable sandeel habitat. Whilst the three sediment categories, sand (S), slightly gravelly sand ((g)S) and gravelly sand (gS), are considered to contain potentially suitable habitat for sandeels. As shown in Figure 3.2, the latter categories are widely distributed throughout the Moray Firth.

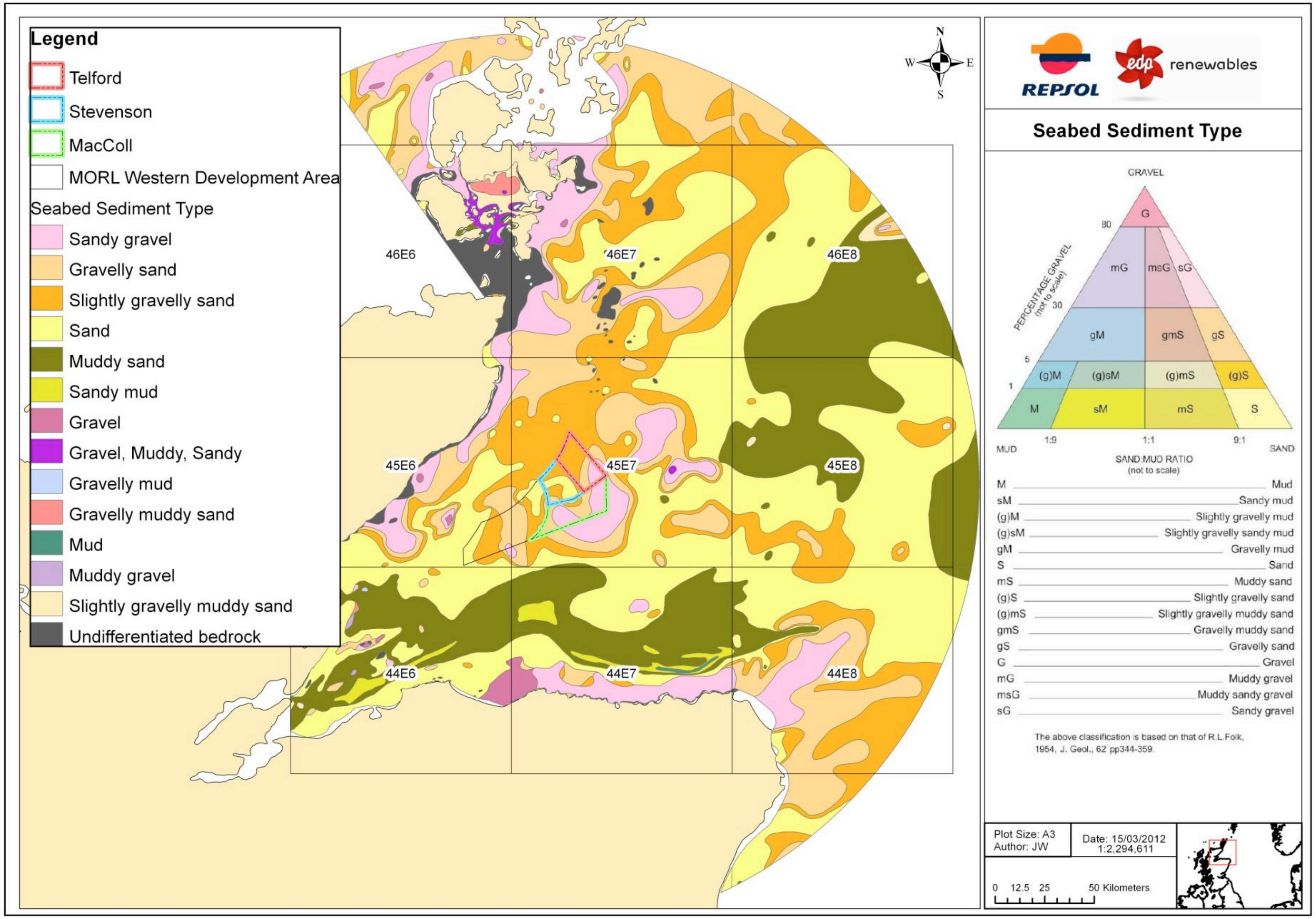


Figure 3.2 Seabed Sediment in the Area of the MORL Offshore Wind Farm (Source: British Geological Survey Data)

3.2 Site Specific Benthic Surveys Eastern Development Area (EMU 2010)

In October 2010, EMU Ltd undertook a series of grabs and benthic trawls within the MacColl, Stevenson and Telford wind farms and their surroundings (EMU 2010). The results of these are detailed below in terms of sandeel presence/absence as well as sediment composition.

Ammodytes spp. (Raitt's sandeel, *A. marinus* and/or lesser sandeel, *A. tobianus*, nine stations), greater sandeel, *Hyperoplus lanceolatus* (five stations) and smooth sandeel, *Gymnammodytes semisquamatus* (one station) were all caught in the benthic trawls. *A. tobiabus* was the only sandeel species recorded in grab samples (six stations).

The distribution of beam trawl stations, together with the total number of sandeels caught in each trawl, is illustrated in Figure 3.3. The distribution of grab samples together with the results of the sediment particle size analysis (PSA) and the number of sandeels caught in grabs are shown in Figure 3.4.

The interpretation of the figures below should take account of the limitations of the data used. The number of sandeels caught in beam trawl samples and in grab samples are indicative of presence by species and should not to be used for quantitative analysis, as the sampling methods (e.g. beam trawl) and survey design (e.g. locations and sampling time) were not aimed at mapping sandeel populations but at describing the benthic and epi-benthic community in the area.

As shown in Figure 3.3, sandeels were found in low numbers in beam trawl samples in the Stevenson and Telford wind farms. The highest numbers of sandeels were found in the western side of the MacColl wind farm and outside the MORL Zone to the north east of the site.

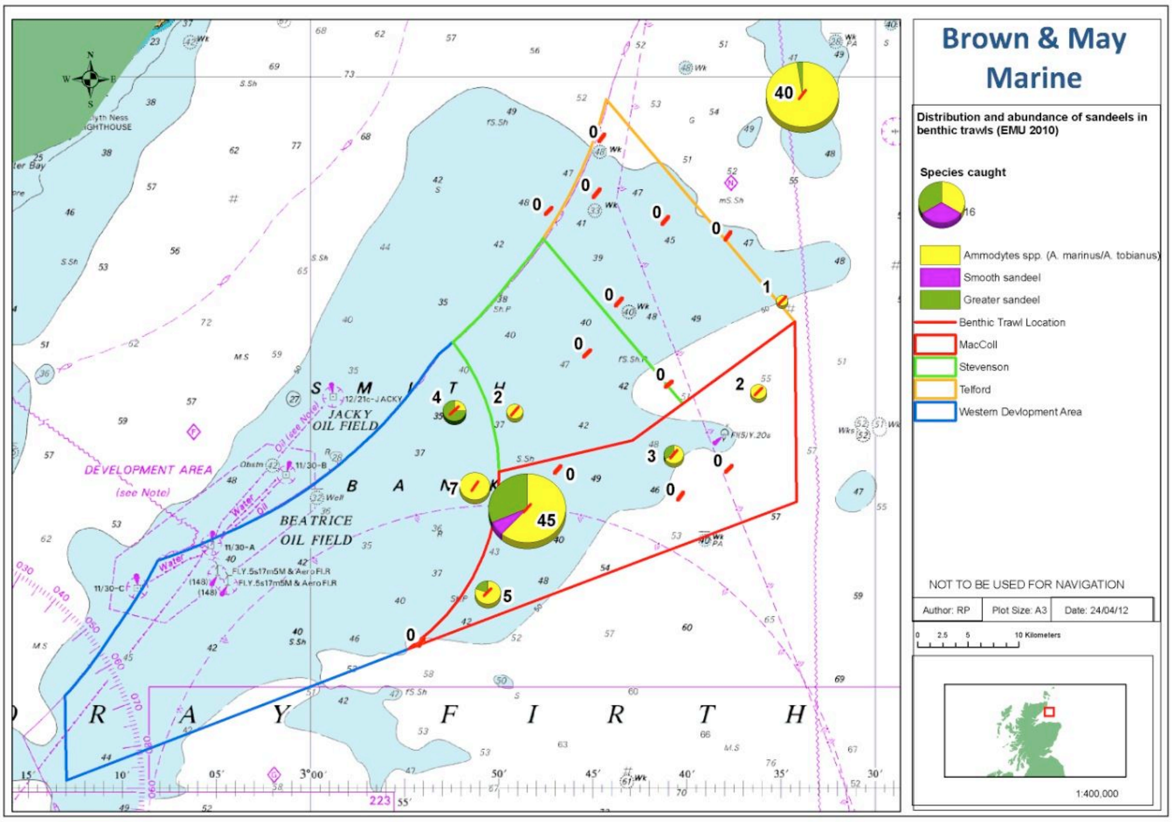


Figure 3.3 Distribution and Abundance of Sandeels in EMU Benthic Trawls (2010)

An indication of the suitability of the three wind farm sites as a sandeel habitat based on the distribution of sediment classes from grab samples (EMU 2010) is given in Figure 3.4. The number of sandeels caught at each grab station, the presence of sandeels recorded by video footage and the grab samples where the silt content was higher than 4% are also noted in Figure 3.4.

In order to interpret the results of the PSA of grab samples two sediment categories were defined: coarse sands (particle size ≥ 0.25 to < 2 mm) and silts and fine sands (less than 0.25 mm) (Greenstreet *et al* 2010). Stations in which the proportion of "coarse sands" is high (larger pie charts Figure 3.4) are more likely to constitute a suitable habitat for sandeels than those characterised by a high proportion of "silts and fine sands".

On the basis of the results of the PSA of grab samples it appeared that the majority of the three wind farm sites may be potentially suitable as a sandeel habitat. Silt contents higher than four percent, at which sandeels are considered to be rare, were only found at six stations.

Given the relatively small sampling effort (e.g. distance between grab samples) and the general patchiness of sandeel distribution, sediment types, and therefore habitat suitability, should not be assumed to be continuous between stations.

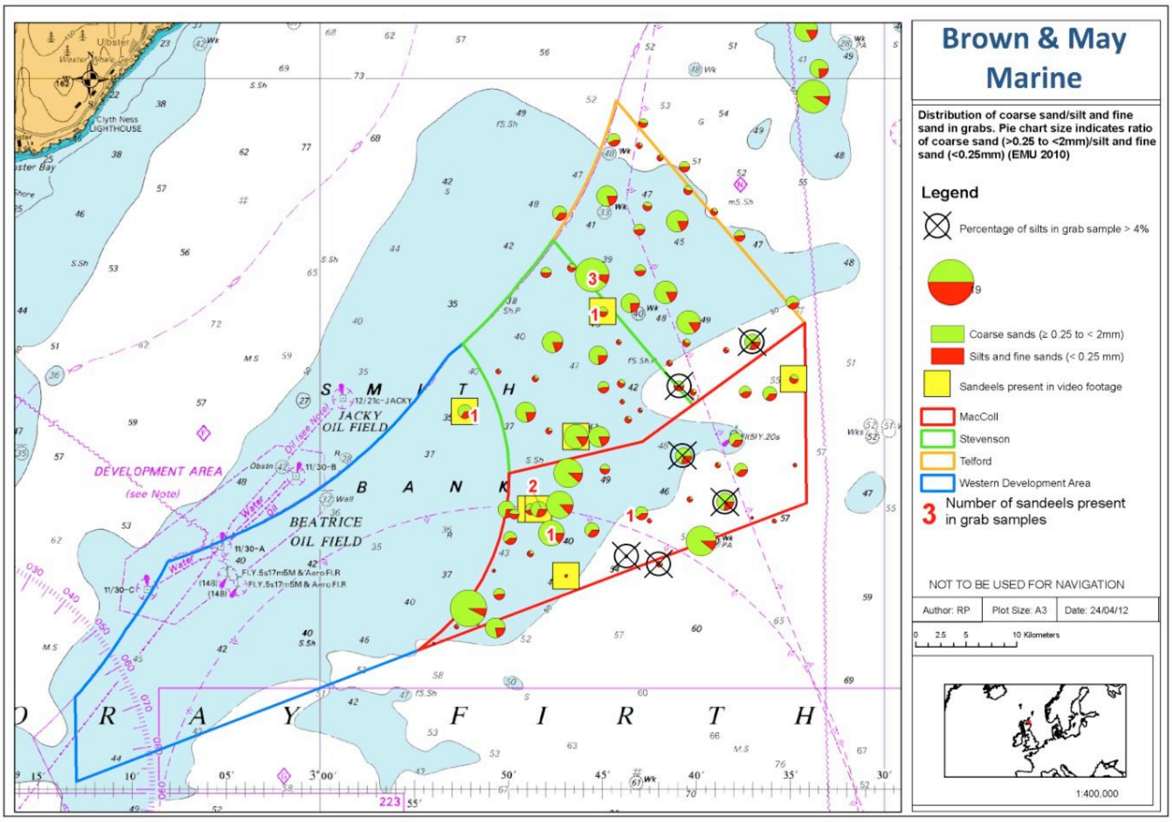


Figure 3.4 Sandeel Substrate Suitability: distribution of coarse sands/ fine sands and silts proportion in EMU grab samples red

4.0 Distribution of Sandeel Predators

As previously mentioned, sandeels constitute an important food source for a number of seabirds known to be present in the Moray Firth, including guillemots, kittiwakes, puffins, razorbills and fulmars (Wright & Kennedy 1999).

Owing to their dependence on suitable sediment types, the distribution of post-settled sandeels is restricted and constant through time. Consequently it is possible to compare the presence/absence of post-settled sandeels with the distribution of predators without the requirement for simultaneous collection of data on predator and prey distribution (Wright & Begg 1997).

In order to inform the ornithological assessment within the three proposed three wind farm sites, modelling was undertaken to predict the foraging distributions of breeding fulmar, kittiwake, guillemot and razorbill from three SPAs (East Caithness Cliffs SPA, North Caithness Cliffs SPA, and Troup, Pennan and Lion’s Heads SPA) (Figure 4.1 to Figure 4.4). These predictions were based on mean foraging distance from the tracking data and environmental covariates (sea depth and slope, sediment type, sea surface temperature and chlorophyll a measures) initially tested for correlation with the tracking data using GLMMs (Generalised Linear Mixed Models). In addition, density surface models (model-based methods) were produced for key bird species. These are shown in Figure 4.5 to Figure 4.8 (See ES Chapter 7.4, Ornithology for further details).

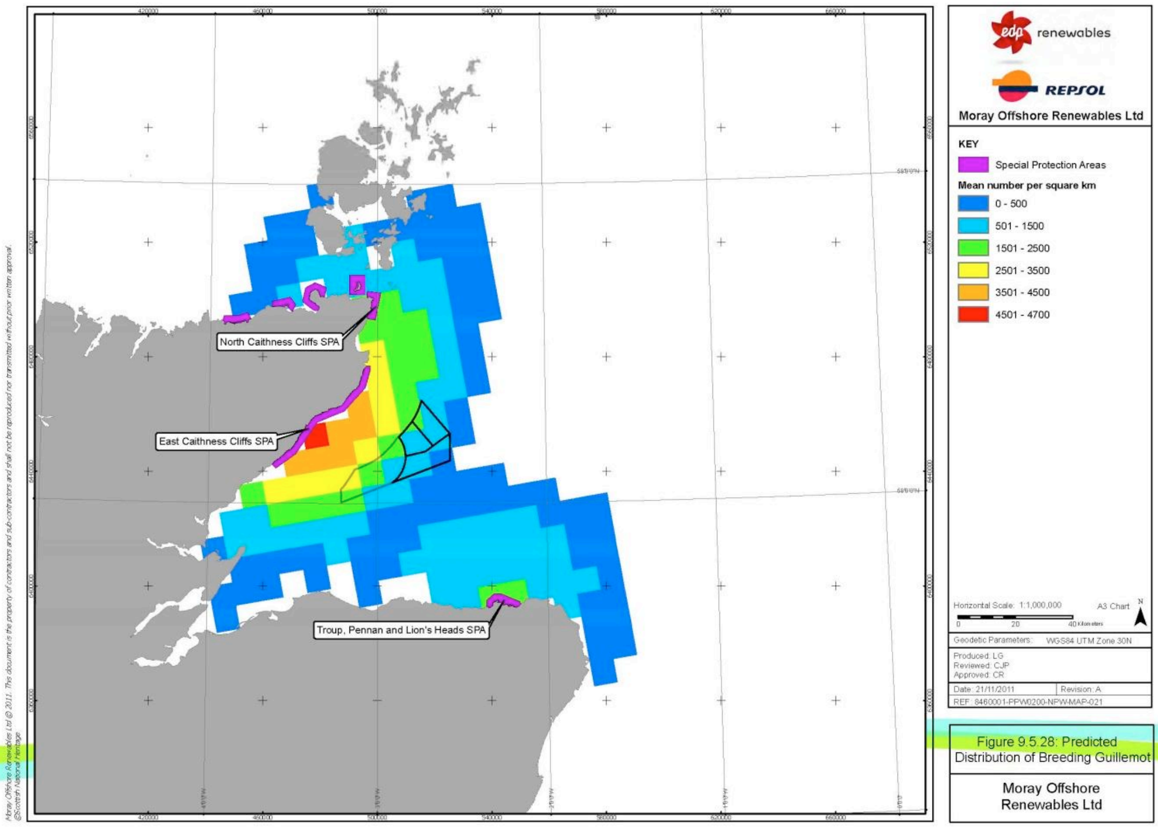


Figure 4.1 Predicted Distribution of Breeding Guillemot

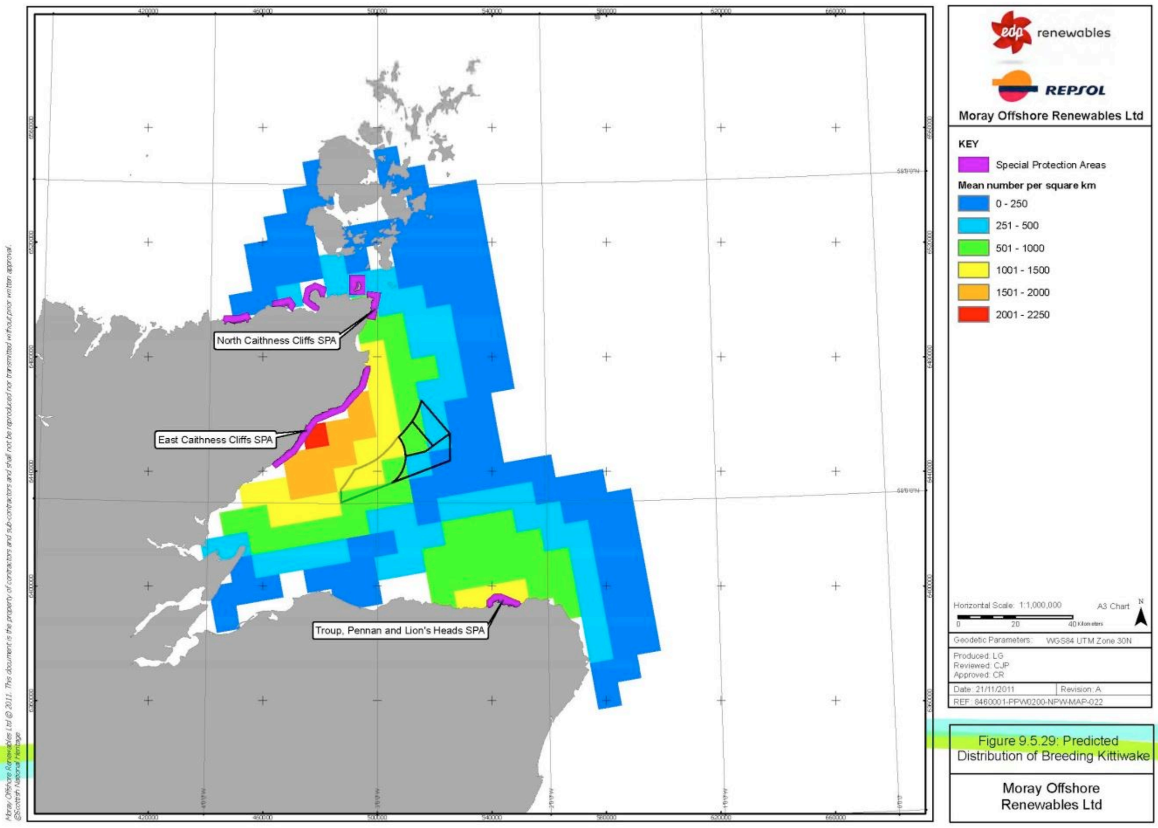


Figure 4.2 Predicted Distribution of Breeding Kittiwake

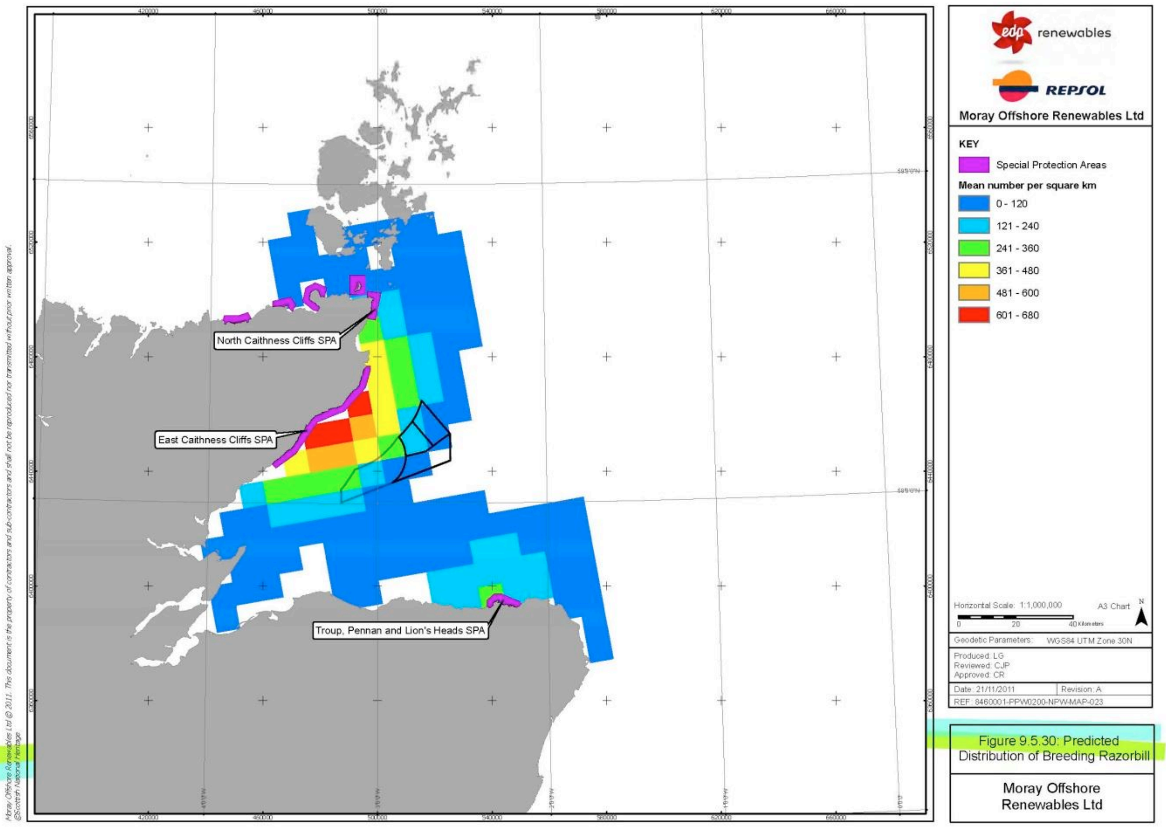


Figure 4.3 Predicted Distribution of Breeding Razorbill

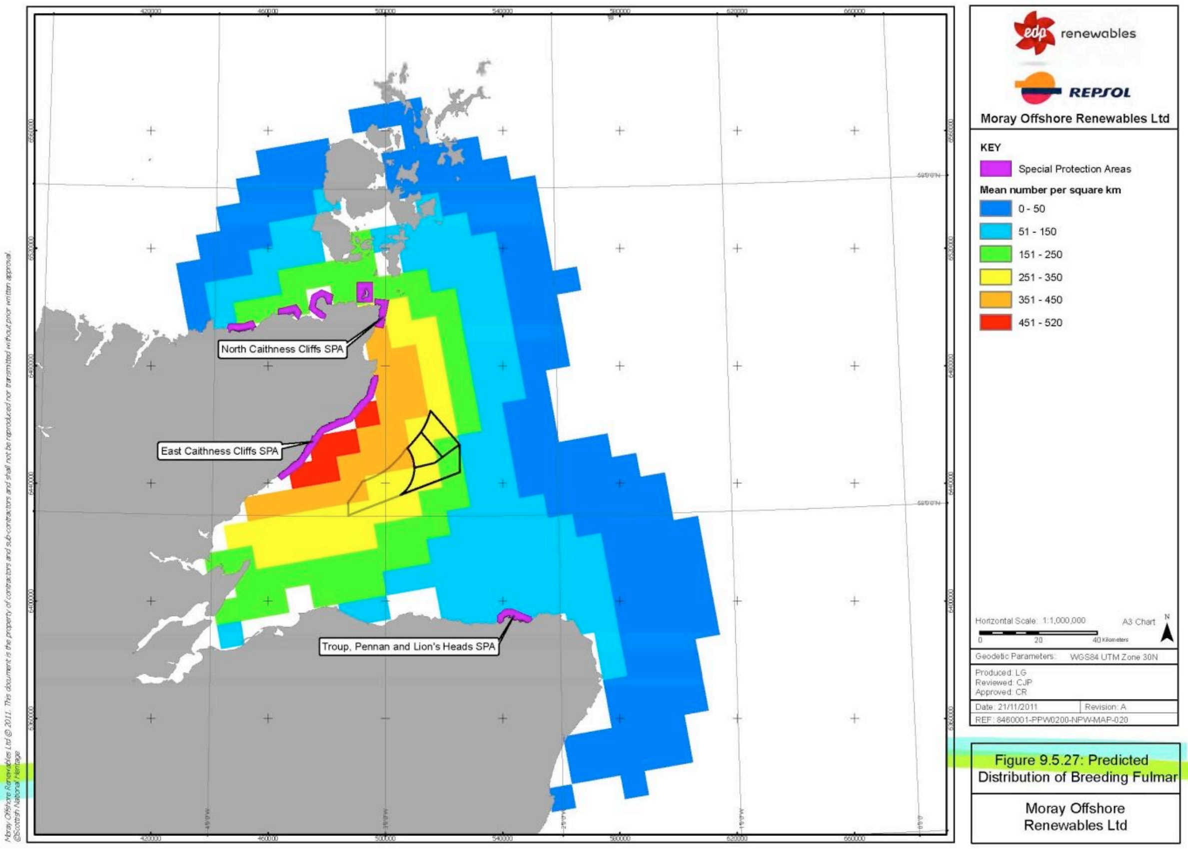


Figure 4.4 Predicted Distribution of Breeding Fulmar

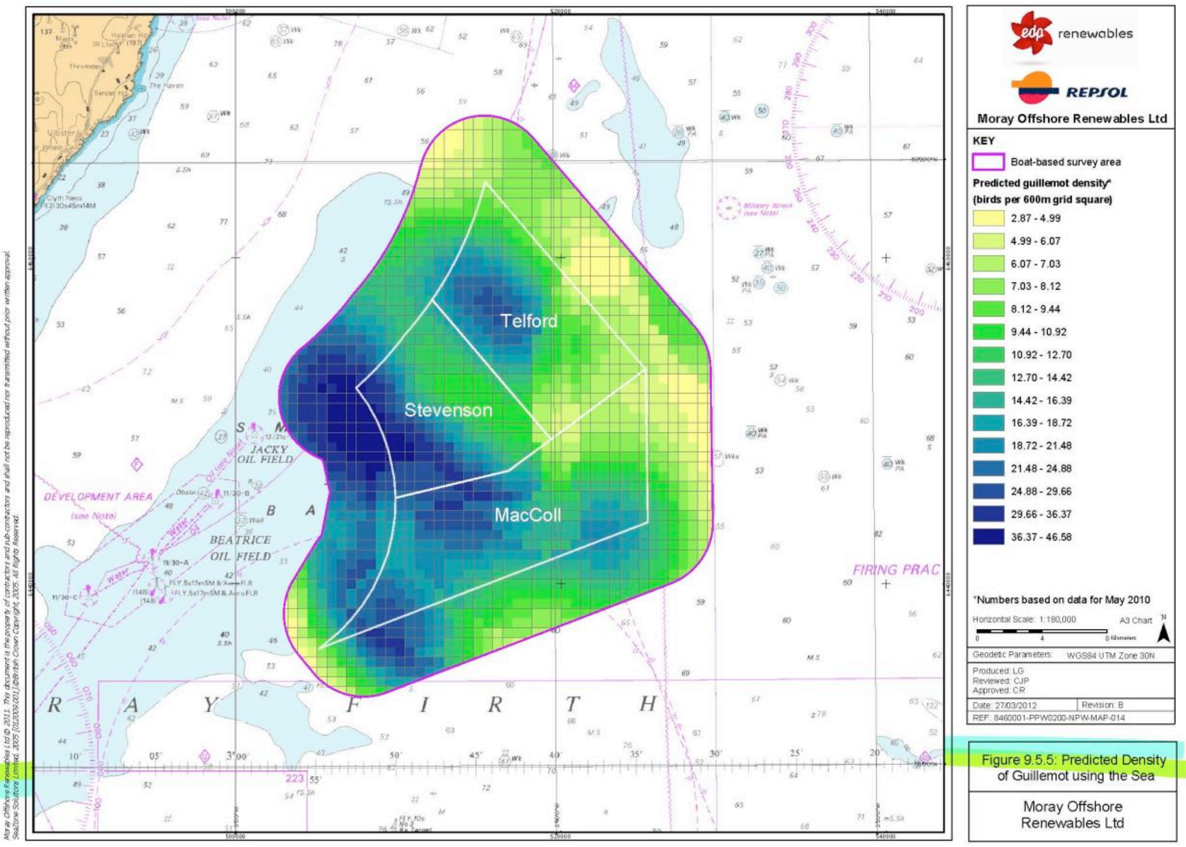


Figure 4.5 Predicted Guillemot Density based on Density Surface Models

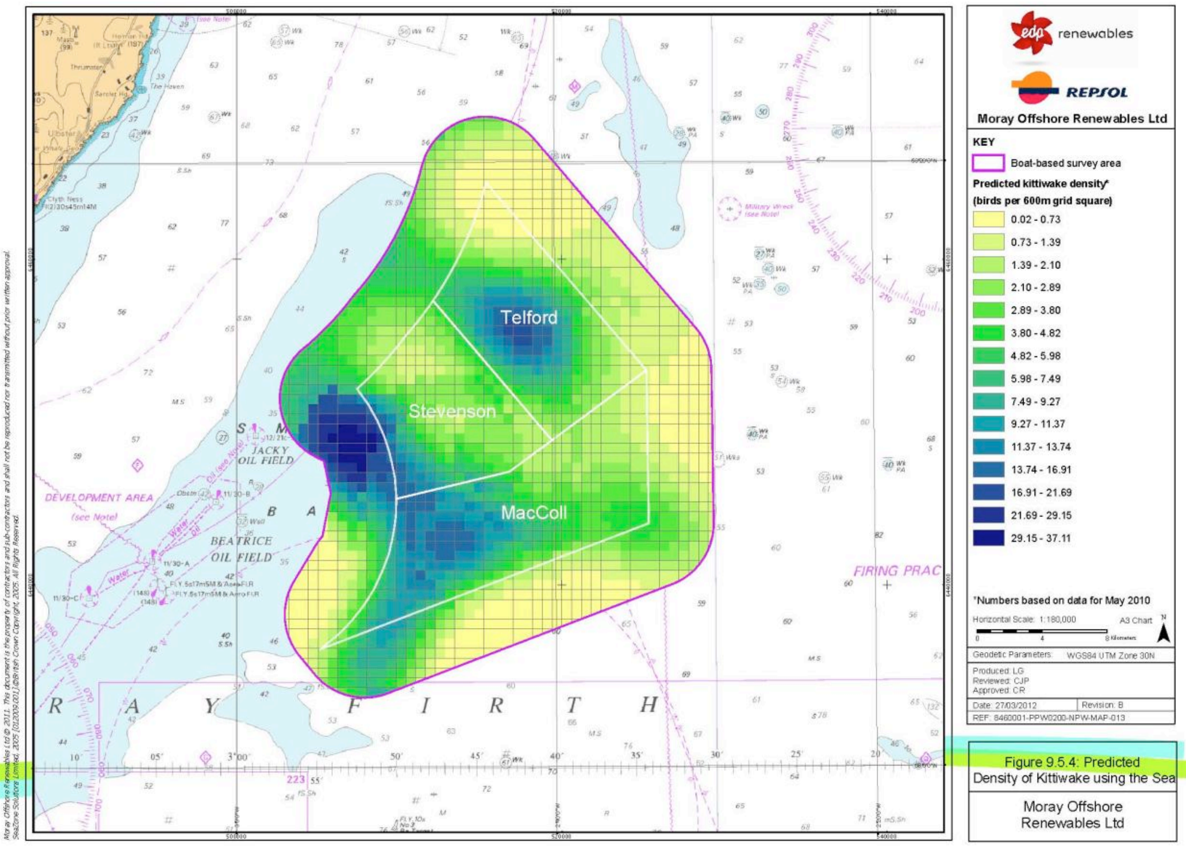


Figure 4.6 Predicted Kittiwake Density based on Density Surface Models

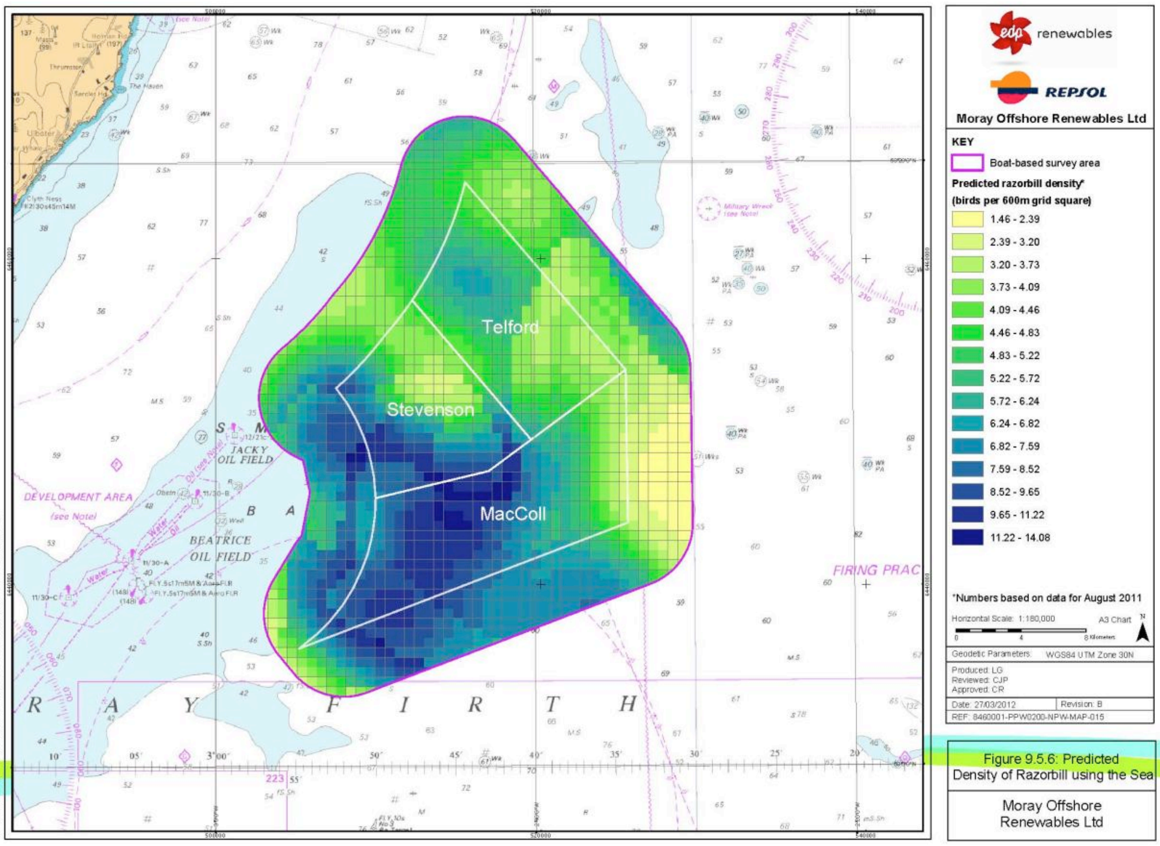


Figure 4.7 Predicted Razorbill Density based on Density Surface Models

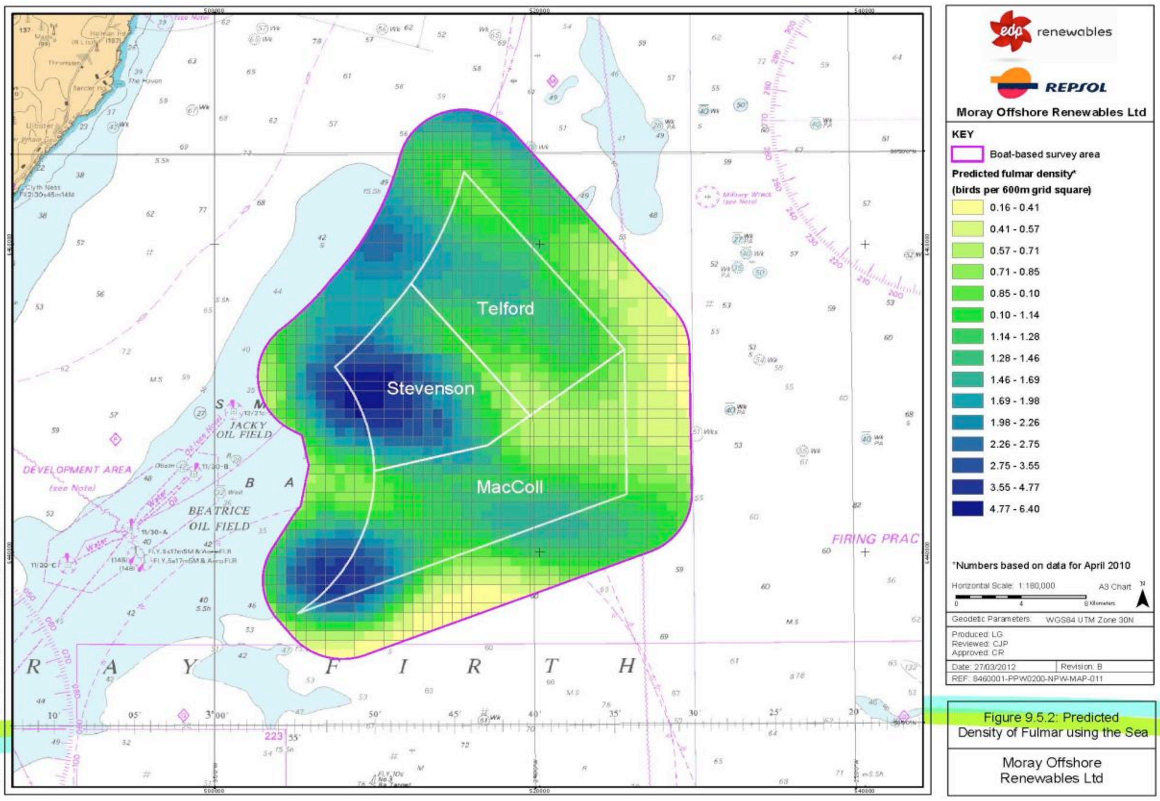


Figure 4.8 Predicted Fulmar Density based on Density Surface Models

APPENDIX 4.3 C

5.0 Survey Methodology

The survey methodology was designed in consultation with Marine Scotland (MS). A dispensation from MS, in accordance with the terms of Section 9 of the Sea Fish Conservation Act 1967 and Article 43 of Council Regulation No. 850/98, to fish in Area IVab, related to days at sea was obtained prior to commencement of this survey. A licence (no. 04338/12/0) for sediment removal was also obtained from MS, as part of the Marine and Coastal Access Act 2009. A summary of the Health and Safety performance of the survey is provided in Appendix 10.1.

As previously mentioned sandeels spend most of the year buried in the seabed 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, and after spawning sandeels remain buried in the sediment until April. The survey was undertaken during night hours between the end of January and the beginning of March, when the majority of sandeels were expected to be buried in the sediment.

A total of 114 stations were sampled using two survey techniques: dredging and grabbing. Dredging was used as a means of recording the presence and relative abundance of sandeels, whilst grabbing was undertaken as a means of obtaining site specific information on the distribution of sediment types across the MORL Zone.

5.1 Survey Vessel

The vessel chartered for the survey (Figure 5.1), the "Shemarah II", is a Peterhead-based commercial trawler. The specifications of the vessel are given below in Table 5.1.

Figure 5.1 Survey Vessel "Shemarah II"

Table 5.1 Survey Vessel Specifications

Survey Vessel Specifications	
Length	26.3m
Beam	8.5m
Draft	4.5m
Main engine	Cummins KTA-50-MTA - 738kW / 980 H
Gearbox	Hydraulic Variable Pitch 6:1 reduction
Propeller	3 Blade Fixed Pitch 2.3m diameter with a Kort Nozzle
GPS	2 x MLR FX 412
Plotters	Sodena Plotter with Electronic Charts x 2
Sounder	Simrad EQ 40 + Atlas 382 Colour

5.2 Sampling gear

5.2.1 Modified 1.24m Shellfish Dredge

A modified 1.24 m shellfish dredge with a fixed tooth bar (6” teeth) 10 mm mesh and an 6 mm mesh cod-end liner was used for sampling which is shown in 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 from a meeting held at Marine Scotland with their gear technician responsible for constructing the sandeel dredges used by Marine Scotland Science for their sandeel surveys.

Figure 5.2 Modified 1.24m Shellfish Dredge Used

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”

5.2.2 Mini-Hamon Grab

A 0.1 m^2 mini-Hamon grab was used for the collection of sediment samples (Figure 5.3).The mini-Hamon grab consists of a rectangular frame forming a stable support for a sampling bucket attached to a pivoted arm. On reaching the seabed, tension in the wire is released which activates the grab; the pivoted arm is rotated through 90°, driving the stainless-steel sample bucket through the sediment. At the end of its movement, the sample locates onto an inclined rubber-covered steel plate, sealing it completely and preventing the sample washing out during recovery.

Figure 5.3 A 0.1m^2 Mini-Hamon Grab

5.3 Sampling Procedures

The survey was undertaken from the 30th January to the 2nd March 2012. A summarised log of events is given in Appendix 10.2. Severe delays were incurred due to poor weather conditions between 13th and 28th February 2012.

5.3.1 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. Fix points were taken when the grab was on-bottom. Dredge tow start times and positions were taken when the winch stopped paying out the gear. Similarly, dredge tow end times and positions were taken when hauling of the gear commenced.

5.3.2 Dredge Sampling

A total of 114 tows were undertaken within the MORL Zone. The tow tracks of the dredge are given in Figure 5.4. The start and end times, co-ordinates and duration of each dredge tow are given in Appendix 10.3.1.

The catch from each tow was emptied into a bucket, photographed, and any sandeels present were retained. The sandeels were then bagged, labelled, photographed, and stored at -18°C before transportation to Jacobs Engineering Ltd. for analysis at the end of the survey. The length (nearest mm below) and weight of each sandeel were recorded by Jacobs Engineering Ltd. All bycatch species were identified, counted, measured and returned to the sea.

5.3.3 Grab Sampling

The locations of the grab samples are given in Figure 5.5. The start and end times, co-ordinates and duration of each grab sample are given in Appendix 10.3.2.

Strict quality control procedures for horizontal control (DGPS) were adhered to target station locations being entered into the navigation software package (HydroPro), together with acceptable limits for sampling displayed on a helmsman monitor. Comprehensive logging of sampling coordinates, times and on-board activities/observations were also carried out.

Grabs were undertaken at each of the sandeel dredge locations, within a 50 m radius of the start point of each dredge tow and prior to deploying the sandeel dredge. Grab samples were emptied into a box, photographed and any species present were removed for identification. Notes were always taken on the nature of sediment and any obvious larger fauna recovered within the grab.

One litre sub-samples of each successful grab were taken for PSA. These were stored chilled, but not frozen, to avoid the alteration of the natural particle size distribution due to the breakdown of any clay mineral lattice bonds present. Samples were then delivered to the specialist laboratory where they were dried and passed through stainless-steel sieves with mesh apertures of 8000 µm, 4000 µm, 2000 µm and 1000 µm with a nesting receiver. The sediment particle size distributions below 1000 µm were determined using a Malvern Mastersizer 2000 particle sizer.

On most occasions an adequate sample (≥ 1 litre) was obtained with the first deployment of the grab at each station. When this was not the case the grab was deployed between two and seven times in an attempt to get a valid sample. At some stations (i.e. those where sandeels were found in relatively high numbers) multiple valid grabs were taken for PSA. In those instances, the sample with the highest weight has for consistency been included in the analysis of sediment data provided in this report.

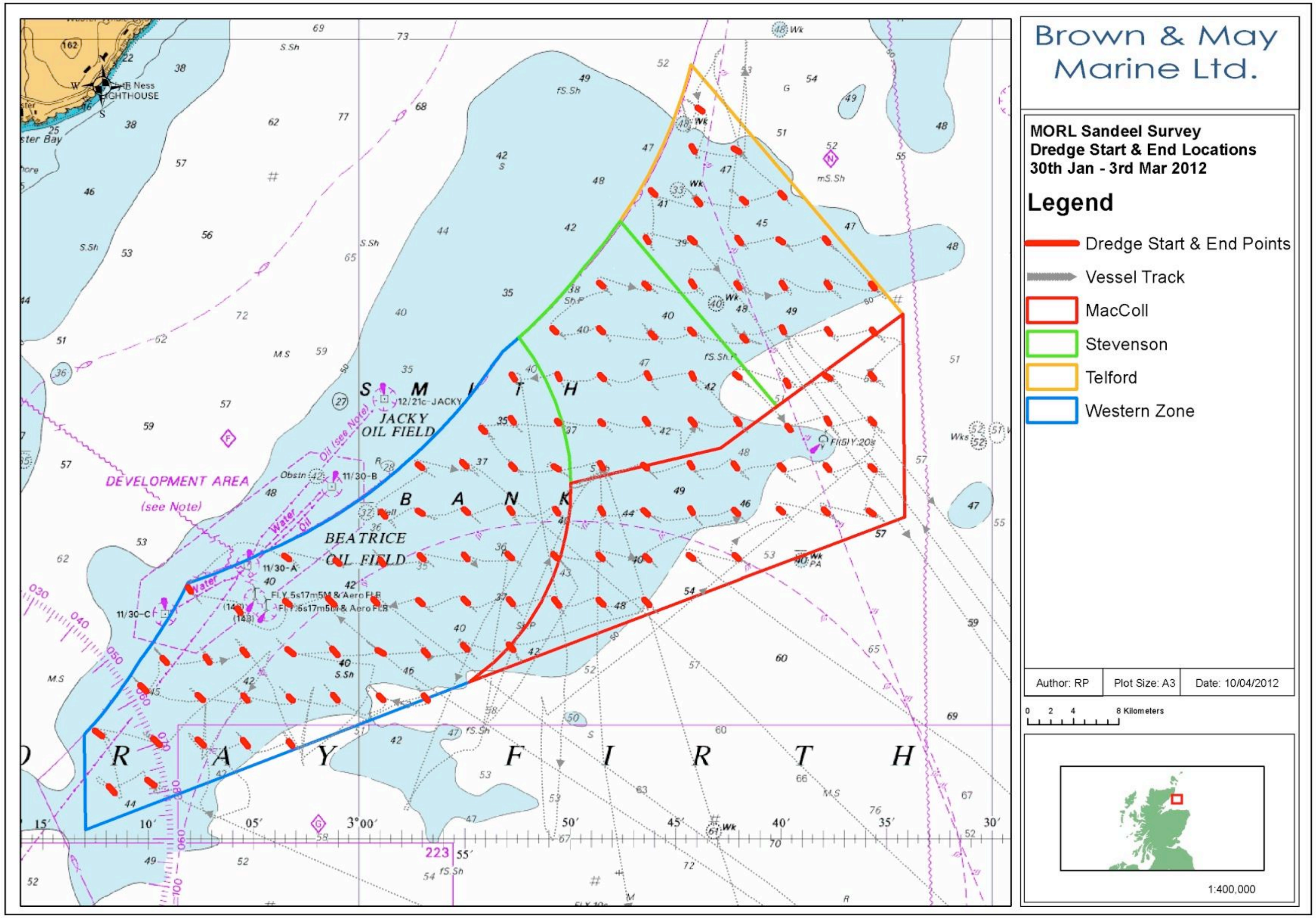


Figure 5.4 Vessel Tracks and Locations of Shooting/Hauling the Dredge

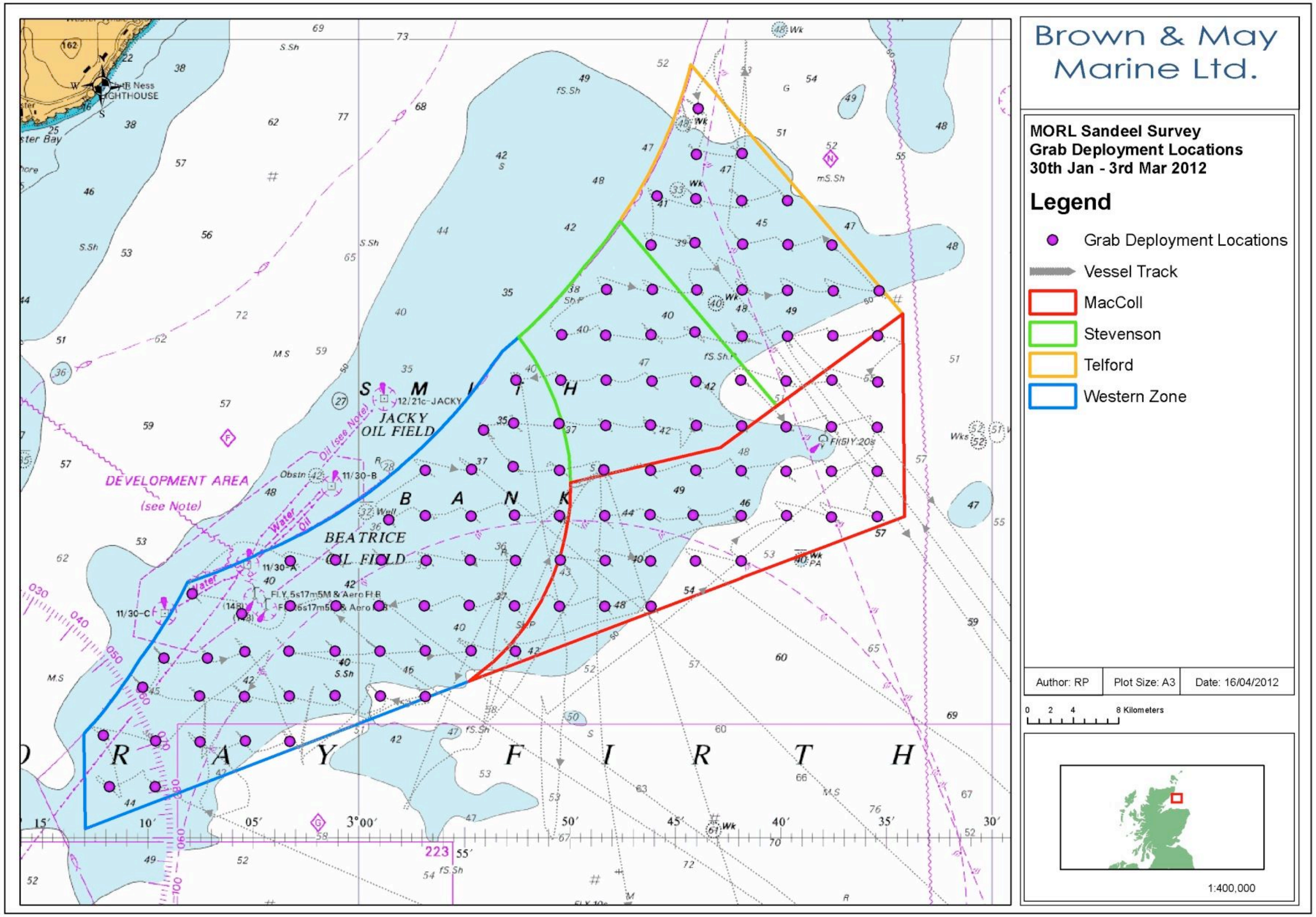


Figure 5.5 Vessel Tracks and Locations of Grab Deployment

6.0 Dredge Sampling Results

6.1 Sandeel Abundance and Distribution

Dredge sampling is believed to be a reliable method for estimating sandeel density and population structure, although it underestimates the abundance of 0-group sandeels, which escape through the 10 mm mesh that is necessary to prevent the dredge blocking up with sediment material (Greenstreet 2007).

The total number of individuals caught by species and development area is given in Table 6.1. In addition, the total number of individuals caught and catch rates (number of sandeels/m^2) by station are provided in Table 6.2. Catch rates for each sample were calculated dividing the total number of sandeels caught by the area swept by the dredge.

Sandeels were caught in only 29 out of 114 stations, in relatively low numbers, with a maximum of 40 individuals caught at a single station.

Three species of sandeels (*Ammodytidae spp*.) were caught during the survey:

- Raitt's sandeel (*Ammodytes marinus*);
- Smooth sandeel (*Gymnammodytes semisquamatus*); and
- Greater sandeel (*Hyperoplus lanceolatus*).

Raitt's sandeel was the species caught in greatest numbers, accounting for 89.8% of the total sandeel catch, with the majority (78.5%) being caught within the WDA. The highest number of Raitt's sandeel was recorded at station SD060, where 40 individuals were caught. Smooth sandeel were found in highest numbers in MacColl (12 individuals caught). Greater sandeel were caught in very low numbers in Stevenson (one individual) and the WDA (one individual).

Table 6.1 Total Numbers of Individuals Caught by Species and Development Area

Sandeel Species		Number of Individuals Caught				Total
		Development Area				
Common name	Latin Name	MacColl	Stevenson	Telford	WDA	
Raitt's sandeel	*Ammodytes marinus*	23	7	8	139	177
Smooth sandeel	*Gymnammodytes semisquamatus*	12	2	1	3	18
Greater sandeel	*Hyperoplus lanceolatus*	0	1	0	1	2
Total		**35**	**10**	**9**	**143**	**197**

Table 6.2 Total Numbers of Individuals Caught by Species and Sampling Station together with Sandeel catch rate (n/m²)

Station	Development	Sandeel Species (*Ammodytidae spp.*)			Total number of sandeels	Sandeel Catch rate (n/ m2)
		Raitt's Sandeel (*A. marinus*)	Smooth Sandeel (*G. semisquamatus*)	Greater Sandeel (*H. lanceolatus*)		
SD060	WDA	40	0	0	40	0.120
SD076	WDA	23	1	0	24	0.108
SD078	WDA	24	0	0	24	0.074
SD079	WDA	14	0	0	14	0.042
SD052	MacColl	9	4	0	13	0.039
SD061	WDA	12	0	0	12	0.036
SD023	MacColl	8	2	0	10	0.024
SD077	WDA	9	0	0	9	0.029
SD059	WDA	8	0	0	8	0.021
SD027	WDA	4	2	0	6	0.017
SD050	MacColl	2	4	0	6	0.019
SD075	Stevenson	2	1	1	4	0.018
SD064	MacColl	4	0	0	4	0.012
SD107	Telford	3	0	0	3	0.009
SD038	WDA	1	0	1	2	0.006
SD080	Stevenson	2	0	0	2	0.006
SD097	Stevenson	2	0	0	2	0.006
SD099	Telford	1	1	0	2	0.006
SD109	Telford	2	0	0	2	0.006
SD028	WDA	1	0	0	1	0.003
SD037	WDA	1	0	0	1	0.003
SD042	MacColl	0	1	0	1	0.003
SD051	MacColl	0	1	0	1	0.003
SD053	WDA	1	0	0	1	0.003
SD055	WDA	1	0	0	1	0.003
SD085	Telford	1	0	0	1	0.003
SD092	Stevenson	0	1	0	1	0.003
SD093	Stevenson	1	0	0	1	0.003
SD108	Telford	1	0	0	1	0.003
Total		**177**	**18**	**2**	**197**	

The distribution and abundance of the sandeels caught by station are shown in Figure 6.1. Sandeels were caught in highest numbers in the north eastern section of the WDA and to a lesser extent in the western section of MacColl, as well as in areas located at the border between Stevenson and Telford.

It should be noted that 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). Zero catch rates should therefore not be taken as an indication of unsuitable sandeel habitat.

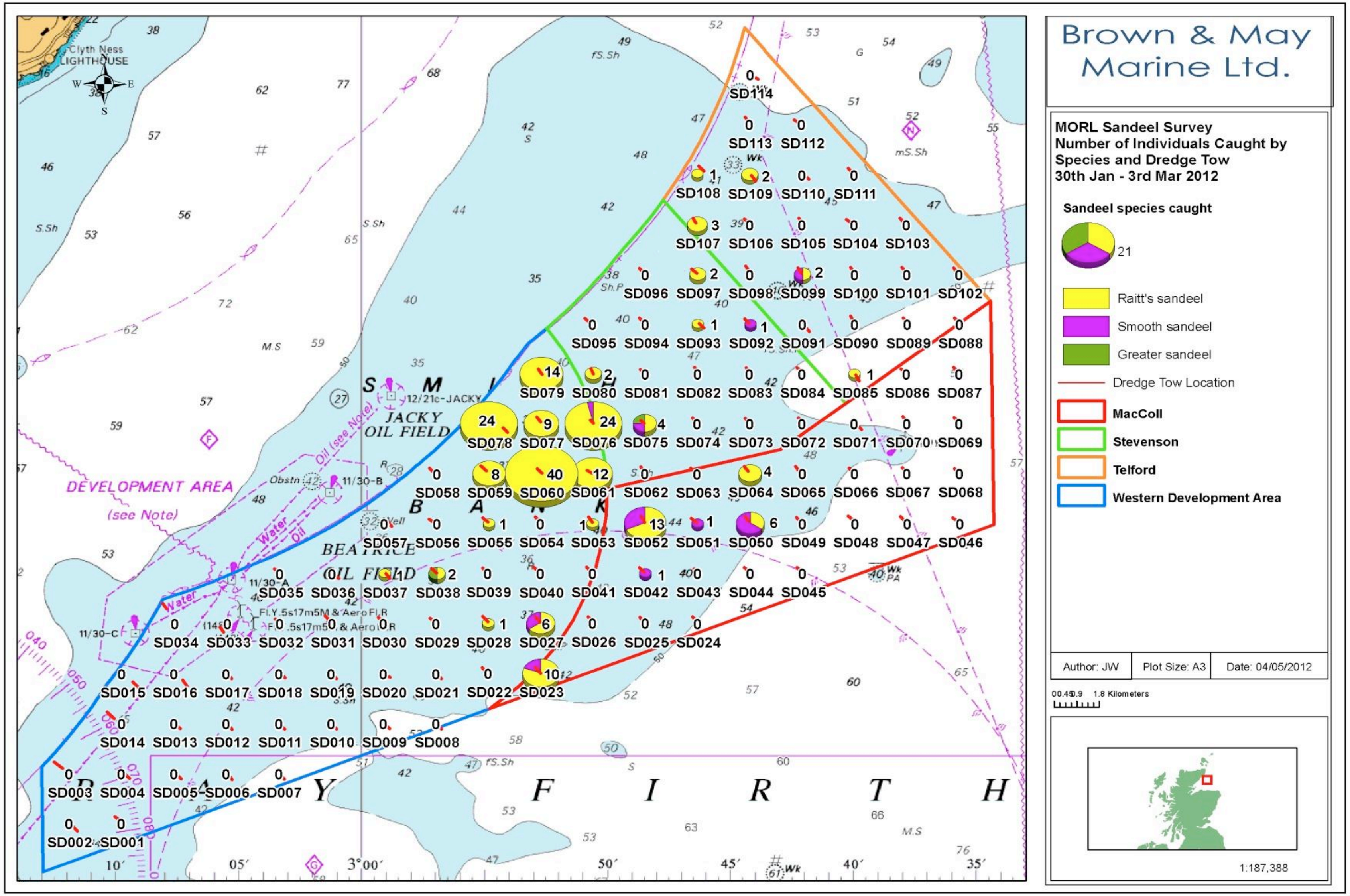


Figure 6.1 Number of individuals Caught by Species and Station in the Dredge

7.0 Grab Sampling Results

7.1 Sediment Sample Analysis

For the purposes of the sediment sample analysis, particle size ranges were rearranged into Greentstreet *et al's* (2010) sediment categories:

- Coarse Sands (particle size ≥ 250 µm to < 2 mm); and
- Silt and Fine Sands (particle size < 250 µm).

The definition of these two sediment categories was based on the results of Holland *et al*'s (2005) study, during which 2885 grab-samples from the Firth of Forth were analysed to determine sandeel preferences for particular seabed sediment types. Holland *et al* (2005) showed that, as the percentage of fine sand, coarse silt, medium silt, and fine silt (particle size < 250 µm) increased, sandeels increasingly avoided the habitat. Conversely, as the percentage of coarse sand and medium sand (particle size ≥ 250 µm to < 2mm) increased; sandeels showed increased preference for the habitat.

In addition, as previously mentioned, sandeels are rare in sediments where the silt content (particle size < 0.63 µm) is greater than 4 % (Holland *et al* 2005) and absent where the silt content is greater than 10 % (Wright *et al* 2000).

The definition of sediment categories used by Holland *et al* (2005) and Greenstreet *et al* (2010) is shown in Table 7.1 below.

Table 7.1 Particle Size Ranges for Sediment Categories defined by Holland *et al* (2005) and Greenstreet *et al* (2010)

Particle Size Range	Sediment Category (Holland *et al*., 2005)	Sediment Category (Greenstreet *et al*., 2010)
≥ 8mm	Coarse Gravel	n/a
≥ 2 to < 8mm	Fine Gravel	
≥ 710 to < 2mm	Coarse Sand	**Coarse Sands**
≥ 250 to < 710 µm	Medium Sand	
≥ 63 to < 250 µm	Fine Sand	**Silt and Fine Sands**
≥ 16 to < 63 µm	Coarse Silt	
≥ 3.9 to < 16 µm	Medium Silt	
≥ 0.1 to < 3.9 µm	Fine Silt	

An indication of the suitability of the MORL Zone as a sandeel habitat, based on the distribution of “coarse sands” and “silt and fine sands” is given in Figure 7.1. Stations in which the proportion of “coarse sands” is high are more likely to constitute suitable sandeel habitats than those characterised by a high proportion of “silts and fine sands”. Detailed results of the PSA by station/grab sample are provided in Appendix 10.4.2.

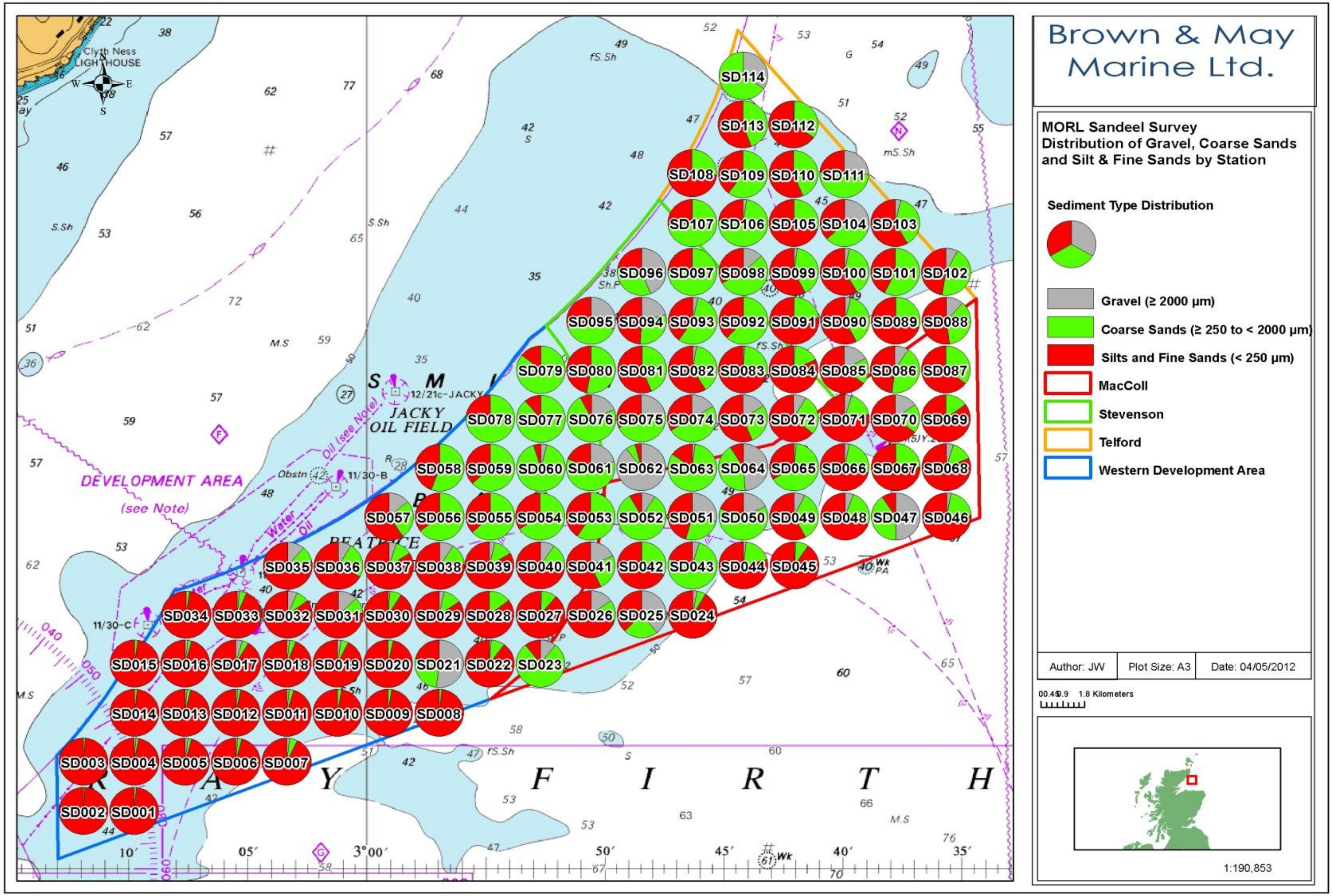


Figure 7.1 Distribution of Gravel, Coarse Sands and Silt & Fine Sands at Grab Stations

The relationship between the number of sandeels caught in dredge samples and the percentage of "coarse sands" and "silt and fine sands" is shown in Figure 7.2 and Figure 7.3 respectively. In line with the findings of Greenstreet *et al* (2010) and Holland *et al* (2005), the results of the survey suggest a preference for sediments with a high proportion of coarse sands and a low proportion of silt and fine sands.

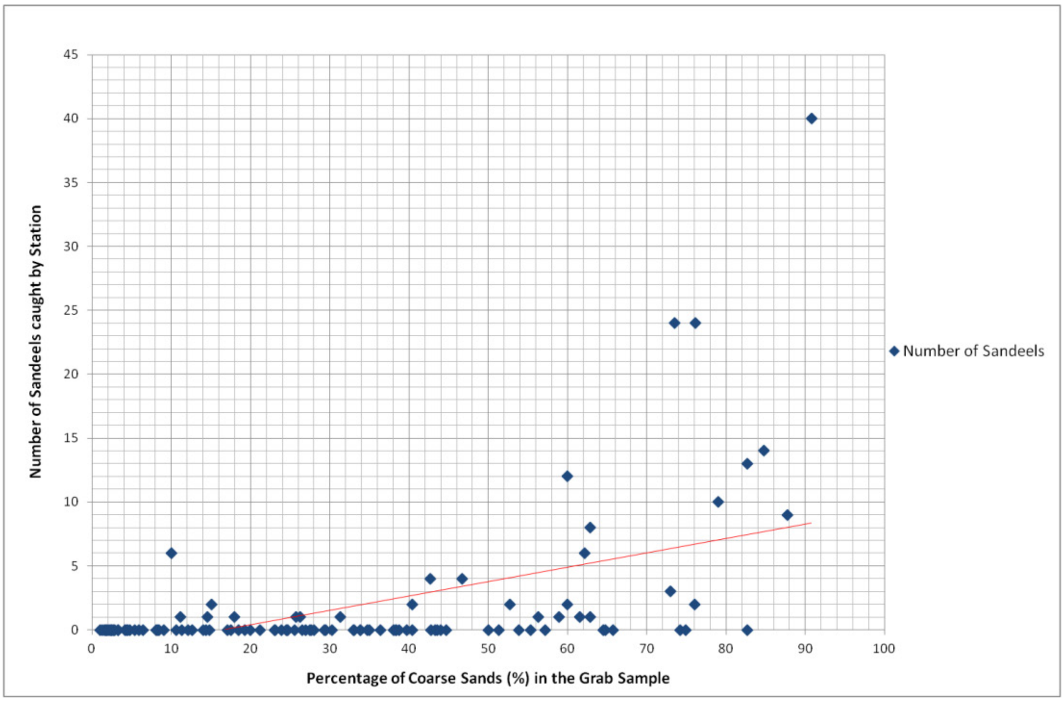


Figure 7.2 Number of Sandeels Caught by Percentage of Coarse Sands (particle size ≥ 250 µm to < 2mm)

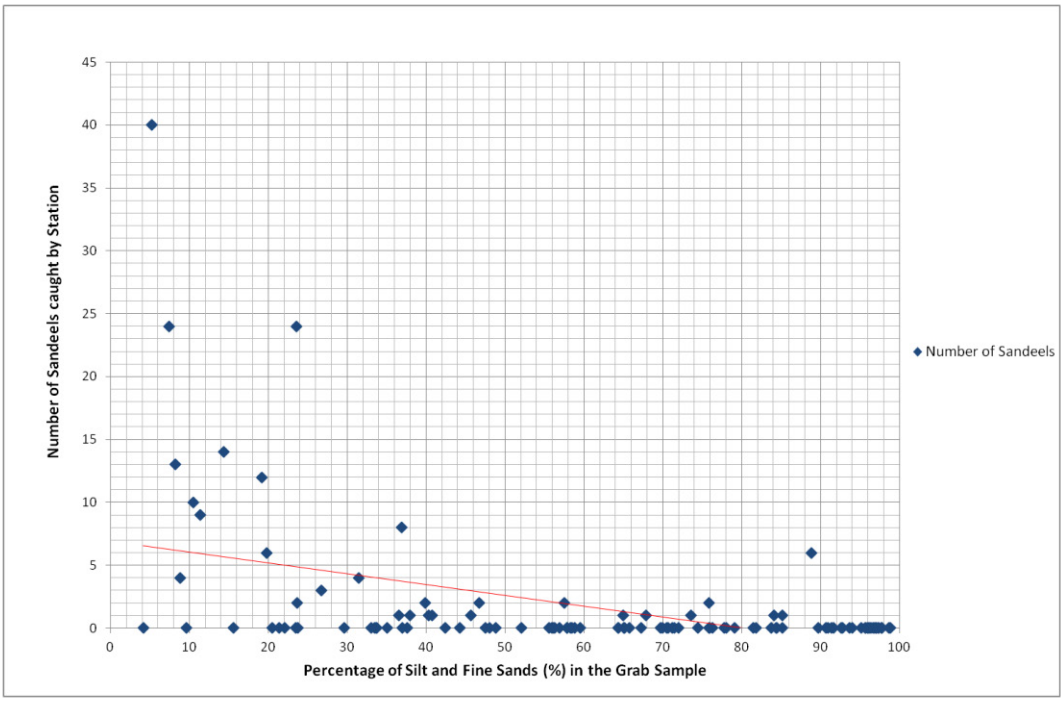


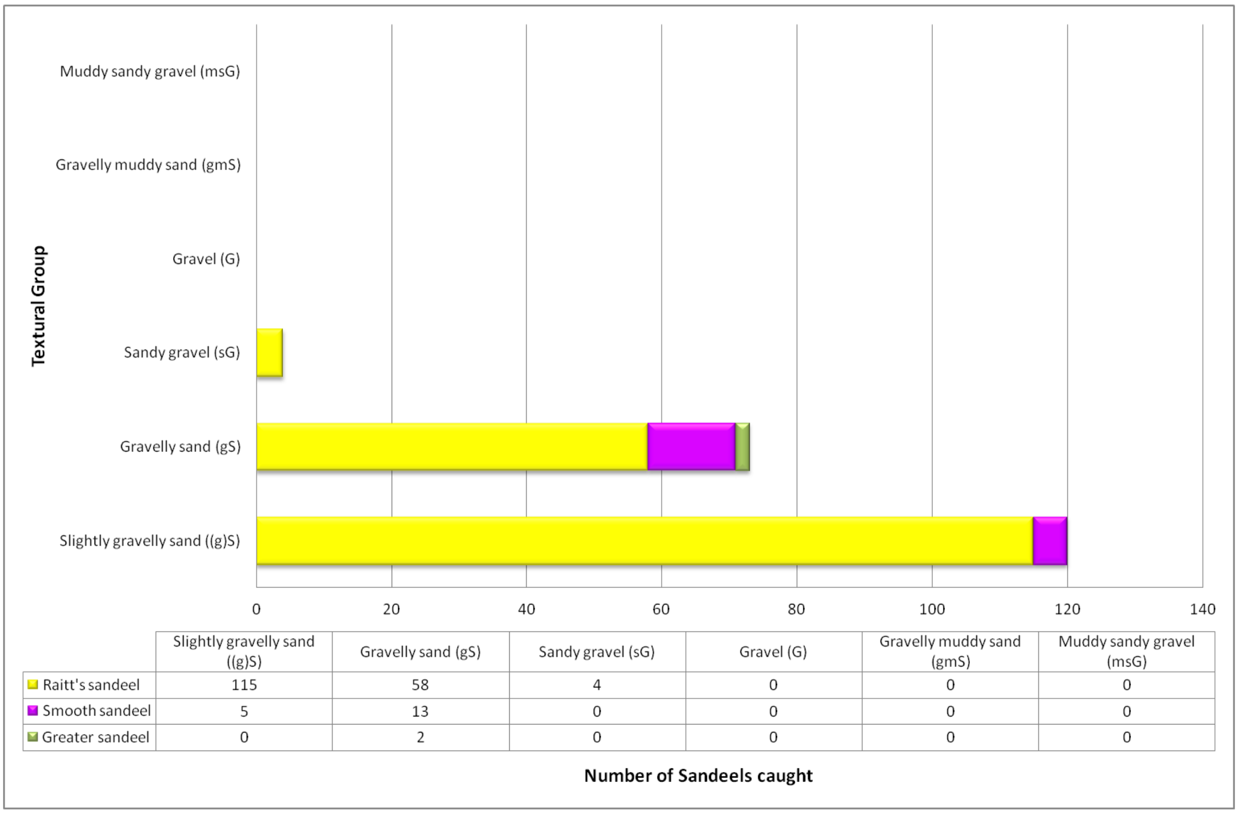
Figure 7.3 Number of Sandeels Caught by Percentage of Silt and Fine Sand (particle size < 250µm)

7.1.1 FOLK's Classification System

The total number of sandeels caught by seabed sediment type, based on Folk's classification system, is given in Figure 7.4 below. Six different seabed sediment types were recorded during the survey. Sandeels were only recorded at stations where the following three sediment types were found:

- Slightly gravelly sand ((g)S);
- Gravelly sand (gS); and to a lesser extent
- Sandy gravel (sG).

Sandeels were absent from seabed sediments characterised by gravel (G), muddy sandy gravel (msG) or gravelly muddy sand (gmS).



	Slightly gravelly sand ((g)S)	Gravelly sand (gS)	Sandy gravel (sG)	Gravel (G)	Gravelly muddy sand (gmS)	Muddy sandy gravel (msG)
Raitt's sandeel	115	58	4	0	0	0
Smooth sandeel	5	13	0	0	0	0
Greater sandeel	0	2	0	0	0	0

Figure 7.4 Number of Sandeels Caught by Seabed Sediment Type (Folk, 1954)

The distribution of sandeel catches across the MORL Zone Area together with seabed sediment types as defined by the British Geological Survey (BGS), following Folk's sediment classification, is illustrated in Figure 7.5. As shown, sandeels were primarily found in areas defined by the BGS as sandy (S) areas, and to a lesser extent, in areas defined as sandy gravel (sG), gravelly sand (gS) and slightly gravelly sand ((g)S).

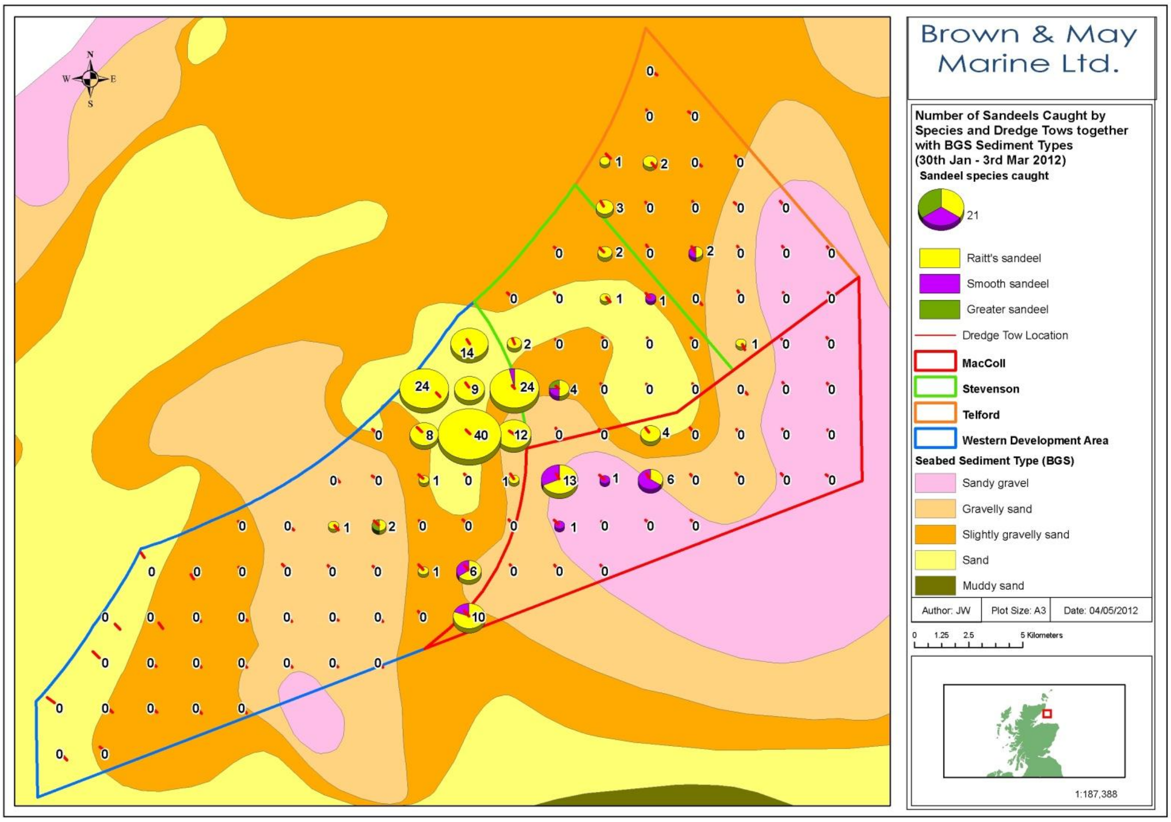


Figure 7.5 The Distribution of Sandeel Catches in the Dredge together with Seabed Sediment Types as defined by the British Geological Survey Data (BGS)

8.0 Conclusion

The results of the sandeel survey indicate an overall patchy distribution of sandeels across the MORL Zone. Sandeels were caught in 29 out of the 114 stations sampled, in relatively low numbers, with a maximum of 40 individuals caught at a single station. The highest numbers of sandeels were found in dredge samples from the north eastern section of the WDA and to a lesser extent in the western section of MacColl, as well as in areas located at the border between Stevenson and Telford. In general terms, sandeels were found in highest numbers in areas where sediments containing a high proportion of coarse sands and a low proportion of silt and fine sands were recorded in grab samples. Raitt's sandeel was the species caught in greatest numbers, accounting for 89.8% of the total sandeel catch, with the majority (78.5%) being caught within the WDA.

The relatively low sandeel catches recorded in the survey suggest that there are not extensive areas supporting important sandeel populations in the MORL Zone. It should be noted, however, that sandeel distribution is extremely patchy and even the most suitable habitats often render zero-catch samples. Zero catch rates should therefore not be taken as an indication of unsuitable sandeel habitat. It should also be noted, that areas considered to potentially constitute suitable habitat for sandeels (sand, slightly gravelly sand, gravelly sand and sandy gravel) are widespread throughout the Moray Firth.

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10.0 Appendices

10.1 Appendix 1 – Health and Safety

10.1.1 Personnel

Brown and May Marine (BMM) staff 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), Seafish Safety Awareness, Basic Fire Fighting and Basic First Aid certificates before participating in offshore works.

10.1.2 Vessel Induction

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

10.1.3 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.

10.1.4 Post Trip Survey Review

Upon completion of the survey a "Post Trip Survey Review" was filled, see Table 10.1 below.

Table 10.1 Post Trip Survey Review

Project: MORL Sandeel February 2012	**Vessel:** Shemarah II
Surveyors: Lucy Shuff, Alexandria Winrow-Giffin, Kelly Hayes	**Skipper:** Donald Moodie
Survey Area: Moray Firth	**Total Time at Sea:** 12 Days
Dates at Sea: 30/01/12 – 02/3/12	

	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?	Leak in steering hydraulics	Engineer fixed when in port
Safety equipment failures?	None	N/A
Accidents?	None	N/A
Injuries?	None	N/A

10.2 Appendix 2 – Survey Log

Survey log of events is given in Table 10.2.

Table 10.2 Summarised Log of Events

Friday 27th January 2012
Vessel audited
Monday 30th January 2012
Depart BMM/Titan, travel to South Queensferry, Edinburgh
Vessel complete post-audit works
Tuesday 31st January 2012
Travel to Fraserburgh, load vessel.
Wednesday 1st February 2012
Depart Fraserburgh 1400, steam to survey area
Stations Completed: SD01 (repeat grab x6), SD02 (repeat grab x3), SD03 (repeat grab x2), SD04 (repeat grab x2, repeat dredge x2)
Sandeels Caught: None
Weather:BF4, moderate
Overnight at sea
Thursday 2nd February 2012
Stations Completed: SD05, SD06, SD07, SD08, SD09, SD10, SD11, SD12 (repeat dredge x2), SD13, SD14, SD15 (repeat dredge x2), SD16, SD17
Sandeels Caught: None
Weather: BF2-3, slight
Overnight at sea
Friday 3rd February 2012
Stations Completed: SD18, SD19, SD20, SD21, SD22 (repeat dredge x2), SD23 (additional grab along line), SD24, SD25, SD26, SD27, SD28, SD29, SD30
Sandeels Caught: SD23 (8), SD27 (5), SD28 (1)
Weather: BF2 increasing to BF6/7, slight, worsening to moderate and then rough
Return to Fraserburgh due to poor weather conditions
Overnight at sea
Saturday 4th February 2012
Arrive Fraserburgh 0600
Weather: BF6/7 to BF8/9, rough to very rough
Weather day in port
Sunday 5th February 2012
Depart Fraserburgh 1630, steam to survey area, arrive 2300
Stations Completed: SD31, SD32, SD33, SD34, SD35, SD36 (repeat dredge x2), SD37, SD38, SD39, SD40
Sandeels Caught: SD37 (1), SD38 (2)
Weather:BF5/6 decreasing to BF4
Overnight at sea
Monday 6th February 2012
Stations Completed: SD41, SD42, SD43, SD49, SD50 (additional grab along line), SD51 (repeat grab x3), SD52, SD53, SD54, SD55, SD56, SD57, SD58 (repeat grab x2), SD59
Sandeels Caught: SD42 (1), SD50 (6), SD51 (1), SD52 (13), SD53 (1), SD55 (1), SD59 (8)
Weather: BF4/5, increasing to BF7/8, moderate to rough
Return to Fraserburgh due to poor weather conditions
Overnight at sea
Tuesday 7th February 2012
Arrive Fraserburgh 0700
Weather: BF6 to 8, rough to very rough
Weather day in port

Wednesday 8th February 2012
Weather: BF7/8, rough to very rough
Weather day in port
Thursday 9th February 2012
Depart Fraserburgh 1100, steam to survey area, arrive 1600
Stations Completed: SD44, SD45, SD48, SD47 (repeat grab x2), SD46, SD68, SD67, SD66, SD65, SD64 (repeat grab x3), SD63 (repeat grab x2), SD62 abandoned due to worsening weather conditions
Sandeel Caught: SD64 (4)
Weather: BF1/2 increasing to BF6/7, slight, increasing to moderate and then rough
Steam inshore to take shelter from the land.
Overnight at sea
Friday 10th February 2012
Steam to survey area, arrive 2130
Stations Completed: SD62 grab attempted a number of times between 2130 and 0230; no sample obtained due to sea state. Sampling abandoned at 0230
Weather: BF5/6 decreasing to BF3, rough to moderate
Weather day at sea
Overnight at sea
Saturday 11th February 2012
Stations Completed: SD62, SD61, SD60, SD78, SD77, SD76, SD75, SD74, SD73, SD72, SD83, SD82, SD81, SD80, SD79
Sandeels Caught: SD61 (11), SD60 (41), SD78 (24), SD77 (9), SD76 (24), SD75 (4), SD80 (2), SD79 (14)
Weather: BF3/4, slight
Overnight at sea
Sunday 12th February 2012
Stations Completed: SD69, SD70, SD71, SD84, SD85, SD86, SD87, SD88, SD89
Sandeels Caught: SD85 (1)
Weather: BF4/5, increasing to BF7/8, moderate to rough
Return to Fraserburgh
Overnight at Sea
Monday 13th February 2012
Arrive Fraserburgh 0430
Weather: BF6 to 8, rough to very rough
Weather day in port
Tuesday 14th February 2012
Weather: BF6 to 8, rough to very rough
Weather day in port
Wednesday 15th February 2012
Weather: BF7/8, rough to very rough
Weather day in port
Thursday 16th February 2012
Weather: BF6 to 8, rough to very rough
Weather day in port
Friday 17th February 2012
Surveyors temporarily demobilised
Weather: BF6 to 7, rough to very rough
Weather day in port
Saturday 18th February 2012
Weather: BF6 to 9, rough to very rough
Weather day in port
Sunday 19th February 2012
Weather: BF6 to 9, rough to very rough

Weather day in port
Monday 20th February 2012
Weather: BF6 to 8 , rough to very rough
Weather day in port
Tuesday 21st February 2012
Weather: BF6 to 8, rough to very rough
Weather day in port
Wednesday 22nd February 2012
Weather: BF6 to 8, rough to very rough
Weather day in port
Thursday 23rd February 2012
Weather: BF6 to 8, rough to very rough
Weather day in port
Friday 24th February 2012
Weather: BF6 to 9, rough to very rough to high
Weather day in port
Saturday 25th February 2012
Weather: BF4 to 8, moderate to rough to very rough
Weather day in port
Sunday 26th February 2012
Weather: BF6 to 9, rough to very rough
Weather day in port
Monday 27th February 2012
Weather: BF6 to 7, rough
Weather day in port
Tuesday 28th February 2012
Weather: BF4 to 6, moderate
Surveyors re-mobilise
Overnight aboard vessel
Weather day in port
Wednesday 29th February 2012
Depart Fraserburgh 1030, steam to survey area, arrive 1530
Stations Completed: SD90, SD91 (repeat dredge x 1), SD92 (additional grab along line), SD93 (repeat dredge x 1), SD94, SD95 (repeat grab x 1), SD96 (repeat grab x 2), SD97, SD98, SD99, SD100, SD101, SD102 (repeat grab x 2), SD103, SD104 (repeat grab x 1), SD105 (repeat grab x 3)
Sandeels Caught: SD92 (1), SD93 (1), SD97 (2), SD99 (2)
Weather: BF2 to 4, slight
Overnight at sea
Thursday 1st March 2012
Stations Completed: SD114 (repeat dredge x 1), SD113, SD112, SD111, SD110 (repeat dredge x 1), SD109 (repeat grab x 2, repeat dredge x 1), SD108, SD107, SD106 (repeat grab x 5)
Sandeels Caught: SD09 (2), SD08 (1), SD07 (3)
Weather: BF3 to 5, slight to moderate
Return to Fraserburgh
Overnight at sea
Friday 2nd March 2012
Arrive Fraserburgh 0130
Demobilise survey vessel
Travel to South Queensferry, Edinburgh
Saturday 3rd March 2012
Return to BMM/Titan

10.3 Appendix 3 – Times and Coordinates

10.3.1 Dredge Tows

Table 10.3 Start and End Times, Co-ordinates and Duration of Each Dredge Tow

Trawl	Date	Start				End				Duration (mm:ss)
		Time (GMT)	WGS84 Latitude	WGS84 Longitude	Depth (m)	Time (GMT)	WGS84 Latitude	WGS84 Longitude	Depth (m)	
SD001	01/02/2012	22:51:10	58.0226	-3.16223	50.6	22:58:12	58.0249	-3.16782	50.9	07:02
SD002	02/02/2012	00:24:24	58.0222	-3.19814	50.6	00:27:52	58.0194	-3.19341	50.2	03:28
SD003		01:15:39	58.0431	-3.20340	50.2	01:20:27	58.0454	-3.20928	51.4	04:48
SD004		02:45:39	58.0422	-3.16335	48.5	02:49:58	58.0394	-3.15787	48.5	04:19
SD005		17:03:10	58.0418	-3.12820	49.3	17:06:46	58.0393	-3.12291	50.0	03:36
SD006		17:38:29	58.0417	-3.09222	50.7	17:42:06	58.0389	-3.08830	50.8	03:37
SD007		18:14:36	58.0411	-3.05615	52.2	18:17:18	58.0391	-3.05308	52.7	02:42
SD008		19:05:55	58.0601	-2.94933	55.0	19:08:46	58.0581	-2.94613	55.7	02:51
SD009		19:40:50	58.0601	-2.98488	55.0	19:43:41	58.0582	-2.98128	55.9	02:51
SD010		20:17:01	58.0604	-3.02116	52.0	20:19:59	58.0581	-3.01732	52.4	02:58
SD011		20:52:34	58.0598	-3.05630	50.5	20:55:03	58.0580	-3.05270	50.8	02:29
SD012		21:46:51	58.0602	-3.09186	49.0	21:49:47	58.0580	-3.08856	49.1	02:56
SD013		22:19:55	58.0603	-3.12822	47.3	22:23:42	58.0583	-3.12361	47.5	03:47
SD014		23:04:47	58.0645	-3.17341	49.7	23:09:00	58.0619	-3.16834	49.0	04:13
SD015	03/02/2012	01:02:50	58.0759	-3.15597	48.6	01:05:58	58.0738	-3.15227	48.0	03:08
SD016		01:42:36	58.0765	-3.12189	46.1	01:46:52	58.0740	-3.11868	46.1	04:16
SD017		02:19:04	58.0794	-3.09268	46.1	02:24:25	58.0771	-3.08892	46.3	05:21
SD018		16:20:48	58.0795	-3.05708	47.0	16:26:57	58.0774	-3.05230	47.4	06:09
SD019		16:58:38	58.0797	-3.02186	49.2	17:04:57	58.0770	-3.01752	50.3	06:19
SD020		17:37:19	58.0791	-2.98586	51.1	17:42:00	58.0775	-2.98099	51.3	04:41
SD021		18:15:07	58.0790	-2.94935	49.5	18:17:59	58.0770	-2.94606	49.8	02:52
SD022		19:06:48	58.0795	-2.91511	49.0	19:09:35	58.0814	-2.91828	48.4	02:47
SD023		19:45:20	58.0792	-2.87877	49.4	19:49:01	58.0815	-2.88215	47.4	03:41
SD024		21:39:59	58.0980	-2.77130	53.7	21:43:32	58.1003	-2.77535	53.1	03:33
SD025		22:15:28	58.0980	-2.80751	52.3	22:19:31	58.1003	-2.81129	50.1	04:03
SD026		22:55:12	58.0978	-2.84254	47.1	23:00:27	58.1005	-2.84645	47.0	05:15
SD027		23:32:13	58.0984	-2.87908	42.1	23:35:32	58.1005	-2.88211	42.1	03:19
SD028	04/02/2012	00:09:42	58.0986	-2.91443	41.3	00:12:56	58.1006	-2.91792	41.1	03:14
SD029		00:47:41	58.0983	-2.95016	43.7	00:51:19	58.1000	-2.95402	43.4	03:38
SD030		01:17:07	58.0985	-2.98588	49.3	01:20:02	58.1004	-2.98914	48.6	02:55
SD031	05/02/2012	23:31:43	58.0982	-3.02011	48.8	23:37:34	58.1009	-3.02512	48.6	05:51
SD032	06/02/2012	00:12:25	58.0982	-3.05560	45.6	00:16:18	58.0996	-3.05922	45.4	03:53
SD033		01:00:33	58.0946	-3.09431	46.3	01:04:25	58.0966	-3.09656	46.3	03:52
SD034		01:39:07	58.1035	-3.13310	50.7	01:43:14	58.1056	-3.13578	41.4	04:07
SD035		02:40:19	58.1170	-3.05589	44.2	02:44:34	58.1186	-3.05969	44.2	04:15
SD036		03:31:14	58.1168	-3.01911	45.9	03:34:00	58.1151	-3.01583	46.2	02:46
SD037		04:22:00	58.1169	-2.98380	43.4	04:26:02	58.1150	-2.98115	43.8	04:02
SD038		04:53:22	58.1171	-2.94935	38.7	04:56:48	58.1188	-2.95296	39.0	03:26
SD039		05:25:52	58.1171	-2.91486	40.2	05:29:14	58.1190	-2.91783	40.1	03:22
SD040		05:59:56	58.1175	-2.87989	40.8	06:02:39	58.1193	-2.88326	39.5	02:43
SD041		17:07:16	58.1174	-2.84396	42.2	17:10:09	58.1192	-2.84728	42.2	02:53
SD042		17:48:12	58.1173	-2.80808	45.5	17:51:22	58.1190	-2.81150	44.0	03:10
SD043		18:29:58	58.1168	-2.77133	48.7	18:33:37	58.1184	-2.77434	48.7	03:39
SD044	09/02/2012	16:41:48	58.1172	-2.73644	51.1	16:44:55	58.1189	-2.74001	52.2	03:07
SD045		17:18:51	58.1172	-2.70060	52.7	17:22:10	58.1188	-2.70418	52.6	03:19
SD046		19:23:18	58.1359	-2.59417	55.0	19:25:52	58.1373	-2.59793	54.6	02:34
SD047		18:46:30	58.1363	-2.63009	52.8	18:49:21	58.1379	-2.63345	52.5	02:51
SD048		17:59:22	58.1365	-2.66560	52.2	18:02:08	58.1382	-2.66892	52.4	02:46
SD049	06/02/2012	19:20:40	58.1360	-2.70125	53.0	19:24:36	58.1378	-2.70435	51.4	03:56
SD050		19:59:38	58.1363	-2.73682	50.5	20:02:51	58.1383	-2.73908	51.0	03:13
SD051		21:08:22	58.1359	-2.77221	48.2	21:12:08	58.1376	-2.77610	47.4	03:46
SD052		21:43:45	58.1362	-2.80779	43.8	21:47:57	58.1383	-2.80988	44.5	04:12
SD053		23:27:10	58.1361	-2.84336	44.1	23:31:08	58.1382	-2.84585	43.7	03:58
SD054	07/02/2012	00:02:15	58.1364	-2.87927	42.2	00:05:04	58.1383	-2.88198	41.7	02:49
SD055		00:35:36	58.1363	-2.91433	42.8	00:38:31	58.1379	-2.91788	42.6	02:55
SD056		01:11:34	58.1360	-2.95033	41.4	01:15:12	58.1374	-2.95438	41.1	03:38
SD057		01:43:59	58.1348	-2.97998	39.4	01:46:46	58.1369	-2.98326	39.6	02:47

Trawl	Date	Start				End				Duration (mm:ss)
		Time (GMT)	WGS84		Depth (m)	Time (GMT)	WGS84		Depth (m)	
			Latitude	Longitude			Latitude	Longitude		
SD058		02:30:12	58.1551	-2.95075	40.2	02:32:44	58.1567	-2.95406	39.7	02:32
SD059		03:03:23	58.1557	-2.91535	41.1	03:06:46	58.1576	-2.91920	40.4	03:23
SD060	11/02/2012	18:12:50	58.1548	-2.87737	40.2	18:17:13	58.1565	-2.88057	38.7	04:23
SD061		17:02:40	58.1546	-2.84281	43.7	17:07:12	58.1559	-2.84668	42.6	04:32
SD062		16:25:56	58.1550	-2.80787	43.0	16:29:52	58.1572	-2.81023	42.6	03:56
SD063	10/02/2012	00:41:26	58.1550	-2.77307	45.4	00:44:17	58.1565	-2.77632	45.4	02:51
SD064	09/02/2012	23:56:00	58.1553	-2.73709	48.4	23:59:22	58.1572	-2.73954	48.9	03:22
SD065		22:59:51	58.1550	-2.70187	50.3	23:02:55	58.1571	-2.70469	50.3	03:04
SD066		21:07:20	58.1546	-2.66519	51.7	21:11:16	58.1563	-2.66814	51.4	03:56
SD067		20:31:29	58.1543	-2.62911	54.7	20:35:18	58.1564	-2.63207	54.3	03:49
SD068		19:56:02	58.1543	-2.59339	54.8	19:59:23	58.1560	-2.59655	54.4	03:21
SD069	12/02/2012	16:44:14	58.1736	-2.59364	56.3	16:47:43	58.1753	-2.59651	56.4	03:29
SD070		17:18:37	58.1737	-2.62900	55.4	17:22:26	58.1758	-2.63150	56.2	03:49
SD071		18:11:10	58.1727	-2.66247	53.5	18:14:09	58.1709	-2.65966	54.2	02:59
SD072		00:19:53	58.1735	-2.70017	50.7	00:23:49	58.1754	-2.70268	51.5	03:56
SD073	11/02/2012	23:42:39	58.1734	-2.73551	49.8	23:46:54	58.1753	-2.73886	49.8	04:15
SD074		21:50:45	58.1737	-2.77230	43.4	21:54:25	58.1756	-2.77489	44.2	03:40
SD075		21:14:17	58.1735	-2.80772	41.2	21:17:21	58.1746	-2.80993	40.6	03:04
SD076		20:31:18	58.1736	-2.84257	37.4	20:35:00	58.1749	-2.84446	39.1	03:42
SD077		19:49:51	58.1741	-2.87834	37.6	19:53:20	58.1760	-2.88083	39.3	03:29
SD078		19:00:58	58.1702	-2.90092	40.5	19:04:55	58.1719	-2.90409	40.3	03:57
SD079	12/02/2012	02:57:27	58.1921	-2.87750	39.9	03:01:18	58.1941	-2.88007	42.3	03:51
SD080		02:27:15	58.1922	-2.84223	45.7	02:31:00	58.1944	-2.84402	45.4	03:45
SD081		01:57:32	58.1922	-2.80685	45.8	02:01:32	58.1940	-2.81022	46.8	04:00
SD082		01:25:29	58.1926	-2.77109	48.2	01:29:07	58.1947	-2.77346	48.3	03:38
SD083		00:54:46	58.1924	-2.73616	47.8	00:59:13	58.1945	-2.73813	48.4	04:27
SD084		18:49:55	58.1928	-2.70012	51.9	18:53:15	58.1943	-2.70355	51.2	03:20
SD085		19:50:53	58.1916	-2.66335	52.6	19:54:35	58.1894	-2.66118	52.7	03:42
SD086		20:37:32	58.1924	-2.62851	51.8	20:40:58	58.1937	-2.63257	50.7	03:26
SD087		21:20:12	58.1924	-2.59387	54.3	21:23:32	58.1943	-2.59667	55.6	03:20
SD088		23:05:11	58.2112	-2.59284	56.8	23:08:48	58.2129	-2.59561	56.0	03:37
SD089		23:42:37	58.2111	-2.62846	55.0	23:46:02	58.2130	-2.63082	56.2	03:25
SD090	29/02/2012	15:58:02	58.2117	-2.66480	53.7	16:01:08	58.2137	-2.66671	54.1	03:06
SD091		17:17:53	58.2099	-2.69797	56.1	17:20:58	58.2081	-2.69493	54.9	03:05
SD092		17:52:19	58.2112	-2.73601	46.6	17:55:01	58.2129	-2.73893	46.6	02:42
SD093		18:57:29	58.2113	-2.77000	47.8	19:00:21	58.2095	-2.76694	47.6	02:52
SD094		19:28:38	58.2117	-2.80785	45.6	19:32:09	58.2134	-2.81099	45.6	03:31
SD095		20:04:40	58.2117	-2.84457	43.4	20:07:25	58.2133	-2.84811	42.9	02:45
SD096		20:50:20	58.2307	-2.80786	44.6	20:53:29	58.2323	-2.81090	44.5	03:09
SD097		21:22:13	58.2302	-2.77170	47.7	21:25:23	58.2318	-2.77512	47.3	03:10
SD098		21:54:50	58.2308	-2.73590	47.0	21:57:46	58.2329	-2.73829	48.1	02:56
SD099		23:33:36	58.2302	-2.70016	50.9	23:37:30	58.2322	-2.70265	50.3	03:54
SD100	01/03/2012	00:06:56	58.2303	-2.66423	52.3	00:10:36	58.2323	-2.66660	52.6	03:40
SD101		00:37:10	58.2303	-2.62862	52.0	00:40:02	58.2322	-2.63144	51.3	02:52
SD102		01:22:58	58.2299	-2.59351	55.6	01:25:57	58.2319	-2.59618	54.9	02:59
SD103		01:52:21	58.2488	-2.62971	52.4	01:55:00	58.2509	-2.63268	52.6	02:39
SD104		02:23:23	58.2490	-2.66583	51.1	02:26:08	58.2505	-2.66916	50.8	02:45
SD105		03:08:57	58.2488	-2.69886	50.7	03:11:54	58.2509	-2.70183	49.7	02:57
SD106		20:49:08	58.2491	-2.73555	44.9	20:51:36	58.2507	-2.73899	44.7	02:28
SD107		19:48:23	58.2492	-2.77193	45.2	19:51:22	58.2512	-2.77411	46.2	02:59
SD108		19:19:30	58.2689	-2.76642	50.2	19:22:47	58.2708	-2.76997	50.7	03:17
SD109		18:53:00	58.2670	-2.73407	45.3	18:56:02	58.2651	-2.73105	45.6	03:02
SD110		18:00:31	58.2672	-2.69815	48.2	18:02:56	58.2656	-2.69481	48.4	02:25
SD111		17:21:49	58.2677	-2.66453	52.7	17:24:56	58.2697	-2.66791	51.9	03:07
SD112		16:49:58	58.2867	-2.70048	52.6	16:53:13	58.2882	-2.70470	52.6	03:15
SD113		16:20:33	58.2868	-2.73525	51.2	16:24:09	58.2891	-2.73805	51.1	03:36
SD114		15:53:54	58.3050	-2.73327	55.2	15:57:06	58.3035	-2.72931	54.7	03:12

10.3.2 Grab Samples

Table 10.4 Times, Co-ordinates and Depths of Grab Deployments

Trawl	Date	Time (GMT)	WGS84		Depth (m)
			Latitude	Longitude	
SD001 Ga	01/02/2012	21:01:50	58.0205	-3.16156	51.0
SD001 Gb	01/02/2012	21:12:28	58.0216	-3.16156	50.3
SD001 Gc	01/02/2012	21:15:09	58.0221	-3.16127	50.6
SD001 Gd	01/02/2012	21:34:50	58.0219	-3.16228	50.9
SD001 Ge	01/02/2012	21:54:25	58.0216	-3.16178	50.5
SD001 Gf	01/02/2012	22:22:16	58.0216	-3.16145	49.8
SD002 Ga	01/02/2012	23:37:41	58.0217	-3.19801	50.1
SD002 Gb	01/02/2012	23:47:33	58.0216	-3.1973	60.2
SD002 Gc	01/02/2012	23:55:42	58.0216	-3.19755	50.6
SD003 Ga	02/02/2012	00:49:27	58.0431	-3.20196	50.7
SD003 Gb	02/02/2012	00:59:20	58.0432	-3.20219	50.7
SD004 Ga	02/02/2012	01:42:11	58.0405	-3.16039	49.0
SD004 Gb	02/02/2012	01:54:36	58.0408	-3.16106	48.4
SD005 Ga	02/02/2012	16:46:03	58.0404	-3.12583	49.8
SD006 Ga	02/02/2012	17:25:11	58.0408	-3.09017	50.9
SD007 Ga	02/02/2012	17:59:08	58.0406	-3.05499	52.6
SD008 Ga	02/02/2012	18:51:50	58.0595	-2.9481	55.2
SD009 Ga	02/02/2012	19:27:40	58.0597	-2.98346	55.4
SD010 Ga	02/02/2012	20:03:58	58.0598	-3.01944	52.2
SD011 Ga	02/02/2012	20:40:17	58.0596	-3.05529	50.7
SD012 Ga	02/02/2012	21:13:56	58.0595	-3.09094	49.4
SD013 Ga	02/02/2012	22:08:07	58.0597	-3.12632	47.7
SD014 Ga	02/02/2012	22:45:50	58.0634	-3.1712	49.6
SD015 Ga	03/02/2012	00:23:38	58.0756	-3.15433	48.3
SD016 Ga	03/02/2012	01:22:43	58.0754	-3.12009	46.1
SD017 Ga	03/02/2012	02:01:13	58.0783	-3.09048	46.2
SD018 Ga	03/02/2012	16:04:43	58.0784	-3.05578	47.3
SD019 Ga	03/02/2012	16:45:37	58.0785	-3.01925	49.8
SD020 Ga	03/02/2012	17:20:33	58.0784	-2.98376	51.1
SD021 Ga	03/02/2012	17:59:19	58.0786	-2.94788	50.1
SD022 Ga	03/02/2012	18:34:14	58.0785	-2.91185	49.0
SD023 Ga	03/02/2012	19:30:13	58.0784	-2.87693	48.4
SD023 Gb	03/02/2012	20:14:33	58.0792	-2.87972	49.1
SD024 Ga	03/02/2012	21:24:39	58.0972	-2.76995	54.1
SD025 Ga	03/02/2012	22:02:18	58.0972	-2.80642	53.4
SD026 Ga	03/02/2012	22:39:36	58.0972	-2.84218	46.2
SD027 Ga	03/02/2012	23:17:52	58.0973	-2.87761	42.7
SD028 Ga	03/02/2012	23:55:26	58.0975	-2.91318	42.2
SD029 Ga	04/02/2012	00:35:08	58.0973	-2.9486	44.1
SD030 Ga	04/02/2012	01:05:15	58.0974	-2.98442	49.2
SD031 Ga	05/02/2012	23:15:32	58.0974	-3.01862	49.0
SD032 Ga	05/02/2012	23:56:19	58.0973	-3.05467	45.8
SD033 Ga	06/02/2012	00:45:49	58.0941	-3.09323	47.0
SD034 Ga	06/02/2012	01:21:41	58.1024	-3.13214	50.9
SD035 Ga	06/02/2012	02:19:44	58.1162	-3.05477	44.3
SD036 Ga	06/02/2012	03:03:06	58.1164	-3.01873	46.5
SD037 Ga	06/02/2012	04:08:02	58.1164	-2.9828	43.2
SD038 Ga	06/02/2012	04:41:13	58.1163	-2.94712	39.0
SD039 Ga	06/02/2012	05:14:54	58.1164	-2.91246	39.9
SD040 Ga	06/02/2012	05:48:10	58.1163	-2.87673	40.5
SD041 Ga	06/02/2012	16:50:29	58.1166	-2.84145	42.4
SD042 Ga	06/02/2012	17:33:45	58.1162	-2.80588	45.4
SD043 Ga	06/02/2012	18:15:08	58.1162	-2.77	48.7
SD044 Ga	09/02/2012	16:27:23	58.1162	-2.73458	51.8
SD045 Ga	09/02/2012	17:05:22	58.1162	-2.69869	53.4
SD046 Ga	09/02/2012	19:10:37	58.1347	-2.59098	55.8
SD047 Ga	09/02/2012	18:23:42	58.1349	-2.62706	54.2
SD047 Gb	09/02/2012	18:32:18	58.1345	-2.62743	54.5
SD048 Ga	09/02/2012	17:45:20	58.135	-2.66284	51.8
SD049 Ga	06/02/2012	19:05:26	58.135	-2.69864	53.3
SD050 Ga	06/02/2012	19:42:01	58.1349	-2.73468	52.4
SD050 Gb	06/02/2012	20:18:26	58.1353	-2.73661	51.8

Trawl	Date	Time (GMT)	WGS84		Depth (m)
			Latitude	Longitude	
SD051 Ga	06/02/2012	20:37:57	58.1351	-2.77045	48.6
SD051 Gb	06/02/2012	20:45:19	58.135	-2.77052	48.0
SD051 Gc	06/02/2012	20:54:10	58.1354	-2.77041	49.2
SD052 Ga	06/02/2012	21:26:55	58.1351	-2.80641	43.2
SD053 Ga	06/02/2012	23:14:01	58.135	-2.84202	44.2
SD054 Ga	06/02/2012	23:48:10	58.1352	-2.87751	41.2
SD055 Ga	07/02/2012	00:22:54	58.1349	-2.91203	42.9
SD056 Ga	07/02/2012	00:55:19	58.1351	-2.94808	41.6
SD057 Ga	07/02/2012	01:30:53	58.1332	-2.97699	39.8
SD058 Ga	07/02/2012	02:07:03	58.1544	-2.94755	40.2
SD058 Gb	07/02/2012	02:15:36	58.1539	-2.94794	40.1
SD059 Ga	07/02/2012	02:50:49	58.1543	-2.91167	41.0
SD060 Ga	11/02/2012	17:38:22	58.1542	-2.8765	40.1
SD060 Gb	11/02/2012	17:43:15	58.1538	-2.87578	39.5
SD060 Gc	11/02/2012	17:50:15	58.1541	-2.87742	39.5
SD060 Gd	11/02/2012	17:58:59	58.154	-2.8754	39.6
SD060 Ge	11/02/2012	18:32:51	58.1555	-2.87879	38.9
SD061 Ga	11/02/2012	16:47:24	58.154	-2.84202	44.0
SD061 Gb	11/02/2012	17:21:28	58.1546	-2.84192	44.0
SD062 Ga	10/02/2012	01:03:08	58.1541	-2.80612	43.2
SD062 Ga	10/02/2012	22:12:01	58.1538	-2.80582	41.9
SD062 Ga	11/02/2012	16:03:16	58.1539	-2.80549	42.4
SD062 Gb	10/02/2012	01:09:33	58.1541	-2.80555	44.2
SD062 Gb	10/02/2012	23:55:12	58.1541	-2.80513	43.4
SD062 Gb	11/02/2012	16:11:18	58.1542	-2.80714	42.9
SD062 Gc	10/02/2012	01:21:32	58.1542	-2.80614	43.4
SD063 Ga	10/02/2012	00:19:28	58.1538	-2.77042	46.1
SD063 Gb	10/02/2012	00:26:45	58.154	-2.77027	45.5
SD064 Ga	09/02/2012	23:24:35	58.1537	-2.7341	48.6
SD064 Gb	09/02/2012	23:30:53	58.1537	-2.73446	49.2
SD064 Gc	09/02/2012	23:38:39	58.1541	-2.73427	48.9
SD065 Ga	09/02/2012	22:44:38	58.1538	-2.69844	50.6
SD066 Ga	09/02/2012	20:52:10	58.1535	-2.66317	52.0
SD067 Ga	09/02/2012	20:16:59	58.1535	-2.62734	54.4
SD068 Ga	09/02/2012	19:42:27	58.1536	-2.59115	54.2
SD069 Ga	12/02/2012	16:25:00	58.1723	-2.59121	56.6
SD069 Gb	12/02/2012	16:31:09	58.1719	-2.59099	56.6
SD070 Ga	12/02/2012	17:05:28	58.172	-2.62738	55.1
SD071 Ga	12/02/2012	17:40:43	58.1722	-2.66296	53.8
SD072 Ga	12/02/2012	00:05:42	58.1726	-2.69802	50.4
SD073 Ga	11/02/2012	23:30:20	58.1728	-2.73383	49.3
SD074 Ga	11/02/2012	21:36:56	58.1728	-2.77006	43.5
SD075 Ga	11/02/2012	21:01:49	58.1728	-2.80546	41.4
SD076 Ga	11/02/2012	20:18:03	58.1731	-2.84075	38.2
SD076 Gb	11/02/2012	20:45:05	58.1735	-2.84262	37.6
SD077 Ga	11/02/2012	19:37:21	58.1727	-2.87617	36.7
SD077 Gb	11/02/2012	20:03:38	58.1736	-2.87814	37.5
SD078 Ga	11/02/2012	18:47:07	58.1695	-2.89892	39.6
SD078 Gb	11/02/2012	19:18:53	58.1707	-2.90185	40.6
SD079 Ga	12/02/2012	02:45:14	58.1915	-2.87644	39.4
SD080 Ga	12/02/2012	02:15:06	58.1917	-2.841	45.0
SD081 Ga	12/02/2012	01:45:23	58.1917	-2.80531	45.8
SD082 Ga	12/02/2012	01:13:30	58.1912	-2.76911	48.1
SD083 Ga	12/02/2012	00:43:13	58.191	-2.7344	48.4
SD084 Ga	12/02/2012	18:37:08	58.1916	-2.6988	52.5
SD085 Ga	12/02/2012	19:12:14	58.1912	-2.66237	52.5
SD085 Gb	12/02/2012	19:19:35	58.1913	-2.66319	52.6
SD086 Ga	12/02/2012	20:10:48	58.1915	-2.6267	52.2
SD086 Gb	12/02/2012	20:20:33	58.1917	-2.62712	52.4
SD087 Ga	12/02/2012	21:00:17	58.1912	-2.59115	53.5
SD087 Gb	12/02/2012	21:07:31	58.1909	-2.59093	53.4
SD088 Ga	12/02/2012	22:50:03	58.2102	-2.59074	57.3
SD089 Ga	12/02/2012	23:29:18	58.2102	-2.62636	54.2

Trawl	Date	Time (GMT)	WGS84		Depth (m)
			Latitude	Longitude	
SD090 Ga	13/02/2012	00:03:55	58.2103	-2.66218	53.0
SD090 Ga	29/02/2012	15:41:38	58.2098	-2.66212	53.7
SD091 Ga	29/02/2012	16:16:11	58.21	-2.69783	56.7
SD092 Ga	29/02/2012	17:40:04	58.2106	-2.7341	46.6
SD092 Gb	29/02/2012	18:05:47	58.2116	-2.73504	46.8
SD093 Ga	29/02/2012	18:22:48	58.2105	-2.76981	47.7
SD094 Ga	29/02/2012	19:17:01	58.2103	-2.80539	45.4
SD095 Ga	29/02/2012	19:46:31	58.2105	-2.84155	42.9
SD095 Gb	29/02/2012	19:54:58	58.2106	-2.84022	42.6
SD096 Ga	29/02/2012	20:26:36	58.2294	-2.80484	44.6
SD096 Gb	29/02/2012	20:32:41	58.2289	-2.80467	44.6
SD096 Gc	29/02/2012	20:38:11	58.2295	-2.8059	44.2
SD097 Ga	29/02/2012	21:11:53	58.2293	-2.76851	47.2
SD098 Ga	29/02/2012	21:42:16	58.2292	-2.73375	47.5
SD099 Ga	29/02/2012	23:23:15	58.2293	-2.6978	51.6
SD100 Ga	29/02/2012	23:56:02	58.2291	-2.66184	52.1
SD101 Ga	01/03/2012	00:27:16	58.2289	-2.62573	51.1
SD102 Ga	01/03/2012	00:59:08	58.2291	-2.59127	57.3
SD102 Gb	01/03/2012	01:05:37	58.2291	-2.59031	57.5
SD102 Gc	01/03/2012	01:12:52	58.2287	-2.58986	58.3
SD103 Ga	01/03/2012	01:42:28	58.2479	-2.62688	52.5
SD104 Ga	01/03/2012	02:07:29	58.2475	-2.66281	51.7
SD104 Gb	01/03/2012	02:13:35	58.2481	-2.66177	52.4
SD105 Ga	01/03/2012	02:38:52	58.2481	-2.69775	50.2
SD105 Gb	01/03/2012	02:44:47	58.2476	-2.69778	49.8
SD105 Gc	01/03/2012	02:51:23	58.248	-2.69879	50.2
SD105 Gd	01/03/2012	02:58:34	58.2482	-2.69744	50.2
SD106 Ga	01/03/2012	20:08:00	58.2475	-2.73331	46.1
SD106 Gb	01/03/2012	20:13:47	58.248	-2.73444	45.7
SD106 Gc	01/03/2012	20:19:07	58.2481	-2.73421	45.8
SD106 Gd	01/03/2012	20:24:57	58.2476	-2.73359	46.0
SD106 Ge	01/03/2012	20:30:34	58.248	-2.73383	45.8
SD106 Gf	01/03/2012	20:39:51	58.2489	-2.73518	44.9
SD107 Ga	01/03/2012	19:39:16	58.2479	-2.76975	45.4
SD108 Ga	01/03/2012	19:10:28	58.2683	-2.76511	49.0
SD109 Ga	01/03/2012	18:18:32	58.2667	-2.7335	45.0
SD109 Gb	01/03/2012	18:23:25	58.2669	-2.73444	45.4
SD109 Gc	01/03/2012	18:30:13	58.2671	-2.73424	45.3
SD110 Ga	01/03/2012	17:39:05	58.2663	-2.698	48.8
SD111 Ga	01/03/2012	17:13:04	58.2664	-2.66212	52.1
SD112 Ga	01/03/2012	16:41:23	58.2861	-2.69766	52.4
SD113 Ga	01/03/2012	16:11:00	58.2857	-2.73406	51.1
SD114 Ga	01/03/2012	15:30:18	58.3046	-2.73248	54.8

10.4 Appendix 4 – Raw Data

10.4.1 Sandeel Catch Data

Table 10.5 Sandeels Caught in Dredge Tows by Station, Species, Length and Weight (frozen/wet)

Sample	Date	Species	Common name	Standard Length (mm)	Frozen weight (g)	Wet (defrosted) weight (g)
SD023	03/02/2012	*Ammodytes marinus*	Raitt's sandeel	137	-	6.77
SD023	03/02/2012	*Ammodytes marinus*	Raitt's sandeel	146	-	8.67
SD023	03/02/2012	*Ammodytes marinus*	Raitt's sandeel	115	-	4.15
SD023	03/02/2012	*Ammodytes marinus*	Raitt's sandeel	143	-	7.61
SD023	03/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	141	-	7.71
SD023	03/02/2012	*Ammodytes marinus*	Raitt's sandeel	149	-	8.45
SD023	03/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	180	-	18.27
SD023	03/02/2012	*Ammodytes marinus*	Raitt's sandeel	150	-	8.04
SD023	03/02/2012	*Ammodytes marinus*	Raitt's sandeel	151	-	10.91
SD023	03/02/2012	*Ammodytes marinus*	Raitt's sandeel	145	-	7.96
SD027	03/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	146	9.13	8.74

Sample	Date	Species	Common name	Standard Length (mm)	Frozen weight (g)	Wet (defrosted) weight (g)
SD027	03/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	196	24.74	23.85
SD027	03/02/2012	*Ammodytes marinus*	Raitt's sandeel	146	10.89	8.71
SD027	03/02/2012	*Ammodytes marinus*	Raitt's sandeel	151	9.22	9.96
SD027	03/02/2012	*Ammodytes marinus*	Raitt's sandeel	144	9.32	8.62
SD027	03/02/2012	*Ammodytes marinus*	Raitt's sandeel	135	8.14	7.88
SD028	03/02/2012	*Ammodytes marinus*	Raitt's sandeel	152	10.52	10.08
SD037	06/02/2012	*Ammodytes marinus*	Raitt's sandeel	79	1.30	1.28
SD038	06/02/2012	*Hyperoplus lanceolatus*	Greater sandeel	316	97.00	95.00
SD038	06/02/2012	*Ammodytes marinus*	Raitt's sandeel	120	4.91	4.76
SD042	06/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	164	14.09	13.70
SD050	06/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	198	-	29.70
SD050	06/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	222	-	33.50
SD050	06/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	130	-	6.29
SD050	06/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	160	-	11.78
SD050	06/02/2012	*Ammodytes marinus*	Raitt's sandeel	109	-	3.87
SD050	06/02/2012	*Ammodytes marinus*	Raitt's sandeel	107	-	2.29
SD051	06/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	170	15.21	15.21
SD052	06/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	147	7.08	6.94
SD052	06/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	157	12.05	11.79
SD052	06/02/2012	*Ammodytes marinus*	Raitt's sandeel	130	5.99	5.78
SD052	06/02/2012	*Ammodytes marinus*	Raitt's sandeel	146	7.08	6.77
SD052	06/02/2012	*Ammodytes marinus*	Raitt's sandeel	133	5.17	4.75
SD052	06/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	159	11.90	11.47
SD052	06/02/2012	*Ammodytes marinus*	Raitt's sandeel	131	6.52	6.26
SD052	06/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	150	7.00	6.19
SD052	06/02/2012	*Ammodytes marinus*	Raitt's sandeel	144	10.15	9.74
SD052	06/02/2012	*Ammodytes marinus*	Raitt's sandeel	153	9.63	9.13
SD052	06/02/2012	*Ammodytes marinus*	Raitt's sandeel	137	7.41	7.10
SD052	06/02/2012	*Ammodytes marinus*	Raitt's sandeel	135	7.34	6.86
SD052	06/02/2012	*Ammodytes marinus*	Raitt's sandeel	127	6.07	5.87
SD053	06/02/2012	*Ammodytes marinus*	Raitt's sandeel	116	4.49	4.31
SD055	07/02/2012	*Ammodytes marinus*	Raitt's sandeel	126	5.50	5.37
SD059	07/02/2012	*Ammodytes marinus*	Raitt's sandeel	127	4.08	3.79
SD059	07/02/2012	*Ammodytes marinus*	Raitt's sandeel	123	4.28	4.14
SD059	07/02/2012	*Ammodytes marinus*	Raitt's sandeel	126	4.82	4.49
SD059	07/02/2012	*Ammodytes marinus*	Raitt's sandeel	127	5.12	4.82
SD059	07/02/2012	*Ammodytes marinus*	Raitt's sandeel	139	6.81	6.43
SD059	07/02/2012	*Ammodytes marinus*	Raitt's sandeel	136	6.12	5.73
SD059	07/02/2012	*Ammodytes marinus*	Raitt's sandeel	124	4.95	4.71
SD059	07/02/2012	*Ammodytes marinus*	Raitt's sandeel	127	6.08	5.77
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	137	-	5.53
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	130	-	5.59
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	124	-	4.85
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	131	-	6.32
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	127	-	5.25
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	126	-	5.04
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	136	-	6.66
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	126	-	5.26
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	124	-	5.72
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	126	-	5.25
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	136	-	5.73
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	132	-	6.28
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	128	-	4.52
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	130	-	5.48
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	137	-	7.66
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	138	-	7.44
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	116	-	4.53
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	135	-	6.76
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	104	-	2.90
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	138	-	6.76
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	147	-	8.11
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	131	-	6.05

Sample	Date	Species	Common name	Standard Length (mm)	Frozen weight (g)	Wet (defrosted) weight (g)
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	120	-	3.90
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	138	-	6.70
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	121	-	4.06
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	131	-	4.91
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	131	-	5.27
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	129	-	5.28
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	107	-	3.74
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	116	-	3.68
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	103	-	3.37
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	117	-	3.97
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	145	-	8.26
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	129	-	5.98
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	129	-	5.13
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	130	-	5.86
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	130	-	5.73
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	139	-	5.88
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	123	-	4.28
SD060	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	144	-	0.06
SD061	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	137	5.83	5.42
SD061	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	122	4.38	4.08
SD061	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	166	12.84	13.46
SD061	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	128	5.79	5.35
SD061	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	133	5.91	5.45
SD061	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	130	5.47	5.07
SD061	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	125	5.34	4.78
SD061	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	129	5.99	5.42
SD061	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	140	7.28	6.82
SD061	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	139	7.34	7.00
SD061	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	139	7.94	7.49
SD061	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	68	0.50	0.42
SD064	10/02/2012	*Ammodytes marinus*	Raitt's sandeel	142	7.15	6.80
SD064	10/02/2012	*Ammodytes marinus*	Raitt's sandeel	120	4.49	4.25
SD064	10/02/2012	*Ammodytes marinus*	Raitt's sandeel	134	6.70	6.58
SD064	10/02/2012	*Ammodytes marinus*	Raitt's sandeel	126	5.33	5.05
SD075	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	122	6.34	5.97
SD075	11/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	98	2.13	1.81
SD075	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	127	5.30	4.80
SD075	11/02/2012	*Hyperoplus lanceolatus*	Greater sandeel	271	65.00	65.00
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	135	7.53	6.30
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	142	7.03	6.06
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	146	9.24	8.03
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	132	7.08	5.84
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	149	9.21	8.30
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	130	7.46	6.32
SD076	11/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	146	9.81	8.45
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	109	3.43	2.97
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	115	4.88	3.98
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	115	3.87	3.42
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	142	7.00	6.03
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	132	7.28	6.47
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	132	7.04	6.20
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	141	8.68	7.52
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	114	3.44	3.07
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	114	4.49	3.97
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	124	5.11	4.53
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	124	5.45	4.79
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	139	8.23	7.19
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	134	6.51	5.96
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	126	4.92	4.48
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	125	5.07	4.34
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	110	4.56	3.50
SD076	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	181	33.64	26.66

Sample	Date	Species	Common name	Standard Length (mm)	Frozen weight (g)	Wet (defrosted) weight (g)
SD077	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	136	6.11	5.78
SD077	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	112	3.25	2.97
SD077	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	157	8.89	8.96
SD077	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	105	2.81	2.54
SD077	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	139	6.78	5.99
SD077	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	128	6.84	6.30
SD077	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	124	4.79	4.35
SD077	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	97	2.92	2.51
SD077	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	128	4.86	4.56
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	132	6.10	5.86
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	122	4.06	3.87
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	127	5.38	5.17
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	125	5.53	5.01
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	144	7.51	7.39
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	130	5.35	4.91
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	136	7.24	7.07
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	137	-	7.14
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	71	-	0.79
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	148	-	7.32
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	130	-	5.69
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	131	-	5.87
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	125	-	5.52
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	124	-	4.44
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	126	-	4.64
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	127	-	5.00
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	138	-	5.22
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	141	-	7.83
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	110	-	3.01
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	109	-	2.96
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	146	-	7.49
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	135	-	5.46
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	150	-	7.47
SD078	11/02/2012	*Ammodytes marinus*	Raitt's sandeel	132	-	4.88
SD079	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	115	4.07	3.83
SD079	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	117	3.99	3.86
SD079	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	133	6.19	5.84
SD079	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	138	6.24	5.94
SD079	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	137	7.67	7.41
SD079	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	133	7.65	7.11
SD079	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	124	5.25	4.99
SD079	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	132	7.95	6.99
SD079	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	117	4.78	4.46
SD079	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	127	5.83	5.57
SD079	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	122	4.53	4.30
SD079	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	113	3.98	3.67
SD079	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	133	7.60	7.01
SD079	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	132	6.20	5.76
SD080	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	144	8.57	8.15
SD080	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	155	10.12	9.80
SD085	12/02/2012	*Ammodytes marinus*	Raitt's sandeel	83	0.95	0.84
SD092	29/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	198	27.50	27.34
SD093	06/02/2012	*Ammodytes marinus*	Raitt's sandeel	142	7.00	6.74
SD097	29/02/2012	*Ammodytes marinus*	Raitt's sandeel	130	5.72	5.88
SD097	29/02/2012	*Ammodytes marinus*	Raitt's sandeel	127	4.79	5.14
SD099	29/02/2012	*Ammodytes marinus*	Raitt's sandeel	137	7.70	7.34
SD099	29/02/2012	*Gymnammodytes semisquamatus*	Smooth sandeel	194	22.58	22.14
SD107	01/03/2012	*Ammodytes marinus*	Raitt's sandeel	125	5.20	5.01
SD107	01/03/2012	*Ammodytes marinus*	Raitt's sandeel	126	5.46	5.45
SD107	01/03/2012	*Ammodytes marinus*	Raitt's sandeel	135	6.81	6.61
SD108	29/02/2012	*Ammodytes marinus*	Raitt's sandeel	84	1.59	1.55
SD109	01/03/2012	*Ammodytes marinus*	Raitt's sandeel	132	5.19	5.29
SD109	01/03/2012	*Ammodytes marinus*	Raitt's sandeel	82	1.12	1.07

10.4.2 Particle Size Analysis

Table 10.6 RAW Results of the Particle Size Analysis

Sample Identity	Initial Sample Weight (g) / Fractional Percentage % Retained	31500	16000	8000	4000	2000	1000	500	250	125	63	32	16	8	4	2	1	<1
SD001-F	985.3	0	0.334923	0.081194	0.13194	0.200561	0.300842	0.320898	0.962694	87.16395	6.678692	0.0056	1.4884	0.9821	0.8091	0.5391	0	0
SD002-C	989.1	0	0	0	0.050551	0.04137	0.082739	0.206849	0.744655	83.77368	9.949418	0.1301	1.5871	1.4391	1.1451	0.823	0.0262	0
SD003-B	877.3	0	0	0	0	0.046027	0.023014	0.207123	1.081644	79.67343	13.20986	0.7984	1.4038	1.5949	1.1198	0.8156	0.0263	0
SD004-B	981.3	0	0.163049	0.36686	0.224192	0.391902	0.495034	0.371276	0.886936	89.29177	4.372801	0.0236	1.4555	0.8204	0.7287	0.4079	0	0
SD005-A	1021.2	0	0	0.636506	0.52879	0.615263	0.754194	0.575569	1.170985	89.5506	2.778609	0.0243	1.6017	0.6682	0.6698	0.4255	0	0
SD006-A	1058.9	0	0.207763	0.387194	0.207763	0.395279	0.489393	0.545861	1.769342	90.23646	2.597545	0.0008	1.4201	0.7108	0.6147	0.417	0	0
SD007-A	1086.1	0	0.20256	0.451156	0.552435	0.618117	0.745376	0.963535	3.635982	86.53636	3.017865	0.0211	1.293	0.7944	0.6914	0.4768	0	0
SD008-A	873	0	0.400916	0.114548	0.160367	0.203454	0.316484	0.384302	1.062482	88.47988	5.018532	0.0294	1.3974	1.0167	0.8373	0.5781	0	0
SD009-A	896.5	0	0.490798	0.044618	0.122699	0.314048	0.381344	0.403776	1.390783	88.67365	4.351806	0.0271	1.4855	0.997	0.7733	0.5436	0	0
SD010-A	984.7	0	0.152331	0.071088	0.284351	0.301064	0.501773	0.64227	1.685958	88.59309	4.194824	0.0062	1.6539	0.777	0.7173	0.4189	0	0
SD011-A	1139.2	0	0.114115	0.316011	0.465239	0.593714	0.925495	0.768335	1.623982	90.4715	1.711293	0.0293	1.5478	0.5452	0.5712	0.3169	0	0
SD012-A	1099.1	0	0.145574	0.154672	0.254754	0.46005	0.699276	0.55206	1.067316	92.94849	1.306542	0.0407	1.3163	0.3849	0.4466	0.2227	0	0
SD013-A	1075.7	0	0.027889	0.223111	0.511295	0.566463	0.793048	0.585345	1.038515	91.08718	2.209204	0.1418	1.4858	0.4853	0.5718	0.2732	0	0
SD014-A	992.4	0	0	0.130996	0.130996	0.101164	0.161863	0.404657	1.27467	88.29622	4.329833	0.1176	1.7027	1.3444	1.2054	0.7753	0.0243	0
SD015-A	921.6	0	0.195313	0.412326	0.173611	0.195876	0.282933	0.435281	1.284079	87.29561	4.613979	0.0403	2.4486	1.0499	1.0271	0.5451	0	0
SD016-A	1141.5	0	0.183968	0.262812	0.499343	0.672122	0.844461	0.654888	1.206372	90.13324	2.17147	0.2473	1.6785	0.488	0.6674	0.2901	0	0
SD017-A	1167.6	0	0.282631	0.727989	1.378897	1.689482	1.551565	0.999898	1.758441	87.3876	1.448128	0.2439	1.3616	0.3529	0.5731	0.2439	0	0
SD018-A	1182.7	0	0	0.490403	0.659508	0.714949	1.01423	1.030856	2.111593	89.40186	1.812312	0.364936	1.572709	0.281015	0.418047	0.127593	0	0
SD019-A	1097.7	0	0.464608	0.701467	0.583037	0.815845	1.196573	1.033404	2.574444	87.05972	2.646964	0.084	1.4465	0.4764	0.6238	0.2933	0	0
SD020-A	1086.1	0	0	0.082865	0.294632	0.40847	0.835507	0.891207	1.578179	90.12331	2.599354	0.0344	1.5295	0.6054	0.6769	0.3402	0	0
SD021-A	762.2	0	3.08318	1.062713	21.50354	25.97743	21.17554	4.421412	1.390711	9.4201	2.584623	1.3894	1.9973	2.6127	1.9645	0.8611	0.3041	0.2516
SD022-A	1087.4	0	0	0.533382	0.321869	0.329571	0.878856	1.153498	7.049154	86.71375	1.153498	0.097212	0.830311	0.302242	0.440932	0.195603	0	0
SD023-A	952.6	0	0	0.020995	0.230947	0.602287	1.973008	5.545192	30.13511	57.96491	1.744555	0.240503	0.687022	0.371559	0.383858	0.100057	0	0
SD023-B	1050.2	0	0.933156	0.085698	1.504475	8.01161	19.55886	28.00302	31.40702	8.162063	0.583004	0.6232	0.3032	0.4538	0.328	0.0429	0	0
SD023-C	779.1	0	0	0.141189	4.402516	21.71108	37.93616	25.04925	9.367593	0.698688	0.051755	0.088885	0.136165	0.185302	0.135812	0.057574	0.020373	0.017489
SD024-A	973.7	0	0	0.96539	0.708637	1.087217	1.928273	1.33338	2.605219	85.41837	2.37957	0.1298	1.4108	0.7002	0.8752	0.4581	0	0
SD025-A	1064.8	11.76747	5.231029	5.916604	6.705485	9.677385	11.43859	7.137535	4.504989	23.61875	2.706701	2.2707	2.1346	2.4969	2.2618	1.29	0.5068	0.3346
SD026-A	908.3	0	2.444126	2.124849	4.315755	6.072807	6.094496	2.884583	5.378772	64.93566	1.995351	0.0368	1.4795	0.787	0.9249	0.5253	0	0
SD027-A	979.3	0	0.061268	0.265496	0.275707	0.512063	0.860265	1.679565	7.496596	86.35424	1.003643	0.077669	0.663386	0.241479	0.352287	0.156279	0	0
SD028-A	969.2	0	0	0.020636	0.09286	0.208565	0.729977	1.772802	12.01334	82.98801	0.583982	0.174859	0.563989	0.295366	0.398067	0.15752	0	0
SD029-A	1026	0	0.8577	0.721248	0.984405	0.850425	1.024376	1.546228	9.528629	81.87276	0.831097	0.19613	0.632599	0.331297	0.446492	0.176682	0	0
SD030-A	916.6	0	0	0.174558	0.250927	0.608223	1.281613	1.976725	4.800617	87.10622	1.34678	0.127845	1.091955	0.397483	0.579876	0.257241	0	0
SD031-A	769.9	2.610729	0.675412	1.324847	3.584881	4.573453	5.102176	2.458561	3.780369	70.63738	1.744786	0.2004	1.2114	0.7198	0.8723	0.4885	0.0151	0
SD032-A	1000.6	0	0.189886	0.689586	2.038777	3.459552	3.32117	1.621047	3.538627	79.70808	1.976887	0.2347	1.1888	0.7312	0.88	0.4218	0	0
SD033-A	1238.2	0	0.121144	0.379583	0.565337	0.686838	0.894487	0.862541	2.795271	89.51257	1.517433	0.3518	1.5161	0.2709	0.403	0.123	0	0

Sample Identity	Initial Sample Weight (g) / Fractional Percentage % Retained	31500	16000	8000	4000	2000	1000	500	250	125	63	32	16	8	4	2	1	<1
SD034-A	1060.4	0	0	0.084874	0.075443	0.056008	0.149355	0.448064	1.810927	85.78564	5.43278	0.1936	2.0194	1.5516	1.4632	0.9148	0.0143	0
SD035-A	1128.8	0	1.19596	1.364281	4.163714	4.538049	3.509897	1.435867	5.708014	72.59105	1.081332	0.5033	1.4147	0.9043	1.087	0.5025	0	0
SD036-A	1150.2	0	0.495566	1.095462	3.295079	3.902191	3.366935	2.434553	18.12965	63.47103	0.397126	0.378	1.2	0.6322	0.8205	0.3817	0	0
SD037-A	1171.3	0	0.99889	0.435414	1.72458	1.596977	1.579806	1.511118	8.087918	81.85797	0.789903	0.155897	0.502829	0.263336	0.3549	0.140438	0	0
SD038-A	1170.4	0	1.255981	1.708817	2.998975	3.107928	2.683348	1.987036	10.37674	73.94492	0.543463	0.049472	0.477551	0.311219	0.36104	0.193618	0	0
SD039-A	1261.3	0	0.229922	0.348846	1.339887	1.656429	1.576793	1.321958	9.747446	81.59504	0.700797	0.163112	0.526101	0.275524	0.371325	0.146938	0	0
SD040-A	1293.4	0	0.154631	2.62873	2.852946	3.866101	3.927959	2.505234	12.0777	70.14654	0.494861	0.149033	0.473122	0.249256	0.323497	0.150492	0	0
SD041-A	1182.3	0	4.245961	3.949928	5.80225	4.568059	3.644371	3.459633	17.46611	53.75867	0.957277	0.3366	0.8246	0.3222	0.5241	0.1402	0	0
SD042-A	1187.5	0	0	0.042105	0.202105	0.592056	1.590093	2.38514	27.31915	65.93812	0.558224	0.218454	0.483816	0.289555	0.303248	0.077928	0	0
SD043-A	1274.1	0	0.690684	0.816262	1.318578	1.815516	5.399185	15.59765	53.89713	17.64997	0.741993	0.7917	0.3394	0.5	0.3915	0.0504	0	0
SD044-A	1182.6	0	0.118383	0.160663	0.279046	1.02992	1.58709	1.857233	15.83713	75.64002	1.013036	0.4655	1.8511	0.1609	0	0	0	0
SD045-A	1098.7	0	0.100118	0.318558	0.227542	0.404607	0.956343	1.140255	6.179446	86.58581	0.91956	0.165	1.4093	0.513	0.7484	0.332	0	0
SD046-A	1089.3	0	0.87212	0.156064	0.42229	1.497462	2.49577	3.845335	14.80824	68.95721	2.015104	0.3064	1.6827	1.1447	1.1958	0.6009	0	0
SD047-B	983.3	0	7.179904	1.617004	19.83118	21.34531	26.83001	9.84381	3.724685	4.666089	1.432571	0.4264	0.6944	1.0184	0.7991	0.3575	0.1275	0.1062
SD048-A	1209.8	0	0.281038	0.69433	1.702761	3.073271	3.618529	3.255023	17.67957	65.0509	1.404452	0.2252	1.1482	0.7176	0.783	0.3661	0	0
SD049-A	1101.2	0	0.508536	2.470033	1.752633	2.459044	3.872077	5.560376	25.5447	50.1902	2.073672	1.267	1.1362	1.2184	1.2335	0.6339	0.0797	0
SD050-A	1245.6	1.669878	1.188182	1.035645	3.22736	10.94363	21.95144	18.46938	21.71074	14.26523	1.492313	1.0993	0.8156	1.0176	0.7956	0.3181	0	0
SD050-B	1095.6	1.37824	2.637824	1.496897	5.175246	19.6339	30.32819	19.80013	7.628223	6.427656	1.31139	0.5794	0.8876	1.2079	0.8853	0.3753	0.1328	0.114
SD051-C	1103.9	1.748347	4.103633	5.145394	7.256092	10.29617	8.804497	5.875728	11.09658	38.56515	1.47348	0.6158	1.2873	1.351	1.393	0.7931	0.1947	0
SD052-A	1225.2	0	0	0.21221	0.775384	8.133748	19.3052	33.91275	29.43089	6.672993	0.232393	0.471377	0.229335	0.343246	0.248093	0.032449	0	0
SD053-A	1278.5	0	0	0.04693	0.078217	0.156881	0.502019	2.525782	55.92802	38.95351	0.486331	0.171805	0.317052	0.295365	0.350787	0.181751	0.00564	0
SD054-A	1259.8	0	0	0.039689	0.063502	0.418577	0.643965	2.881742	62.22309	32.23043	0.289784	0.461806	0.197975	0.291655	0.228366	0.029399	0	0
SD055-A	1167.2	0	0	0.077108	0.188485	0.292744	0.516607	1.756463	60.61518	35.12925	0.309964	0.144743	0.267111	0.24884	0.295533	0.153122	0.004751	0
SD056-A	1174.9	0	0	0.025534	0.068091	0.271124	0.64392	1.86398	62.03663	33.55163	0.237234	0.169154	0.312161	0.290808	0.345376	0.178947	0.005553	0
SD057-A	1285.3	0	4.349179	2.824243	4.076869	2.699168	1.788984	1.082806	23.6805	58.00074	0.345242	0.127643	0.405216	0.213481	0.277067	0.128893	0	0
SD058-B	1276.6	0	0	0	0.054833	0.347503	0.963531	2.258768	52.14122	42.71126	0.284321	0.160918	0.296961	0.276648	0.328558	0.170234	0.005282	0
SD059-A	1264.4	0	0	0	0.007909	0.253876	0.507751	3.808134	58.55006	35.47912	0.238008	0.150069	0.276941	0.257998	0.306408	0.158757	0.004926	0
SD060-C	719.7	21.23107	31.05461	13.589	5.432819	2.306517	2.237043	2.278727	6.461025	13.90857	0.458524	0.210448	0.217765	0.272421	0.226085	0.10587	0.009611	0
SD060-E	1257.9	0	0	0.047699	0.572383	3.417019	17.33938	43.8332	29.59297	4.24346	0.095359	0.1119	0.181	0.2089	0.2292	0.1142	0.0134	0
SD061-A	1237.7	0	0	0.048477	0.040398	0.339951	0.938912	4.921191	64.34781	27.69789	0.388515	0.487623	0.209043	0.307959	0.241132	0.031042	0	0
SD061-B	1324	0	9.690332	4.539275	4.18429	2.467548	4.041935	11.39916	44.49156	17.89351	0.317905	0.372172	0.159549	0.235046	0.184041	0.023693	0	0
SD062-G	550.6	29.89466	47.1304	9.589539	1.380312	1.416636	2.106793	2.034145	2.306575	2.724301	0.690156	0.1467	0.1518	0.1899	0.1576	0.0738	0.0067	0
SD063-B	1303.9	0	0	0.191732	0.498504	1.119582	3.747489	12.42425	66.45962	14.07252	0.357644	0.4311	0.184812	0.272262	0.213181	0.027444	0	0
SD064-C	1334.3	0	6.093083	4.774039	11.02451	26.60919	29.24286	8.339967	5.085715	4.888946	0.560034	0.6827	0.707	0.8996	0.6377	0.2754	0.094	0.0853
SD065-A	1321	0	0.12112	0.461771	0.249811	0.686285	3.034905	8.814951	52.93546	31.78263	0.655784	0.480138	0.205834	0.303232	0.237431	0.030566	0	0
SD066-A	1246	0	0	0.24077	0.914928	1.856805	2.405773	3.245372	19.90818	68.6372	0.936476	0.2803	0.6565	0.2957	0.4816	0.1405	0	0
SD067-A	1160	0	0.215517	0.034483	0.163793	0.484819	1.437142	2.164371	21.08963	70.9048	1.177418	0.4029	0.8148	0.385	0.5682	0.1571	0	0
SD068-A	1120	0	0	0.607143	1.160714	2.717024	3.598707	3.184856	7.251395	76.67045	0.773722	0.0418	1.3536	0.9439	1.0789	0.6179	0	0
SD069-B	1253.9	0	0	0.111652	0.159502	0.602166	1.07756	1.188486	12.51872	81.30827	0.649706	0.2622	0.8457	0.4429	0.5969	0.2362	0	0
SD070-A	1061.6	0.546345	4.285983	4.78523	3.636021	1.772123	2.705822	5.221093	12.0047	54.8977	1.619682	1.0787	1.7975	2.0267	2.0001	1.1076	0.3231	0.1916

Sample Identity	Initial Sample Weight (g) / Fractional Percentage % Retained	31500	16000	8000	4000	2000	1000	500	250	125	63	32	16	8	4	2	1	<1
SD071-A	1070.4	0	0.186846	0.906203	1.093049	2.53845	3.365796	3.647846	10.51106	73.18256	1.372643	0.1135	1.0956	0.714	0.8283	0.4442	0	0
SD072-A	1112.2	0	2.076965	1.240784	1.933106	2.752799	4.448232	6.398891	16.82671	61.18142	1.075597	0.1938	0.9103	0.3807	0.4517	0.1289	0	0
SD073-A	1146.2	0	2.233467	4.772291	5.173617	3.736747	5.552736	5.413045	17.04236	53.08276	0.646073	0.3205	0.8611	0.4756	0.5449	0.1447	0	0
SD074-A	1186.6	0	1.837182	5.064891	4.348559	5.241787	10.68846	14.35942	24.97959	31.53609	0.512227	0.363533	0.356371	0.333643	0.289134	0.089019	0	0
SD075-A	1357.6	0	12.33058	5.318209	2.150854	2.081887	4.699117	9.517199	32.4477	29.74125	0.386636	0.116772	0.405324	0.313847	0.330842	0.159816	0	0
SD076-A	1305.7	0	0.612698	1.761507	2.289959	14.35691	38.60761	20.11528	14.80947	6.164109	0.156053	0.3645	0.2114	0.3152	0.2353	0	0	0
SD076-B	1254.5	0	0	0.039857	0.039857	0.502711	2.419297	14.98707	55.72238	24.86849	0.377033	0.398409	0.170797	0.251616	0.197015	0.025363	0	0
SD077-A	1299.2	0	0	0.046182	0.330973	1.30739	7.097258	27.84429	52.56018	9.649781	0.124513	0.396919	0.170158	0.250675	0.196279	0.025268	0	0
SD077-B	1343.2	0	0	0.01489	0.059559	0.81577	2.553057	22.26749	62.9049	10.34819	0.105748	0.355291	0.152313	0.224385	0.175693	0.022618	0	0
SD078-A	1238.2	0	0	0	0.06461	0.195107	1.170642	9.088737	65.89741	21.98206	0.308919	0.493657	0.21163	0.31177	0.244116	0.031426	0	0
SD078-B	1201.8	0	0	0	0.166417	0.301404	0.669788	5.944366	63.29494	28.16457	0.334894	0.429114	0.18396	0.271008	0.212199	0.027318	0	0
SD079-A	1081.5	0	0	0.009246	0.138696	0.741794	5.897259	29.37502	49.51472	13.20393	0.148359	0.370835	0.158976	0.234202	0.18338	0.023608	0	0
SD080-A	1154.6	0	0	0	0.103932	0.454925	1.994671	8.048671	42.67545	44.96757	0.507416	0.162048	0.299046	0.278591	0.330866	0.171429	0.005319	0
SD081-A	1208.1	0	0	0	0.049665	0.353468	1.026741	3.23171	39.06667	54.46779	0.3703	0.186252	0.343713	0.320202	0.380285	0.197035	0.006114	0
SD082-A	1157.8	0	0.086371	0.302297	0.941441	1.09459	1.285709	1.581075	35.84348	56.90131	0.521233	0.187408	0.345847	0.32219	0.382646	0.198258	0.006152	0
SD083-A	1092.5	0	0	0.146453	0.366133	0.779828	1.450842	2.91982	23.10467	69.20518	0.435253	0.275488	0.55713	0.263249	0.388514	0.107419	0	0
SD084-A	1096.7	0	0	0.072946	0.392085	0.662698	1.730378	2.816467	12.51763	79.21082	0.699515	0.356523	1.417745	0.123232	0	0	0	0
SD085-B	858.4	1.887232	3.657968	3.122088	4.869525	3.592082	4.132068	4.296412	9.508452	57.61418	2.019079	0.4019	1.7641	1.3182	1.2192	0.5974	0	0
SD086-B	1178.7	0	2.154916	1.399847	1.934334	3.751133	7.639923	9.291798	25.81055	43.24127	1.084043	0.325	1.1281	0.8735	0.9208	0.4448	0	0
SD087-B	1058.6	0	0	0.047232	0.236161	0.650474	1.8175	4.170685	28.71651	61.12541	1.0905	0.2894	0.8267	0.4471	0.4619	0.1204	0	0
SD088-A	1056	2.026515	2.357955	2.613636	1.979167	2.536216	3.747544	4.599258	28.06872	46.04936	1.627721	0.9379	0.9832	1.0037	0.961	0.4937	0.0145	0
SD089-A	1132.9	0	0	0.017654	0.11475	0.431594	0.683357	0.899154	27.89175	67.11283	0.665374	0.377892	0.764225	0.361103	0.532932	0.147349	0	0
SD090-B	1050.9	0	0	0.532877	1.227519	2.077062	2.480936	3.192522	32.59834	54.50365	0.807746	0.3351	0.6184	0.5761	0.6842	0.3545	0.011	0
SD091-A	934.9	0	0	0.021393	0.224623	0.427526	0.855052	0.897804	21.26941	72.93592	1.218449	0.372077	0.752465	0.355546	0.524731	0.145081	0	0
SD092-A	1122.1	0	0	0	0.026736	0.305594	0.701069	1.905469	47.76255	47.58279	0.449403	0.164529	0.303626	0.282857	0.335933	0.174055	0.005401	0
SD092-B	1227.8	0	0	0.008145	0.12217	0.326865	0.473954	0.866192	60.20851	36.20029	0.522984	0.165101	0.304681	0.28384	0.3371	0.174659	0.00542	0
SD093-A	966.5	0	0.331092	1.407139	0.54837	1.089022	2.052387	4.041947	50.24161	38.30425	0.565454	0.184316	0.34014	0.316874	0.376333	0.194987	0.00605	0
SD094-A	1223.8	14.20167	1.585226	3.047884	0.947867	1.160984	2.487823	4.245885	23.50164	47.28523	0.381466	0.262628	0.235516	0.252554	0.255684	0.131397	0.016521	0
SD095-B	1129.8	1.442733	10.9931	10.13454	3.974155	4.178861	8.179899	13.33679	18.15582	25.58886	1.120291	0.5045	0.665	0.7326	0.6718	0.3123	0.0088	0
SD096-A	1188.4	9.087849	14.91922	6.98418	5.797711	7.24089	11.36417	11.12952	11.36417	18.21955	0.787782	0.5324	0.6816	0.7381	0.7221	0.3827	0.048	0
SD097-A	1203.2	0	0	0	0.024934	0.235743	0.791425	4.984291	70.30208	21.92415	0.454648	0.489953	0.210042	0.309431	0.242284	0.031191	0	0
SD098-A	1141.3	0	0.771051	0.394287	2.689915	9.249504	13.43464	11.00797	29.38388	29.64765	1.002323	0.6142	0.6021	0.5637	0.4885	0.1504	0	0
SD099-A	1183.2	0	0	0.25355	0.540906	1.310374	2.008105	3.335497	35.07377	55.61431	0.544571	0.17135	0.316213	0.294583	0.349859	0.18127	0.005625	0
SD100-A	1170.9	0	0	0.076864	0.324537	2.731353	8.451734	10.49595	19.46304	56.03568	0.532528	0.2022	0.4374	0.4293	0.5349	0.2764	0.0082	0
SD101-A	1212.1	0	0	0	0.082501	0.333187	1.132836	3.448485	52.56024	39.99909	0.849627	0.207104	0.382193	0.35605	0.42286	0.219094	0.006798	0
SD102-C	1115	0	0.430493	0.484305	2.035874	4.809905	7.359516	6.708551	30.61342	42.87325	1.374258	0.5715	0.8692	0.8023	0.7268	0.3407	0	0
SD103-A	798.4	0	0	0.07515	0.964429	2.653583	5.585161	7.910206	24.53933	53.45075	1.213067	0.5902	1.173	0.859	0.7498	0.2363	0	0
SD104-B	1159.9	0	4.845245	5.560824	7.845504	11.73601	15.26551	9.180168	8.554248	33.45198	0.886721	0.2068	0.7914	0.6895	0.6542	0.3228	0.0091	0
SD105-D	1104.8	0	0	0	0.027154	0.164251	0.839505	2.226513	26.26191	68.56566	0.474503	0.249286	0.50414	0.23821	0.351562	0.097202	0	0
SD106-F	1095.3	0	0.109559	0.209988	0.739523	1.288285	3.662411	12.34913	58.17528	21.80883	0.49691	0.443054	0.189936	0.279812	0.219093	0.028205	0	0

Sample Identity	Initial Sample Weight (g) / Fractional Percentage % Retained	31500	16000	8000	4000	2000	1000	500	250	125	63	32	16	8	4	2	1	<1
SD107-A	1219.6	0	0	0	0.032798	0.21393	0.740526	3.488699	68.78662	24.9804	0.460772	0.49507	0.212236	0.312663	0.244815	0.031516	0	0
SD108-A	1114.4	0	0	0	0.053841	0.091174	0.528809	2.078766	23.63228	71.20684	0.674687	0.300029	0.60676	0.286699	0.423124	0.116988	0	0
SD109-C	1177.6	0	0	0	0.059443	0.137667	1.101338	6.212236	52.64053	38.23709	0.378585	0.160216	0.295666	0.275442	0.327126	0.169491	0.005259	0
SD110-A	1163.5	0	0	0	0.120327	0.401872	1.817162	6.674574	35.0852	54.07803	0.45429	0.177794	0.328105	0.305662	0.363016	0.188087	0.005836	0
SD111-A	1099.6	0	4.074209	4.046926	6.993452	9.824067	20.43773	15.9205	14.94727	21.41096	0.679421	0.2916	0.5475	0.3922	0.3438	0.0904	0	0
SD112-A	967.3	0	0.093042	0.062028	0.144733	0.894564	2.371636	5.596228	25.0686	62.93156	0.624115	0.4518	0.9888	0.3438	0.4291	0	0	0
SD113-A	1034.1	0	0	0	0.087032	0.351728	0.879319	2.950605	40.1165	53.28675	0.625294	0.221226	0.408255	0.380329	0.451695	0.234033	0.007262	0
SD114-A	837.5	0	0	0.107463	0.191045	0.652217	2.077432	3.961615	27.82793	60.72866	1.01456	0.5472	1.2119	0.7253	0.7596	0.1952	0	0

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