

The logo for Moray East Offshore Windfarm features a large, stylized sun or gear-like graphic in the background, composed of light blue and white segments. The text 'MORAY EAST' is in a bold, dark blue sans-serif font, with the 'O' in 'MORAY' containing a small blue circle. Below it, 'OFFSHORE WINDFARM' is in a smaller, light blue sans-serif font.

MORAY EAST

OFFSHORE WINDFARM

A series of overlapping, wavy lines in shades of blue and teal, creating a sense of movement and depth, positioned above the dark teal background.

Sandeel Survey Report

Offshore Commercial Fisheries

September 2024

Moray Offshore Windfarm (East) Limited

Produced by Brown and May Marine Ltd on behalf of Moray Offshore WindFarm (East) Limited	
	
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List of Abbreviations

BGS	British Geological Society
BMM	Brown & May Marine
BOWL	Beatrice Offshore Windfarm Ltd
CPUE	Catch Per Unit Effort
EGNOS	European Geostationary Navigation Overlay Service
g	Gram
ICES	International Council for Exploration of the Seas
m	Metre
Moray East	Moray Offshore Windfarm (East) Limited
mm	Millimetre
MD	Marine Directorate
MORL	Moray Offshore Renewables Limited
MSS	Marine Scotland Science
MD-LOT	Marine Directorate Licensing and Operations Team
PEMP	Project Environmental Monitoring Programme
PSD	Particle Size Distribution
SD	Sandeel Dredge
STCW	Standards of Training, Certification and Watchkeeping for Seafarers
TAC	Total Allowable Catches
t	Tonnes (metric)

Definitions

- **Moray Offshore Windfarm (East) Limited** - formerly known as Moray Offshore Renewables Limited and hereinafter referred to as Moray East.
- **The Moray East site** - the area in which the Moray East Offshore Wind Farm will be located. Section 36 Consents and associated Marine Licences to develop and operate up to three generating stations on the Moray East site were granted in March 2014. At that time the Moray East site was known as the “Eastern Development Area” and was made up of three sites known as the Telford, Stevenson and MacColl Offshore Wind Farm sites. The Section 36 Consents and Marine Licences were subsequently varied in March 2018;
- **Telford, Stevenson and MacColl wind farms** – these names refer to the three consented offshore wind farm sites located within the Moray East site;

Moray East Offshore Wind Farm Consents – are comprised of the following:

- Section 36 Consents:
 - Section 36 consent for the Telford Offshore Wind Farm (as varied) – consent under section 36 of the Electricity Act 1989 for the construction and operation of the Telford Offshore Wind Farm assigned to Moray East on 19 June 2018.
 - Section 36 consent for the Stevenson Offshore Wind Farm (as varied) – consent under section 36 of the Electricity Act 1989 for the construction and operation of the Stevenson Offshore Wind Farm assigned to Moray East on 19 June 2018.
 - Section 36 consent for the MacColl Offshore Wind Farm (as varied) – consent under section 36 of the Electricity Act 1989 for the construction and operation of the MacColl Offshore Wind Farm assigned to Moray East on 19 June 2018.
- Marine Licences
 - Marine Licence for the Telford Offshore Wind Farm (as varied) – Licence Number: 04629/19/0 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area transferred to Moray East on 19 July 2018.
 - Marine Licence for the Stevenson Offshore Wind Farm (as varied) – Licence Number: 04627/19/0 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area transferred to Moray East on 19 July 2018.
 - Marine Licence for the MacColl Offshore Wind Farm (as varied) – Licence Number: 04628/19/0 (as varied) - consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area transferred to Moray East on 19 July 2018.
- **OfTI Licences** – These licences have now been transferred to the OfTO and are comprised of the following:
 - Marine Licence for the Offshore Transmission infrastructure – Licence Number 05340/19/0 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction works and deposits of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area (referred to as the “OfTI Marine Licence”).

- Marine Licence for two additional distributed OSPs – Licence Number 06347/19/0 – consent under the Marine (Scotland) Act 2010 & Marine and Coastal Access Act 2009, Part 4 marine licensing for marine renewables construction, operation and maintenance works and the deposit of substances or objects in the Scottish Marine Area and the United Kingdom Marine Licensing Area (referred to as the “OSP Marine Licence”).

Executive Summary

This Post-construction Sandeel Survey Report has been prepared by Moray Offshore Windfarm (East) Ltd (Moray East) to inform the Project Environmental Monitoring Programme (PEMP) required as part of Section 36 Consents. This report describes the post-construction element (in relation to sandeel) of condition 26 (Telford, Stevenson and MacColl Offshore Wind Farms) of the PEMP and condition 35 (Stevenson Offshore Wind Farm) and 34 (MacColl Offshore Wind Farm) in regard to post-construction survey requirements.

The objective of this survey was to collect data to characterise the spatial distribution and abundance of sandeel in and around the Moray East site. The survey methodology was designed in consultation with Marine Scotland Science (MSS) and Marine Directorate Licensing and Operations Team (MD-LOT) and the sandeel survey took place between 17 March 2024 to the 31 March 2024. A total of 28 stations were sampled using a modified shellfish dredge (sandeel dredge) carried out during night hours when the majority of sandeel were expected to be buried in the sediment. Grab sampling for sediment analysis was successfully undertaken at 21 grab stations via mini-Hamon grab.

The results of the sandeel survey indicate an overall patchy distribution of sandeel across the Moray East Sandeel Survey Area. Sandeel were caught in low numbers with a total of 45 sandeel caught across 15 out of 28 stations sampled.

Four species of sandeel (*Ammodytidae*) were caught during the survey in order of abundance:

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

The highest numbers of sandeel were found in dredge samples from the northern areas of the Sandeel Survey Area. Raitt's sandeel was the most abundant species caught (37 individuals), accounting for 77% of the total sandeel catch. A total of five smooth sandeel (10%), two lesser sandeel (4%), and one greater sandeel (2%) were recorded. The greatest number of individuals (11) were recorded at station SD76 (in the north of the site).

Low numbers of sandeel were recorded in both the pre and post-construction surveys, suggesting that the Sandeel Survey Area does not support important sandeel populations.

1 Introduction

This Post-construction Sandeel Survey Report has been commissioned by Moray Offshore Windfarm (East) Limited (Moray East) to inform the Project Environmental Monitoring Programme (PEMP) required as part of the Section 36 Consents for the Telford, Stevenson and MacColl Offshore Wind Farms (together forming the Section 36 Consents).

This report is submitted in accordance with the following Moray East Section 36 Consent Conditions

- Section 36 Condition 26 (Telford, Stevenson and MacColl Offshore Wind Farms) in relation to sandeel monitoring surveys;
- Section 36 Condition 34 (MacColl Offshore Wind Farm); and
- Section 36 Condition 35 (Stevenson Offshore Wind Farm).

This report has been prepared by Brown and May Marine Ltd (BMM).

This report details the findings of the sandeel survey undertaken between 17 March 2024 and 31 March 2024 in the vicinity of the Moray East site, providing an assessment of the spatial abundance and distribution of sandeel within the defined “Sandeel Survey Area”.

The survey methodology was previously agreed with Marine Scotland Science (MSS) and Marine Directorate Licensing and Operations Team (MD-LOT) in January 2019. The sampling area was agreed with MSS with the “Sandeel Survey Area” defined within the Moray East Section 36 Consents for the Stevenson and MacColl Offshore Wind Farms in regard to post-construction survey requirements.

A Marine Directorate (MD) derogation to catch and land undersized and out of quota fish utilising specified cod end mesh sizes was granted prior to the commencement of the survey, in accordance with the terms of Section 9 of the Sea Fish Conservation Act 1967 and Article 43 of Council Regulation No. 850/98.

Following discussions with the MD Access to Fisheries teams, the landing obligation (i.e. discard ban) was not derogated against through allocation of scientific Total Allowable Catch (TAC). Instead, the species caught were either landed against the survey vessel’s quota, or discarded at sea, as required by the landing obligation. The text within the MS derogation is given below:

“•All quota species subject to the landing obligation must be landed and will be recorded against the uptake of the vessels PO¹.

•Electronic logbooks and landing declarations are to be completed and returned as per regular voyages”.

A summary of the Health and Safety performance of the survey is provided in Appendix 1.

¹ Producers Organisation

2 Scope of works

The scope of works for the sandeel survey is detailed below. The location of the Sandeel Survey Area and sampling stations, along with the sandeel dredging and grab sample locations, are illustrated in Figure 2-1.

It should be noted that the Sandeel Survey Area includes sampling locations within Moray West, an adjacent offshore wind farm that is currently under construction. Some stations were relocated from the pre-construction position to avoid wind farm infrastructure (e.g. turbines and cables). The pre-construction sampling locations were plotted against the operational Moray East offshore wind farm and the in construction Moray West infrastructure. If a dredge station was considered to be too close to a turbine or subsea cable (within 250 m and 100 m, respectively), the station was moved to the nearest feasible location.

The scope of works included:

- Sandeel Dredge Sampling:
 - 29 tows of approximately 250 m.
 - Number of individuals, catch per unit effort (CPUE) per species;
 - Length (mm) distribution by species; and
 - Weight (g) distribution by species.
- Grab Sampling:
 - 29 grabs.
 - Particle Size Distribution (PSD) analysis.

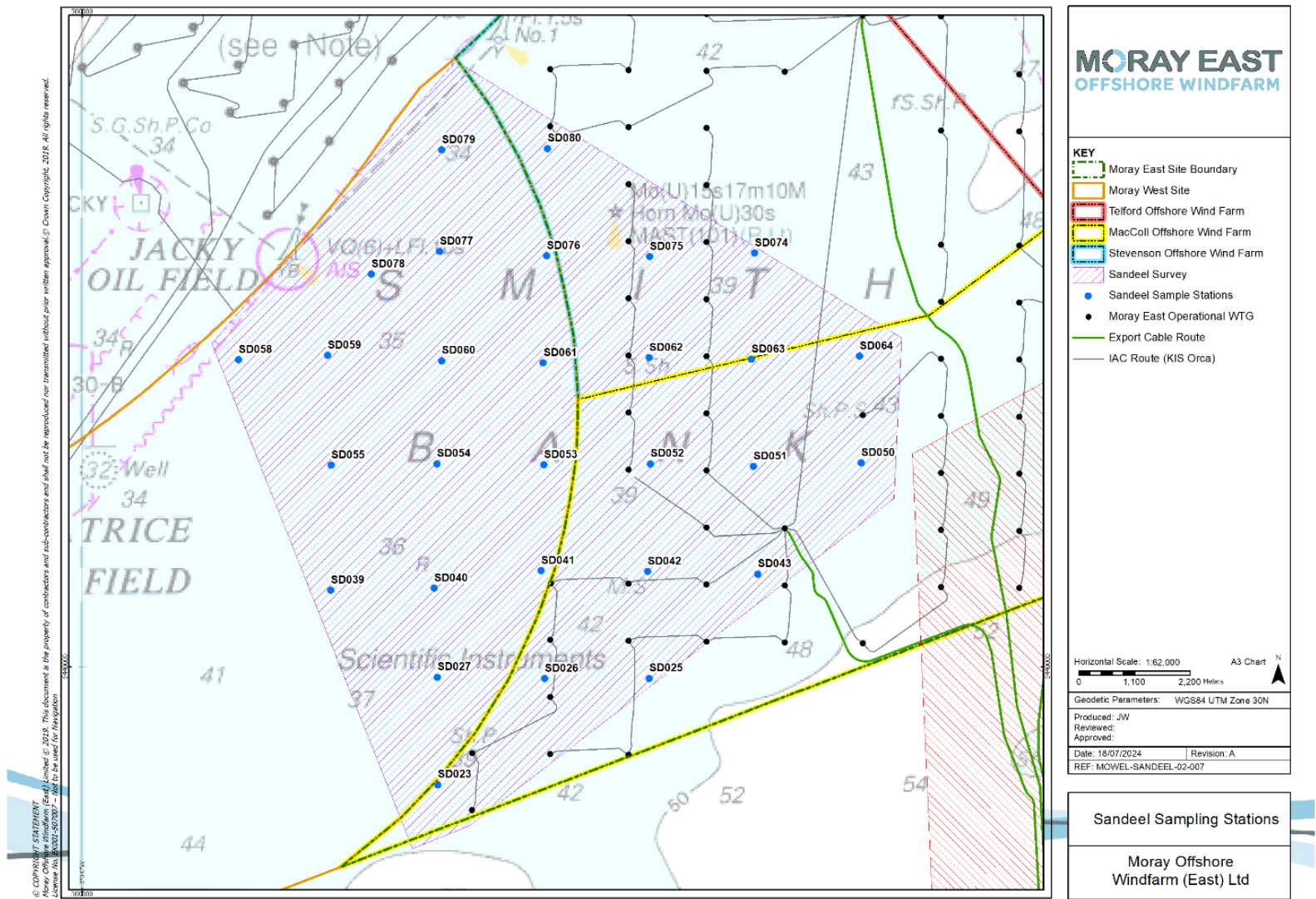


Figure 2-1: Sandeel Survey Area and proposed sampling stations

3 Survey Methodology

The survey methodology, including the Sandeel Survey Area, was designed in consultation with MSS and MD-LOT and included both sandeel dredge sampling and grab sampling. Dredging was used as a means of recording the presence and relative abundance of sandeel, whilst grabbing was undertaken as a means of obtaining site specific information on the distribution of sediment types across the Sandeel Survey Area.

Sandeel 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, sandeel remain buried in the sediment until April. The sandeel dredge sampling was undertaken at night from 17th March 2024 to 19th March 2024 when the majority of sandeel were expected to be buried in the sediment.

Grab sampling was undertaken during daylight hours from 30th March 2024 to 31st March 2024.

3.1 Survey Vessel

The vessel chartered for the survey, the fishing vessel (FV) "Reaper" (Figure 3-1), is a Wick-based commercial trawler. The specifications of the vessel are given in Table 3-1.



Figure 3-1: Survey vessel "FV Reaper"

Table 3-1: Survey vessel (FV Reaper) specifications

Survey Vessel Specifications	
Length	16.75 m
Beam	7.0 m
Draft	4.2 m
Main Engine	650HP Cat, 8 berths
GPS	2 x Furuno GP-39
Plotters	2 x Soden, 1 x Furuno MaxSEA TIMEZERO (with wassp/3D mapping)
Sounder	1 x WASP Furuno and 1 x JRC
Net sensors	Simrad TV80 Data Logging

3.2 Sandeel Sampling Gear

As used for the previous sandeel surveys (2019), a modified 1.24 m shellfish dredge with a fixed tooth bar (6" teeth) 10 mm mesh and a 6 mm mesh cod-end liner was used for sampling (Figure 3-2). The specifications of the gear used are given in Table 3-2. The dredges, steel bellies and nets were manufactured using the specifications obtained from a meeting held with MSS's gear technician, who is responsible for constructing the sandeel dredges used by MSS for their North Sea Sandeel Surveys (NSSS).



Figure 3-2: Modified 1.24 m shellfish dredge used

Table 3-2: Modified 1.24 m shellfish dredge specifications

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

3.3 Sediment Sampling Gear

A 0.1 m² mini-Hamon grab was used for the collection of sediment samples (Figure 3-3). 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.

A grab sample was taken within a 50 m radius of the start point of each dredge tow and stored for PSD analysis to UKAS accreditation.



Figure 3-3: 0.1 m² Mini-Hamon Grab

3.4 Sampling Procedures

The survey was undertaken during the second half of March 2024 (from 17th to 19th and from 30th to 31st, for dredge and grab sampling, respectively). A summarised log of events is given in Appendix 2. 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. Dredge tows were completed against the direction of the tide where possible.

3.4.1 Sandeel Dredge Sampling

Of the 29 planned tows within the Sandeel Survey Area, a total of 28 sampling locations were able to be completed. The station omitted, SD39, could not be sampled due to the Moray West construction restrictions around inter-array cable works. The sandeel dredge tow tracks are given in Figure 3-4.

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

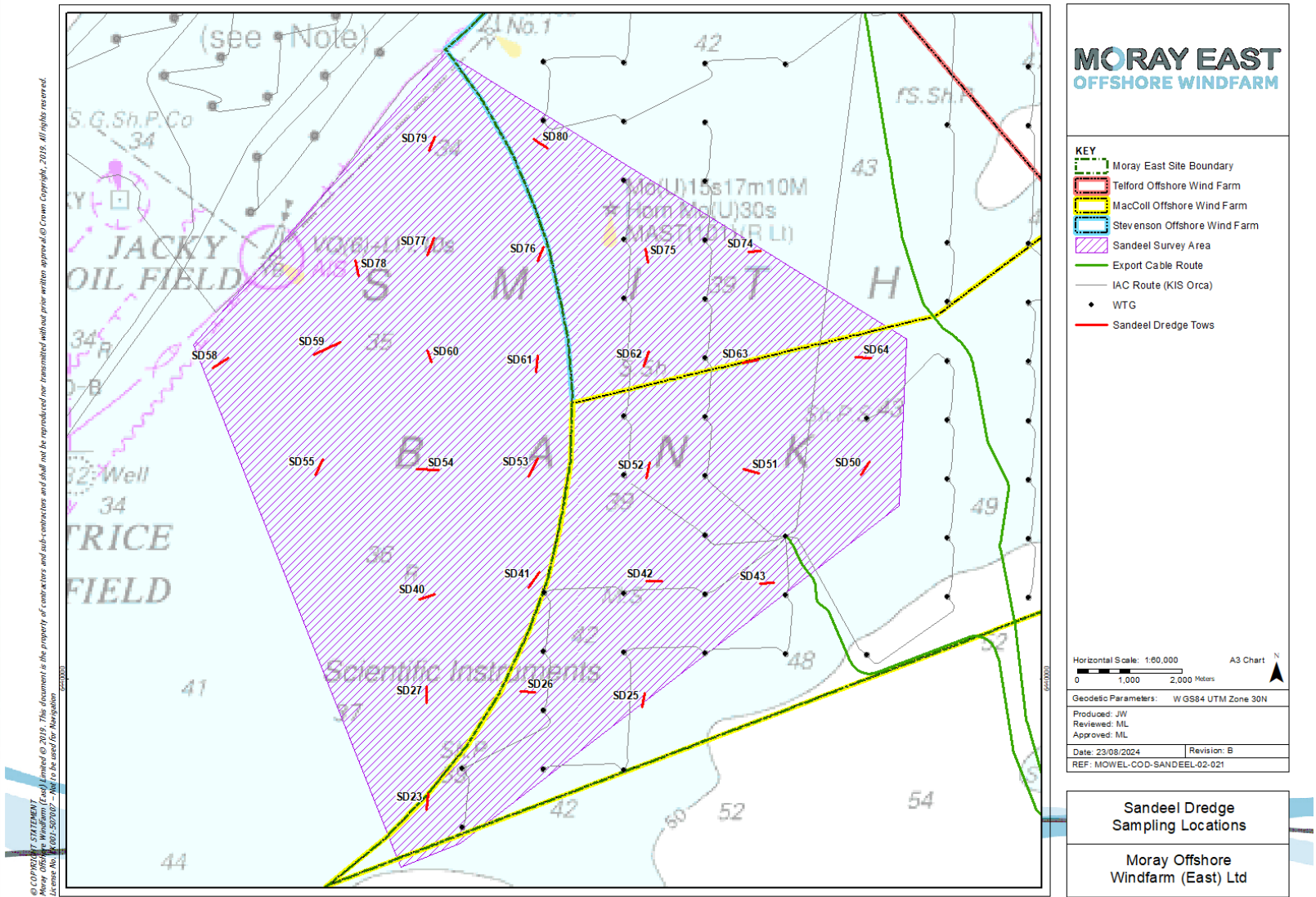


Figure 3-4: Sandeel dredge tows

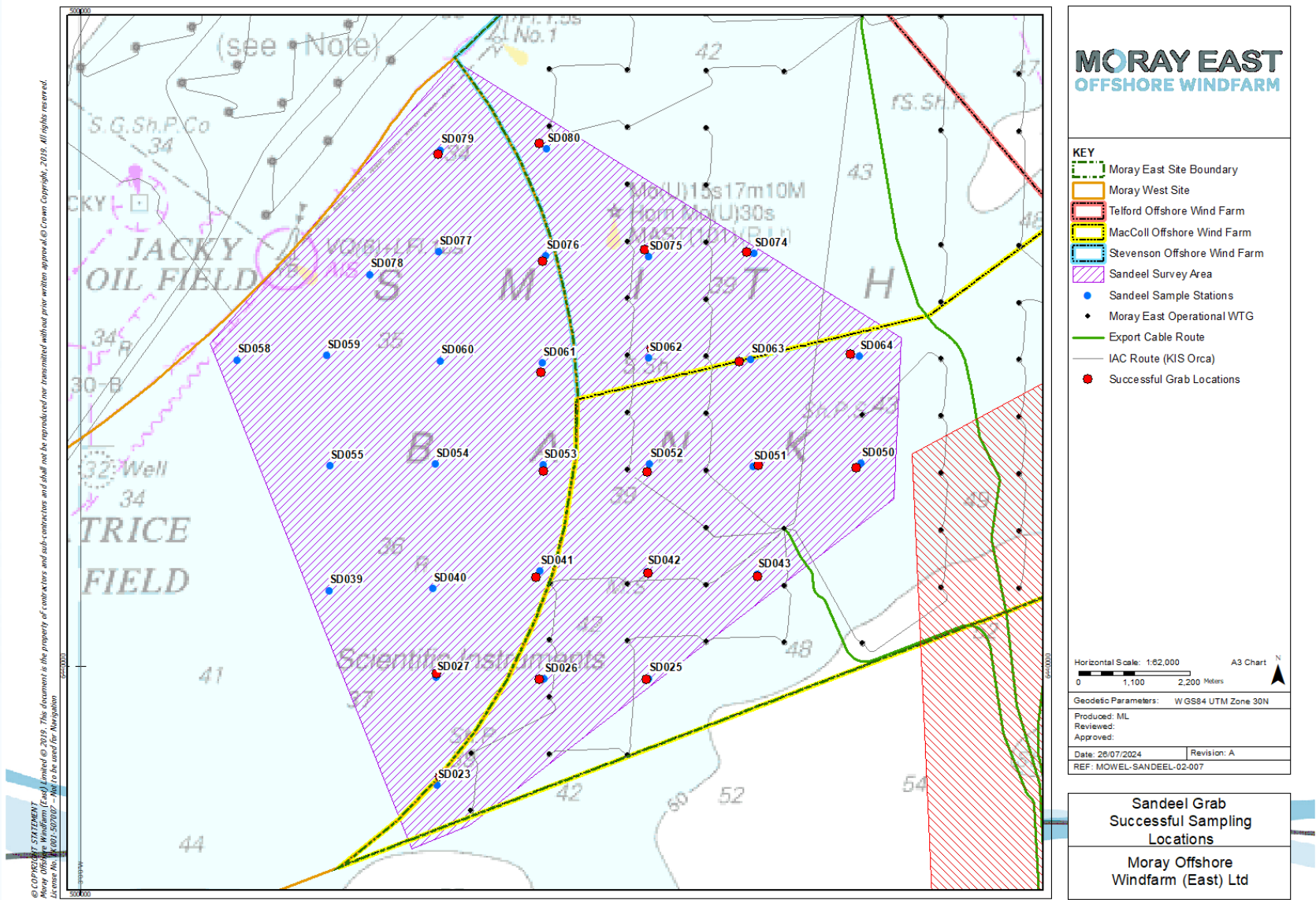
3.4.2 *Grab Sampling*

Grab sampling and subsequent sample analysis was undertaken by Envision during daylight hours from 30th March 2024 to 31st March 2024. Grab sampling was successfully undertaken at 21 of the 29 planned grab stations. The location of the grab stations sampled is shown in Figure 3-5.

A maximum of five attempts were made to sample each grab station, with any indication of mechanical malfunction of the grab mechanism deemed as a failed deployment and taken again. If no sample was retained after five attempts, the station was deemed unsuitable for sampling. Sample collection was unsuccessful at two stations (SD040 and SD077). One station (SD058) was not sampled due to time constraints and the distance to the sample location which was agreed by on-site representatives. Stations SD039, SD054, SD055, SD059 and SD078 were not sampled due to ongoing construction operations taking place at Moray West which prevented access to the sampling locations.

Samples were emptied into a box and photographed. Notes were 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 PSD analysis.

One station, SD51, had a sample size of approximately 500 ml, after the maximum number of attempts were undertaken. This sample was determined to be sufficient, following confirmation from the third-party laboratory that PSD analysis could still be carried out on this sample volume.



3.4.3 Position and Navigation

The position of the vessel was tracked at all times using a Garmin GPSMap 27CX with a European Geostationary Navigation Overlay Service (EGNOS) differential connected to an external Garmin GA30 antenna.

During grab sampling, horizontal positioning quality control was adhered to through use of navigation software and position fixes were taken when the grab was on-bottom. The coordinates of each grab are given in Appendix 3.

3.5 Sample Analysis

3.5.1 Sandeel dredge

In addition to the analysis of sandeel abundance and distribution by species and by station, the CPUE was calculated by area (m^2 ; density) for each sandeel species by station. Any damaged or partial sandeel e.g. tails, were not included in the analysis.

The sandeel density (n/m^2) for each sample was calculated by dividing the total number of sandeel caught by the swept area (dredge width; 1.24 m, multiplied by tow track length in metres):

$$\frac{\text{Total number of sandeels}(n)}{\text{area swept } (m^2)}$$

3.5.2 Grab

Grab samples 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.

4 Survey Results

4.1 Sandeel Abundance and Distribution

Sandeel were caught in low numbers during the post-construction survey with a total of 45 sandeel recorded during the dredge survey. Sandeel were only recorded at 15 out of 28 sandeel dredge stations sampled, with a maximum of 11 individuals caught at a single station (SD76). While sandeel distribution was patchy across the Sandeel Survey Area, higher abundance of sandeel were recorded at more stations in the northern extents of the Sandeel Survey Area (Figure 4-1; Figure 4-2). It should be noted that the second highest abundance however was recorded in a southerly station (SD23; ten individuals caught).

Three sandeel tails were also caught, however these have not been included in the analysis as they could not be identified to species level.

Four species of sandeel (Ammodytidae) were caught during the survey in order of abundance:

- Raitt's sandeel;
- Lesser sandeel;
- Smooth sandeel; and
- Greater sandeel.

The most abundant species caught during the survey was Raitt's sandeel (37 individuals), accounting for 77% of the total sandeel catch. Five smooth sandeel (10%), two lesser sandeel (4%), and one greater sandeel (2%) were recorded. A summary of the sandeel abundance by species is given in Table 4-1.

The majority of smooth sandeel caught during the survey were recorded at one station in the southern extent of the Sandeel Survey Area (SD23; four individuals caught). The CPUE by area (number of individuals caught per m²), is given in Table 4-1 for each species. The CPUE by species and station is given in Table 4-2. Please note that this only shows the stations where sandeel were caught. The raw data is provided in Appendix 4.

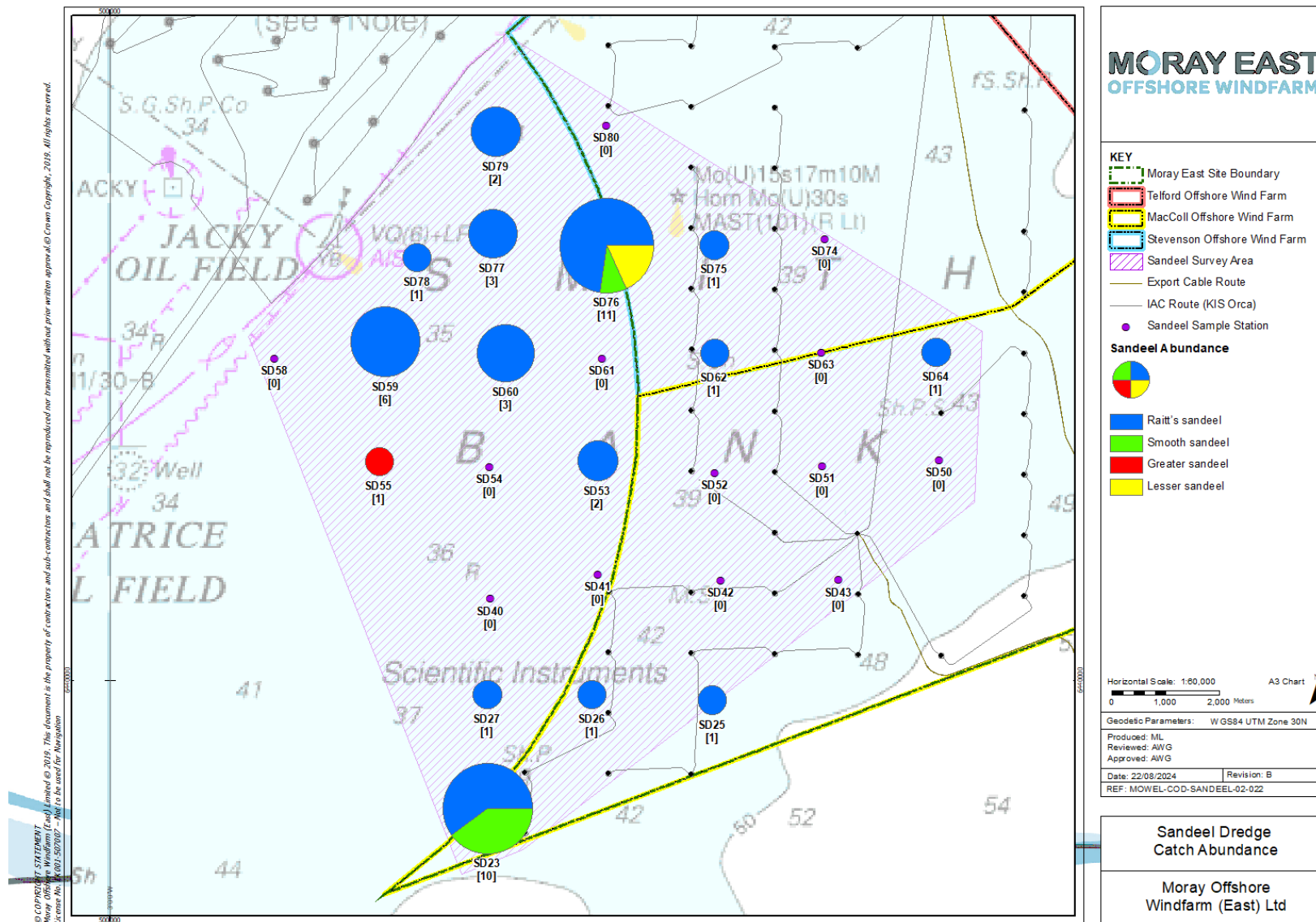


Figure 4-1: Spatial distribution of sandeel caught during the survey (abundance is given in brackets below each station)

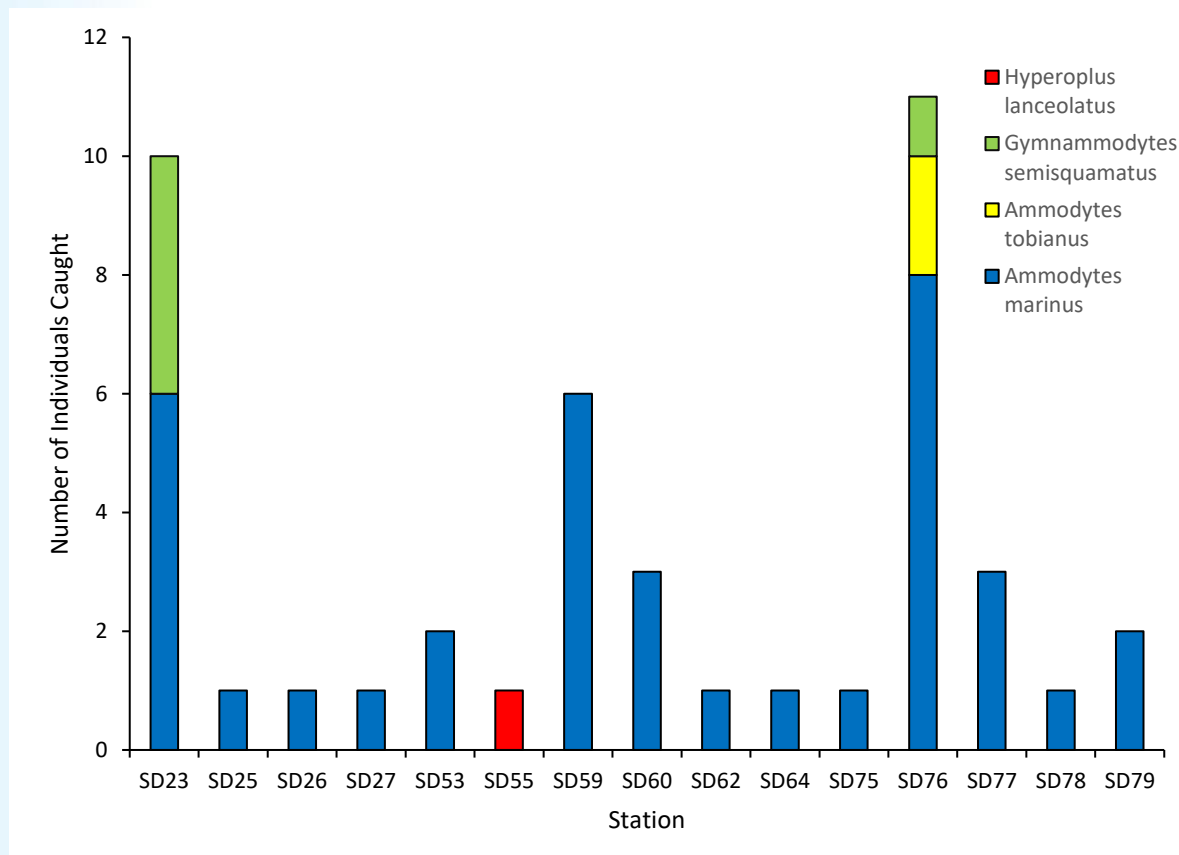


Figure 4-2: Number of individuals caught by station

Table 4-1: Total numbers of individuals caught by species

Sandeel Species		Number of Individuals Caught
Common Name	Scientific Name	Sandeel Survey Area
Raitt's sandeel	<i>Ammodytes marinus</i>	37
Lesser sandeel	<i>Ammodytes tobianus</i>	2
Smooth sandeel	<i>Gymnammodytes</i>	5
Greater sandeel	<i>Hyperoplus lanceolatus</i>	1
Total		45

Table 4-2: Sandeel catch results by station

Station	Sandeel Species (<i>Ammodytidae</i> spp.)				Total Number of Sandeel	Total Sandeel Density by Station (n/m ²)
	Raitt's sandeel (<i>Ammodytes marinus</i>)	Lesser sandeel (<i>Ammodytes tobianus</i>)	Smooth sandeel (<i>Gymnammodytes semisquamatus</i>)	Greater sandeel (<i>Hyperoplus lanceolatus</i>)		
SD23	6	0	4	0	10	0.0254
SD25	1	0	0	0	1	0.0030
SD26	1	0	0	0	1	0.0028
SD27	1	0	0	0	1	0.0027
SD53	2	0	0	0	2	0.0047
SD55	0	0	0	1	1	0.0025
SD59	6	0	0	0	6	0.0086

Station	Sandeel Species (<i>Ammodytidae spp.</i>)				Total Number of Sandeel	Total Sandeel Density by Station (n/m ²)
	Raitt's sandeel (<i>Ammodytes marinus</i>)	Lesser sandeel (<i>Ammodytes tobianus</i>)	Smooth sandeel (<i>Gymnammodytes semisquamatus</i>)	Greater sandeel (<i>Hyperoplus lanceolatus</i>)		
SD60	3	0	0	0	3	0.0128
SD62	1	0	0	0	1	0.0026
SD64	1	0	0	0	1	0.0026
SD75	1	0	0	0	1	0.0029
SD76	8	2	1	0	11	0.0294
SD77	3	0	0	0	3	0.0066
SD78	1	0	0	0	1	0.0027
SD79	2	0	0	0	2	0.0084

4.2 Sandeel Length Distribution

The length range (mm) by species is given below in Table 4-3. The length distributions of Raitt's sandeel, expressed as number of individuals caught, by length (mm) is shown in Figure 4-3. Length distribution charts have not been produced for smooth sandeel, lesser sandeel, and greater sandeel given the very low numbers of individuals caught (five, two and one, respectively).

The greatest numbers of Raitt's sandeel caught were between 110 and 119 mm in length. The two lesser sandeel caught had lengths of 119 mm and 123 mm respectively. Each of the five smooth sandeel recorded fell within a different length category ranging from 72 mm to 210 mm. The single greater sandeel caught in the survey had a length of 235 mm.

Table 4-3: Length ranges by species

Species		Length Range (mm)	
Common Name	Scientific Name	Minimum	Maximum
Raitt's sandeel	<i>Ammodytes marinus</i>	54	182
Lesser sandeel	<i>Ammodytes tobianus</i>	119	123
Smooth sandeel	<i>Gymnammodytes semisquamatus</i>	72	210
Greater sandeel	<i>Hyperoplus lanceolatus</i>	235	235

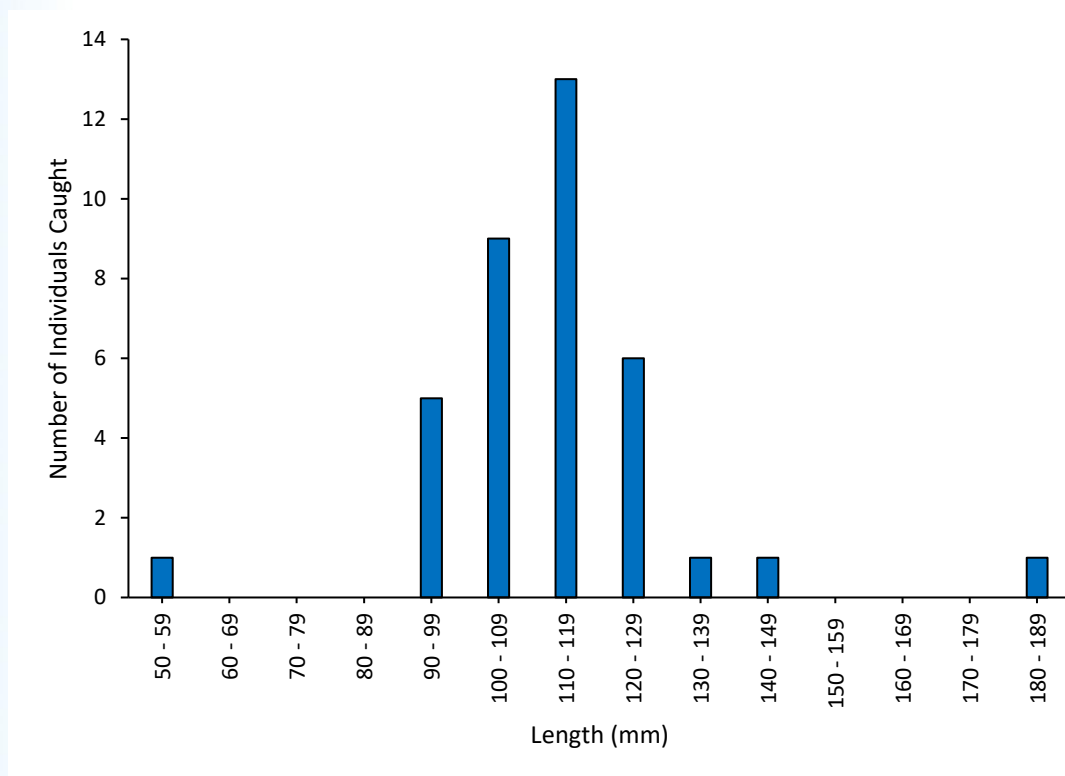


Figure 4-3: Raitt's sandeel length distribution

4.3 Wet (defrosted) Weight Distribution

The wet (defrosted) weight range (g) by species is given below in Table 4-4. The weight distribution of Raitt's sandeel caught during the survey, expressed as the number of individuals by wet (defrosted) weight (g), are shown in Figure 4-4.

The greatest numbers of Raitt's sandeel caught had a wet weight of between 3.0 and 3.9 g. The two lesser sandeel caught had wet weights of 3.89 g and 4.89 g respectively. The five smooth sandeel caught fell within different weight classes, ranging from a wet weight of 0.52 g and 27.27 g. The single greater sandeel caught during the survey had a wet weight of 39.79 g.

Table 4-4: Wet (defrosted) Weight (g)

Species		Wet (defrosted) Weight (g)	
Common Name	Scientific Name	Minimum	Maximum
Raitt's sandeel	<i>Ammodytes marinus</i>	0.35	16.51
Lesser sandeel	<i>Ammodytes tobianus</i>	3.89	4.89
Smooth sandeel	<i>Gymnammodytes semisquamatus</i>	0.52	27.27
Greater sandeel	<i>Hyperoplus lanceolatus</i>	39.79	39.79

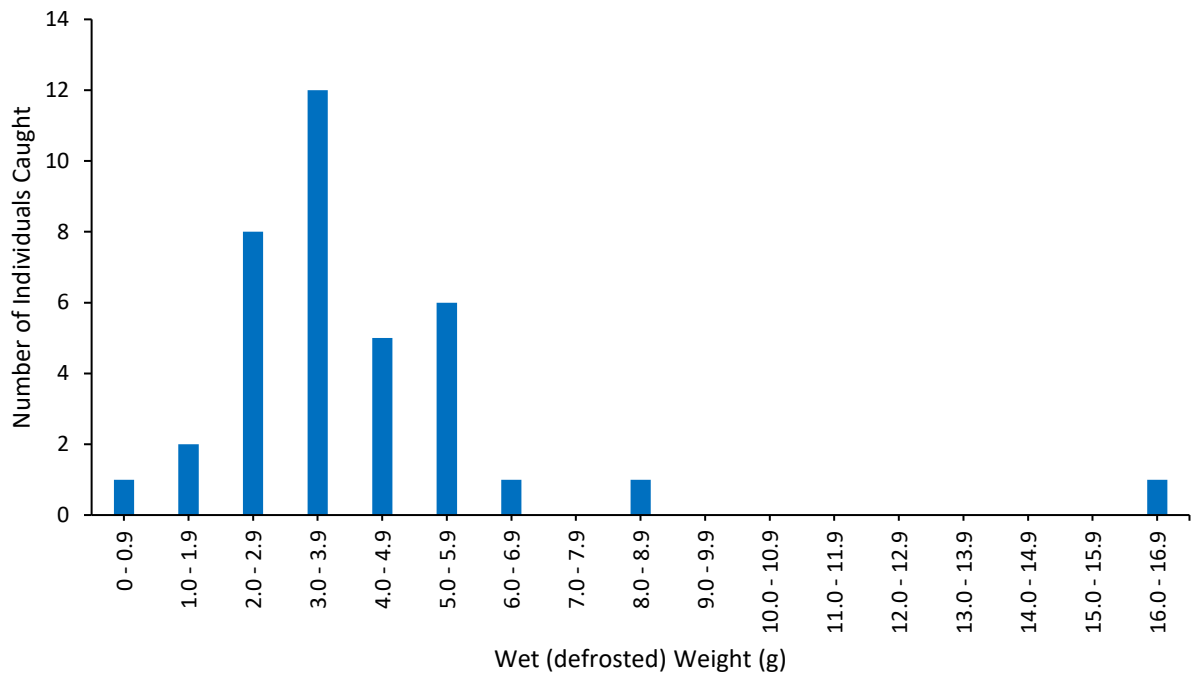


Figure 4-4: Raitt's sandeel wet (defrosted) weight distribution

5 Grab Sampling Results

5.1 Sediment Sample Analysis

For the purpose of the sediment sample analysis, the PSD data were rearranged into sediment categories as given in Greenstreet *et al.* (2010):

- Coarse Sands (particle size $\geq 250 \mu\text{m}$ to $< 2 \text{ mm}$); and
- Silt and Fine Sands (particle size $< 250 \mu\text{m}$).

Greenstreet *et al.*'s (2010) definitions of these two sediment categories were based on the results of Holland *et al.*'s (2005) study, during which 2,885 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 $< 250 \mu\text{m}$) increased, sandeel increasingly avoided the habitat. Conversely, as the percentage of coarse sand and medium sand (particle size $\geq 250 \mu\text{m}$ to $< 2 \text{ mm}$) increased, sandeel showed increased preference for the habitat.

In addition, sandeel are rare in sediments where the silt content (particle size $< 0.63 \mu\text{m}$) 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 5-1 below. The raw PSD data is included in Appendix 5.

Table 5-1: Particle size ranges for sediment categories defined by Holland *et al.* (2005) and Greenstreet *et al.* (2010)

Particle Size Range	Sediment Category	
	Holland <i>et al.</i> (2005)	Greenstreet <i>et al.</i> (2010)
≥ 8 mm	Coarse Gravel	n/a
≥ 2 to < 8 mm	Fine Gravel	
≥ 710 to < 2 mm	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 Sandeel Survey Area as sandeel habitat, based on the distribution of “coarse sands” and “silt and fine sands”, is provided in Figure 5-1. A category for “gravel” (particle size ≥ 2 mm) has also been included to show the relative proportion of all particle sizes.

The relationship between the number of sandeel caught in dredge samples and the percentage of “coarse sands” and “silt and fine sands” was reviewed for stations where both sandeel were caught and grab samples were successful. Given the limited data available however no strong trends were observed (15 stations; 54% of stations sampled). The results of the survey suggest there may have been a potential slight relationship between coarse sands with lower silt content and increased sandeel presence in line with the findings of Greenstreet *et al.* (2010) and Holland *et al.* (2005).

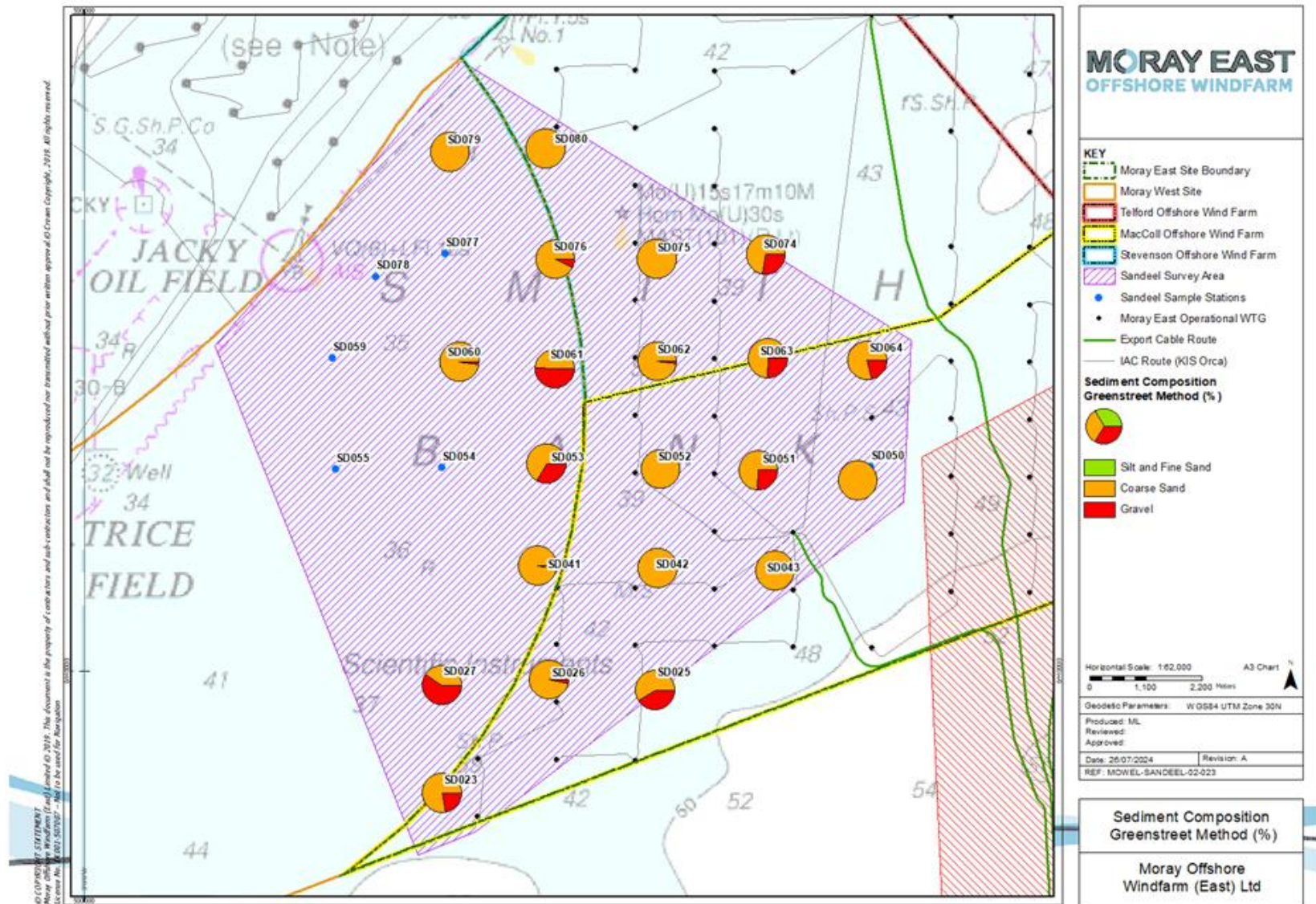


Figure 5-1: Composition (%) distribution of gravel, coarse sands and silt and fine sands at grab sampling stations

5.2 Folk's Classification System

Folk (1954) produced a matrix to describe seabed sediments based upon the ratio of Sand to Mud in relation to the percentage Gravel within a sample (for Folk's Triangle see Appendix 5). The British Geological Survey (BGS) utilises the Folk (1954) classifications of sedimentary rocks for seabed mapping. Three different seabed sediment types were recorded during the survey; sandy gravel, slightly gravelly sand, gravelly sand. Sandeel were recorded in all three of these broad categories as indicated in Figure 5-1. The total number of sandeel caught by station relative to the BGS seabed substrates is shown in Figure 5-2.

The distribution of sandeel catches across the Sandeel Survey Area together with seabed sediment types, as defined by the BGS following Folk's sediment classification, is illustrated in Figure 5-3. According to the BGS map the entire area surveyed is, broadly speaking, sandy and gravelly.

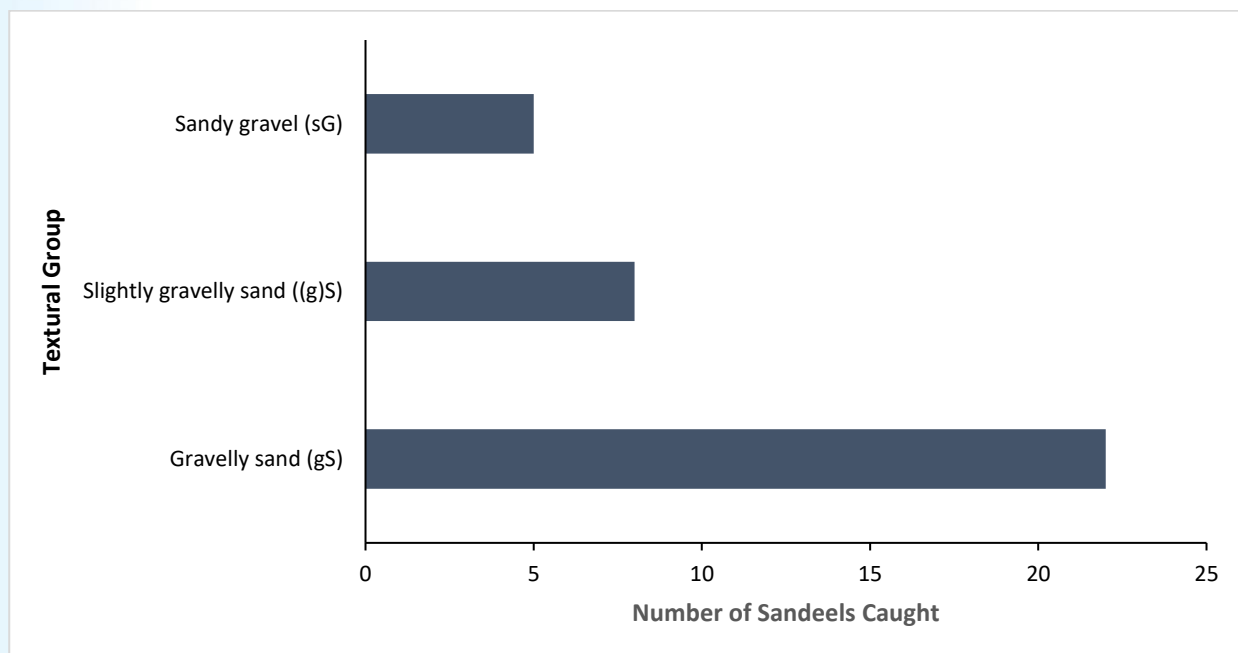


Figure 5-2: Number of sandeel caught by seabed sediment type (Folk, 1954)

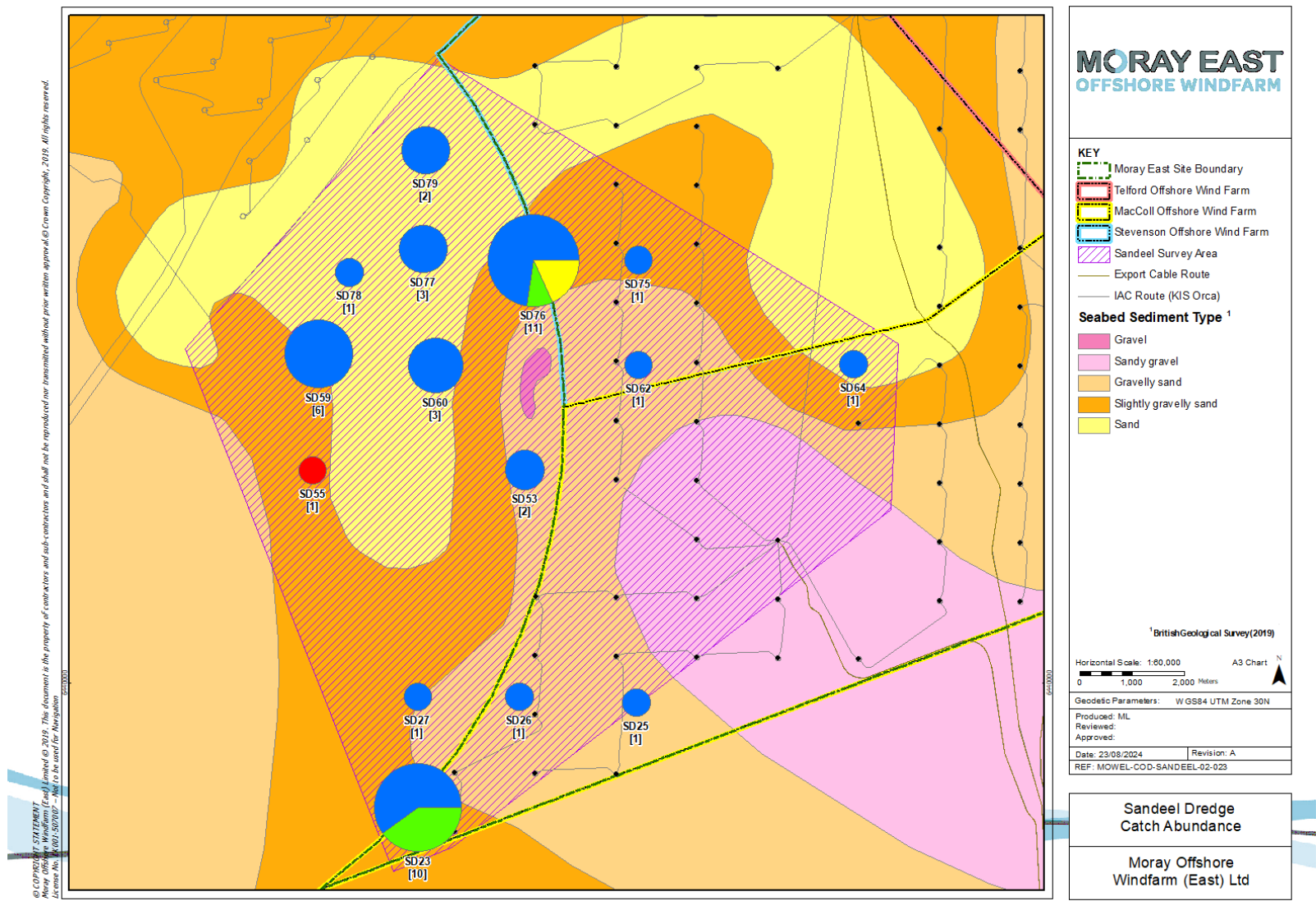


Figure 5-3: Number of sandeel caught per station relative to BGS seabed sediment types

6 Comparison with Pre-construction Surveys

6.1 Moray East 2019 Pre-Construction Survey

6.1.1 Sandeel Species

In 2019, three species of sandeel were caught: Raitt's sandeel, smooth sandeel, and greater sandeel whereas in 2024, two individuals of an additional species, lesser sandeel, were also recorded during the survey. Raitt's sandeel, however, accounted for the majority of the sandeel catch in both the 2019 and 2024 surveys, with the remaining species recorded in low numbers.

6.1.2 Sandeel Abundance and Spatial Distribution

A comparison of the total number of sandeel caught and sandeel density (n/m^2) in the 2019 and 2024 surveys is provided in Table 6-1. The number and density of Raitt's sandeel, the principal species caught across both surveys, by station is given in Table 6-2. Sandeel were caught in low numbers in both the 2019 and 2024 surveys and the numbers of Raitt's sandeel recorded by station appear to be comparable. In both the 2019 and 2024 survey, SD76 was the station where the most sandeel were caught.

In 2019 (pre-construction), a total of 74 sandeel were caught while 45 individuals were recorded post-construction. One station (SD39), where a single sandeel was caught in 2019, was not sampled in 2024 due to construction restrictions in the Moray West site.

The marginally higher total density calculated for Raitt's sandeel in 2024 ($0.09 n/m^2$) compared to 2019 ($0.02 n/m^2$) is likely driven by the lower number of stations sampled in 2024 (28 stations compared to 29 stations in 2019).

As previously described, the highest abundance of sandeel were recorded in the northern extents of the Sandeel Survey Area during the 2024 survey. This is consistent with the distribution of sandeel recorded during the 2019 survey (Figure 4.5).

It is important to note that during the 2024 sandeel survey, piling operations were ongoing as part of the neighbouring wind farm's monopile installation (Moray West Offshore Wind Farm).

Table 6-1: Total number and density of sandeel species caught in 2019 and 2024

Species		Total Number		Density by species (n/m^2)	
Common Name	Scientific Name	2019	2024	2019	2024
Raitt's sandeel	<i>Ammodytes marinus</i>	64	37	0.02	0.09
Lesser sandeel	<i>Ammodytes tobianus</i>	0	2	0	0.01
Smooth sandeel	<i>Gymnammodytes semisquamatus</i>	9	5	0.03	0.01
Greater sandeel	<i>Hyperoplus lanceolatus</i>	1	1	0.003	0.002

Table 6-2 Number and density of Raitt's sandeel caught in 2019 and 2024 by station

Station	2019		2024	
	Number	Density (n/m^2)	Number	Density (n/m^2)
SD23	2	0.006	6	0.015
SD25	1	0.003	1	0.003
SD26	0	0	1	0.003
SD27	1	0.003	1	0.003

Station	2019		2024	
	Number	Density (n/m ²)	Number	Density (n/m ²)
SD39	1	0.003	0*	0*
SD40	0	0	0	0
SD41	0	0	0	0
SD42	1	0.003	0	0
SD43	0	0	0	0
SD50	1	0.003	0	0
SD51	3	0.009	0	0
SD52	3	0.010	0	0
SD53	1	0.003	2	0.005
SD54	0	0	0	0
SD55	4	0.012	0	0
SD58	0	0	0	0
SD59	1	0.003	6	0.009
SD60	1	0.003	3	0.010
SD61	1	0.003	0	0
SD62	1	0.003	1	0.003
SD63	4	0.013	0	0
SD64	3	0.009	1	0.003
SD74	0	0	0	0
SD75	4	0.012	1	0.003
SD76	19	0.060	8	0.021
SD77	0	0	3	0.007
SD78	9	0.028	1	0.003
SD79	3	0.010	2	0.006
SD80	0	0	0	0

* Could not be sampled due to access restrictions to Moray West construction site

6.1.3 Sediment Analysis

Sediment analysis was conducted for 29 grab sample stations pre-construction, and 21 stations post-construction due to Moray West construction activities and unsuccessful grabs.

Using the Greenstreet *et al.* (2010) method, silt and fine sands were present in higher quantities during pre-construction sampling compared to post-construction sampling, where they were found in very small quantities. During post-construction sampling, coarse sand was the dominant sediment found at most stations sampled, whereas sediment composition during pre-construction showed more variety.

Sandeel were caught in three Folk (1954) textural groups (sandy gravel (sG), slightly gravelly sand ((g)S), and gravelly sand (gS)) during post-construction surveying, while they were present in four textural groups during pre-construction (muddy sandy gravel (msG), sandy gravel (sG), gravelly sand (gS), and slightly gravelly sand ((g)S)). Pre-construction, slightly gravelly sand ((g)S) was the textural group associated with the most sandeel caught (45 individuals), while for post-construction this was gravelly sand (gS) (22 individuals).

6.2 MORL 2012 Pre-Construction Survey

The Moray Offshore Renewables Limited (MORL) pre-construction sandeel dredge survey took place between 30th January and 2nd March 2012 in the MORL Zone, which included four development areas: Telford Offshore Wind Farm; MacColl Offshore Wind Farm; Stevenson Offshore Wind Farm; and the Western Development Area.

A total of 114 stations were sampled for a 250 m tow using a sandeel dredge. A total of 197 sandeel were caught in 29 out of 114 stations with a maximum of 40 individuals caught at a single station. The low sandeel catches recorded during the survey suggests that there are not extensive areas supporting important sandeel populations in the MORL Zone.

6.3 BOWL Pre and Post-Construction Surveys

The Beatrice Offshore Wind Limited (BOWL) pre-construction sandeel dredge survey was undertaken between 27th February to the 5th March 2014, and the post-construction survey was undertaken between 8th December 2020 and the 17th of December 2020, following updated advice from MSS. A total of 103 stations were sampled for a 500m tow in 2014, whereas only 61 stations were able to be completed post-construction

The number of sandeel caught increased between 2014 and 2020, with 497 individual sandeel caught in 2014 and 3,556 individual sandeel caught in 2020, despite sampling at fewer stations. There was also an increase in the number of sandeel caught at one station, with a maximum of 36 individual sandeel caught at one location in 2014, compared to 397 individuals in 2020. Following the same trend as in 2014, the highest numbers of sandeel were found at sampling stations located in the south-eastern section of the BOWL site.

The results of the post-construction survey, when compared to those of the pre-construction survey, has shown an increase in sandeel in the southeast of the BOWL site and similar levels of abundance in the north to the pre-construction survey. As such, there was no evidence to suggest that the construction of BOWL resulted in negative impacts on the local sandeel population.

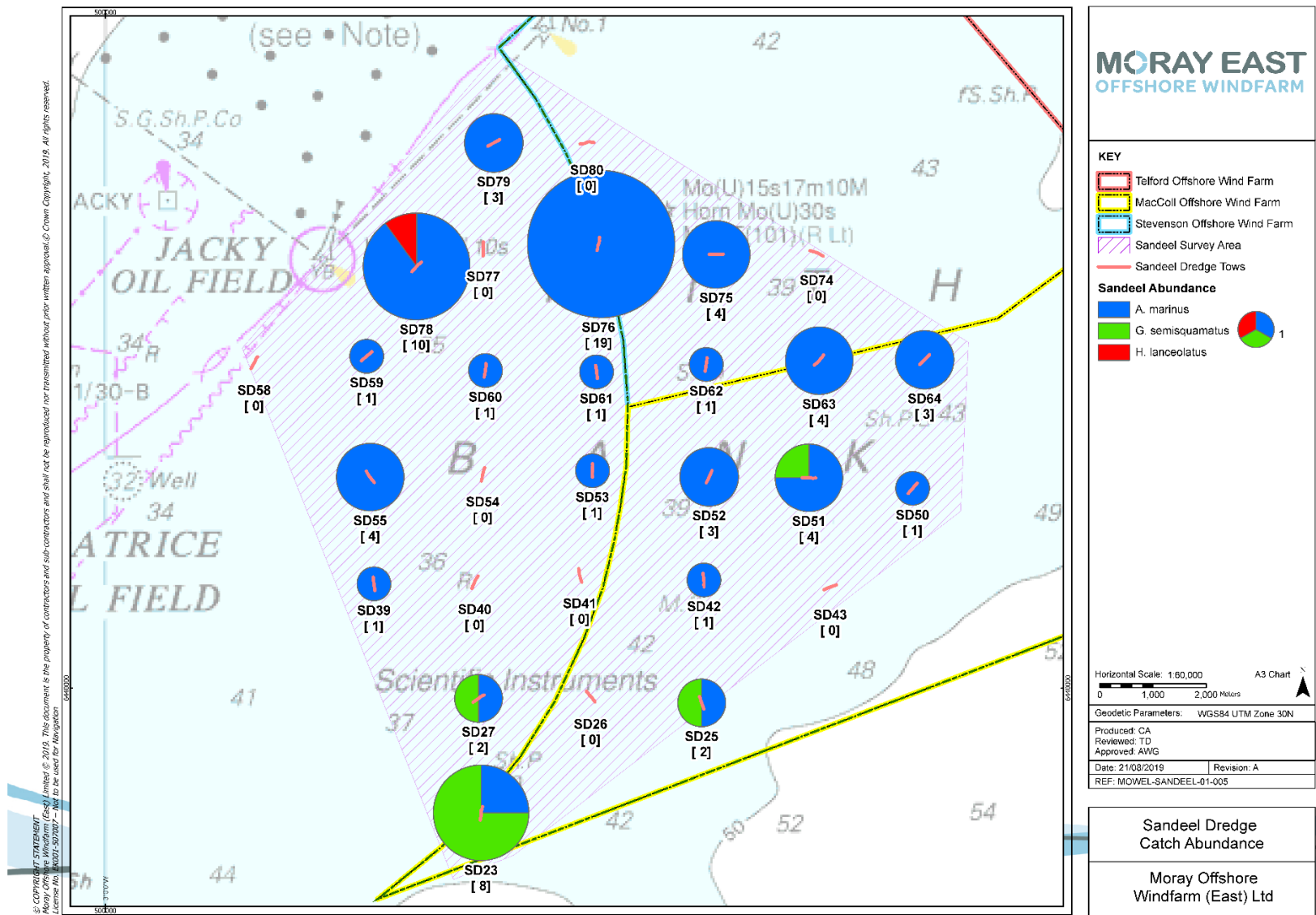


Figure 6-1: Sandeel abundance in the Sandeel Survey Area in 2019

7 Conclusion

Data on the abundance and spatial distribution of sandeel and associated sediments in the vicinity of the Moray East site was collected over the course of two survey trips in March 2024. The results indicated an overall patchy distribution and low abundance of sandeel across the Moray East Sandeel Survey Area. A total of 45 sandeel were caught in 15 out of the 28 stations sampled, with a maximum of 11 individuals caught at a single station (SD76). Raitt's sandeel was the most abundant species, accounting for 77% of the total sandeel catch and the highest numbers of sandeel were caught in the north of the Sandeel Survey Area.

Areas considered to potentially constitute suitable habitat for sandeel (sand, slightly gravelly sand, gravelly sand and sandy gravel) were recorded at all sampling stations and are widespread throughout the Moray Firth.

The pre- and post-construction surveys have provided localised information on sandeel distribution and abundance. Low numbers of sandeel were recorded in both the pre and post-construction surveys, suggesting that the Sandeel Survey Area did not support important sandeel populations pre-construction and this continues to be the case post-construction.

8 References

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APPENDIX 1: HEALTH AND SAFETY

A1.1 Personnel

Brown and May Marine (BMM) staff followed the standard health and safety protocol outline in the BMM Project Health & Safety Plan & Risk Assessment (HSE) and Moray East permit to work documents.

All BMM staff have completed a sea survival course approved by STCW. All crew and BMM staff have valid medical certificates (ENG1).

A1.2 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 when operational. All hazards were assessed prior to the survey in the BMM health and safety risk assessment.

A1.3 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.

A1.4 Post Trip Survey Review

Upon completion of the survey a "post trip survey review" was completed. For the summary see Table A1.0-1 and Table A1.0-2 below.

Table A1.0-1: Post trip survey review (part 1)

Project: Moray East Sandeel Survey 2024	
Vessel	Reaper WK 83
Skipper	Donald Anderson
Dates at Sea	17/03/2014 – 31/03/2024
Survey Area	Moray Firth
Total Time at Sea	2 sampling weeks
Surveyor Supervisors	Alex Winrow-Giffin, Zoe Lawrence
Surveyors:	Shawn Taylor-Michel, Rhys Kibble, Morgan Lord
Envision Surveyors	Charlotte Aldis, Alison Benson, Lottie Turnbull

Table A1.0-2: Post trip survey review (part 2)

	Comments	Actions
Did vessel comply with pre trip safety audits?	Yes (CMID audit undertaken prior to survey and required items closed out)	N/A
Skipper and crew attitude to safety?	Good –correct PPE worn	N/A

	Comments	Actions
Vessel machinery failures?	None	N/A
Safety Equipment failures?	None	N/A
Accidents?	None	N/A
Injuries?	None	N/A

APPENDIX 2: LOG OF EVENTS

A summarised log of events is given below in Table A2.0-1 for the survey.

Table A2.0-1: Summarised log of events

Project: Moray East Sandeel Survey 2024
Sunday 17th March 2024
Vessel departed Fraserburgh at 14:00 and steamed to survey site
Dredge sampling commenced at 19:50. Stations sampled: SD40, 27, 23, 41, 53, 61, 60
Monday 18th March 2024
Stations sampled: 76, 77, 58, 55. Dredge sampling halted at 0200. Vessel returned to port.
Vessel on weather standby. Sample processing and data digitisation.
Tuesday 19th March 2024
Vessel departed Fraserburgh at 14:00 and steamed to survey site
Dredge sampling commenced at 19:50. Stations sampled: SD25, 26, 42, 43, 50, 51, 52, 54
Wednesday 20th March 2024
Stations sampled: SD59, 78, 73, 80, 75, 74, 62, 63 and 64. Dredge sampling completed at 03:00.
Vessel returned to port, arriving into Fraserburgh at 07:00
Thursday 21st March 2024
Vessel on weather standby. Sample processing and data digitisation
Friday 22nd March 2024
Vessel on weather standby
Saturday 23rd March 2024
Vessel on weather standby
Sunday 24th March 2024
Vessel on weather standby.
Saturday 30th March 2024
Vessel departed Fraserburgh at 07:00
Commenced grab sampling at 13:30. Stations sampled: SD50
Grab sampling halted at 14:00 due to increased wave height
Sunday 31st March 2024
Grab sampling commenced at 07:00
Sampling ceased at 18:30. Following stations successfully sampled: SD64, 74, 63, 51, 43, 42, 25, 26, 23, 27, 41, 53, 61, 60, 76, 79, 80, 75, 62 and 52
Unable to sample following stations: SD77 and 40 unable to complete as exceeded maximum number of attempts; SD58 unable to complete due to time restrictions; SD78, 59, 55, 54 and 39 not completed given restrictions around Moray West construction activities
Arrived at Fraserburgh at 22:30
Monday 1st April 2024
Vessel demobilisation.
Vessel and surveyors transit back

APPENDIX 3: SURVEY COORDINATES

Table A3.0-1: Sandeel dredge sampling start and end times, co-ordinates water depth, duration and length of each tow

Station	Date	Sandeel Dredge Tow Start				Sandeel Dredge Tow End				Tow Length (m)	Duration
		Time (GMT)	WGS84 DM		Depth (Fth)	Time (GMT)	WGS84 DM		Depth (Fth)		
			Lat	Long			Lat	Long			
SD23	17/03/2024	21:28:06	58°04.9022N	002°52.8107W	24	21:31:42	58°04.7329N	002°52.8515W	25.3	317	0.06
SD25	19/03/2024	21:31:42	58°04.7329N	002°52.8515W	25.3	19:56:45	58°05.7865N	002°48.6378W	27.2	267	0.04
SD26	19/03/2024	20:25:59	58°05.9423N	002°50.7271W	24	20:28:53	58°05.9515N	002°51.0199W	24.3	288	0.05
SD27	17/03/2024	21:01:21	58°06.0007N	002°52.8347W	21	21:04:58	58°05.8368N	002°52.8459W	22	304	0.06
SD40	17/03/2024	20:19:15	58°06.9038N	002°52.990W	20.9	20:23:07	58°06.9574N	002°52.6749W	21.3	325	0.06
SD41	17/03/2024	22:15:41	58°07.0235N	002°50.8466W	22.1	22:19:32	58°07.1812N	002°50.633W	22.5	360	0.06
SD42	19/03/2024	21:05:42	58°07.0826N	002°48.5560W	24	21:08:25	58°07.085N	002°48.2507W	24.6	325	0.05
SD43	19/03/2024	21:26:51	58°07.0558N	002°46.3459W	26.2	21:29:44	58°07.0627N	002°46.0714W	26	269	0.05
SD50	19/03/2024	21:57:04	58°08.1731N	002°44.3678W	26.5	22:00:16	58°08.3090N	002°44.1992W	26.8	301	0.05
SD51	19/03/2024	22:22:06	58°08.1904N	002°46.3530W	22.8	22:24:57	58°08.2399N	002°46.6534W	24.5	308	0.05
SD52	19/03/2024	22:44:46	58°08.1477N	002°48.5546W	22.5	22:47:46	58°08.13078N	002°48.5013W	23	306	0.05
SD53	17/03/2024	22:37:36	58°08.1639N	002°50.8466W	22	22:40:43	58°08.3516N	002°50.6686W	22.3	340	0.05
SD54	19/03/2024	23:39:26	58°08.2445N	002°53.0221W	21	23:43:59	58°08.2336N	002°52.5986W	21	416	0.08
SD55	18/03/2024	01:50:38	58°08.1896N	002°55.0054W	21.3	01:54:07	58°08'3467N	002°54.8626W	22	324	0.06
SD58	18/03/2024	01:12:06	58°09.3967N	002°56.6991W	20.3	01:15:54	58°09.2922N	002°57.0113W	20.8	362	0.06
SD59	20/03/2024	00:13:17	58°09.4232N	002°55.0258W	21.1	00:18:07	58°09.5522N	002°54.5100W	21.2	560	0.08
SD60	17/03/2024	23:34:00	58°09.3487N	002°52.7297W	20.6	23:37:08	58°09.4656N	002°52.8146W	20.7	253	0.05
SD61	17/03/2024	22:55:57	58°09.2404N	002°50.6941W	21.9	22:58:57	58°09.4132N	002°50.6538W	21.9	323	0.05
SD62	20/03/2024	02:30:52	58°09.4515N	002°48.4897W	21.4	02:33:59	58°09.2969N	002°48.5951W	21.3	305	0.05
SD63	20/03/2024	02:47:19	58°09.3281N	002°46.6693W	22.5	02:50:17	58°09.3641N	002°46.3585W	22.1	312	0.05
SD64	20/03/2024	03:02:28	58°09.3867N	002°44.4705W	24	03:05:38	58°09.3792N	002°44.1518W	24	313	0.05
SD74	20/03/2024	02:08:36	58°10.4783N	002°46.5469W	23	02:10:59	58°10.4897N	002°46.2942W	23	248	0.04
SD75	20/03/2024	01:53:08	58°10.5173N	002°48.5562W	21.3	01:56:07	58°10.3729N	002°48.4968W	21.5	274	0.05
SD76	18/03/2024	00:03:58	58°10.3876N	002°50.6636W	19.5	00:07:16	58°10.5352N	002°50.5352W	20.6	302	0.06

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Station	Date	Sandeel Dredge Tow Start				Sandeel Dredge Tow End				Tow Length (m)	Duration
		Time (GMT)	WGS84 DM		Depth (Fth)	Time (GMT)	WGS84 DM		Depth (Fth)		
			Lat	Long			Lat	Long			
SD77	18/03/2024	00:34:05	58°10.6352N	002°52.6757W	20.8	00:38:30	58°10.4492N	002°52.8094W	20	369	0.07
SD78	19/03/2024	00:39:06	58°10.2405N	002°54.1475W	21.6	00:41:35	58°10.3975N	002°54.2158W	20.6	299	0.04
SD79	19/03/2024	01:10:42	58°11.5279N	002°52.7715W	20	01:13:11	58°11.6723N	002°52.664W	20.4	288	0.04
SD80	19/03/2024	01:29:25	58°11.6505N	002°50.7284W	22.6	01:32:59	58°11.5540N	002°50.4653	22.5	314	0.06

Table A3.0-2: Grab sampling locations

Sediment Grab Deployment Details					
Station	Date	Time (GMT)	WGS84 DM		Depth (Fth)
			Lat	Long	
SD023	31/03/2024	11:18:00	58'04.9088N	002'52.7815W	24.0
SD025	31/03/2024	10:35:00	58'05.9144N	002'48.6526W	26.4
SD026	31/03/2024	10:48:00	58'05.9380N	002'50.7457W	23.0
SD027	31/03/2024	11:44:00	58'06.0191N	002'52.8348W	21.6
SD040	31/03/2024	12:46:00	58'06.8978N	002'53.0107W	21.5
SD041	31/03/2024	12:11:00	58'07.0253N	002'50.8307W	22.6
SD042	31/03/2024	09:54:00	58'07'0400N	002'46.3829W	25.7
SD043	31/03/2024	08:48:00	58'07.0802N	002'46.3375W	25.2
SD050	30/03/2024	13:48:00	58'08.1897N	002'44.3617W	26.8
SD051	31/03/2024	08:20:00	58'08.2168N	002'46.3379W	23.9
SD052	31/03/2024	16:58:00	58'08.1523N	002'48.5923W	22.8
SD053	31/03/2024	13:13:00	58'08.1001N	002'50.6814W	22.2
SD060	31/03/2024	13:52:49	58'09.4714N	002'52.5449W	21.2
SD061	31/03/2024	13:34:00	58'09.2114N	002'50.7167W	27.8
SD062	31/03/2024	16:40:00	58'09.4609N	002'48.4988W	22.1
SD063	31/03/2024	17:17:00	58'09.3202N	002'46.7219W	22.9
SD064	31/03/2024	06:28:00	58'09.3954N	002'44.4740W	24.2
SD074	31/03/2024	07:10:00	58'10.4541N	002'46.5456W	23.0
SD075	31/03/2024	15:57:16	58'10.5218N	002'48.6196W	22.4
SD076	31/03/2024	14:11:54	58'10.3985N	002'50.6836W	20.5
SD077	31/03/2024	14:40:00	58'10.6223N	002'52.7417W	21.1
SD079	31/03/2024	14:55:18	58'11.5427N	002'52.7883W	20.7
SD080	31/03/2024	15:31:00	58'11.6548N	002'50.7460W	23.3

APPENDIX 4: RAW DATA

A4.1 Sandeel Catch Data

Table A4.0-1 Sandeel caught by station, species, length and weight

Moray East Sandeel Survey 2019				
Station No.	Common Name	Scientific Name	Standard Length (mm)	Wet (defrosted) weight (g)
SD23	Raitt's sandeel	<i>Ammodytes marinus</i>	126	5.93
	Raitt's sandeel	<i>Ammodytes marinus</i>	132	6.47
	Raitt's sandeel	<i>Ammodytes marinus</i>	124	5.17
	Raitt's sandeel	<i>Ammodytes marinus</i>	125	5.02
	Raitt's sandeel	<i>Ammodytes marinus</i>	121	5.58
	Raitt's sandeel	<i>Ammodytes marinus</i>	110	3.31
	Smooth sandeel	<i>Gymnammodytes semisquamatus</i>	72	0.52
	Smooth sandeel	<i>Gymnammodytes semisquamatus</i>	196	25.63
	Smooth sandeel	<i>Gymnammodytes semisquamatus</i>	210	27.27
	Smooth sandeel	<i>Gymnammodytes semisquamatus</i>	126	4.82
SD25	Raitt's sandeel	<i>Ammodytes marinus</i>	123	4.77
SD26	Raitt's sandeel	<i>Ammodytes marinus</i>	182	16.51
SD27	Raitt's sandeel	<i>Ammodytes marinus</i>	147	8.87
SD53	Raitt's sandeel	<i>Ammodytes marinus</i>	115	3.45
	Raitt's sandeel	<i>Ammodytes marinus</i>	103	2.88
SD55	Greater sandeel	<i>Hyperoplus lanceolatus</i>	235	39.79
SD59	Raitt's sandeel	<i>Ammodytes marinus</i>	98	2.66
	Raitt's sandeel	<i>Ammodytes marinus</i>	104	3.08
	Raitt's sandeel	<i>Ammodytes marinus</i>	113	4.12
	Raitt's sandeel	<i>Ammodytes marinus</i>	119	5.56
	Raitt's sandeel	<i>Ammodytes marinus</i>	98	2.77
	Raitt's sandeel	<i>Ammodytes marinus</i>	109	3.58
SD60	Raitt's sandeel	<i>Ammodytes marinus</i>	104	2.40
	Raitt's sandeel	<i>Ammodytes marinus</i>	114	3.78
	Raitt's sandeel	<i>Ammodytes marinus</i>	96	1.91
SD62	Raitt's sandeel	<i>Ammodytes marinus</i>	115	3.45
SD64	Raitt's sandeel	<i>Ammodytes marinus</i>	120	5.45
SD75	Raitt's sandeel	<i>Ammodytes marinus</i>	115	3.66
SD76	Raitt's sandeel	<i>Ammodytes marinus</i>	112	4.50
	Raitt's sandeel	<i>Ammodytes marinus</i>	104	3.05
	Lesser sandeel	<i>Ammodytes tobianus</i>	119	4.89
	Raitt's sandeel	<i>Ammodytes marinus</i>	115	4.09
	Raitt's sandeel	<i>Ammodytes marinus</i>	110	3.51
	Raitt's sandeel	<i>Ammodytes marinus</i>	111	4.42
	Raitt's sandeel	<i>Ammodytes marinus</i>	54	0.35
	Lesser sandeel	<i>Ammodytes tobianus</i>	123	3.89
	Raitt's sandeel	<i>Ammodytes marinus</i>	115	3.68
	Raitt's sandeel	<i>Ammodytes marinus</i>	112	4.50
	Smooth sandeel	<i>Gymnammodytes semisquamatus</i>	148	8.57
SD77	Raitt's sandeel	<i>Ammodytes marinus</i>	106	2.97
	Raitt's sandeel	<i>Ammodytes marinus</i>	94	2.19
	Raitt's sandeel	<i>Ammodytes marinus</i>	102	2.94
SD78	Raitt's sandeel	<i>Ammodytes marinus</i>	108	2.80
SD79	Raitt's sandeel	<i>Ammodytes marinus</i>	109	3.79

Moray East Sandeel Survey 2019				
Station No.	Common Name	Scientific Name	Standard Length (mm)	Wet (defrosted) weight (g)
	Raitt's sandeel	<i>Ammodytes marinus</i>	116	3.92

A4.1 By-catch

Table A4.0-2 Name and quantity of by-catch caught

Fish By-catch		
Common Name	Scientific Name	Number/Presence
Butterfish	<i>Pholis gunnellus</i>	1
Cod	<i>Gadus morhua</i>	1
Dab	<i>Limanda limanda</i>	89
Dover Sole	<i>Solea solea</i>	5
Dragonet	<i>Callionymoidei</i>	18
Flounder	<i>Platichthys flesus</i>	1
Grey Gurnard	<i>Eutrigla gurnardus</i>	1
Juvenile fish		9
Lemon sole	<i>Microstomus kitt</i>	13
Plaice	<i>Pleuronectes platessa</i>	31
Scald Fish	<i>Arnoglossus laterna</i>	1
Solenette	<i>Buglossidium luteum</i>	58
Thickback Sole	<i>Microchirus variegatus</i>	2
Invertebrates By-catch		
Bivalve	<i>Bivalvia</i>	30
Bryozoan fern	<i>Bryozoa</i>	Present (1)
Clam	<i>Bivalvia</i>	1
Cockle	<i>Cardioidea</i>	91
Crab	<i>Decapoda</i>	35
Dead man's fingers	<i>Alcyonium digitatum</i>	Present (8)
Edible crab	<i>Cancer pagurus</i>	4
Filamentous broyzoan	<i>Bryozoa</i>	Present (1)
Gastropod	<i>Gastropoda</i>	15
Hermit Crab	<i>Decapoda</i>	29
Hornwrack	<i>Bryozoa</i>	Present (22)
Jellyfish	<i>Cnidaria</i>	1
King Scallop	<i>Pecten maximus</i>	1
Polychaete	<i>Polychaeta</i>	8
Queen Scallop	<i>Aequipecten opercularis</i>	1
Scallop	<i>Pectinidae</i>	1
Sea Potato	<i>Echinoidea</i>	1
Sea urchin	<i>Echinoidea</i>	3
Shrimp	<i>Decapoda</i>	20
Spider Crab	<i>Decopoda</i>	9
Squat Lobster	<i>Galathea</i>	6
Squid	<i>Loliginidae</i>	1
Starfish	<i>Echinoidea</i>	44
Tube Worm	<i>Polychaeta</i>	16
Whelk	<i>Buccinum undatum</i>	4

APPENDIX 5: PARTICLE SIZE DISTRIBUTION ANALYSIS

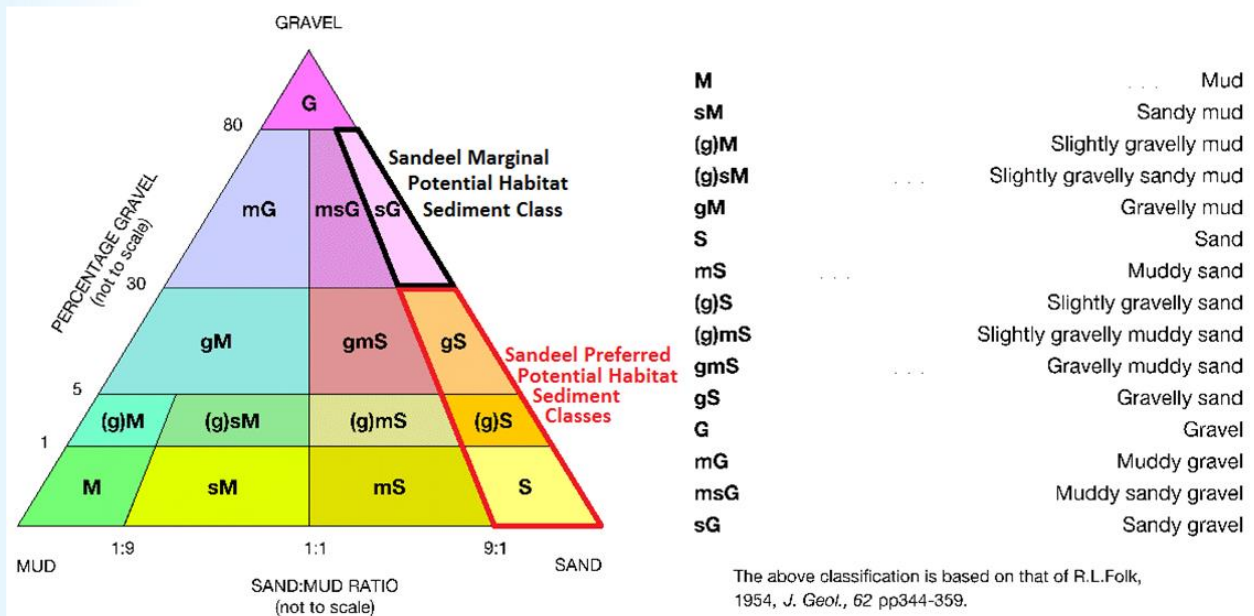


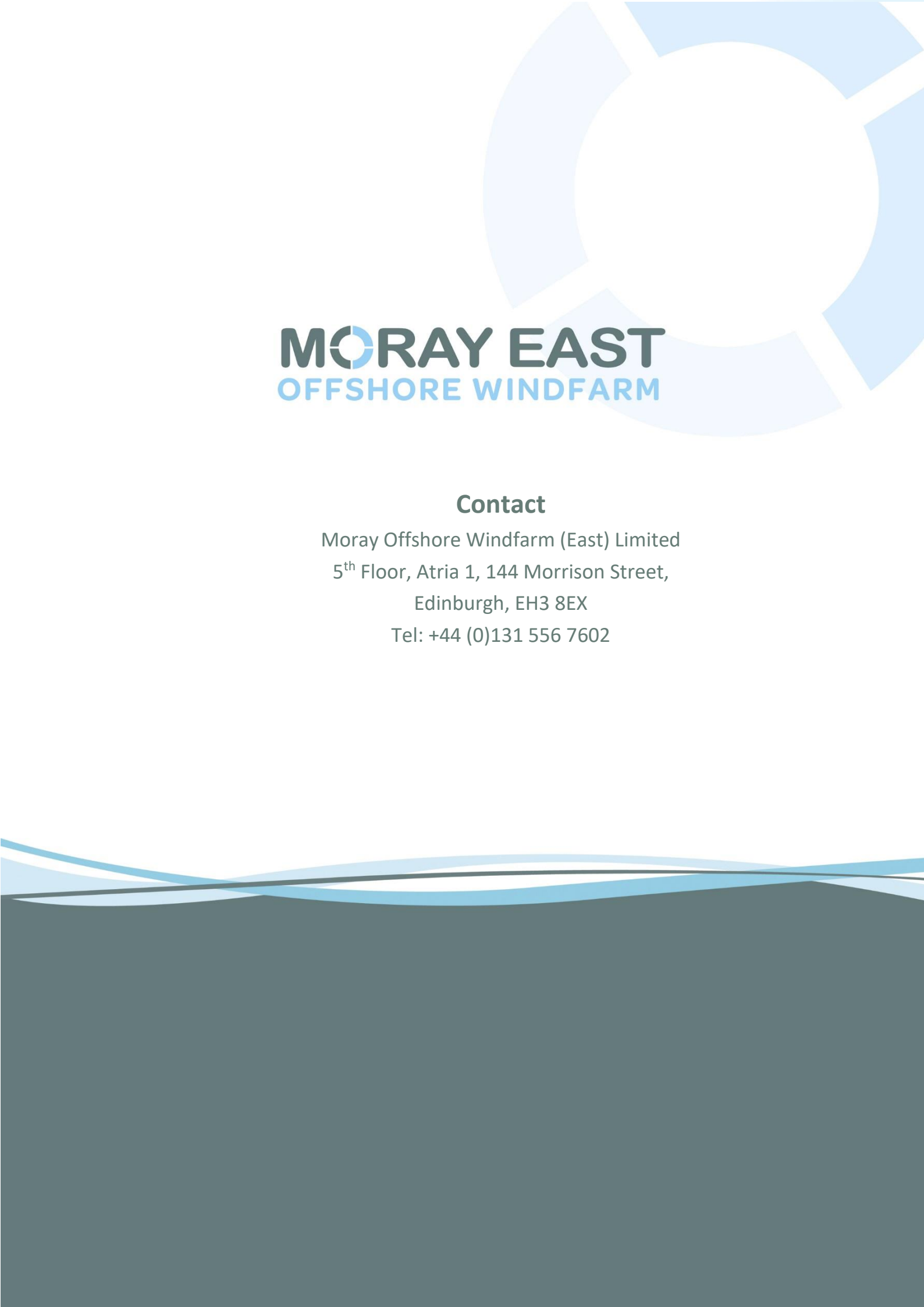
Figure A5.0-1: Folk sediment triangle indicating sandeel preferred and marginal potential habitat sediment classes (Source: Latto *et al.*, 2013)

Table A5.0-1: Particle Size Distribution Analysis

Station	Textural Group	Folk and Ward Description	Folk and Ward Sorting	Mean μm	Mean ϕ	Sorting Coefficient	Skewness	Kurtosis	Major Sediment Fractions		
									Gravel %	Sand %	Mud %
SD023	gS: Gravelly sand	Very coarse sand	Poorly Sorted	1000.846349	-0.0012210	1.525951866	0.1172240	1.2992754	22.35	73.69	3.96
SD025	sG: Sandy gravel	Very coarse sand	Poorly Sorted	1531.066531	-0.6145367	1.181480120	0.2216416	1.1283160	40.84	57.80	1.37
SD026	(g)S: Slightly gravelly sand	Fine sand	Moderately Sorted	208.886488	2.2592088	0.839385409	-0.2377975	1.7965817	3.19	93.86	2.96
SD027	sG: Sandy gravel	Very fine gravel	Very Poorly Sorted	2230.437170	-1.1573267	2.388034790	0.1123168	1.3215506	58.97	38.36	2.67
SD041	(g)S: Slightly gravelly sand	Fine sand	Moderately Well Sorted	241.251899	2.0513878	0.621475095	-0.2103146	1.2027161	2.26	97.74	0.00
SD042	(g)S: Slightly gravelly sand	Fine sand	Moderately Well Sorted	231.081425	2.1135268	0.582306022	-0.0873638	1.0743811	0.18	98.15	1.67
SD043	(g)S: Slightly gravelly sand	Medium sand	Moderately Well Sorted	299.200335	1.7408162	0.670857447	-0.0319549	0.9846117	0.53	98.20	1.26
SD050	(g)S: Slightly gravelly sand	Medium sand	Moderately Sorted	358.089460	1.4816081	0.790163391	-0.0489777	1.1322984	0.73	97.48	1.78
SD051	gS: Gravelly sand	Very coarse sand	Poorly Sorted	1275.653866	-0.3512365	1.239457481	-0.0399110	1.5000026	25.54	73.28	1.18
SD052	(g)S: Slightly gravelly sand	Medium sand	Moderately Well Sorted	323.464017	1.6283228	0.636336739	0.0130861	1.0168714	0.11	98.76	1.13
SD053	sG: Sandy gravel	Very coarse sand	Very Poorly Sorted	1300.679954	-0.3792654	2.166586122	-0.5215404	0.6756638	33.16	66.01	0.83
SD060	(g)S: Slightly gravelly sand	Medium sand	Moderately Well Sorted	288.558040	1.7930666	0.638974274	-0.1511926	1.1512240	2.15	97.85	0.00
SD061	sG: Sandy gravel	Very fine gravel	Very Poorly Sorted	2578.329367	-1.3664356	2.135509842	-0.1582199	0.6311111	51.01	48.65	0.33
SD062	(g)S: Slightly gravelly sand	Medium sand	Moderately Sorted	464.575077	1.1060166	0.800876573	-0.0573429	1.0678853	1.87	96.82	1.31
SD063	gS: Gravelly sand	Very coarse sand	Poorly Sorted	1012.365680	-0.0177300	1.747216881	-0.1293197	1.1160108	25.68	73.06	1.26
SD064	gS: Gravelly sand	Very coarse sand	Poorly Sorted	1017.047501	-0.0243866	1.627707416	-0.2965340	1.4175922	21.42	77.97	0.61

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Station	Textural Group	Folk and Ward Description	Folk and Ward Sorting	Mean μm	Mean ϕ	Sorting Coefficient	Skewness	Kurtosis	Major Sediment Fractions		
									Gravel %	Sand %	Mud %
SD074	gS: Gravelly sand	Very coarse sand	Very Poorly Sorted	1145.569420	-0.1960660	2.581867916	-0.5518016	0.7386256	27.43	71.45	1.12
SD075	(g)S: Slightly gravelly sand	Medium sand	Moderately Well Sorted	263.355169	1.9249184	0.670305254	-0.0933148	1.1019796	0.24	97.97	1.78
SD076	gS: Gravelly sand	Coarse sand	Poorly Sorted	710.418465	0.4932587	1.003766003	-0.1214312	0.8616030	7.13	92.87	0.00
SD079	(g)S: Slightly gravelly sand	Medium sand	Moderately Well Sorted	372.529943	1.4245716	0.655844087	-0.0463366	0.9935986	0.08%	99.59%	0.33%
SD080	(g)S: Slightly gravelly sand	Fine sand	Moderately Well Sorted	234.127223	2.0946353	0.591570189	-0.0781236	1.1004123	0.25%	98.10%	1.65%



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