APPENDIX UES10-6

MARINE SURVEYS AT NORTH KILLINGHOLME AND CHERRY COBB SANDS (AUTUMN 2013)

ABLE MARINE ENERGY PARK
(Material Change 2 – TR030006)

Report to: Able UK Ltd

Marine Surveys at North Killingholme and Cherry Cobb Sands (Autumn 2013).

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Report Title: Marine Surveys at North Killingholme and Cherry Cobb Sands (Autumn 2013).

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1. Introduction

The proposed development of the Able Marine Energy Park (AMEP) east of North Killingholme on the Lincolnshire Coast will partly affect the Humber Estuary Special Area of Conservation (SAC) and the Special Protection Area (SPA) / Ramsar site. Consequently a series of measures have been derived to both compensate and mitigate for the effects of the AMEP on the habitats and species within this area of the Humber estuary and these will be implemented as part of any future development. As part of this process a Marine Environmental Management and Monitoring Plan (MEMMP) was produced in April 2013 following close consultation with stakeholders and in addition to other components included requirements for the monitoring of intertidal and subtidal benthic invertebrate and fish communities in the vicinity of the proposed development at North Killingholme (NKM) and the compensation site at Cherry Cobb Sands (CCS). The current report summarises the results of the autumn 2013 intertidal benthic invertebrate and fish surveys at North Killingholme and Cherry Cobb Sands undertaken from September to December 2013.

2. Methods

2.1 Intertidal Benthic Survey

The methods employed for the survey follow those outlined in the MEMMP and utilised a survey design which aimed to provide additional information on intertidal benthic infauna at North Killingholme and Cherry Cobb Sands in relation to observed avifaunal usage. The survey design and methods outlined in the MEMMP are based on existing guidelines and methodologies followed Procedural Guideline No. 3-6: Quantitative sampling of intertidal sediment species using cores (from the Marine Monitoring Handbook - Davies et al, 2001).

As with the spring 2013 invertebrate surveys a beyond BACI (Before-After Control-Impact) gradient design was utilised to take into account the existence of different zones of impact (primary impact, under the direct footprint of the quay development, and secondary impact) and also control areas subject to no impact. The survey design also takes into account shore level (upper, middle and lower shore strata) to account for the variability of communities that occur at different shore levels. The proposed survey design outlined in the MEMMP involved sampling along a series of 16 transects running from the seawall or lower extent of the saltmarsh to approximately mean low water (tides permitting) which cover the impact zones and a control area to the north. The survey included additional transects within the development area to provide greater coverage and rather than employ replicate sampling a series of nine individual samples were taken along each transect to cover the upper, mid and low shore areas. At each sampling location one 0.01m^2 core was taken from the sediment using a hand held corer (0.01 m^2) and placed into sealable plastic bags, each carrying a unique code for the station. Cores were taken to a depth no less than 15cm to ensure adequate recovery of burrowing invertebrates and an additional sample at each sampling station was collected for Particle Size Analysis. At Cherry Cobb Sands a similar approach was taken with sampling undertaken along the north and south control transects utilised for the Spring 2013 survey and the positions of the samples is provided in Figure 1 in Section 3.

The CCS site differs in terms of general topography from the NKM site as this area has a much wider intertidal area with increasingly sandy sediments on the low shore. There is also extensive encroachment of saltmarsh (*Spartina*) with dense creek systems on the upper shore in the region of the northern control sites which made much of the upper shore area inaccessible – for transects CN1 and CN2 the nine samples were taken from the lowest extent of the upper-mid shore saltmarsh with an additional upper shore sample taken from the fringe of Stone Creek which runs parallel to the shore in this area. In some areas where there was increased small scale variation in habitat type an additional sample was included along the transect (e.g. at the area of sparse *Arenicola* beds along the southernmost CCS transect).

The samples collected were kept cool until laboratory processing which took place the following day in which samples were sieved through a 0.5mm mesh sieve and stored in 4% buffered saline formalin solution. Due to the nature of the sediments in the area (soft mud) sampling was undertaken using a hovercraft platform and sample positions were logged using a Magellan Promark 3 GPS logger. The intertidal survey was undertaken on 3rd, 4th, and 5th September 2013 for the NKM survey and hovercraft survey for the CCS site was undertaken on the 11th and 12th September 2013.

2.2 Intertidal & Subtidal Fish Surveys

2.2.1 Beam Trawl Surveys

As outlined in the MEMMP a total of 8 beam trawl stations, with replicates at each station (16 trawls), were designed to provide coverage throughout the middle stretch of the Humber estuary and which would give coverage of the development/impact area (4 stations – BT1 – BT4). In addition 4 beam trawl stations were located upstream (BT5 – BT8) of the impact area to act as control stations. Survey locations followed those utilised for the spring 2013 surveys. Special dispensation to trawl was requested from the Marine Management Organisation (MMO) and the North Eastern Inshore Fisheries and Conservation Authority (NEIFCA). Following further discussion with the MMO it was determined that dispensation was not required as the vessel was a survey boat and not a fishing vessel, dispensation was required by the NEIFCA, which was issued prior to the commencement of the survey.

The beam trawl survey was undertaken aboard the 12m survey catamaran Precision 1, owned and operated by Precision Marine Survey Limited, this survey was designed to investigate the fish assemblage along the intertidal zone and in close proximity to the development zone and control stations upstream of the impact area. The methodology followed that prescribed by the Environment Agency for the Water Framework Directive's transitional fish surveillance (EA, 2013). Recommendations within the guidelines dictate that a standard beam trawl of 1.5m should be used to ensure compatibility of sampling gears. The beam trawl was comprised of a fishing net attached to steel boom with skies (shoes) attached at either end. The beam trawl is 1.5 metres wide with the head of the net attached to the beam which 0.5m above the base of the skies (shoes). A 1.5m beam trawl net was comprised of 10mm mesh and 5mm cod end liner with 75mm discs on the fishing (ground) line.

Once the vessel had arrived at the study area the proposed trawl path at each site was scouted for obstructions prior to deploying the trawl. Once at the location, the vessel continued at a steady rate (2 knots) along the direction of the tide and the 1.5m beam trawl was lowered over the side of the vessel to the surface using the winch, the winch then paid out the warp until the trawl hit the seabed. Depending on the water depth, additional trawl warp was paid out until the length of warp was greater or equal to 3 ½ times the depth. Once the required length of warp had been paid out the winch was locked and the start point for each trawl commenced from the point at which the winch was locked and the trawl towed for approximately 200m. Upon completion of the 200m run, the trawl was hauled to the surface and the cod end retrieved and the sample recovered. The cod end was then opened over a stainless steel hopper to contain the whole catch, with the net checked for any remaining epifauna and fish, before the cod end was fastened prior to redeployment at the next station. The total volume of the catch was measured and the catch sorted with the fish species separated from the epifaunal invertebrates. A survey log was maintained at all times. The location, direction and path of all trawls was logged by the vessels GPS and uploaded to GIS software to illustrate the actual route of the trawl.

The fish and epifaunal invertebrates were separated to species when possible and enumerated with examples of each species retained for a reference collection. Where species could not be identified in the field (Polychaeta, Crustacea, Bryozoa, Hydrozoa, Echinodermata etc.) samples were retained for laboratory analysis. The beam trawl survey was undertaken on the 22nd October 2013 and any notable observations from individual trawls were recorded on the survey log.

2.2.2 Seine Net Surveys

As outlined in the MEMMP seine net surveys were undertaken at eight locations on the south bank of the Humber with four sites in the vicinity of the development (impact area) and four sites further north (upstream) to act as controls. Survey locations followed those utilised for the spring 2013 surveys and were undertaken using a 4m rigid inflatable dinghy (RIB) as the deployment vessel to deploy and recover the seine net which allowed access into the shallow intertidal area. In addition the 12m survey catamaran Precision 1, owned and operated by Precision Marine Survey Limited, was used as a base vessel for the survey operations. Special dispensation to survey was requested from the Marine Management Organisation (MMO) and the North Eastern Inshore Fisheries and Conservation Authority (NEIFCA). Following further discussion with the MMO it was determined that dispensation was not required as the vessel was a survey boat and not a fishing vessel, dispensation was required by the NEIFCA, which was issued prior to the commencement of the survey.

The seine net was comprised of a 100m net standing 3m high from the leaded base line to the buoyed headline. The mesh size in the outer panels was 10mm reducing to 3mm in the cod end. In order to safely access the intertidal zone investigate the fish assemblage within the intertidal zone and in close proximity to the development zone and control stations upstream of the impact area, the seine net was deployed from a RIB. The methodology followed that prescribed by the Environment Agency for the Water Framework Directive's transitional fish surveillance (EA, 2013).

Recommendations within the guidelines dictate that at least two hauls should be undertaken within site area, ideally at low slack although high slack may be needed at shallow upstream sites (EA, 2013). Standard seine nets of 100m in length and 3m high were used to ensure the compatibility of sampling gears with those likely used during EA WFD surveys in the Humber.

At each survey site the vessel crew deployed one end of the seine net and with the net loaded onto the bow end of the deployment vessel which reversed away from the mudflat tide mark, ensuring that the net deployed smoothly from the boat. The deployment vessel paid out the net in a horseshoe shape across the intertidal zone, migrating back to the point of origin i.e. to the seine net anchor point. At this point the deployment vessels engine was shut off and the seine net was hauled back to the tide mark, with surveyors ensuring that the lead line maintained bottom contact and that the head line did not sink below the surface. As the net is hauled the surveyors move closer to one another to create a "purse" shape.

Once the net had been recovered, the cod end was emptied into a sample container and the net was checked for any remaining epifauna and fish. The sample was handed to crew aboard the main survey vessel for fixing prior to deployment to the next sampling station to continue the survey. The seine net surveys were undertaken on the 5th November 2013 and any notable observations from individual trawls were recorded on the survey log.

2.2.3 Otter Trawl Surveys

The otter trawl survey was undertaken aboard the 12m survey catamaran Precision 1, owned and operated by Precision Marine Survey Limited. This survey was designed to investigate the fish assemblage within the subtidal regions of the Humber estuary in the vicinity of the development zone and control stations upstream and downstream of the impact area.

The otter trawl was comprised of a fishing net attached to steel v shaped boards either side of the trawl and which are commonly referred to as a V-doors. The 2'6" V doors were attached to bridles and ultimately warps which led back to the survey vessel and were attached to the vessels main winch. The main winch was responsible for the deployment and recovery of the trawl as well as dictating the depth at which the trawl fished, in this instance, the otter trawl was set to fish hard on the river bed, so the length of warp paid out was usually a minimum of 3 ½ times the depth to the sea bed depending on tidal conditions. Some areas of the survey area included areas of rough boulder clay and gravel/sand waves or other obstructions (debris) which increased the possibility of snagging/tearing nets and as such certain sites were relocated following dummy runs along the trawl path to assess seabed conditions.

The otter trawl net was constructed on a 60mm outer mesh bag with an inner mesh lining of 22mm, with a 6mm cod end, the fishing line of the trawl was 2.5 fathoms (5m), the foot rope was fitted with 100mm discs to prevent snagging on sea bed obstacles. The methodology followed that prescribed by the Environment Agency for the Water Framework Directive's transitional fish surveillance (EA, 2013). PMSL utilised a 2.5 fathom otter trawl and carried out two sets of trawls at each station to allow compatibility with 5 fathom otter trawls and trawl paths were ran adjacent to each other to avoid interaction between trawl paths. The location, direction and path of all trawls was logged by the vessels GPS and uploaded to GIS software to illustrate the actual route of the trawl.

Following standard EA WFD guidelines standard otter trawl durations are typically 30 minutes, however the WFD programme allows for fragmentation of surveys such that trawling may be split into shorter intervals (e.g. two 15 minute tows) and the results pooled. This approach is typically used over rough ground to reduce damage to fish caught, or if the site is too limited to allow a full 30 minute single tow. Such an approach may be used to provide replication or to allow data to be subsequently pooled to ensure compatibility with other surveys. For the current survey, due to the restrictions in sampling within an estuary (including difficult ground, vessel traffic or other obstructions) and the spatial scale of the survey design standard 30 minute tows would not be feasible at standard tow speeds as the sampling stations and control/impact areas would overlap. Therefore in order to be comparable to other studies which are not constrained by sampling scale (e.g. WFD and other EA surveys) and following consultation with former members of the implementation team with responsibility for the fish component of the Water Framework Directive and in line with the EA guidance the trawl duration was reduced to 15 minutes per trawl. At each site four trawls taken in total per otter trawl location along adjacent tow lines. A total of 12 otter trawl locations were surveyed during the survey to provide coverage throughout the middle stretch of the Humber estuary with four stations in the vicinity of the development area (impact area) and four otter trawl stations located both upstream and downstream of the impact zone to act as control stations.

The otter trawl surveys were undertaken during November and December 2013 and special dispensation to trawl was requested from the Marine Management Organisation (MMO) and the North Eastern Inshore Fisheries and Conservation Authority (NEIFCA). Following further discussion with the MMO it was determined that dispensation was not required as the vessel was a survey boat and not a fishing vessel, dispensation was required by the NEIFCA, which was issued prior to the commencement of the survey.

At each survey location, the proposed tow path was covered during a trial run to assess ground conditions or other potential obstructions. Prior to deployment of the trawl the survey vessel continued at a steady rate (1 - 2 knots) against the direction of the tide and the net was released over the stern of the vessel and once the net was clear of the vessel, the bridles were connected to the trawl doors, which were released and lowered over each side of the vessel using the winch. The winch then paid out the warp until the otter trawl hit the seabed, and when depending on the water depth, additional trawl warp was paid out until the length of warp was greater or equal to 3 ½ times the water depth. Once the required length of warp was paid out the winch was locked and the trawl towed for a duration of 15 minutes.

The start point for each trawl commenced at the point in which the winch was locked and upon completion of the 15 minute time interval, the trawl was hauled to the surface. The trawl doors were secured to each side of the vessel, the bridles released and secured to the winch and the net was recovered aboard the vessel. The cod end was lifted aboard via a lifting boom and then opened over a stainless steel hopper to contain the whole catch, with the net then checked for any remaining epifauna and fish, the cod end was then fastened prior to redeployment at the next station.

The total volume of the catch was assessed and the catch then sorted with the fish species separated from the epifaunal invertebrates. Any notable observations from individual trawls were recorded in the survey log (e.g. large quantities of shell, rocks, cobbles, weed or other debris etc.). The samples of fish which required further assessment were preserved in 10% sea water buffered formalin for subsequent analysis.

The results of the intertidal and subtidal fish surveys and locations of survey sites are provided in Section 4.

2.3 Laboratory Analysis

All laboratory methodologies were based on best practice and followed tried and tested method statements widely acknowledged within the industry (Ware & Kenny, 2011; Worsfold & Hall, 2010; Cooper & Rees 2002; Rees, 1999; Barnett, 1993; Rees et al, 1990). PMSL are members of the National Marine Biological and Analytical Quality Control scheme (NMBAQC).

Two experienced members of PMSL undertook the sample sorting, conducting all the sieving, sorting work and sample description with a further member of staff carrying out standard sorting quality control. Experienced taxonomists carried out the identification of the sorted fauna, with an additional member of staff carrying out quality control for faunal identification. A standard sample tracking procedure was followed throughout the analysis period.

2.4 Sorting of Invertebrate Samples

Each sample was sieved in freshwater water and then rinsed with running tap water through a 0.5mm stainless steel sieve with a nest of 20cm diameter 5mm and 1mm sieves used as required for any coarser material. The sieve contents were backwashed over a white tray to catch any potential spillage, into pre-labelled plastic storage buckets. A borax buffered 4% saline formalin solution was then added to the samples. The samples were then well mixed and stored for at least 48 hours to ensure adequate preservation and shaken once during the period.

Prior to identification each sample was washed through a nest of sieves, with the smallest mesh aperture of 0.5mm, to remove the preservative and partition the sample for ease of sorting. The residue from each sieve was then gently washed into separate white trays. Water was added to the trays and the contents agitated. Immediately after agitation, the light fraction was decanted to another tray. This procedure was repeated up to 3 times, and each tray of light fractions examined as a sub-sample of the heavy fraction. The trays were marked with the appropriate sample code (relating to the client, date, specific site, sample and replicate number). All fractions were then decanted into separate 100mm Petri dishes and examined under a stereoscopic microscope with 20x eyepieces giving a maximum magnification of up to 80x. The fauna derived was added to the retained containers, preserved and stored ready for identification. Each petri dish was checked for a final time by another member of staff.

2.5 Taxonomic Identification

Identification was carried out using Olympus SZ40 zoom microscopes with 10x and 20x eyepieces, giving a maximum magnification of up to 80x. An additional 2x objective was occasionally used to increase the potential magnification to 160x. Olympus BX41 compound microscopes were used for further magnification, up to 800x.

Identification of infaunal samples was to the lowest possible taxonomic level (i.e. species), and during identification, all individuals were initially separated into families, with part animals being assigned to families where possible. The macrofaunal specimens were identified to species level using standard taxonomic keys, low and high power stereoscopic microscopes and dissection when necessary, for identification. Incomplete animals without anterior ends are not recorded as individuals to be included in the quantitative dataset. However, they were identified where possible and recorded as present. Similarly, motile and colonial sessile epibenthic taxa and meiofauna were only recorded as present and not included within the infaunal quantitative data set.

Fish species collected were identified using Wheeler, (1969) and Whitehead *et al.* (1989) and length frequency analysis of key species undertaken as required.

As part of the standard quality assessment (QA) procedure, regular cross-reference identification was carried out. Each sample residue was described textually with the residue retained for possible further analysis and Analytical Quality Control (AQC). All fauna will be retained under the standard codes for 2 years or returned to the clients representative for further analysis and AQC should this be required.

The taxonomic literature used is essentially as given in Rees et al (1990) and reporting nomenclature was based on that of the Species Directory of the Marine Fauna and Flora of the British Isles and Surrounding Seas (Howson & Picton, 1997), with updated nomenclature as required following WoRMS standards (Appletans *et al*., 2010).

2.6 Biomass of Invertebrates

Biomass analysis was performed by wet weight (tissue blotted) and carried out for individual species in each sample. Each taxa was placed on blotting paper for 30 seconds to allow absorption of preservative into the blotting paper. Following this time period the individuals were placed on the microbalance and the reading taken. The macrofaunal organisms were then placed back in their respective pots and stored. Biomass calculations include all identifiable fragments and calculated to ± 0.0001g, all biomass data was recorded in grams or fractions thereof. Following collation of wet weight biomass data conversions to Ash Free Dry Weight Biomass were undertaken using coefficients derived from Rumohr et al. (1987) and Ricciardi and Bourget (1998) for comparison with targets. Following analysis each specimen was returned to its sample pot and stored in 70% IMS (Industrial Methylated Spirits).

2.7 Particle Size Analysis (PSA)

The particle size analysis was carried out by a combination of dry sieving and laser particle size analysis (for the fraction <1mm) using a Malvern Mastersizer 3000. Prior to analysis, photographs were taken of all samples. The sediment samples were then split with one sub-sample being passed through a 1mm sieve to remove the larger size classes of sediment if required. The <1mm fraction of the sample was then analysed using the Malvern Mastersizer 3000 and the >1mm fraction discarded. The second sub-sample of coarser material (if present) was passed through a nest of sieves at 0.5 phi intervals. Each fraction, including the <1mm fraction, was then oven dried at 85°C for 24 hours and weighed. Data generated from these methods was analysed separately but for visualisation purposes the finer fractions were also merged to the coarse fraction (if present) to provide an overall grain size distribution for each sample – although it is acknowledged that merging of such datasets can be problematic due to differing techniques. The data derived from PSA was then used to derive statistics such as mean grain size, bulk sediment classes (% silt, sand & gravel), skewness and sorting coefficient using the program Gradistat. These methods are consistent with the procedures identified at the NMBAQC PSA workshop on laboratory methods, which was held at the Cefas Lowestoft laboratory in July 2009.

Estimates of total organic carbon were determined by loss on ignition. Each sample was oven dried at 105ºC until the weight stabilises (± 0.01g). The weight of the sample was recorded and the sample was then placed into a kiln at 480ºC for six hours. Once the sample had cooled the sample was then re-weighed and the difference between the two weights expressed as the percentage loss on ignition (% LOI).

3. Intertidal Benthic Survey Results

As described in Section 2 In total 145 samples were collected along 16 transects at North Killingholme whilst 58 samples were collected from Cherry Cobb Sands from 6 transects. The location of sampling sites surveyed during the intertidal survey is provided in Figures 1 and 2.

3.1 Sedimentary Parameters

3.1.1 North Killingholme

A summary of sedimentary parameters from survey sites at North Killingholme are provided in Table 1 with the full data provided in Appendix 1. The mean values of key sedimentary parameters for each survey area and shore position are provided in Figures 3 to 8 whilst maps showing sediment composition, sediment type and median phi grain size are given in Figures 9, 11 and 13.

Sediments at North Killingholme were relatively uniform sandy muds or mud and correspond to the sediment types recorded during the spring 2013 survey. Median phi grain sizes showed relatively little variation across the survey area and ranged 4.6 to 6.6 phi with slightly larger values (finer sediments) in upper shore areas. Gravels were generally absent aside from a few samples (NKM 3.2 MA and NKM 1.7 UA) which had very low quantities of gravel (<1%). Mud content ranged from 68.5% to 97.8% and the majority of sites had sediments with greater than 80% mud and a number of sites (primarily on the upper shore) had sediments classified as mud with in excess of 90% mud content. Sand content ranged from 5% to 31.5% with higher values of sand content generally recorded at sites on the lower shore.

All sites at North Killingholme were characterised by sediments which were poorly sorted whilst sediment skewness was quite variable with sediments ranging from coarse skewed to very fine skewed. The majority of sites exhibited fine skewed or symmetrical distributions with coarser skewed sediments generally recorded in muddier upper shore habitats. Levels of organic content (represented by % LOI) were low to moderate with % LOI ranging from 4% to 11.7% and higher values were generally at upper shore sites and particularly those adjacent to saltmarsh. Overall there were relatively few obvious differences between the different survey areas and sedimentary parameters were very similar to those recorded during the spring survey. The only other feature of note in terms of sediment were the presence of small areas of barren pebbles on extreme low shore mud at the upstream end of the northern indirect impact area adjacent to Humber Sea Terminal. These were adjacent to the survey transects and not amenable to coring but appear to have a similar mud habitat beneath the pebbles.

3.1.2 Cherry Cobb Sands

A summary of sedimentary parameters from survey sites at Cherry Cobb Sands are provided in Table 2 with the full data provided in Appendix 2. Mean values of key sedimentary parameters for the northern and southern control areas are provided per shore area in Figures 3 to 8 whilst maps showing sediment composition, sediment type and median phi grain size are given in Figures 10, 12 and 14. Sediments at Cherry Cobb Sands were quite heterogeneous and exhibited much more variability than at North Killingholme with a similar range of sediments to those recorded during the spring 2013 survey. Sediments included (slightly muddy) sands, muddy sands and sandy mud with occasional slightly gravelly sandy muds. Median phi grain size ranged from 2.6 to 6.06 phi with progressively higher values (finer sediments) recorded higher up the shore. Mud content ranged from 2% to 88% and whilst the majority of sites in the northern control area had mud contents in excess of 60% and less than 30% sand (sandy mud) a number of sites, primarily on the low shore, exhibited mud contents below 50% and a correspondingly higher sand content and were classified as muddy sands.

Sediments were generally sandier in the southern control area with the exception of the upper shore areas which were generally characterised by muddy sediment (67% to 80% mud). Sediments on the mid shore were more variable and included sandy muds, muddy sands or sand (e.g. site S3 MB2 in the vicinity of the *Arenicola* bed on transect S3). Whilst somewhat variable the lower shore sites in the southern control area were generally much sandier with sand content ranging from 35% to 98% whilst mud content ranged from 2% to 64.5%. Three sites on the low shore had a particularly low mud content (<10%) with predominantly sandy sediments (sites S2 LB, S2 LC and S3 LC).

The majority of CCS sites exhibited poorly sorted sediments with the exception of those characterised by sandier sediments which tended to be moderately sorted and a greater level of variability was evident in the southern control area. Sediment skewness was variable and sediments ranged from very fine skewed to symmetrical and sites on the upper shore tended to have lower skewness values particularly in the northern control area which predominantly had symmetrical distributions. Levels of organic matter in the sediment as expressed by % LOI were similar to those recorded at North Killingholme but generally slightly lower (particularly at sandier sites) with values ranging from 1.35% to 9.09%. As at North Killingholme higher levels of organic matter tended to be recorded at the muddier areas particularly on the upper shore with a general increase in % LOI from low shore to upper shore and higher values in the northern control area.

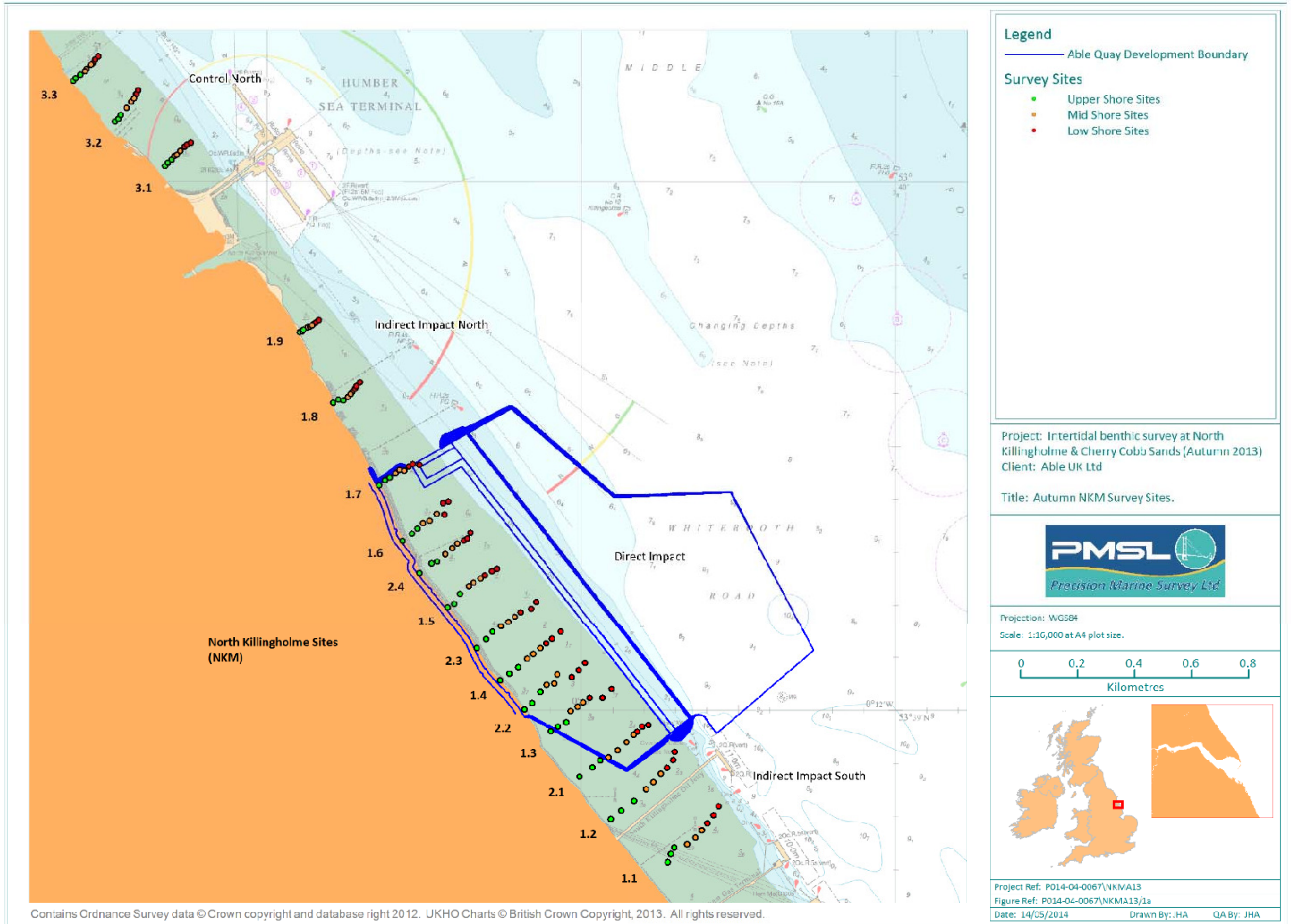

Figure 1. Location of survey sites at North Killingholme (NKM).

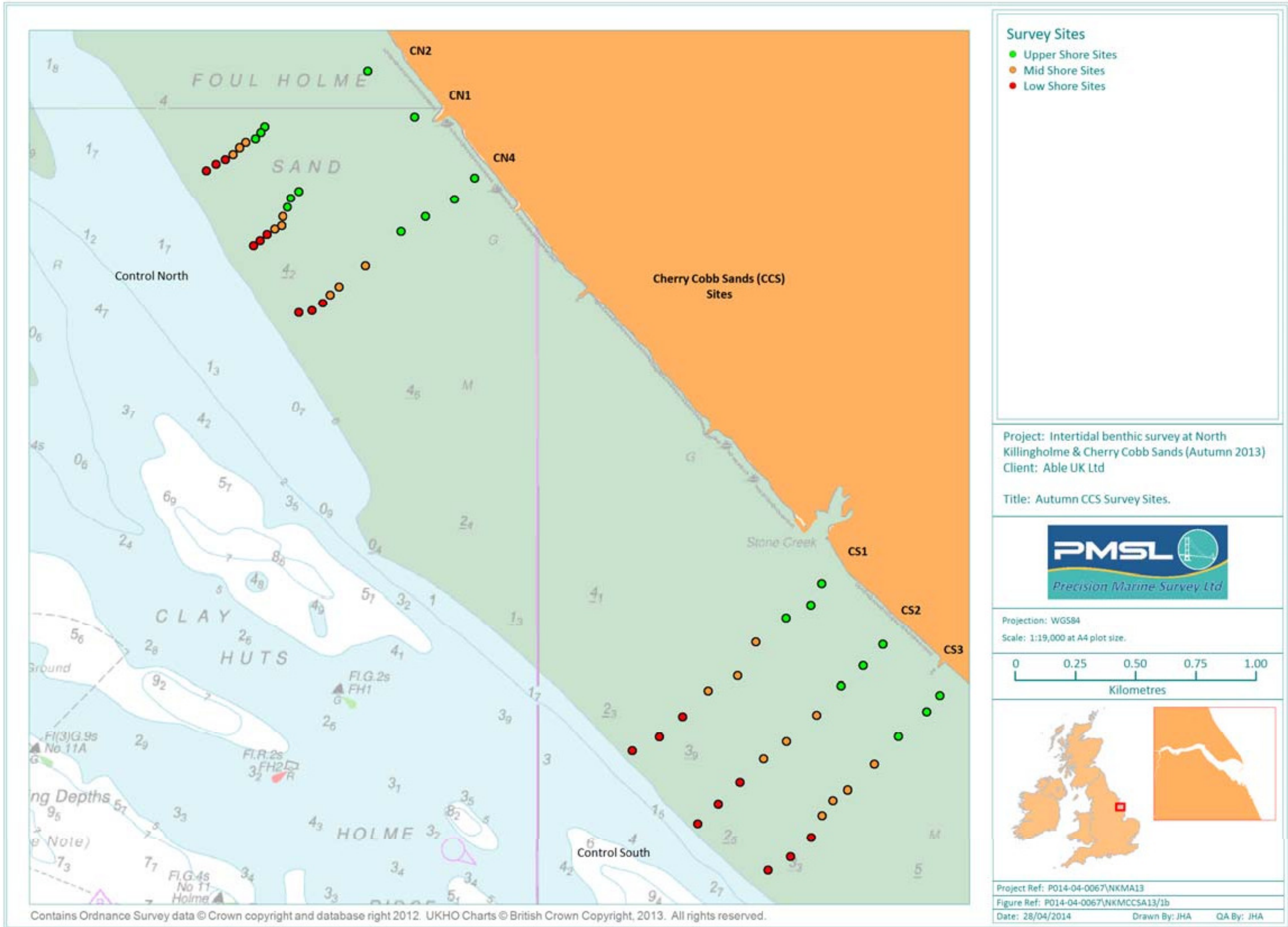

Figure 2. Location of survey sites at Cherry Cobb Sands (CCS).

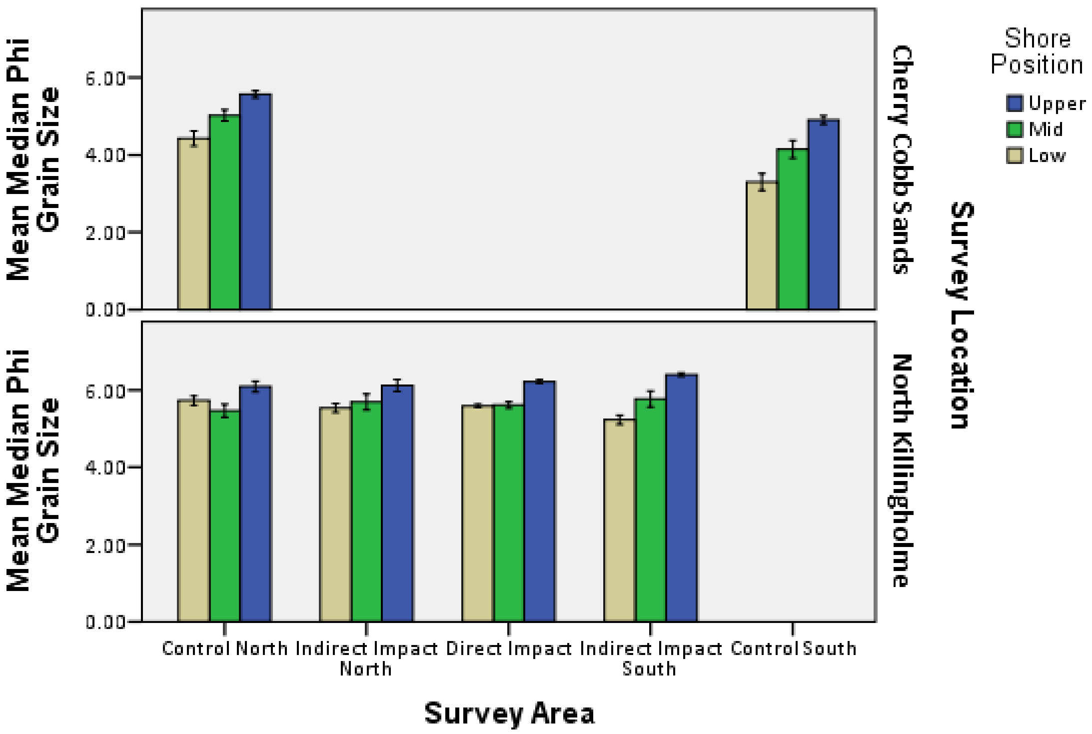

Figure 3. Mean median phi grain size with standard error for each survey area at North Killingholme & Cherry Cobb Sands.

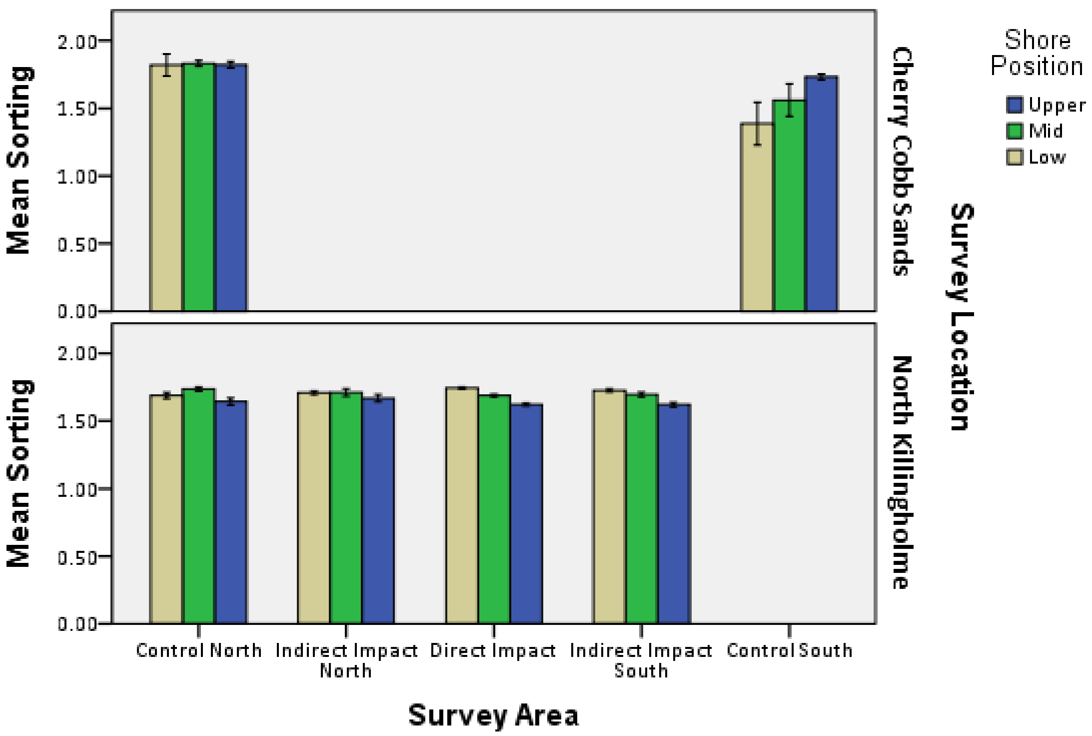

Figure 4. Mean sediment sorting with standard error for each survey area at North Killingholme & Cherry Cobb Sands.

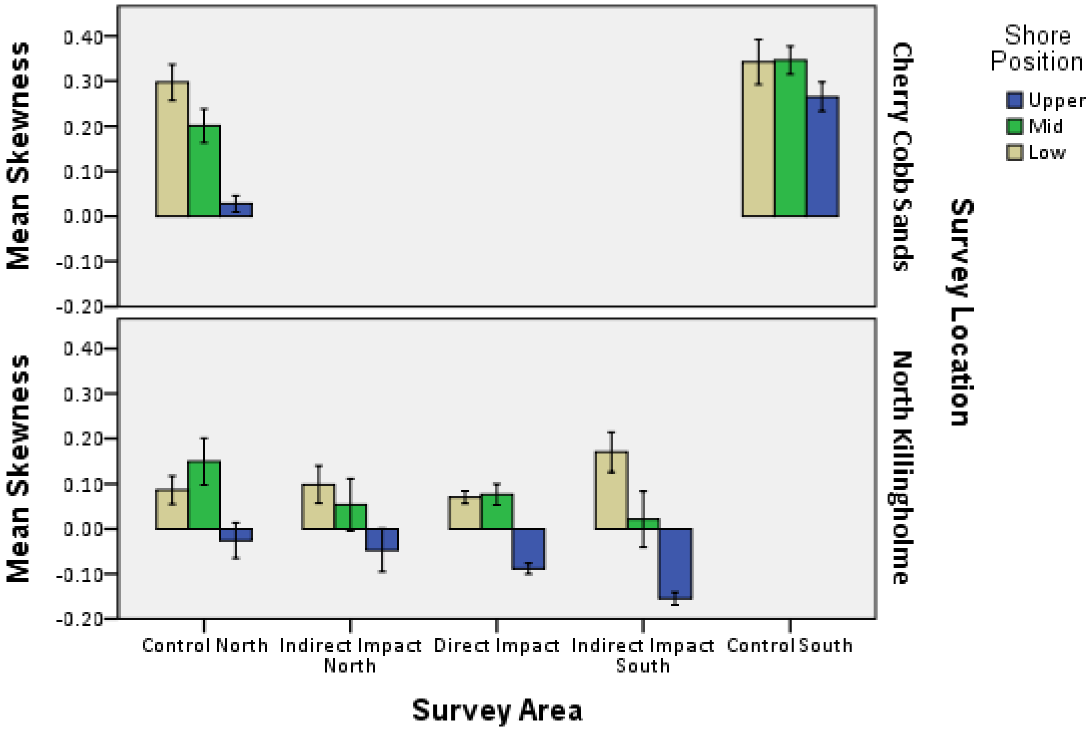

Figure 5. Mean sediment skewness with standard error for each survey area at North Killingholme & Cherry Cobb Sands.

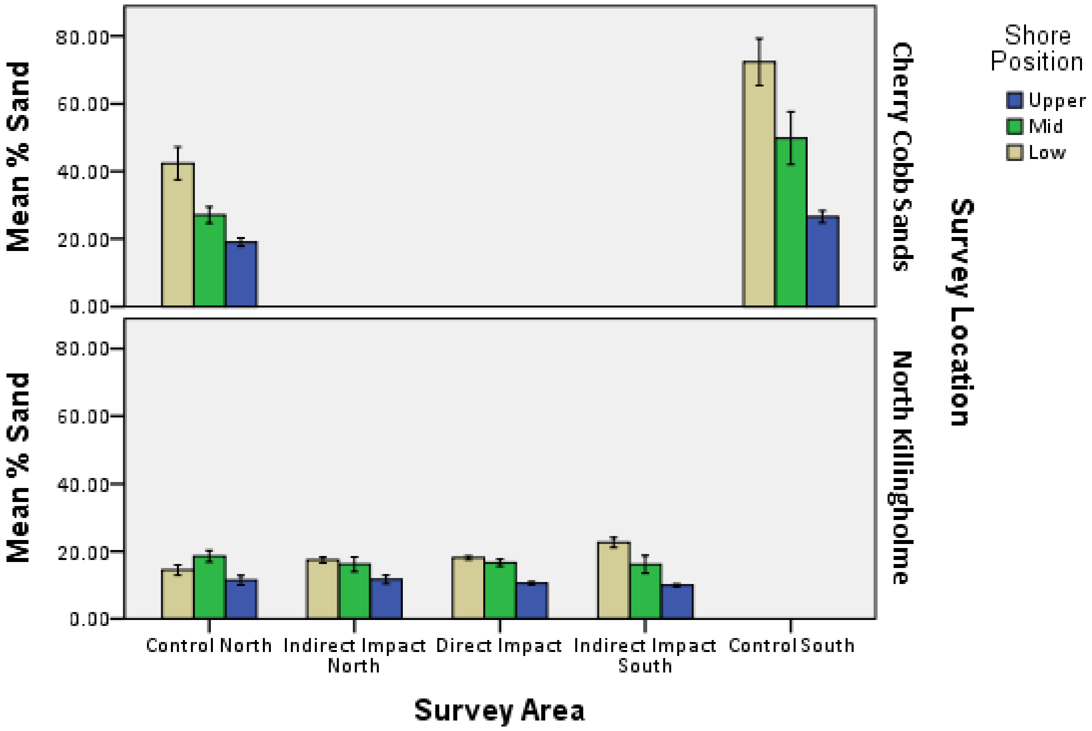

Figure 6. Mean sand content with standard error for each survey area at North Killingholme & Cherry Cobb Sands.

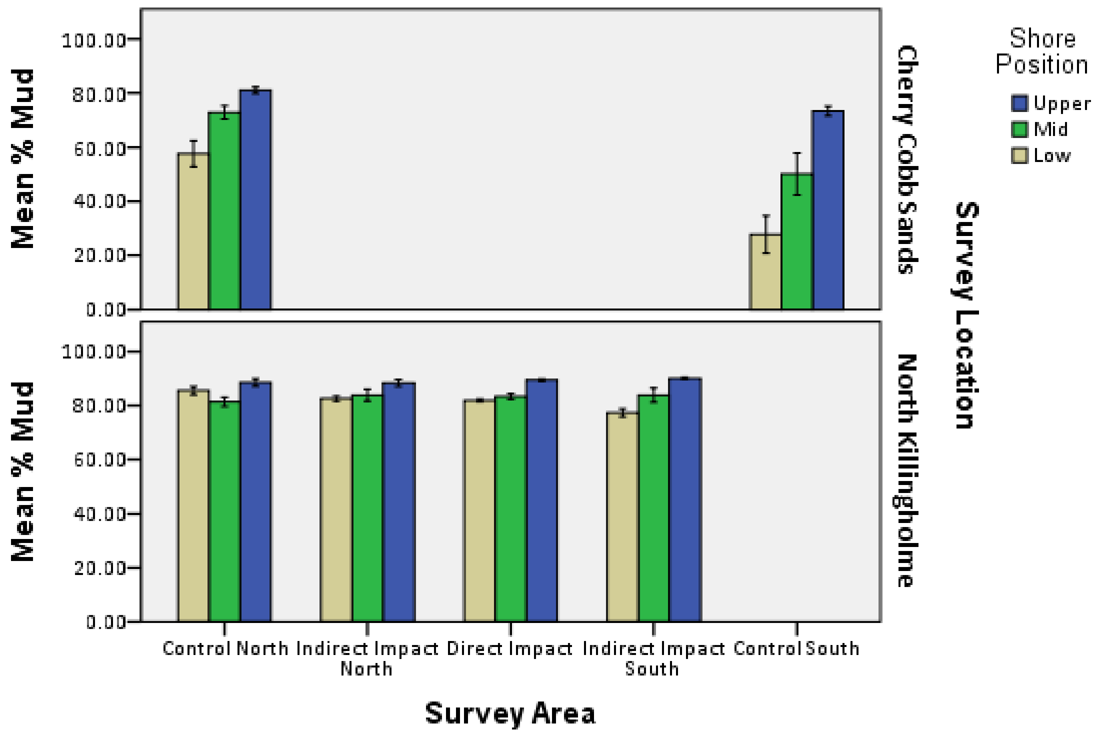

Figure 7. Mean mud content with standard error for each survey area at North Killingholme & Cherry Cobb Sands.

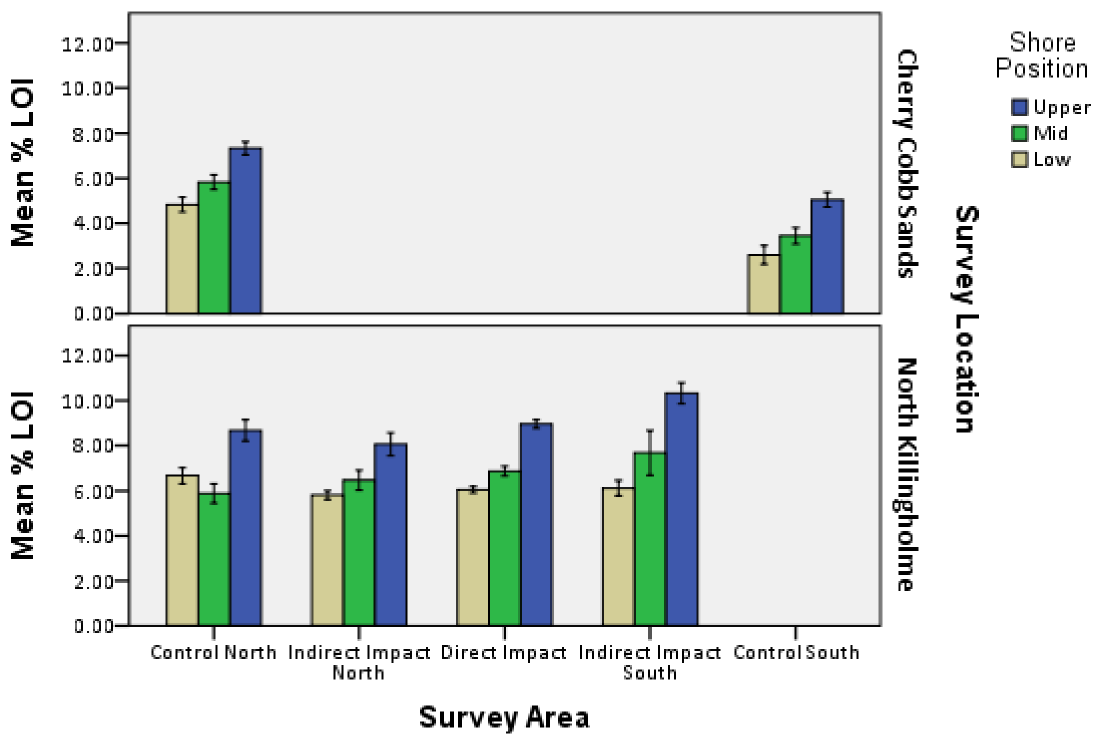

Figure 8. Mean % LOI with standard error for each survey area at North Killingholme & Cherry Cobb Sands.

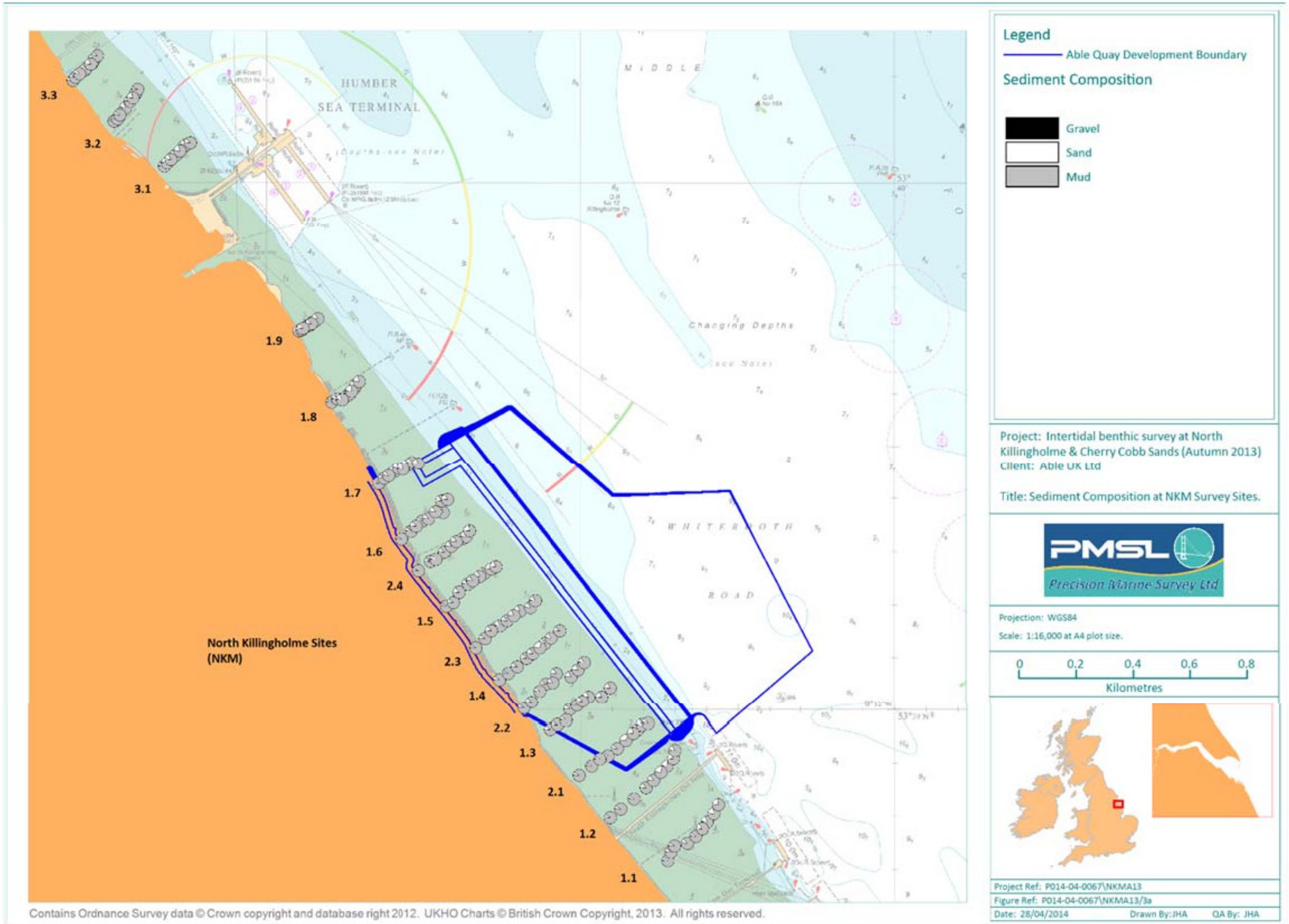

Figure 9. Sediment composition at North Killingholme.

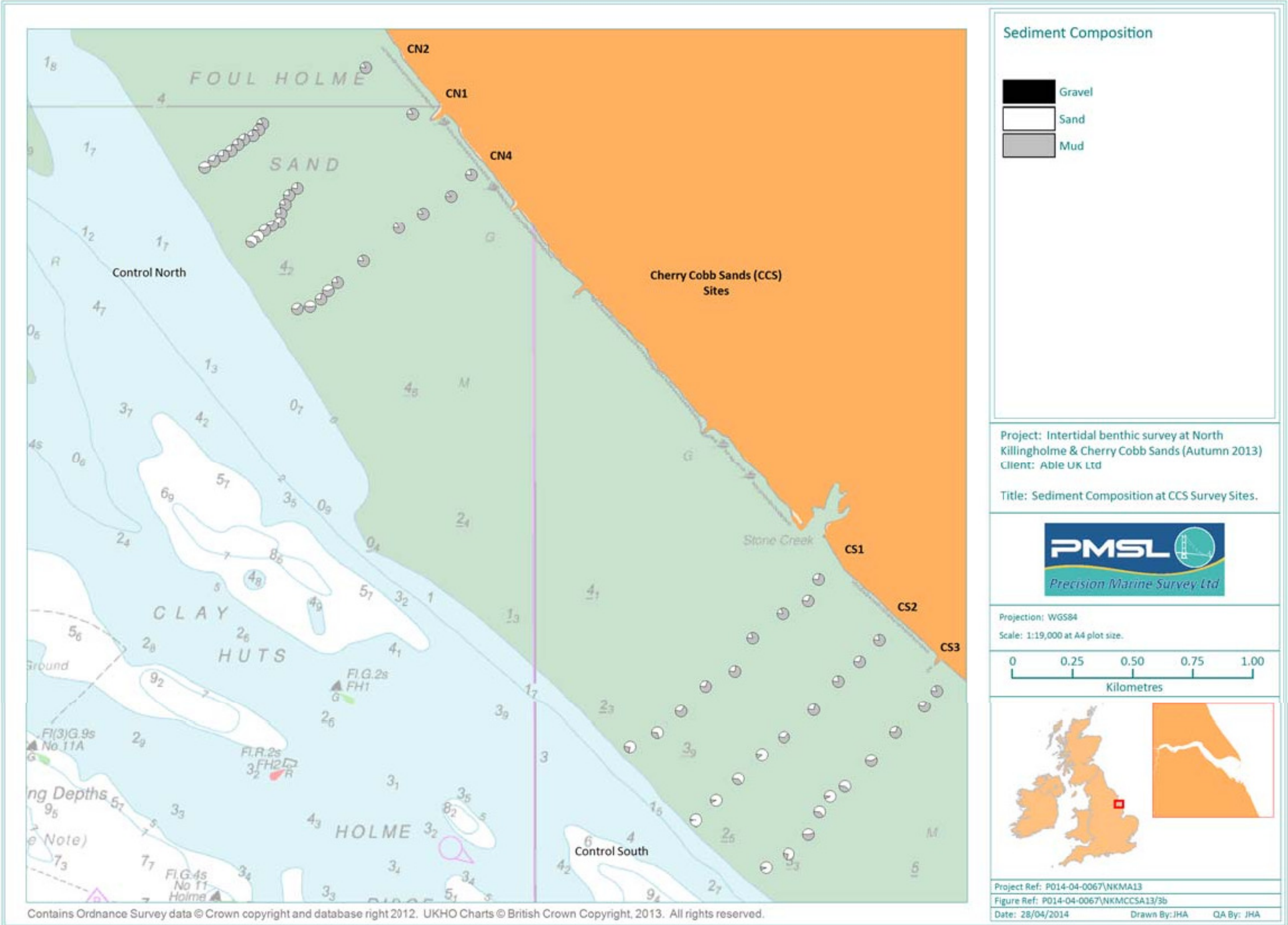

Figure 10. Sediment composition at Cherry Cobb Sands.

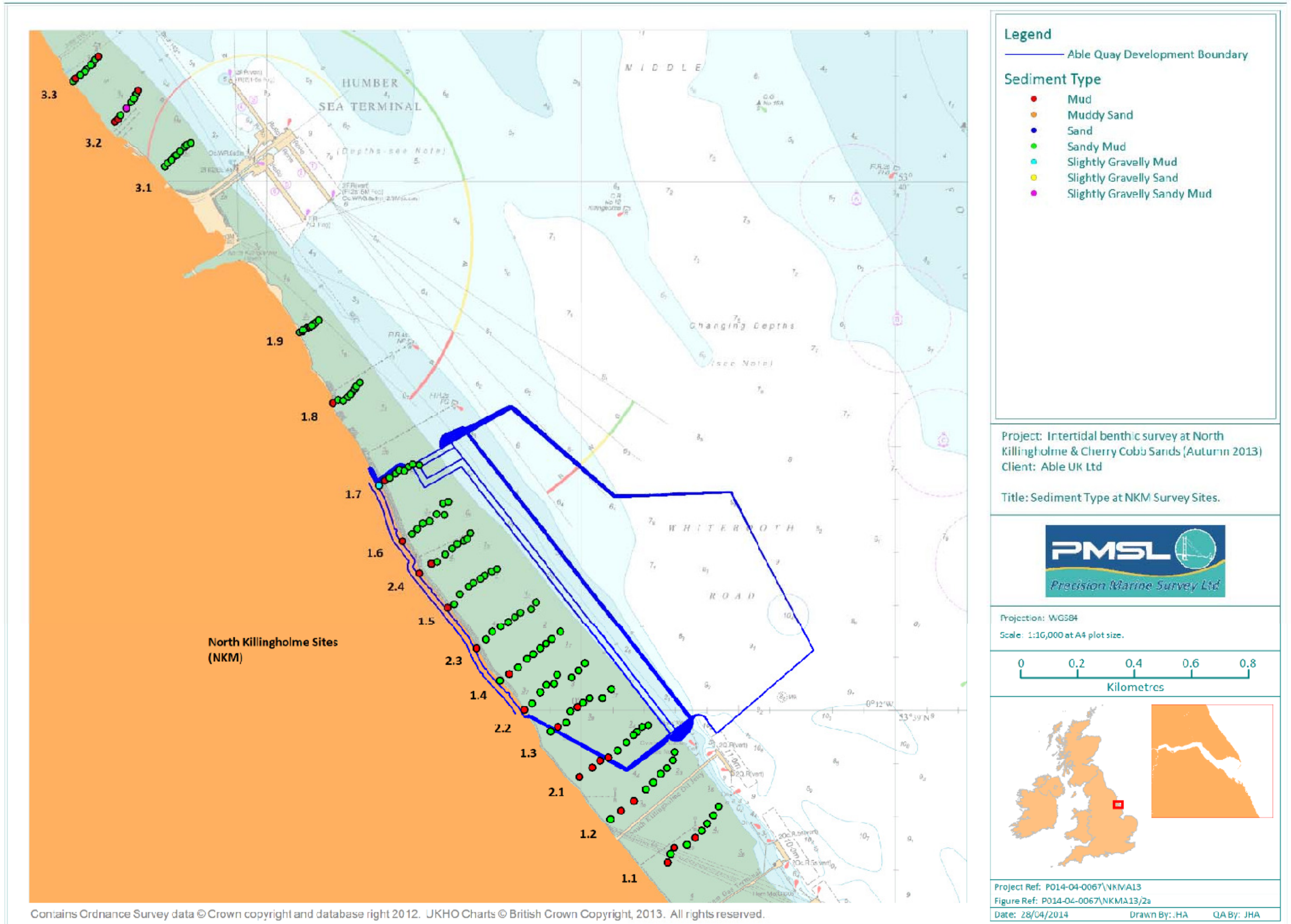

Figure 11. Sediment type at North Killingholme.

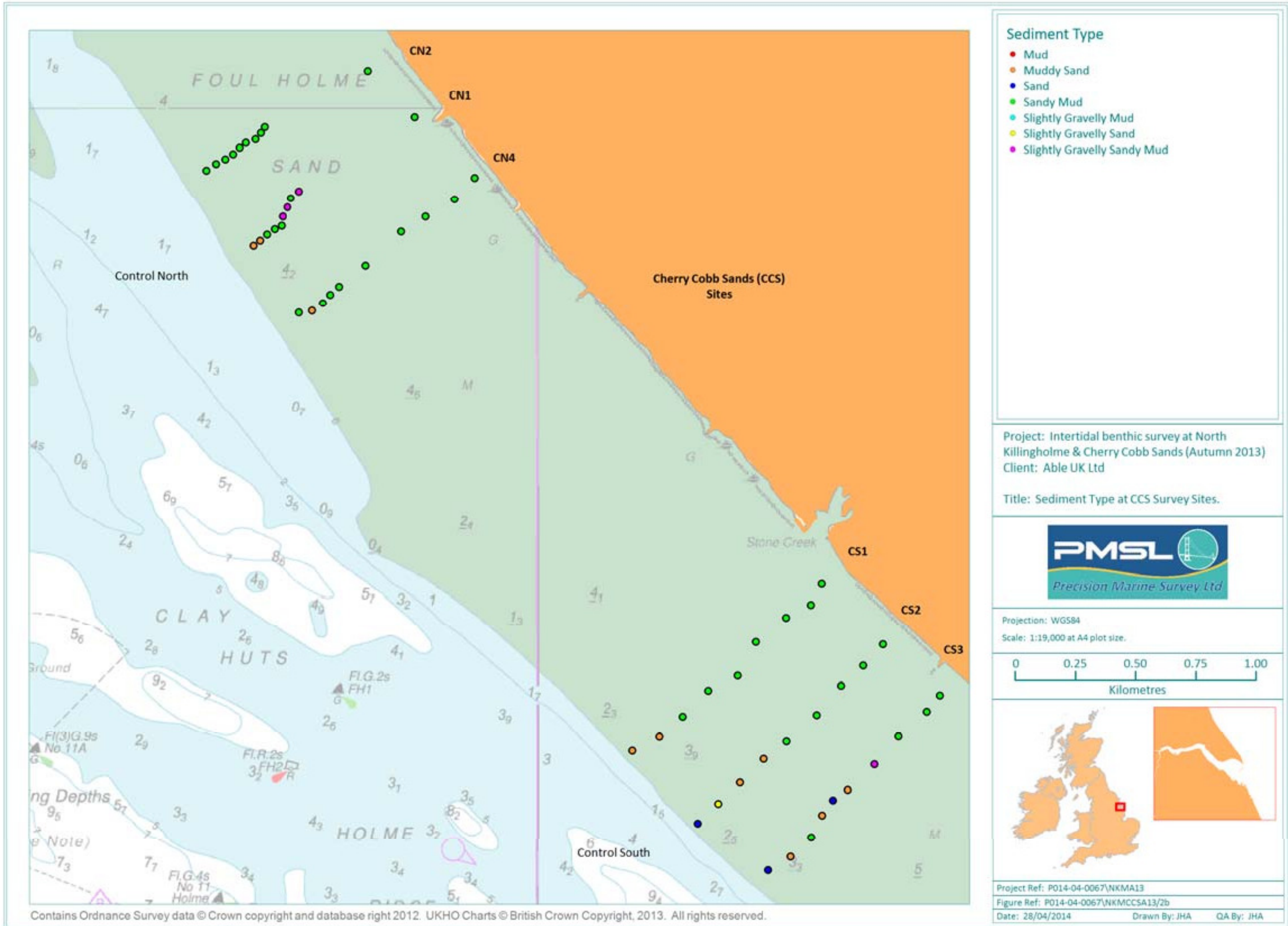

Figure 12. Sediment type at Cherry Cobb Sands.

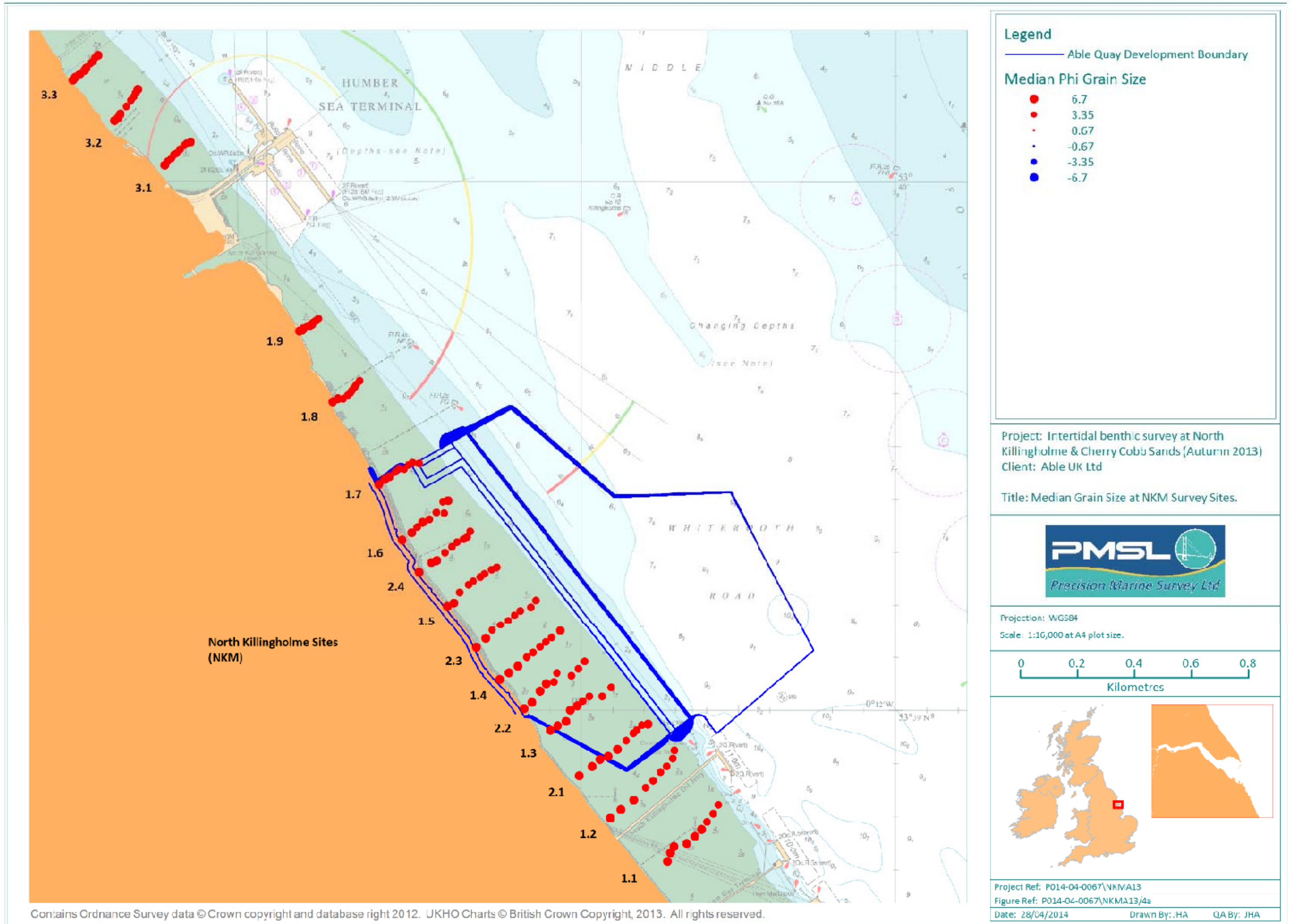

Figure 13. Median phi grain size at North Killingholme.

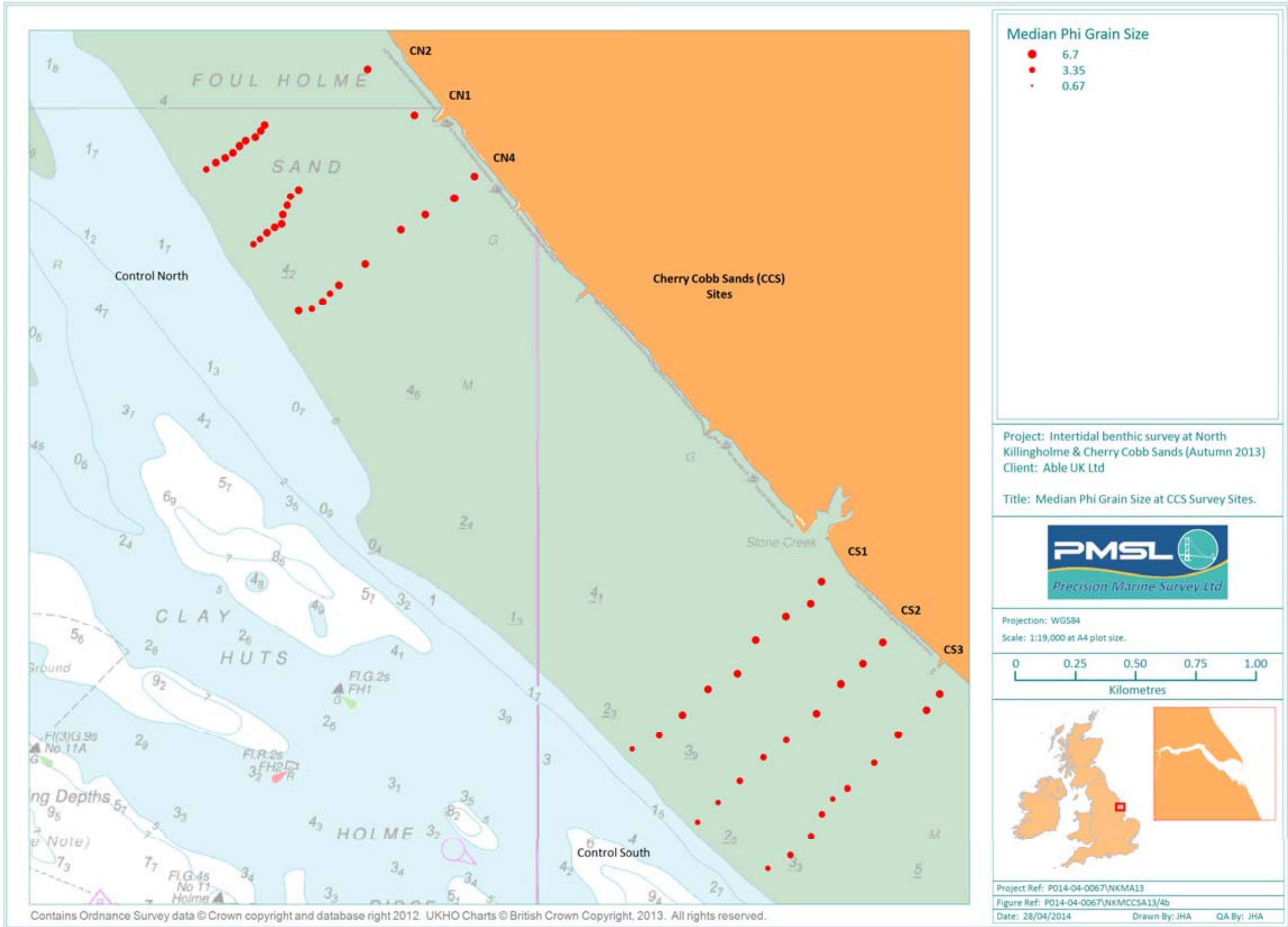

Figure 14. Median phi grain size at Cherry Cobb Sands.

Table 1. Summary of sedimentary parameters at North Killingholme.

AREA	SAMPLE	TEXTURAL GROUP	MEDIAN PHI GRAIN SIZE	MEAN PHI GRAIN SIZE	SORTING		SKEWNESS		% GRAVEL	% SAND	% MUD	% LOI
Control North	NKM 3.1 LA	Sandy Mud	5.098	5.417	1.784	Poorly Sorted	0.230	Fine Skewed	0.00	23.13	76.87	5.81
Control North	NKM 3.1 LB	Sandy Mud	5.836	5.856	1.773	Poorly Sorted	0.002	Symmetrical	0.00	16.69	83.31	6.06
Control North	NKM 3.1 LC	Sandy Mud	5.921	5.967	1.688	Poorly Sorted	0.027	Symmetrical	0.00	12.85	87.15	6.98
Control North	NKM 3.1 MA	Sandy Mud	5.270	5.572	1.711	Poorly Sorted	0.228	Fine Skewed	0.00	18.42	81.58	5.45
Control North	NKM 3.1 MB	Sandy Mud	4.948	5.371	1.775	Poorly Sorted	0.315	Very Fine Skewed	0.00	25.48	74.52	4.04
Control North	NKM 3.1 MC	Sandy Mud	5.167	5.492	1.783	Poorly Sorted	0.233	Fine Skewed	0.00	21.79	78.21	5.27
Control North	NKM 3.1 UA	Sandy Mud	6.215	6.134	1.687	Poorly Sorted	-0.105	Coarse Skewed	0.00	11.78	88.22	9.64
Control North	NKM 3.1 UB	Sandy Mud	5.447	5.665	1.715	Poorly Sorted	0.156	Fine Skewed	0.00	17.06	82.94	6.76
Control North	NKM 3.1 UC	Sandy Mud	5.363	5.629	1.714	Poorly Sorted	0.199	Fine Skewed	0.00	17.73	82.27	6.18
Control North	NKM 3.2 LA	Sandy Mud	5.734	5.844	1.629	Poorly Sorted	0.081	Symmetrical	0.00	12.85	87.15	7.35
Control North	NKM 3.2 LB	Sandy Mud	5.666	5.811	1.701	Poorly Sorted	0.107	Fine Skewed	0.00	15.20	84.80	6.17
Control North	NKM 3.2 LC	Mud	6.253	6.254	1.577	Poorly Sorted	-0.016	Symmetrical	0.00	7.37	92.63	8.54
Control North	NKM 3.2 MA	Slightly Gravelly Sandy Mud	5.387	5.616	1.790	Poorly Sorted	0.154	Fine Skewed	0.43	19.18	80.40	5.52
Control North	NKM 3.2 MB	Sandy Mud	5.138	5.466	1.766	Poorly Sorted	0.245	Fine Skewed	0.00	22.32	77.68	5.06
Control North	NKM 3.2 MC	Sandy Mud	5.249	5.499	1.728	Poorly Sorted	0.188	Fine Skewed	0.00	20.54	79.46	6.16
Control North	NKM 3.2 UA	Mud	6.646	6.560	1.494	Poorly Sorted	-0.105	Coarse Skewed	0.00	5.23	94.77	9.99
Control North	NKM 3.2 UB	Mud	6.348	6.294	1.579	Poorly Sorted	-0.072	Symmetrical	0.00	7.97	92.03	9.35
Control North	NKM 3.2 UC	Sandy Mud	6.180	6.154	1.631	Poorly Sorted	-0.046	Symmetrical	0.00	10.12	89.88	8.45
Control North	NKM 3.3 LA	Sandy Mud	5.331	5.621	1.697	Poorly Sorted	0.219	Fine Skewed	0.00	17.08	82.92	6.27
Control North	NKM 3.3 LB	Sandy Mud	5.588	5.779	1.705	Poorly Sorted	0.134	Fine Skewed	0.00	15.04	84.96	5.21
Control North	NKM 3.3 LC	Mud	6.130	6.149	1.639	Poorly Sorted	-0.006	Symmetrical	0.00	9.83	90.17	7.63
Control North	NKM 3.3 MA	Sandy Mud	6.282	6.200	1.650	Poorly Sorted	-0.077	Symmetrical	0.00	10.08	89.92	6.80
Control North	NKM 3.3 MB	Sandy Mud	6.380	6.228	1.675	Poorly Sorted	-0.140	Coarse Skewed	0.00	11.00	89.00	8.68
Control North	NKM 3.3 MC	Sandy Mud	5.355	5.625	1.739	Poorly Sorted	0.195	Fine Skewed	0.00	18.28	81.72	6.01
Control North	NKM 3.3 UA	Sandy Mud	6.033	5.990	1.684	Poorly Sorted	-0.065	Symmetrical	0.00	13.13	86.87	10.40
Control North	NKM 3.3 UB	Mud	6.391	6.324	1.585	Poorly Sorted	-0.080	Symmetrical	0.00	7.94	92.06	8.35
Control North	NKM 3.3 UC	Sandy Mud	6.208	6.125	1.700	Poorly Sorted	-0.113	Coarse Skewed	0.00	11.94	88.06	8.92
Direct Impact	NKM 1.3 LA	Sandy Mud	5.408	5.526	1.760	Poorly Sorted	0.068	Symmetrical	0.00	20.30	79.70	5.68
Direct Impact	NKM 1.3 LB	Sandy Mud	5.447	5.642	1.731	Poorly Sorted	0.140	Fine Skewed	0.00	18.52	81.48	5.64
Direct Impact	NKM 1.3 LC	Sandy Mud	5.668	5.733	1.755	Poorly Sorted	0.036	Symmetrical	0.00	17.88	82.12	6.67
Direct Impact	NKM 1.3 MA	Sandy Mud	6.098	6.040	1.686	Poorly Sorted	-0.081	Symmetrical	0.00	12.45	87.55	8.03
Direct Impact	NKM 1.3 MB	Mud	6.364	6.248	1.610	Poorly Sorted	-0.122	Coarse Skewed	0.00	9.67	90.33	8.37
Direct Impact	NKM 1.3 MC	Sandy Mud	5.809	5.812	1.718	Poorly Sorted	-0.021	Symmetrical	0.00	15.96	84.04	8.14
Direct Impact	NKM 1.3 UA	Sandy Mud	6.257	6.168	1.642	Poorly Sorted	-0.119	Coarse Skewed	0.00	11.04	88.96	9.02
Direct Impact	NKM 1.3 UB	Mud	6.484	6.361	1.576	Poorly Sorted	-0.137	Coarse Skewed	0.00	8.23	91.77	9.96

AREA	SAMPLE	TEXTURAL GROUP	MEDIAN PHI GRAIN SIZE	MEAN PHI GRAIN SIZE	SORTING		SKEWNESS		% GRAVEL	% SAND	% MUD	% LOI
Direct Impact	NKM 1.3 UC	Sandy Mud	6.088	6.070	1.603	Poorly Sorted	-0.038	Symmetrical	0.00	10.74	89.26	8.38
Direct Impact	NKM 1.4 LA	Sandy Mud	5.808	5.850	1.681	Poorly Sorted	0.016	Symmetrical	0.00	14.53	85.47	6.45
Direct Impact	NKM 1.4 LB	Sandy Mud	5.621	5.764	1.697	Poorly Sorted	0.098	Symmetrical	0.00	15.55	84.45	5.80
Direct Impact	NKM 1.4 LC	Sandy Mud	6.084	6.060	1.667	Poorly Sorted	-0.042	Symmetrical	0.00	11.73	88.27	7.74
Direct Impact	NKM 1.4 MA	Sandy Mud	5.814	5.889	1.665	Poorly Sorted	0.040	Symmetrical	0.00	13.11	86.89	7.33
Direct Impact	NKM 1.4 MB	Sandy Mud	5.483	5.654	1.701	Poorly Sorted	0.114	Fine Skewed	0.00	16.89	83.11	5.62
Direct Impact	NKM 1.4 MC	Sandy Mud	4.672	5.063	1.778	Poorly Sorted	0.287	Fine Skewed	0.00	31.52	68.48	6.32
Direct Impact	NKM 1.4 UA	Sandy Mud	6.328	6.227	1.624	Poorly Sorted	-0.129	Coarse Skewed	0.00	10.31	89.69	10.15
Direct Impact	NKM 1.4 UB	Mud	6.296	6.230	1.553	Poorly Sorted	-0.089	Symmetrical	0.00	8.59	91.41	6.98
Direct Impact	NKM 1.4 UC	Sandy Mud	6.036	6.022	1.663	Poorly Sorted	-0.046	Symmetrical	0.00	12.01	87.99	8.44
Direct Impact	NKM 1.5 LA	Sandy Mud	5.387	5.633	1.738	Poorly Sorted	0.175	Fine Skewed	0.00	18.11	81.89	6.19
Direct Impact	NKM 1.5 LB	Sandy Mud	5.211	5.443	1.793	Poorly Sorted	0.158	Fine Skewed	0.00	23.09	76.91	6.60
Direct Impact	NKM 1.5 LC	Sandy Mud	5.494	5.637	1.749	Poorly Sorted	0.102	Fine Skewed	0.00	19.34	80.66	4.84
Direct Impact	NKM 1.5 MA	Sandy Mud	5.842	5.888	1.668	Poorly Sorted	0.010	Symmetrical	0.00	13.31	86.69	7.23
Direct Impact	NKM 1.5 MB	Sandy Mud	5.382	5.548	1.733	Poorly Sorted	0.109	Fine Skewed	0.00	19.29	80.71	5.98
Direct Impact	NKM 1.5 MC	Sandy Mud	5.599	5.762	1.692	Poorly Sorted	0.115	Fine Skewed	0.00	15.47	84.53	6.70
Direct Impact	NKM 1.5 UA	Mud	6.524	6.380	1.569	Poorly Sorted	-0.168	Coarse Skewed	0.00	8.48	91.52	10.01
Direct Impact	NKM 1.5 UB	Sandy Mud	6.145	6.107	1.648	Poorly Sorted	-0.070	Symmetrical	0.00	10.90	89.10	8.41
Direct Impact	NKM 1.5 UC	Sandy Mud	5.774	5.846	1.743	Poorly Sorted	0.021	Symmetrical	0.00	15.13	84.87	8.29
Direct Impact	NKM 1.6 LA	Sandy Mud	5.386	5.604	1.762	Poorly Sorted	0.156	Fine Skewed	0.00	19.80	80.20	6.53
Direct Impact	NKM 1.6 LB	Sandy Mud	5.703	5.753	1.710	Poorly Sorted	0.031	Symmetrical	0.00	16.88	83.12	6.04
Direct Impact	NKM 1.6 LC	Sandy Mud	6.017	5.914	1.829	Poorly Sorted	-0.082	Symmetrical	0.00	17.86	82.14	6.70
Direct Impact	NKM 1.6 MA	Sandy Mud	6.185	6.131	1.622	Poorly Sorted	-0.067	Symmetrical	0.00	10.38	89.62	7.62
Direct Impact	NKM 1.6 MB	Sandy Mud	5.685	5.808	1.653	Poorly Sorted	0.083	Symmetrical	0.00	13.81	86.19	7.12
Direct Impact	NKM 1.6 MC	Sandy Mud	5.413	5.661	1.711	Poorly Sorted	0.180	Fine Skewed	0.00	17.11	82.89	6.16
Direct Impact	NKM 1.6 UA	Mud	6.564	6.435	1.532	Poorly Sorted	-0.163	Coarse Skewed	0.00	7.58	92.42	10.25
Direct Impact	NKM 1.6 UB	Sandy Mud	6.012	5.989	1.669	Poorly Sorted	-0.054	Symmetrical	0.00	12.67	87.33	9.07
Direct Impact	NKM 1.6 UC	Sandy Mud	5.765	5.816	1.666	Poorly Sorted	0.013	Symmetrical	0.00	14.23	85.77	7.43
Direct Impact	NKM 1.7 LA	Sandy Mud	5.413	5.616	1.749	Poorly Sorted	0.145	Fine Skewed	0.00	19.24	80.76	5.31
Direct Impact	NKM 1.7 LB	Sandy Mud	5.625	5.724	1.701	Poorly Sorted	0.068	Symmetrical	0.00	16.71	83.29	6.18
Direct Impact	NKM 1.7 LC	Sandy Mud	5.633	5.726	1.804	Poorly Sorted	0.057	Symmetrical	0.00	19.21	80.79	5.01
Direct Impact	NKM 1.7 MA	Sandy Mud	5.285	5.538	1.730	Poorly Sorted	0.179	Fine Skewed	0.00	19.06	80.94	6.87
Direct Impact	NKM 1.7 MB	Sandy Mud	5.132	5.401	1.715	Poorly Sorted	0.199	Fine Skewed	0.00	21.45	78.55	5.33
Direct Impact	NKM 1.7 MC	Sandy Mud	5.150	5.441	1.685	Poorly Sorted	0.225	Fine Skewed	0.00	20.23	79.77	5.85
Direct Impact	NKM 1.7 UA	Slightly Gravelly Mud	6.486	6.355	1.624	Poorly Sorted	-0.156	Coarse Skewed	0.33	8.82	90.85	10.39
Direct Impact	NKM 1.7 UB	Mud	6.357	6.263	1.639	Poorly Sorted	-0.119	Coarse Skewed	0.00	9.65	90.35	9.30
Direct Impact	NKM 1.7 UC	Sandy Mud	5.961	5.940	1.691	Poorly Sorted	-0.046	Symmetrical	0.00	13.53	86.47	7.89

AREA	SAMPLE	TEXTURAL GROUP	MEDIAN PHI GRAIN SIZE	MEAN PHI GRAIN SIZE	SORTING		SKEWNESS		% GRAVEL	% SAND	% MUD	% LOI
Direct Impact	NKM 2.1 LA	Sandy Mud	5.291	5.501	1.764	Poorly Sorted	0.146	Fine Skewed	0.00	21.58	78.42	5.96
Direct Impact	NKM 2.1 LB	Sandy Mud	5.475	5.606	1.718	Poorly Sorted	0.096	Symmetrical	0.00	19.16	80.84	6.05
Direct Impact	NKM 2.1 LC	Sandy Mud	6.108	6.028	1.713	Poorly Sorted	-0.087	Symmetrical	0.00	13.37	86.63	7.54
Direct Impact	NKM 2.1 MA	Sandy Mud	6.133	6.062	1.633	Poorly Sorted	-0.087	Symmetrical	0.00	11.63	88.37	9.46
Direct Impact	NKM 2.1 MA2	Mud	6.572	6.390	1.621	Poorly Sorted	-0.207	Coarse Skewed	0.00	9.18	90.82	9.71
Direct Impact	NKM 2.1 MB	Sandy Mud	4.643	5.079	1.706	Poorly Sorted	0.340	Very Fine Skewed	0.00	31.09	68.91	5.68
Direct Impact	NKM 2.1 MC	Sandy Mud	5.264	5.504	1.768	Poorly Sorted	0.174	Fine Skewed	0.00	22.30	77.70	6.12
Direct Impact	NKM 2.1 UA	Mud	6.619	6.435	1.612	Poorly Sorted	-0.214	Coarse Skewed	0.00	9.07	90.93	10.33
Direct Impact	NKM 2.1 UB	Mud	6.418	6.290	1.557	Poorly Sorted	-0.163	Coarse Skewed	0.00	8.88	91.12	10.11
Direct Impact	NKM 2.1 UC	Mud	6.549	6.393	1.594	Poorly Sorted	-0.172	Coarse Skewed	0.00	8.50	91.50	9.76
Direct Impact	NKM 2.2 LA	Sandy Mud	5.650	5.719	1.774	Poorly Sorted	0.020	Symmetrical	0.00	17.62	82.38	6.29
Direct Impact	NKM 2.2 LB	Sandy Mud	5.452	5.588	1.747	Poorly Sorted	0.090	Symmetrical	0.00	19.42	80.58	6.54
Direct Impact	NKM 2.2 LC	Sandy Mud	5.825	5.841	1.736	Poorly Sorted	-0.017	Symmetrical	0.00	15.58	84.42	6.16
Direct Impact	NKM 2.2 MA	Sandy Mud	6.094	6.074	1.633	Poorly Sorted	-0.037	Symmetrical	0.00	11.03	88.97	7.88
Direct Impact	NKM 2.2 MB	Sandy Mud	5.710	5.793	1.727	Poorly Sorted	0.051	Symmetrical	0.00	16.28	83.72	6.11
Direct Impact	NKM 2.2 MC	Sandy Mud	5.720	5.789	1.679	Poorly Sorted	0.037	Symmetrical	0.00	15.09	84.91	6.69
Direct Impact	NKM 2.2 UA	Mud	6.313	6.221	1.590	Poorly Sorted	-0.116	Coarse Skewed	0.00	9.89	90.11	8.84
Direct Impact	NKM 2.2 UB	Sandy Mud	6.012	5.979	1.692	Poorly Sorted	-0.071	Symmetrical	0.00	13.06	86.94	9.98
Direct Impact	NKM 2.2 UC	Sandy Mud	6.071	6.060	1.657	Poorly Sorted	-0.058	Symmetrical	0.00	11.23	88.77	7.32
Direct Impact	NKM 2.3 LA	Sandy Mud	5.317	5.561	1.701	Poorly Sorted	0.185	Fine Skewed	0.00	18.78	81.22	6.28
Direct Impact	NKM 2.3 LB	Sandy Mud	5.754	5.796	1.742	Poorly Sorted	0.012	Symmetrical	0.00	16.56	83.44	5.69
Direct Impact	NKM 2.3 LC	Sandy Mud	5.662	5.781	1.694	Poorly Sorted	0.079	Symmetrical	0.00	15.57	84.43	4.78
Direct Impact	NKM 2.3 MA	Sandy Mud	5.443	5.624	1.720	Poorly Sorted	0.122	Fine Skewed	0.00	17.80	82.20	6.43
Direct Impact	NKM 2.3 MB	Sandy Mud	5.687	5.808	1.691	Poorly Sorted	0.084	Symmetrical	0.00	14.93	85.07	6.67
Direct Impact	NKM 2.3 MC	Sandy Mud	5.471	5.584	1.757	Poorly Sorted	0.075	Symmetrical	0.00	19.95	80.05	6.33
Direct Impact	NKM 2.3 UA	Mud	6.206	6.191	1.568	Poorly Sorted	-0.044	Symmetrical	0.00	8.79	91.21	9.25
Direct Impact	NKM 2.3 UB	Sandy Mud	6.146	6.111	1.608	Poorly Sorted	-0.056	Symmetrical	0.00	10.47	89.53	8.69
Direct Impact	NKM 2.3 UC	Sandy Mud	5.771	5.797	1.684	Poorly Sorted	-0.001	Symmetrical	0.00	15.28	84.72	8.22
Direct Impact	NKM 2.4 LA	Sandy Mud	5.649	5.747	1.701	Poorly Sorted	0.065	Symmetrical	0.00	16.38	83.62	6.42
Direct Impact	NKM 2.4 LB	Sandy Mud	5.466	5.586	1.801	Poorly Sorted	0.090	Symmetrical	0.00	22.33	77.67	5.94
Direct Impact	NKM 2.4 LC	Sandy Mud	5.422	5.568	1.840	Poorly Sorted	0.097	Symmetrical	0.00	23.03	76.97	4.46
Direct Impact	NKM 2.4 MA	Sandy Mud	5.665	5.785	1.614	Poorly Sorted	0.085	Symmetrical	0.00	13.39	86.61	7.21
Direct Impact	NKM 2.4 MB	Sandy Mud	5.489	5.651	1.644	Poorly Sorted	0.118	Fine Skewed	0.00	16.07	83.93	5.46
Direct Impact	NKM 2.4 MC	Sandy Mud	5.463	5.665	1.701	Poorly Sorted	0.143	Fine Skewed	0.00	16.88	83.12	5.59
Direct Impact	NKM 2.4 UA	Mud	6.505	6.414	1.500	Poorly Sorted	-0.124	Coarse Skewed	0.00	6.78	93.22	7.80
Direct Impact	NKM 2.4 UB	Mud	6.264	6.215	1.592	Poorly Sorted	-0.071	Symmetrical	0.00	9.09	90.91	9.40
Direct Impact	NKM 2.4 UC	Sandy Mud	5.961	5.993	1.659	Poorly Sorted	0.002	Symmetrical	0.00	11.86	88.14	8.21

AREA	SAMPLE	TEXTURAL GROUP	MEDIAN PHI GRAIN SIZE	MEAN PHI GRAIN SIZE	SORTING		SKEWNESS		% GRAVEL	% SAND	% MUD	% LOI
Indirect Impact North	NKM 1.8 LA	Sandy Mud	5.424	5.630	1.706	Poorly Sorted	0.152	Fine Skewed	0.00	17.85	82.15	6.40
Indirect Impact North	NKM 1.8 LB	Sandy Mud	5.656	5.771	1.687	Poorly Sorted	0.077	Symmetrical	0.00	15.57	84.43	5.18
Indirect Impact North	NKM 1.8 LC	Sandy Mud	5.014	5.358	1.672	Poorly Sorted	0.277	Fine Skewed	0.00	20.94	79.06	5.31
Indirect Impact North	NKM 1.8 MA	Sandy Mud	5.858	5.923	1.701	Poorly Sorted	0.033	Symmetrical	0.00	13.59	86.41	6.35
Indirect Impact North	NKM 1.8 MB	Sandy Mud	5.529	5.729	1.672	Poorly Sorted	0.148	Fine Skewed	0.00	15.13	84.87	6.69
Indirect Impact North	NKM 1.8 MC	Sandy Mud	4.862	5.236	1.724	Poorly Sorted	0.284	Fine Skewed	0.00	25.07	74.93	5.19
Indirect Impact North	NKM 1.8 UA	Mud	6.401	6.306	1.573	Poorly Sorted	-0.121	Coarse Skewed	0.00	8.57	91.43	9.25
Indirect Impact North	NKM 1.8 UB	Sandy Mud	6.041	5.994	1.747	Poorly Sorted	-0.076	Symmetrical	0.00	13.86	86.14	8.84
Indirect Impact North	NKM 1.8 UC	Sandy Mud	5.421	5.680	1.711	Poorly Sorted	0.185	Fine Skewed	0.00	16.36	83.64	6.13
Indirect Impact North	NKM 1.9 LA	Sandy Mud	5.785	5.844	1.709	Poorly Sorted	0.027	Symmetrical	0.00	15.18	84.82	5.98
Indirect Impact North	NKM 1.9 LB	Sandy Mud	5.674	5.745	1.764	Poorly Sorted	0.040	Symmetrical	0.00	18.01	81.99	5.86
Indirect Impact North	NKM 1.9 LC	Sandy Mud	5.678	5.722	1.710	Poorly Sorted	0.016	Symmetrical	0.00	16.94	83.06	6.16
Indirect Impact North	NKM 1.9 MA	Sandy Mud	5.577	5.641	1.809	Poorly Sorted	0.013	Symmetrical	0.00	19.08	80.92	7.31
Indirect Impact North	NKM 1.9 MB	Mud	6.342	6.231	1.606	Poorly Sorted	-0.115	Coarse Skewed	0.00	9.50	90.50	5.35
Indirect Impact North	NKM 1.9 MC	Sandy Mud	5.988	5.964	1.744	Poorly Sorted	-0.041	Symmetrical	0.00	14.50	85.50	7.91
Indirect Impact North	NKM 1.9 UA	Sandy Mud	6.360	6.252	1.671	Poorly Sorted	-0.122	Coarse Skewed	0.00	10.41	89.59	9.21
Indirect Impact North	NKM 1.9 UB	Mud	6.418	6.308	1.608	Poorly Sorted	-0.109	Coarse Skewed	0.00	8.41	91.59	7.42
Indirect Impact North	NKM 1.9 UC	Sandy Mud	6.084	6.052	1.696	Poorly Sorted	-0.041	Symmetrical	0.00	12.30	87.70	7.48
Indirect Impact South	NKM 1.1 LA	Sandy Mud	5.474	5.624	1.763	Poorly Sorted	0.107	Fine Skewed	0.00	20.17	79.83	6.20
Indirect Impact South	NKM 1.1 LB	Sandy Mud	4.967	5.300	1.706	Poorly Sorted	0.262	Fine Skewed	0.00	24.62	75.38	6.00
Indirect Impact South	NKM 1.1 LC	Sandy Mud	5.101	5.387	1.697	Poorly Sorted	0.228	Fine Skewed	0.00	23.35	76.65	5.51
Indirect Impact South	NKM 1.1 MA	Sandy Mud	6.104	6.024	1.715	Poorly Sorted	-0.106	Coarse Skewed	0.00	13.28	86.72	10.27
Indirect Impact South	NKM 1.1 MB	Mud	6.319	6.223	1.620	Poorly Sorted	-0.118	Coarse Skewed	0.00	9.96	90.04	10.65
Indirect Impact South	NKM 1.1 MC	Sandy Mud	5.888	5.885	1.698	Poorly Sorted	-0.025	Symmetrical	0.00	14.49	85.51	7.36
Indirect Impact South	NKM 1.1 UA	Mud	6.372	6.254	1.601	Poorly Sorted	-0.142	Coarse Skewed	0.00	9.76	90.24	10.87
Indirect Impact South	NKM 1.1 UB	Sandy Mud	6.232	6.145	1.690	Poorly Sorted	-0.117	Coarse Skewed	0.00	11.69	88.31	9.37
Indirect Impact South	NKM 1.1 UC	Mud	6.332	6.244	1.621	Poorly Sorted	-0.119	Coarse Skewed	0.00	9.65	90.35	9.23
Indirect Impact South	NKM 1.2 LA	Sandy Mud	4.893	5.260	1.762	Poorly Sorted	0.279	Fine Skewed	0.00	28.14	71.86	5.37
Indirect Impact South	NKM 1.2 LB	Sandy Mud	5.282	5.466	1.708	Poorly Sorted	0.145	Fine Skewed	0.00	21.76	78.24	6.01
Indirect Impact South	NKM 1.2 LC	Sandy Mud	5.660	5.678	1.717	Poorly Sorted	-0.003	Symmetrical	0.00	17.75	82.25	7.65
Indirect Impact South	NKM 1.2 MA	Sandy Mud	5.787	5.823	1.713	Poorly Sorted	0.003	Symmetrical	0.00	15.46	84.54	6.61
Indirect Impact South	NKM 1.2 MB	Sandy Mud	5.691	5.804	1.685	Poorly Sorted	0.076	Symmetrical	0.00	14.94	85.06	7.03
Indirect Impact South	NKM 1.2 MC	Sandy Mud	4.831	5.214	1.737	Poorly Sorted	0.297	Fine Skewed	0.00	28.68	71.32	4.14
Indirect Impact South	NKM 1.2 UA	Sandy Mud	6.441	6.299	1.636	Poorly Sorted	-0.162	Coarse Skewed	0.00	10.06	89.94	9.32
Indirect Impact South	NKM 1.2 UB	Mud	6.524	6.356	1.590	Poorly Sorted	-0.197	Coarse Skewed	0.00	9.18	90.82	11.70
Indirect Impact South	NKM 1.2 UC	Mud	6.491	6.324	1.582	Poorly Sorted	-0.193	Coarse Skewed	0.00	9.18	90.82	11.45

Table 2. Summary of sedimentary parameters at Cherry Cobb Sands.

AREA	SAMPLE	TEXTURAL GROUP	MEDIAN PHI GRAIN SIZE	MEAN PHI GRAIN SIZE	SORTING		SKEWNESS		% GRAVEL	% SAND	% MUD	% LOI
Control North	CCS N1 U2	Sandy Mud	5.672	5.683	1.826	Poorly Sorted	-0.030	Symmetrical	0.000	18.83	81.17	8.05
Control North	CCS N1 UA	Slightly Gravelly Sandy Mud	5.218	5.377	2.033	Very Poorly Sorted	0.039	Symmetrical	0.003	25.46	74.53	7.00
Control North	CCS N1 UB	Sandy Mud	5.037	5.288	1.834	Poorly Sorted	0.152	Fine Skewed	0.000	25.48	74.52	5.99
Control North	CCS N1 UC	Slightly Gravelly Sandy Mud	5.536	5.608	1.869	Poorly Sorted	0.009	Symmetrical	0.402	20.33	79.26	7.23
Control North	CCS N1 MA	Slightly Gravelly Sandy Mud	5.384	5.522	1.882	Poorly Sorted	0.063	Symmetrical	0.147	22.69	77.16	6.12
Control North	CCS N1 MB	Sandy Mud	4.717	5.103	1.834	Poorly Sorted	0.264	Fine Skewed	0.000	31.94	68.06	4.43
Control North	CCS N1 MC	Sandy Mud	4.783	5.219	1.821	Poorly Sorted	0.311	Very Fine Skewed	0.000	29.97	70.03	5.18
Control North	CCS N1 LA	Sandy Mud	4.517	4.981	1.841	Poorly Sorted	0.322	Very Fine Skewed	0.000	35.15	64.85	4.63
Control North	CCS N1 LB	Muddy Sand	3.689	3.787	1.177	Poorly Sorted	0.343	Very Fine Skewed	0.000	65.38	34.62	3.52
Control North	CCS N1 LC	Muddy Sand	3.645	4.313	1.844	Poorly Sorted	0.513	Very Fine Skewed	0.000	61.30	38.70	3.21
Control North	CCS N2 U2	Sandy Mud	5.795	5.770	1.823	Poorly Sorted	-0.054	Symmetrical	0.000	17.78	82.22	9.09
Control North	CCS N2 UA	Sandy Mud	5.668	5.721	1.859	Poorly Sorted	-0.004	Symmetrical	0.000	18.71	81.29	8.22
Control North	CCS N2 UB	Sandy Mud	5.779	5.867	1.737	Poorly Sorted	0.044	Symmetrical	0.000	14.90	85.10	7.74
Control North	CCS N2 UC	Sandy Mud	5.267	5.471	1.828	Poorly Sorted	0.109	Fine Skewed	0.000	21.47	78.53	6.61
Control North	CCS N2 MA	Sandy Mud	5.030	5.312	1.964	Poorly Sorted	0.146	Fine Skewed	0.000	27.20	72.80	7.07
Control North	CCS N2 MB	Sandy Mud	5.093	5.418	1.770	Poorly Sorted	0.238	Fine Skewed	0.000	22.97	77.03	5.73
Control North	CCS N2 MC	Sandy Mud	4.922	5.326	1.789	Poorly Sorted	0.295	Fine Skewed	0.000	26.06	73.94	5.68
Control North	CCS N2 LA	Sandy Mud	5.125	5.377	1.867	Poorly Sorted	0.159	Fine Skewed	0.000	26.40	73.60	6.22
Control North	CCS N2 LB	Sandy Mud	4.859	5.205	1.916	Poorly Sorted	0.222	Fine Skewed	0.000	31.49	68.51	5.53
Control North	CCS N2 LC	Sandy Mud	4.086	4.691	1.892	Poorly Sorted	0.425	Very Fine Skewed	0.000	47.98	52.02	4.39
Control North	CCS N4 U2	Sandy Mud	5.303	5.448	1.797	Poorly Sorted	0.079	Symmetrical	0.000	21.80	78.20	5.53
Control North	CCS N4 UA	Sandy Mud	6.062	6.064	1.722	Poorly Sorted	-0.047	Symmetrical	0.000	12.05	87.95	7.60
Control North	CCS N4 UB	Sandy Mud	5.832	5.882	1.794	Poorly Sorted	-0.012	Symmetrical	0.000	15.27	84.73	7.98
Control North	CCS N4 UC	Sandy Mud	5.632	5.740	1.721	Poorly Sorted	0.048	Symmetrical	0.000	15.88	84.12	7.02
Control North	CCS N4 MA	Sandy Mud	5.431	5.656	1.785	Poorly Sorted	0.149	Fine Skewed	0.000	18.61	81.39	5.48
Control North	CCS N4 MB	Sandy Mud	5.671	5.711	1.855	Poorly Sorted	0.016	Symmetrical	0.000	20.85	79.15	7.60
Control North	CCS N4 MC	Sandy Mud	4.216	4.658	1.769	Poorly Sorted	0.331	Very Fine Skewed	0.000	43.04	56.96	5.18
Control North	CCS N4 LA	Sandy Mud	5.075	5.390	1.877	Poorly Sorted	0.205	Fine Skewed	0.000	26.90	73.10	5.41
Control North	CCS N4 LB	Muddy Sand	3.985	4.468	1.978	Poorly Sorted	0.302	Very Fine Skewed	0.000	50.48	49.52	5.38
Control North	CCS N4 LC	Sandy Mud	4.897	5.168	1.970	Poorly Sorted	0.183	Fine Skewed	0.000	36.05	63.95	5.14
Control South	CCS S1 UA	Sandy Mud	4.952	5.253	1.818	Poorly Sorted	0.205	Fine Skewed	0.000	27.91	72.09	4.38
Control South	CCS S1 UB	Sandy Mud	4.598	5.000	1.673	Poorly Sorted	0.334	Very Fine Skewed	0.000	31.34	68.66	4.01
Control South	CCS S1 UC	Sandy Mud	5.320	5.528	1.717	Poorly Sorted	0.151	Fine Skewed	0.000	19.56	80.44	4.97
Control South	CCS S1 MA	Sandy Mud	5.224	5.480	1.776	Poorly Sorted	0.170	Fine Skewed	0.000	20.96	79.04	4.57
Control South	CCS S1 MB	Sandy Mud	4.753	5.157	1.733	Poorly Sorted	0.311	Very Fine Skewed	0.000	28.46	71.54	4.82

AREA	SAMPLE	TEXTURAL GROUP	MEDIAN PHI GRAIN SIZE	MEAN PHI GRAIN SIZE	SORTING		SKEWNESS		% GRAVEL	% SAND	% MUD	% LOI
Control South	CCS S1 MC	Sandy Mud	4.700	5.131	1.795	Poorly Sorted	0.315	Very Fine Skewed	0.000	31.98	68.02	3.89
Control South	CCS S1 LA	Sandy Mud	4.514	4.961	1.800	Poorly Sorted	0.344	Very Fine Skewed	0.000	35.55	64.45	3.76
Control South	CCS S1 LB	Muddy Sand	3.223	3.813	1.751	Poorly Sorted	0.548	Very Fine Skewed	0.000	70.09	29.91	1.86
Control South	CCS S1 LC	Muddy Sand	3.047	3.540	1.680	Poorly Sorted	0.523	Very Fine Skewed	0.000	76.65	23.35	2.23
Control South	CCS S2 UA	Sandy Mud	5.233	5.503	1.806	Poorly Sorted	0.177	Fine Skewed	0.000	21.31	78.69	6.73
Control South	CCS S2 UB	Sandy Mud	4.596	5.010	1.650	Poorly Sorted	0.368	Very Fine Skewed	0.000	29.86	70.14	4.69
Control South	CCS S2 UC	Sandy Mud	4.891	5.252	1.704	Poorly Sorted	0.289	Fine Skewed	0.000	25.06	74.94	5.24
Control South	CCS S2 MA	Sandy Mud	4.741	5.196	1.816	Poorly Sorted	0.325	Very Fine Skewed	0.000	29.76	70.24	4.32
Control South	CCS S2 MB	Sandy Mud	4.334	4.905	1.812	Poorly Sorted	0.433	Very Fine Skewed	0.000	40.54	59.46	3.81
Control South	CCS S2 MC	Muddy Sand	3.231	3.261	0.870	Moderately Sorted	0.250	Fine Skewed	0.000	86.10	13.90	1.67
Control South	CCS S2 LA	Muddy Sand	3.638	3.977	1.576	Poorly Sorted	0.411	Very Fine Skewed	0.000	63.02	36.98	4.20
Control South	CCS S2 LB	Slightly Gravelly Sand	2.824	2.874	0.877	Moderately Sorted	0.218	Fine Skewed	0.004	91.17	8.83	1.35
Control South	CCS S2 LC	Sand	2.604	2.630	0.621	Moderately Well Sorted	0.077	Symmetrical	0.000	97.89	2.11	1.39
Control South	CCS S3 UA	Sandy Mud	5.358	5.581	1.791	Poorly Sorted	0.144	Fine Skewed	0.000	19.61	80.39	6.55
Control South	CCS S3 UB	Sandy Mud	4.575	4.997	1.665	Poorly Sorted	0.371	Very Fine Skewed	0.000	32.34	67.66	4.18
Control South	CCS S3 UC	Sandy Mud	4.656	5.106	1.754	Poorly Sorted	0.350	Very Fine Skewed	0.000	31.95	68.05	4.69
Control South	CCS S3 MA	Slightly Gravelly Sandy Mud	4.161	4.560	1.610	Poorly Sorted	0.397	Very Fine Skewed	0.040	44.65	55.31	3.41
Control South	CCS S3 MB	Muddy Sand	3.684	4.114	1.588	Poorly Sorted	0.470	Very Fine Skewed	0.000	62.05	37.95	3.35
Control South	CCS S3 MB2	Sand	3.043	3.094	0.866	Moderately Sorted	0.314	Very Fine Skewed	0.000	91.31	8.69	1.41
Control South	CCS S3 MC	Muddy Sand	3.612	4.150	1.743	Poorly Sorted	0.475	Very Fine Skewed	0.000	62.70	37.30	3.16
Control South	CCS S3 LA	Sandy Mud	4.114	4.586	1.904	Poorly Sorted	0.339	Very Fine Skewed	0.000	47.32	52.68	4.56
Control South	CCS S3 LB	Muddy Sand	3.091	3.288	1.412	Poorly Sorted	0.392	Very Fine Skewed	0.000	77.39	22.61	2.23
Control South	CCS S3 LC	Sand	2.644	2.696	0.864	Moderately Sorted	0.228	Fine Skewed	0.000	91.64	8.36	1.73

3.2 Biological Parameters

A number of primary and derived biological parameters values were calculated from the species data tabulated and input into GIS. Standard biological parameters utilised for benthic analysis include the following:

- The total number of taxa at each site/replicate (S)
- The total number of individuals (abundance) at each site/replicate (N)
- The total biomass (in grams AFDW) at each site/replicate (B).
- Margalef's index of species richness (d)
- Shannon's diversity index (H')

This index is a univariate measure of diversity which incorporates both the number of species and the distribution or equitability of individuals between species. High values of H' indicate a more diverse community whilst low values indicate low diversity.

- Pielou's evenness (J)

This index is a univariate measure of evenness or equitability which describes the distribution of individuals between species. High values of J (approaching 1) indicate that the abundance of animals are evenly spread between species whilst low values of J (approaching 0) indicate that the majority of animals are comprised of a few species, a situation which often occurs in low diversity areas subject to disturbance or organic enrichment.

In addition, the PRIMER package developed by Primer-E (Clarke and Gorley, 2006) was used to derive the w statistic from Abundance Biomass Comparison (ABC) plots (Warwick, 1986) for each replicate and per site. ABC plots show the cumulative % dominance of abundance and biomass per species rank and have been used to detect stress in benthic communities. In healthy communities the biomass curve is usually elevated above the abundance curve whilst in transitional or disturbed communities the abundance curves intersects the biomass curves or is elevated above it as the community is characterised by numerous small-bodied opportunist species. In naturally stressed environments such as estuaries some communities naturally exhibit curves indicative of chronic levels of disturbance e.g. due to salinity fluctuations or sediment disturbance although the curves still provide a useful graphical description of community structure and the contribution of larger bodied animals which may for example be an important food source for other groups of animals such as birds/fish. The ABC plots produced by PRIMER also provide the w statistic, which is a univariate descriptor of the ABC plots and measures the extent to which the biomass curve lies above the abundance curve (positive values for relatively undisturbed communities and negative values for potentially disturbed communities) and this was subsequently used as an additional biological parameter.

A summary of the biological parameters at each site is provided in Tables 3 and 4 which gives values per $0.01m^2$ sample for North Killingholme and Cherry Cobb Sands respectively.

Average values (and standard error) per $0.01m^2$ of the biological parameters have also been derived for each survey area and shore level (Figures 15 to 21) and the spatial variation in these number of taxa, number of individuals, AFDW biomass and Shannon's diversity H' is highlighted in Figures 22 to 29.

3.2.1 North Killingholme

Values of biological parameters appear to be typical for mid estuary muddy intertidal habitats and generally correspond to values recorded elsewhere in the middle Humber and the previous benthic survey at North Killingholme undertaken in spring 2013. Total numbers of taxa recorded were relatively low and ranged from zero to 10 taxa per $0.01m^2$ sample whilst the total numbers of individuals was very variable with fewer than 10 animals per core recorded in some areas, predominantly at lower shore sites or occasionally on the upper shore. The number of individuals ranged from 0 to 756 individuals per $0.01m^2$ (0 to 75600 animals per m^2) whilst AFDW biomass values ranged from 0 g to 0.205 g per $0.01m^2$ (0 g to 20.5g per m^2).

Some spatial patterns in biological patterns were evident (Figures 15 to 29) predominantly with respect to position on the shore. Numbers of taxa tended to show little variation across the survey area although sites from the indirect impact areas had slightly lower values with mean numbers of taxa within the southern indirect impact area for example having on average 3.65 taxa per $0.01m^2$ whilst the direct impact and northern control area had an average value of around 5 taxa per $0.01m^2$. The mid shore sites tended to have the highest number of taxa in each area with slightly higher numbers recorded in the direct impact area. Numbers of individuals and biomass tended to show more distinct patterns in relation to shore position with higher numbers of individuals generally recorded on the mid shore particularly in the direct impact area. Biomass tended to show a trend of decreasing values down the shore across all areas with slightly higher values on the upper shore in the direct impact area whilst mid and low show biomass tended to be fairly consistent across all areas. Biomass and numbers of individuals were relatively variable with sporadic high or low values occurring throughout the area but in general the direct impact area and the control area tended to have somewhat higher values of these parameters with slightly lower values often recorded at the indirect impact sites. Values for diversity indices such as Margalef's d and Shannon's H tended to be moderate to low (values ranging from 0 to 2.26 and 0 to 2.68 respectively) as is commonly the case in estuarine habitats with few clear spatial patterns in relation to the development area. Values of Pielou's evenness J were highly variable and ranged from 0.08 to 1 with slightly higher values usually recorded on the low or mid shore but with relatively little difference between survey areas.

The majority of sites had values of the ABC w statistic above zero indicating biomass curves elevated above the abundance curve (i.e. normal communities) although a number of sites had w statistics close to or below zero indicating plots in which the curves intersected or with elevated abundance curves. This can occur in naturally stressed estuarine habitats and in the current study is likely to be due to increased dominance by taxa such as *Corophium volutator* or *Tubificoides* spp. and no communities particularly indicative of organic enrichment or anthropogenic disturbance were observed. Whilst examples of high and low values of the w statistic were recorded throughout the survey area, mid shore habitats tended to have somewhat lower values (particularly in the northern areas) whilst slightly higher values were recorded on the upper or lower shore in the northern control and indirect impact areas and such patterns are likely to reflect variation in densities of species such as *Corophium volutator*.

3.2.2 Cherry Cobb Sands

The mean biological parameters derived from Cherry Cobb Sands dataset are shown in Table 4 and graphs showing mean values per 0.01m^2 for each survey area and shore level are given in Figures 15 to 21. The spatial distribution of numbers of taxa, numbers of individuals, AFDW biomass and Shannon's diversity H' are provided in Figures 23, 25, 27 and 29. The results of the CCS survey indicate that numbers of taxa were broadly similar to those recorded at NKM although somewhat higher numbers of taxa were generally recorded at CCS as reflected in the mean values per area shown in Figure 15. The total number of taxa recorded at CCS was also slightly higher than at NKM (28 taxa as opposed to 25 taxa) despite the much higher number of samples taken at NKM which presumably reflects the wider range of sediment types in this area. Numbers of taxa ranged from 1 to 10 taxa per 0.01m^2 with lower numbers of taxa on the lower shore sites and particularly in sandier areas in the southern control area.

The mean numbers of individuals at CCS were also broadly similar to the NKM sites (ranging from 1 to 422 individuals per 0.01m^2 (100 to 42200 animals per m^2) with lower numbers recorded on the low shore to the south. AFDW biomass ranged from 0.00003 g to 0.48g per 0.01m^2 (0.003 g to 48 g per m^2) and lowest values were typically recorded in lower shore habitats and it is evident from Figures 17 and 27 that biomass on the mid and upper shore tended to be considerably higher in some areas at CCS in comparison to NKM. Total numbers of individuals and biomass generally correspond to other intertidal surveys in the middle Humber and the lower values recorded in low shore areas presumably reflect a more dynamic sedimentary environment in these habitats. Diversity parameters were quite variable with Margalef's d ranging from 0.56 to 2, Shannon's H' ranging from 0 to 2.68 and Pielou's evenness ranging from 0.41 to 1. Most sites exhibited moderate to low levels of diversity with relatively few clear spatial patterns although values for Shannon's H tended to decrease in lower shore areas and overall the CCS survey areas tended to have slightly higher diversity and evenness in comparison to NKM. The w statistics derived from ABC curves ranged from -0.34 to 0.97 although the majority of sites had w values greater than zero with elevated biomass curves and whilst occasional sites on the low or mid shore had lower w values around or below zero the CCS sites tended to have more consistently higher w values than those recorded at NKM.

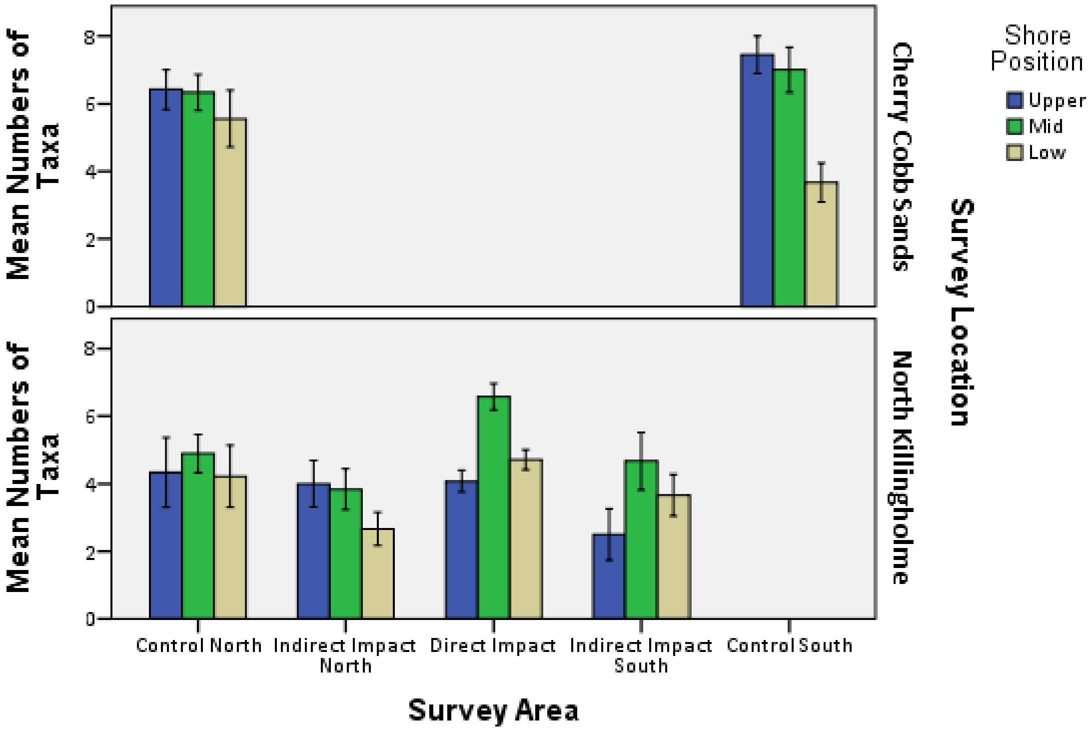

Figure 15. Mean numbers of taxa with standard error (per 0.01m^2) for each survey area at North Killingholme & Cherry Cobb Sands.

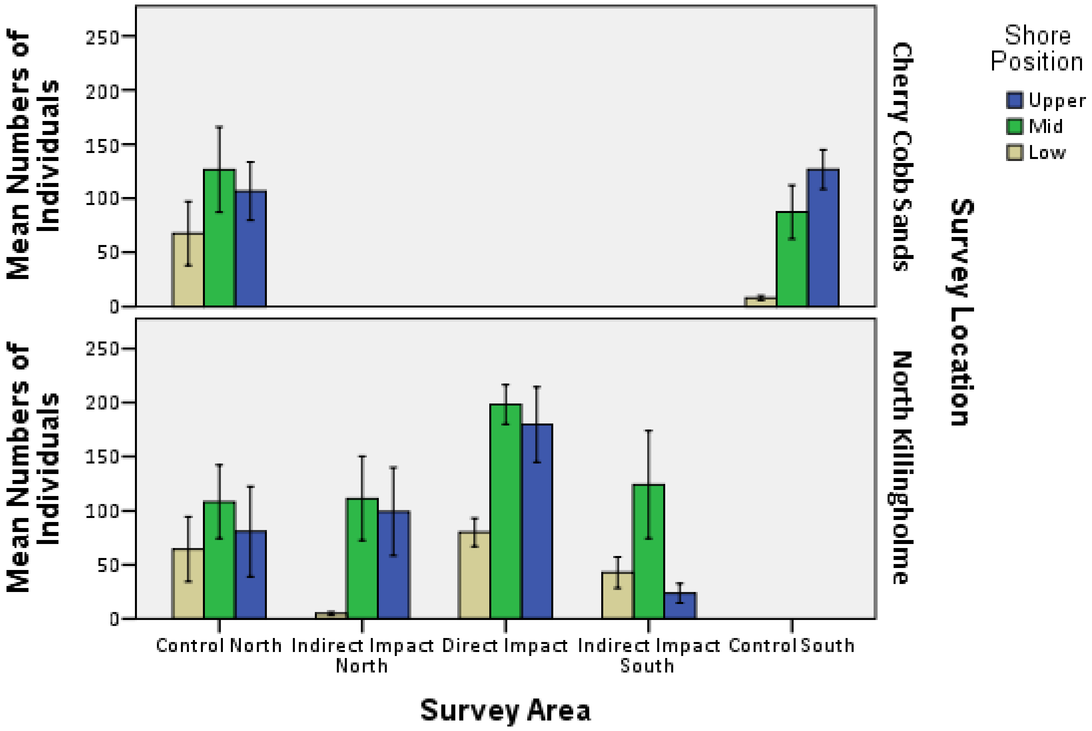

Figure 16. Mean numbers of individuals with standard error (per 0.01m^2) for each survey area at North Killingholme & Cherry Cobb Sands.

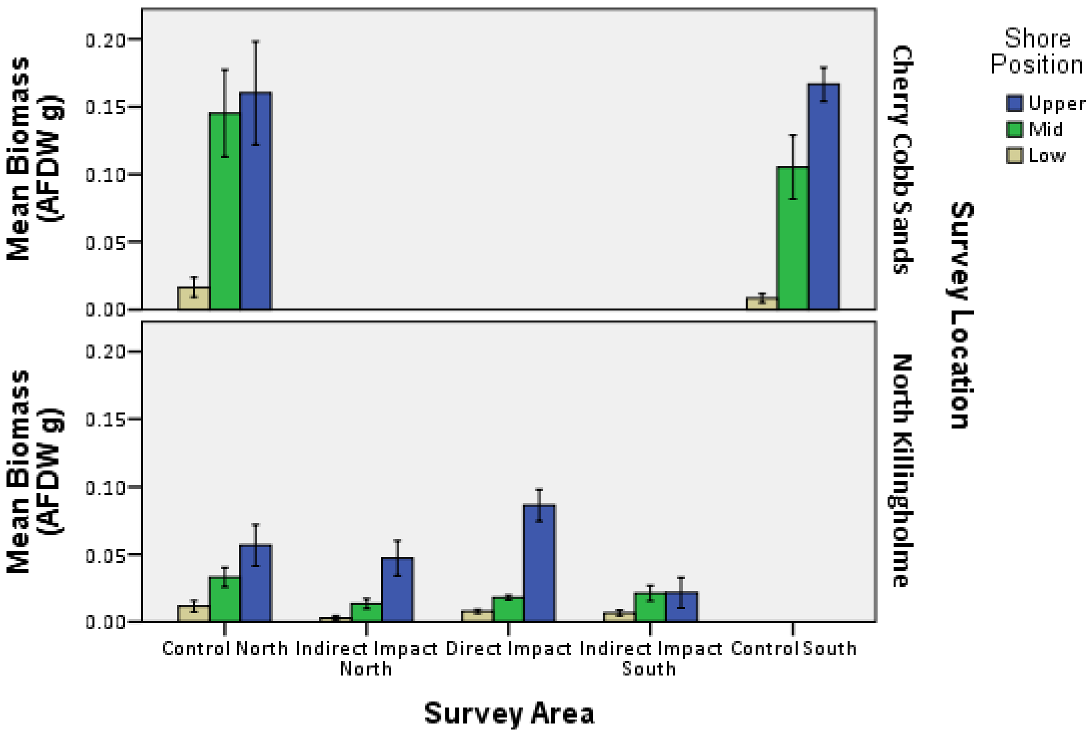

Figure 17. Mean AFDW biomass with standard error (per 0.01m²) for each survey area at North Killingholme & Cherry Cobb Sands.

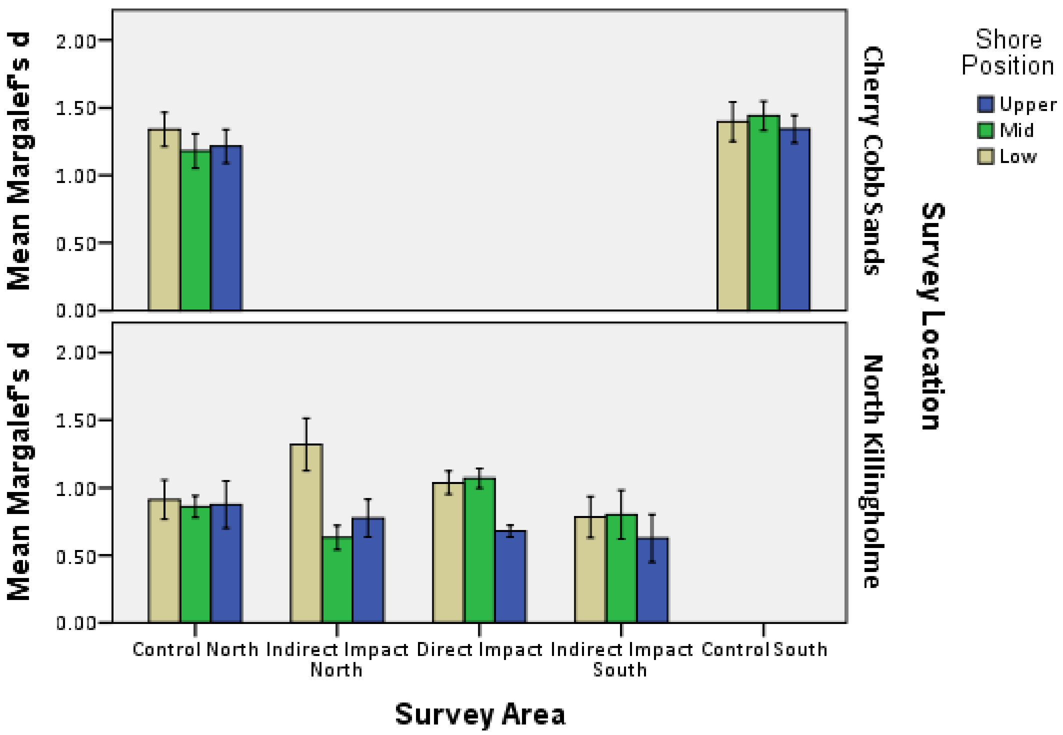

Figure 18. Mean Margalef's d with standard error (per 0.01m²) for each survey area at North Killingholme & Cherry Cobb Sands.

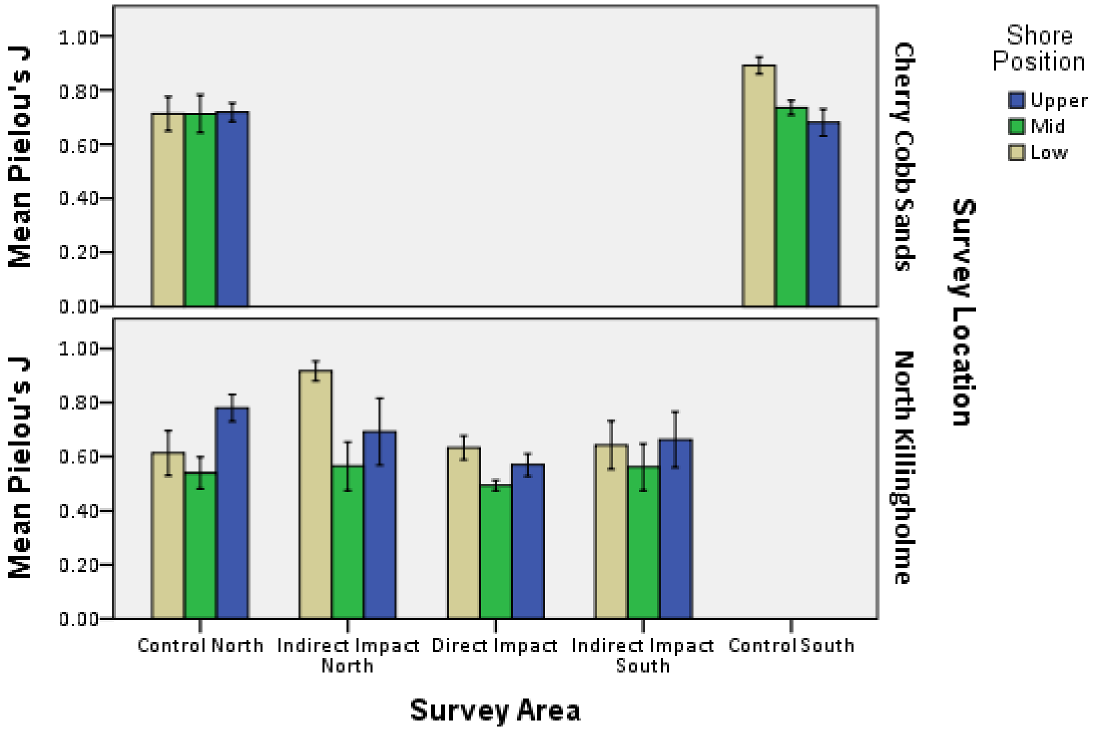

Figure 19. Mean Pielou's evenness with standard error (per $0.01m^2$) for each survey area at North Killingholme & Cherry Cobb Sands.

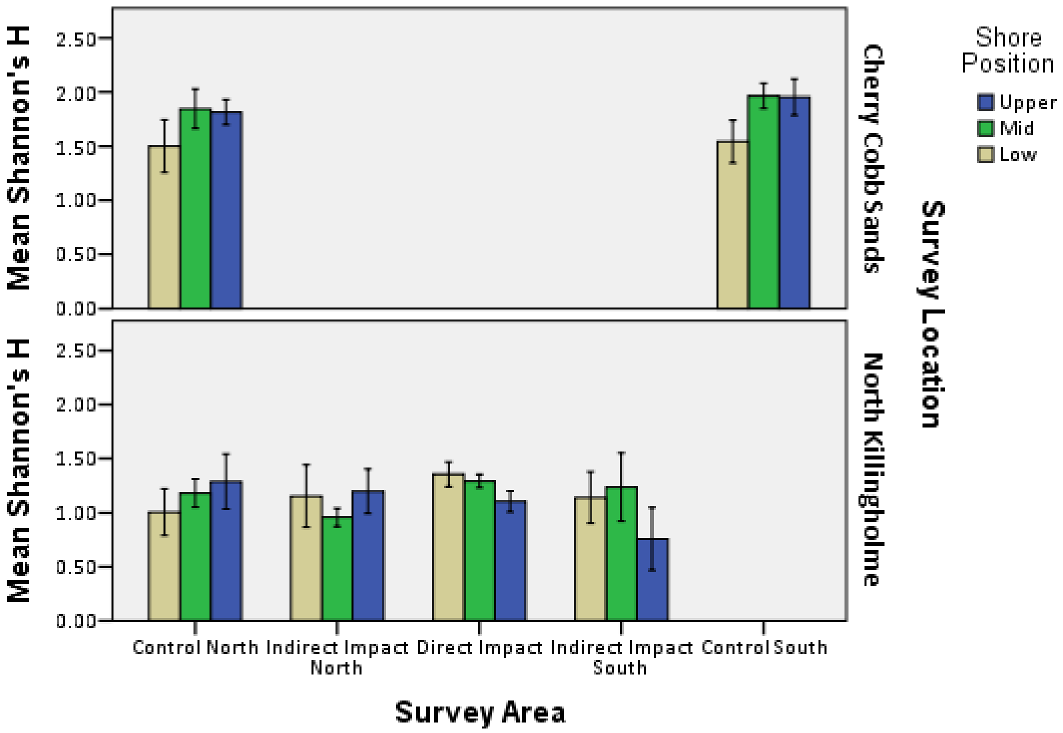

Figure 20. Mean Shannon's diversity with standard error (per $0.01m^2$) for each survey area at North Killingholme & Cherry Cobb Sands.

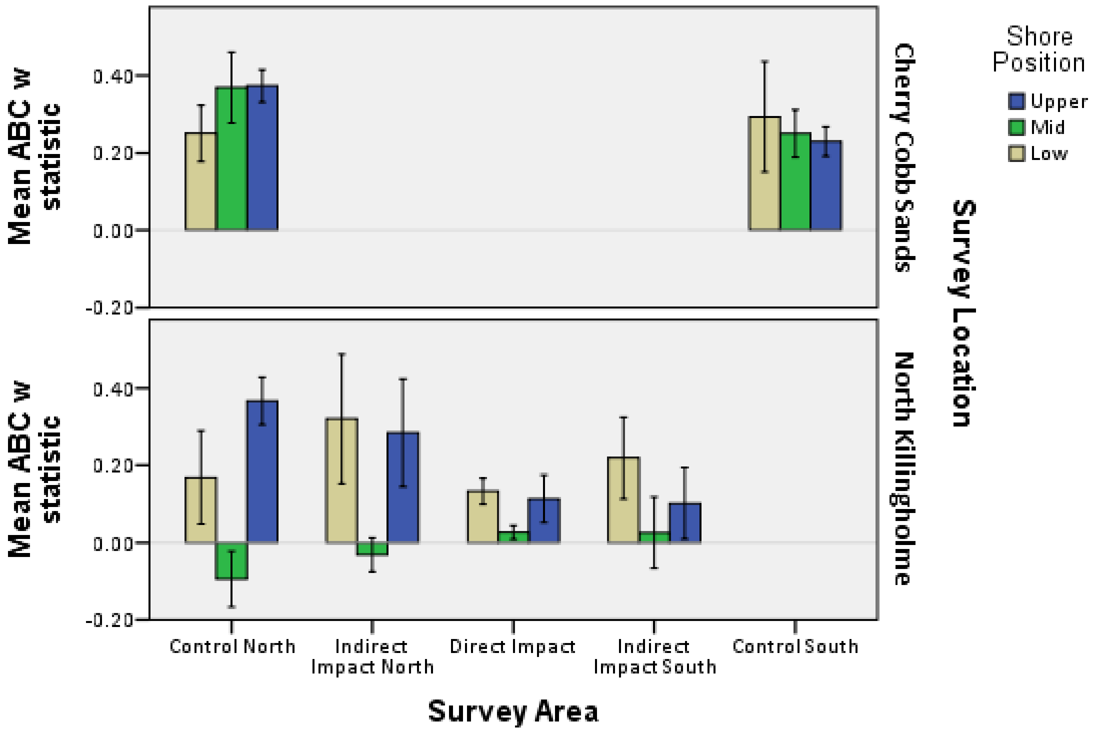

Figure 21. Mean AFDW ABC w statistic with standard error (per 0.01m^2) for each survey area at North Killingholme & Cherry Cobb Sands.

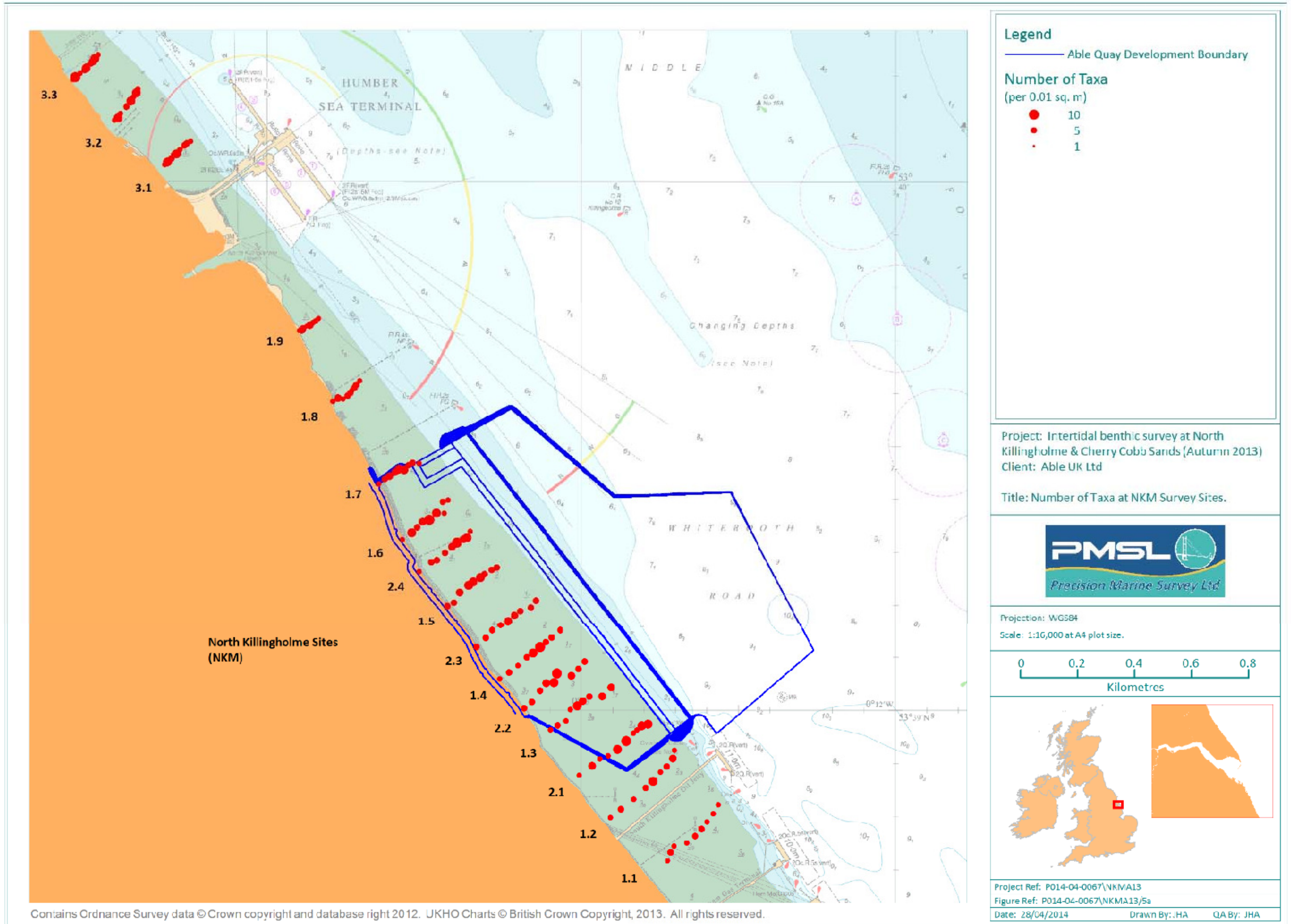

Figure 22. Number of taxa per $0.01m^2$ at North Killingholme.

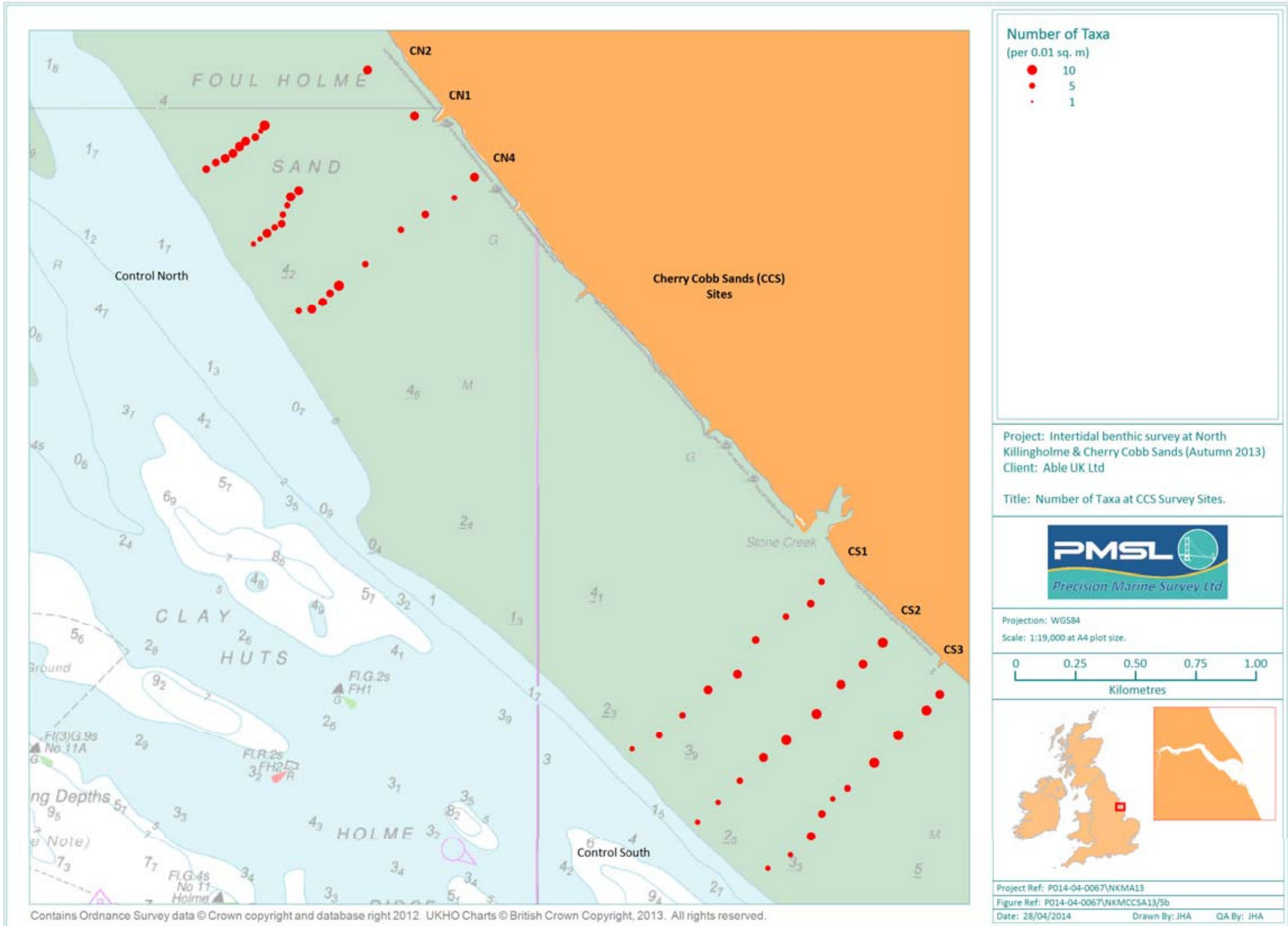

Figure 23. Number of taxa per 0.01m^2 at Cherry Cobb Sands.

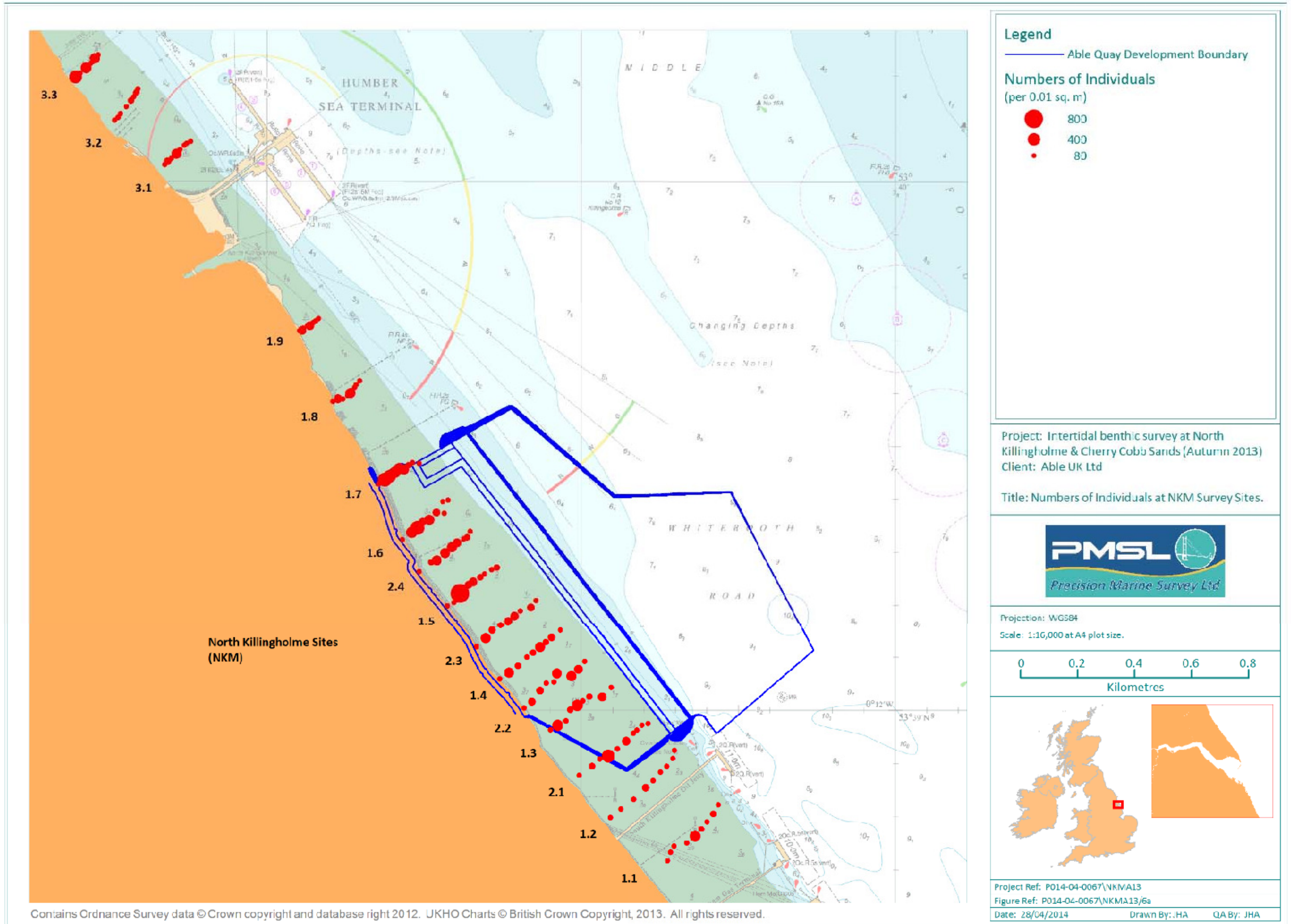

Figure 24. Numbers of individuals per $0.01m^2$ at North Killingholme.

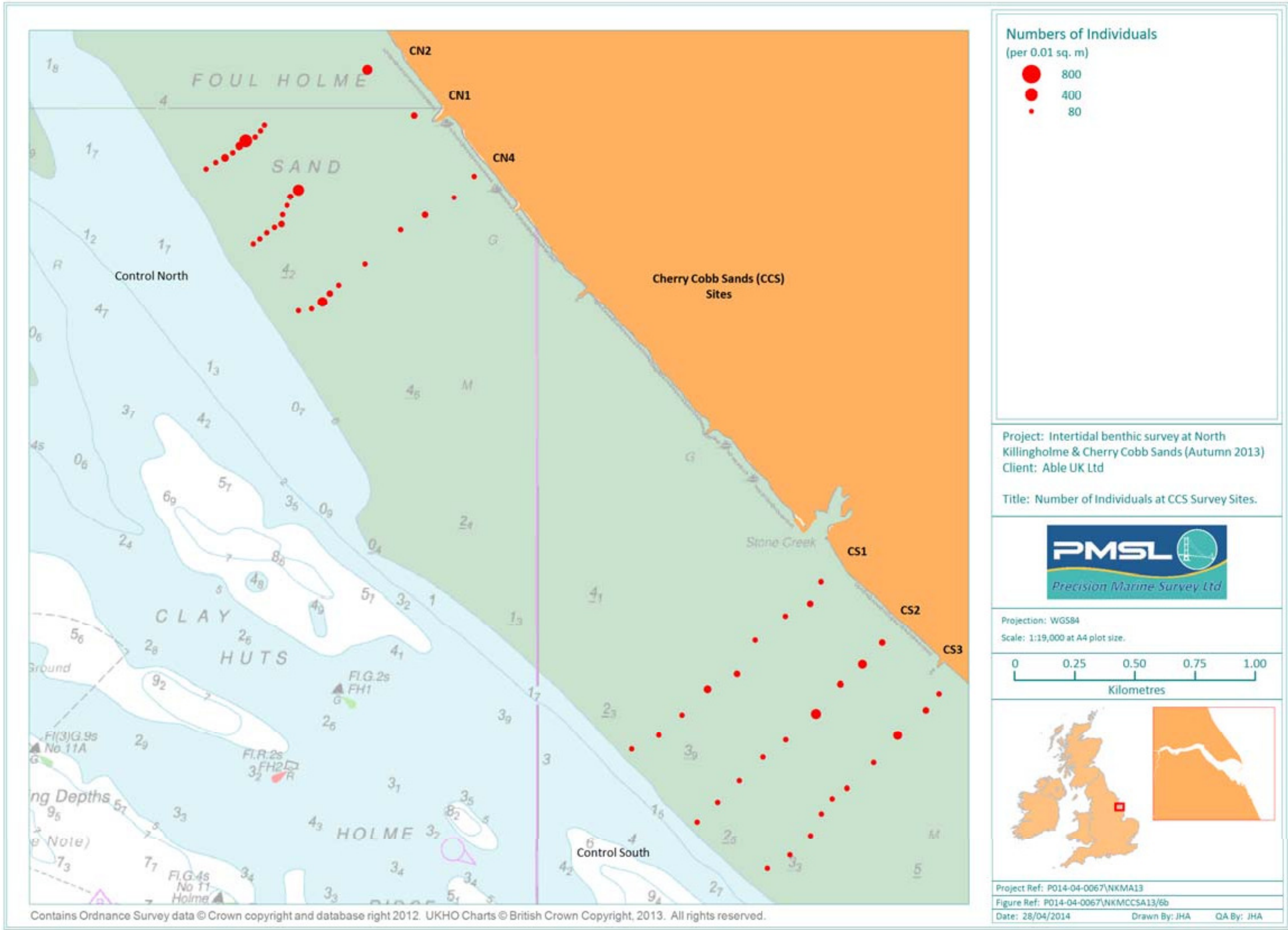

Figure 25. Numbers of individuals per 0.01m^2 at Cherry Cobb Sands.

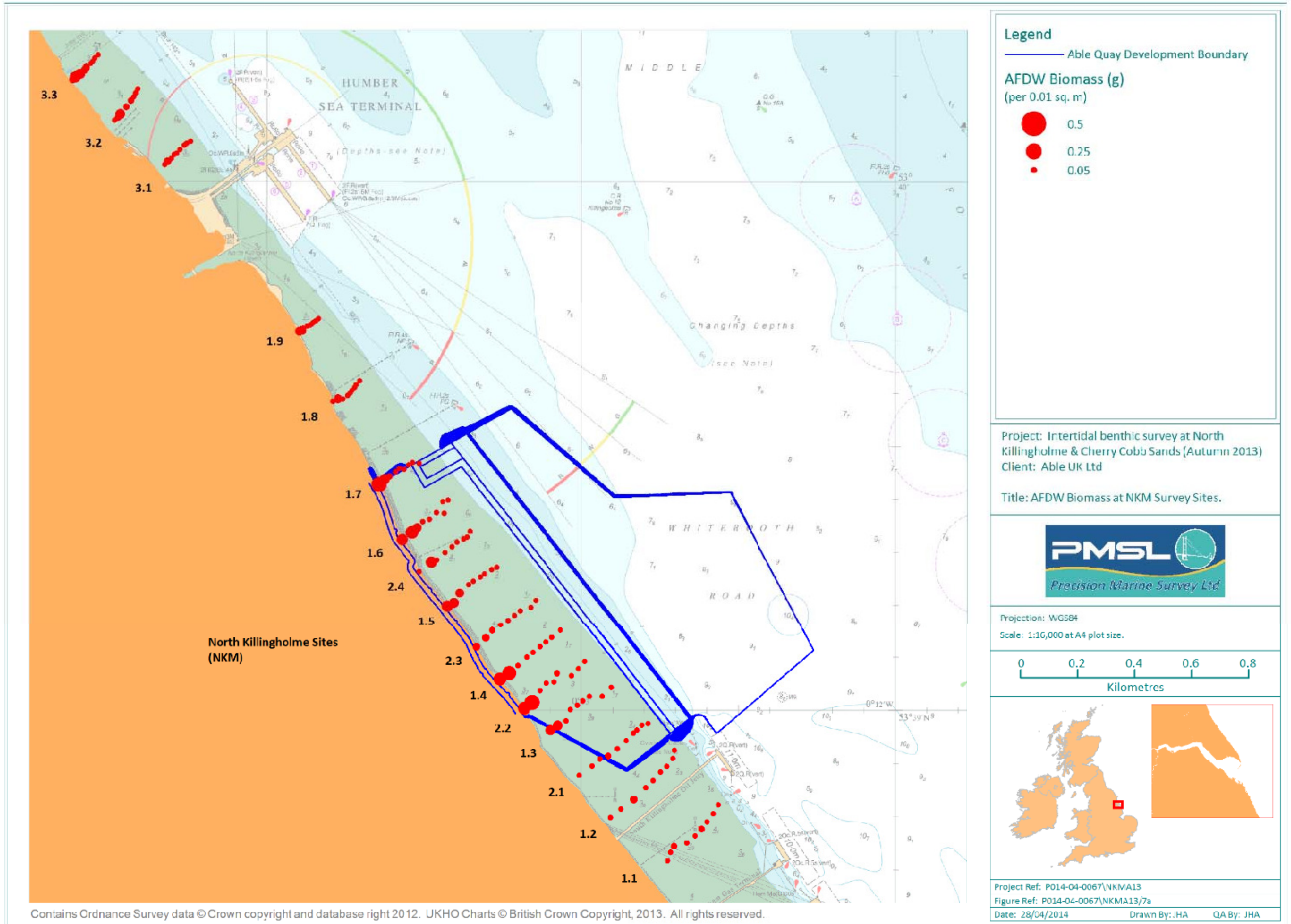

Figure 26. AFDW Biomass (g per 0.01m^2) at North Killingholme.

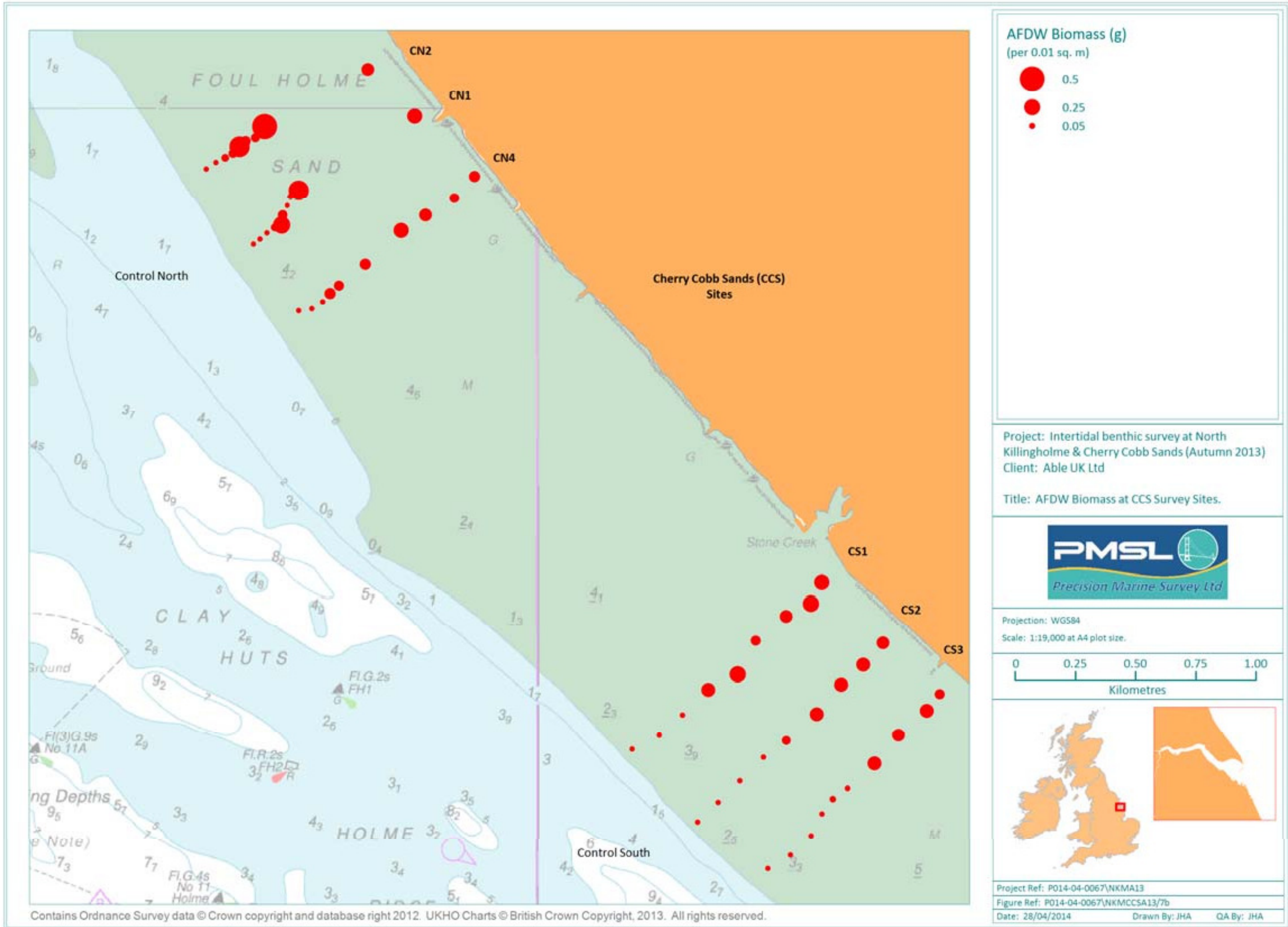

Figure 27. AFDW Biomass (g per 0.01m^2) at Cherry Cobb Sands.

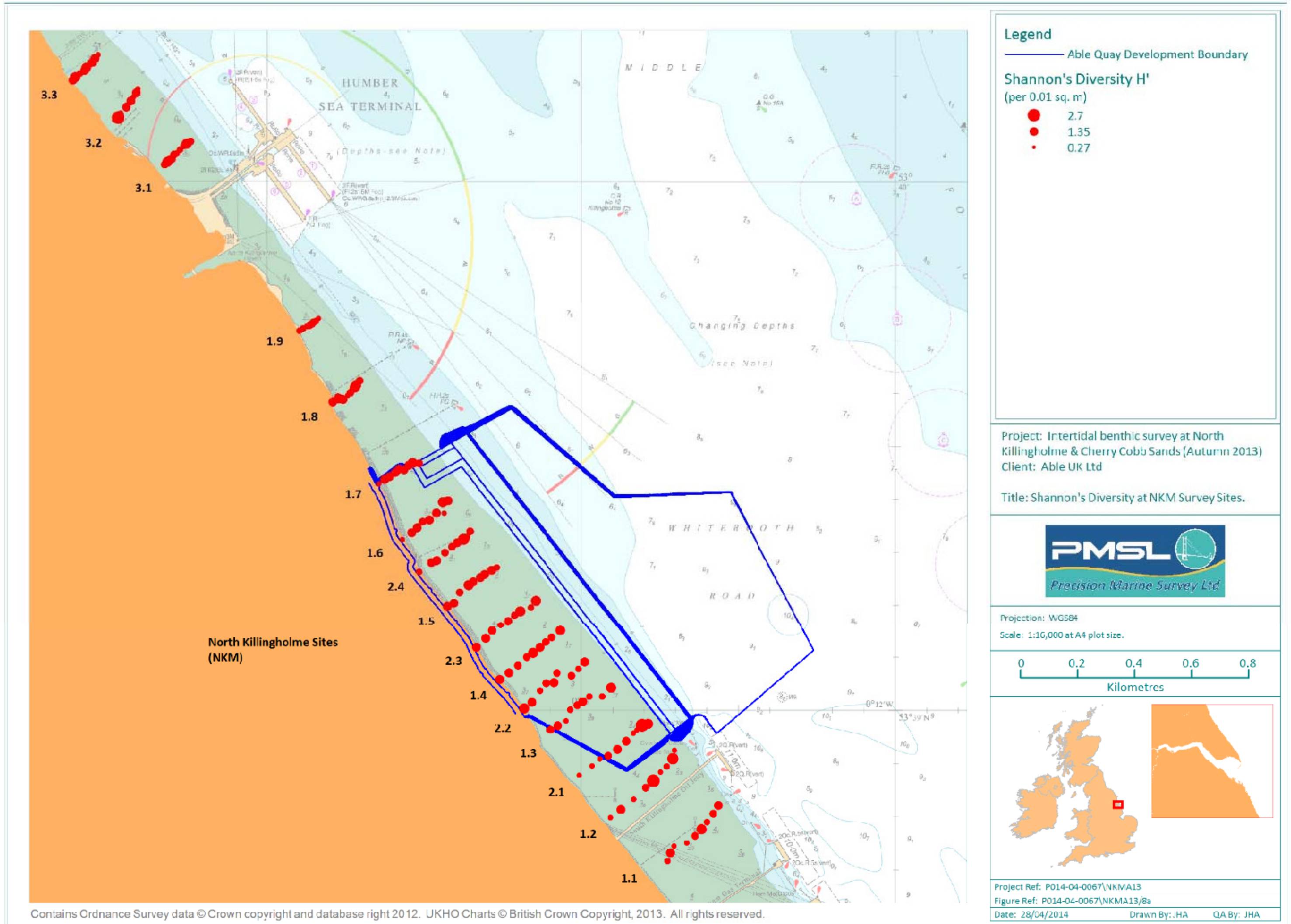

Figure 28. Shannon's diversity H' at North Killingholme (per 0.01m²).

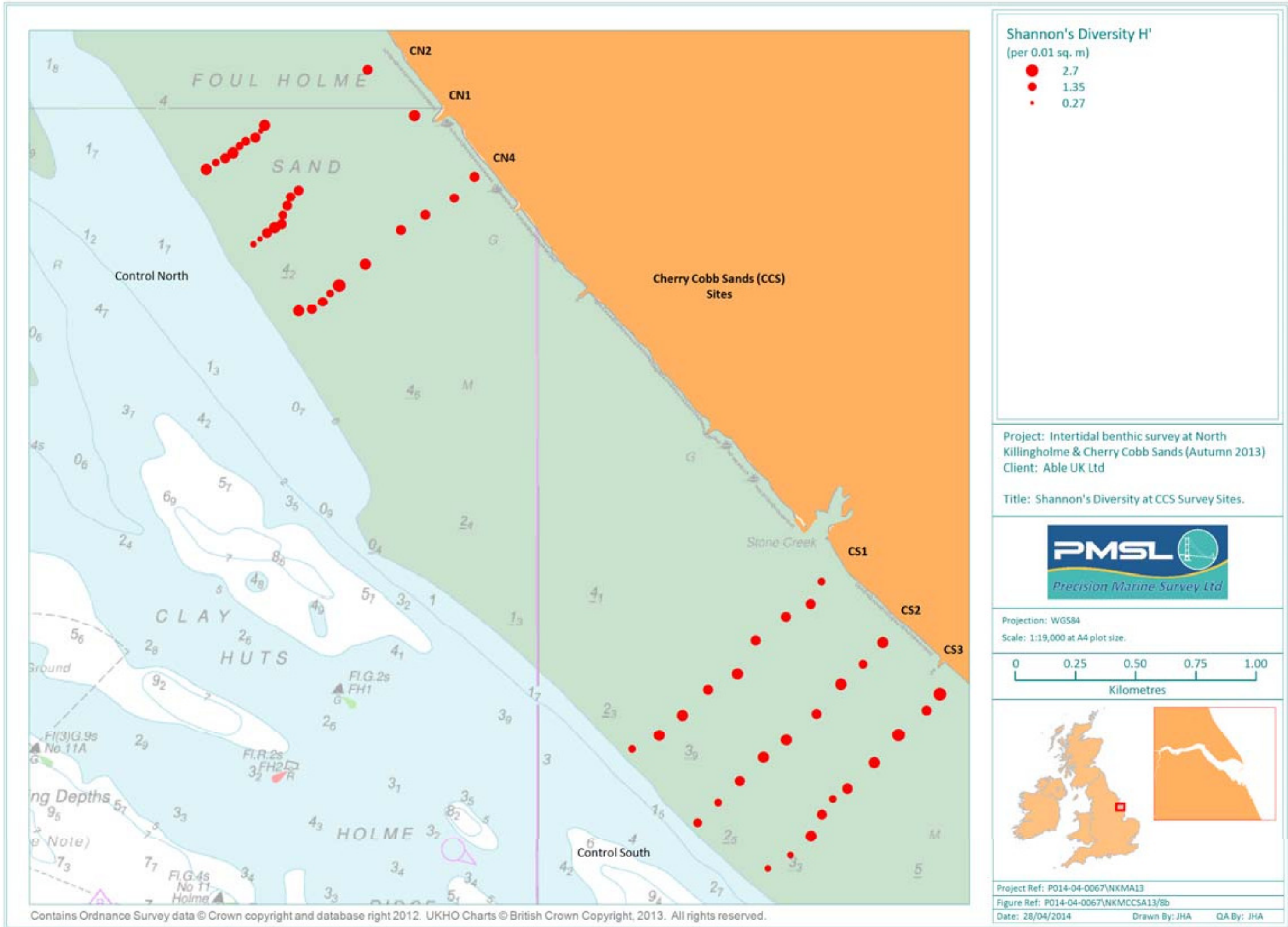

Figure 29. Shannon's diversity H' at Cherry Cobb Sands (per 0.01m^2).

Table 3. Values of biological parameters for each site (0.01m^2) at North Killingholme.

Area	Sample	Numbers of Taxa	Numbers of Individuals		Biomass (AFDW g)		Margalef's d	Pielou's J	Shannon's H	AFDW ABC w stat
			per 0.01 m^2	per 1 m^2	per 0.01 m^2	per 1 m^2				
Control North	3.1 LA	4	35	3500	0.0304	3.04	0.84	0.51	1.01	0.10
Control North	3.1 LB	5	30	3000	0.0006	0.06	1.18	0.80	1.85	0.16
Control North	3.1 LC	2	4	400	0.0049	0.49	0.72	1.00	1.00	1.00
Control North	3.1 MA	5	60	6000	0.0143	1.43	0.98	0.46	1.08	-0.15
Control North	3.1 MB	7	242	24200	0.0255	2.55	1.09	0.33	0.94	-0.03
Control North	3.1 MC	3	47	4700	0.0166	1.66	0.52	0.54	0.85	-0.30
Control North	3.1 UA	3	4	400	0.0010	0.10	0.72	1.00	1.00	0.48
Control North	3.1 UB	7	148	14800	0.0623	6.23	1.20	0.64	1.80	0.18
Control North	3.1 UC	5	31	3100	0.0181	1.81	0.87	0.73	1.46	0.13
Control North	3.2 LA	5	44	4400	0.0208	2.08	1.06	0.36	0.84	-0.02
Control North	3.2 LB	7	128	12800	0.0104	1.04	1.24	0.57	1.60	0.11
Control North	3.2 LC	0	0	0	0.0000	0.00	-	-	0.00	-
Control North	3.2 MA	4	51	5100	0.0397	3.97	0.76	0.80	1.59	0.11
Control North	3.2 MB	7	137	13700	0.0478	4.78	1.22	0.47	1.31	-0.30
Control North	3.2 MC	3	37	3700	0.0123	1.23	0.55	0.30	0.48	-0.38
Control North	3.2 UA	0	0	0	0.0000	0.00	-	-	0.00	-
Control North	3.2 UB	8	66	6600	0.0469	4.69	1.67	0.88	2.64	0.52
Control North	3.2 UC	2	34	3400	0.0971	9.71	0.28	0.73	0.73	0.39
Control North	3.3 LA	6	48	4800	0.0074	0.74	1.03	0.60	1.39	-0.01
Control North	3.3 LB	8	283	28300	0.0290	2.90	1.24	0.46	1.38	0.01
Control North	3.3 LC	1	8	800	0.0004	0.04	0.00	-	0.00	0.00
Control North	3.3 MA	4	42	4200	0.0586	5.86	0.80	0.79	1.58	0.28
Control North	3.3 MB	7	311	31100	0.0698	6.98	1.05	0.59	1.65	0.04
Control North	3.3 MC	4	47	4700	0.0124	1.24	0.78	0.58	1.16	-0.11
Control North	3.3 UA	3	28	2800	0.0547	5.47	0.60	0.87	1.37	0.55
Control North	3.3 UB	9	394	39400	0.1294	12.94	1.34	0.56	1.77	0.18
Control North	3.3 UC	2	23	2300	0.1007	10.07	0.32	0.83	0.83	0.49
Direct Impact	1.3 LA	4	103	10300	0.0132	1.32	0.65	0.44	0.88	0.06
Direct Impact	1.3 LB	6	192	19200	0.0190	1.90	0.95	0.29	0.76	0.07
Direct Impact	1.3 LC	6	33	3300	0.0008	0.08	1.43	0.78	2.01	0.20
Direct Impact	1.3 MA	3	133	13300	0.0158	1.58	0.41	0.57	0.90	-0.21
Direct Impact	1.3 MB	8	347	34700	0.0225	2.25	1.03	0.39	1.11	0.06
Direct Impact	1.3 MC	6	84	8400	0.0085	0.85	1.13	0.51	1.31	0.08
Direct Impact	1.3 UA	3	30	3000	0.1083	10.83	0.59	0.79	1.25	0.48
Direct Impact	1.3 UB	5	328	32800	0.0949	9.49	0.69	0.64	1.48	0.19
Direct Impact	1.3 UC	2	97	9700	0.0176	1.76	0.22	0.08	0.08	-0.76
Direct Impact	1.4 LA	5	127	12700	0.0083	0.83	0.83	0.42	0.97	0.05
Direct Impact	1.4 LB	4	157	15700	0.0115	1.15	0.59	0.56	1.12	0.15
Direct Impact	1.4 LC	4	18	1800	0.0003	0.03	1.04	0.95	1.89	0.36
Direct Impact	1.4 MA	4	73	7300	0.0099	0.99	0.70	0.59	1.18	0.08
Direct Impact	1.4 MB	7	135	13500	0.0089	0.89	1.22	0.59	1.64	0.04
Direct Impact	1.4 MC	10	245	24500	0.0287	2.87	1.64	0.46	1.51	0.04
Direct Impact	1.4 UA	3	34	3400	0.1450	14.50	0.57	0.88	1.40	0.61
Direct Impact	1.4 UB	5	261	26100	0.1830	18.30	0.72	0.63	1.46	0.24
Direct Impact	1.4 UC	3	122	12200	0.0311	3.11	0.42	0.62	0.98	-0.36
Direct Impact	1.5 LA	4	24	2400	0.0008	0.08	0.94	0.74	1.48	-0.13
Direct Impact	1.5 LB	4	96	9600	0.0061	0.61	0.66	0.70	1.40	0.27
Direct Impact	1.5 LC	4	115	11500	0.0121	1.21	0.63	0.40	0.80	0.09
Direct Impact	1.5 MA	7	168	16800	0.0086	0.86	1.17	0.63	1.76	-0.17
Direct Impact	1.5 MB	7	125	12500	0.0087	0.87	1.24	0.52	1.46	0.10
Direct Impact	1.5 MC	7	219	21900	0.0140	1.40	1.11	0.58	1.62	0.08
Direct Impact	1.5 UA	5	84	8400	0.1245	12.45	0.90	0.67	1.55	0.18
Direct Impact	1.5 UB	4	65	6500	0.1079	10.79	0.72	0.76	1.51	0.38
Direct Impact	1.5 UC	6	756	75600	0.0815	8.15	0.75	0.45	1.16	-0.17
Direct Impact	1.6 LA	2	53	5300	0.0039	0.39	0.25	0.39	0.39	0.08
Direct Impact	1.6 LB	5	24	2400	0.0009	0.09	1.26	0.75	1.74	-0.13
Direct Impact	1.6 LC	3	4	400	0.0064	0.64	1.44	0.95	1.50	0.60
Direct Impact	1.6 MA	6	178	17800	0.0260	2.60	0.96	0.38	0.99	-0.01
Direct Impact	1.6 MB	10	271	27100	0.0251	2.51	1.61	0.43	1.42	0.02
Direct Impact	1.6 MC	8	169	16900	0.0288	2.88	1.36	0.49	1.48	-0.07
Direct Impact	1.6 UA	2	20	2000	0.1354	13.54	0.33	0.47	0.47	0.19
Direct Impact	1.6 UB	7	341	34100	0.1524	15.24	1.03	0.55	1.55	0.15

Area	Sample	Numbers of Taxa	Numbers of Individuals		Biomass (AFDW g)		Margalef's d	Pielou's J	Shannon's H	AFDW ABC w stat
			per 0.01 m^2	per 1 m^2	per 0.01 m^2	per 1 m^2				
Direct Impact	1.6 UC	5	461	46100	0.0859	8.59	0.65	0.58	1.34	0.02
Direct Impact	1.7 LA	5	125	12500	0.0073	0.73	0.83	0.63	1.46	0.11
Direct Impact	1.7 LB	5	44	4400	0.0014	0.14	1.06	0.82	1.90	0.01
Direct Impact	1.7 LC	3	6	600	0.0004	0.04	1.12	0.79	1.25	0.15
Direct Impact	1.7 MA	6	334	33400	0.0199	1.99	0.86	0.56	1.44	0.15
Direct Impact	1.7 MB	7	348	34800	0.0289	2.89	1.03	0.56	1.58	0.07
Direct Impact	1.7 MC	7	261	26100	0.0186	1.86	1.08	0.54	1.53	0.00
Direct Impact	1.7 UA	2	42	4200	0.2020	20.20	0.27	0.16	0.16	0.04
Direct Impact	1.7 UB	5	456	45600	0.0906	9.06	0.65	0.55	1.28	0.07
Direct Impact	1.7 UC	6	393	39300	0.0480	4.80	0.84	0.54	1.40	-0.06
Direct Impact	2.1 LA	3	59	5900	0.0110	1.10	0.49	0.21	0.34	0.03
Direct Impact	2.1 LB	8	22	2200	0.0008	0.08	2.26	0.89	2.68	0.31
Direct Impact	2.1 LC	8	58	5800	0.0168	1.68	1.72	0.66	1.97	0.18
Direct Impact	2.1 MA	7	78	7800	0.0139	1.39	1.38	0.54	1.51	0.00
Direct Impact	2.1 MA2	3	428	42800	0.0376	3.76	0.33	0.70	1.11	0.18
Direct Impact	2.1 MB	9	217	21700	0.0152	1.52	1.49	0.45	1.41	0.11
Direct Impact	2.1 MC	2	49	4900	0.0101	1.01	0.26	0.25	0.25	0.07
Direct Impact	2.1 UA	0	0	0	0.0000	0.00	-	-	0.00	-
Direct Impact	2.1 UB	6	116	11600	0.0188	1.88	1.05	0.23	0.60	-0.13
Direct Impact	2.1 UC	2	40	4000	0.0027	0.27	0.27	0.29	0.29	0.09
Direct Impact	2.2 LA	6	242	24200	0.0173	1.73	0.91	0.40	1.03	0.09
Direct Impact	2.2 LB	4	216	21600	0.0176	1.76	0.56	0.47	0.93	0.12
Direct Impact	2.2 LC	4	8	800	0.0002	0.02	1.44	0.77	1.55	0.00
Direct Impact	2.2 MA	6	85	8500	0.0120	1.20	1.13	0.43	1.12	-0.16
Direct Impact	2.2 MB	9	262	26200	0.0390	3.90	1.44	0.34	1.07	-0.06
Direct Impact	2.2 MC	7	93	9300	0.0137	1.37	1.32	0.50	1.41	-0.04
Direct Impact	2.2 UA	4	37	3700	0.1390	13.90	0.83	0.89	1.79	0.59
Direct Impact	2.2 UB	5	141	14100	0.2045	20.45	0.81	0.66	1.54	0.31
Direct Impact	2.2 UC	4	181	18100	0.0219	2.19	0.58	0.43	0.86	-0.23
Direct Impact	2.3 LA	5	79	7900	0.0039	0.39	0.92	0.70	1.64	-0.05
Direct Impact	2.3 LB	5	152	15200	0.0217	2.17	0.80	0.38	0.89	0.10
Direct Impact	2.3 LC	5	60	6000	0.0044	0.44	0.98	0.78	1.82	0.19
Direct Impact	2.3 MA	5	106	10600	0.0068	0.68	0.86	0.41	0.94	0.03
Direct Impact	2.3 MB	7	219	21900	0.0129	1.29	1.11	0.56	1.58	0.15
Direct Impact	2.3 MC	6	206	20600	0.0150	1.50	0.94	0.44	1.14	0.11
Direct Impact	2.3 UA	4	41	4100	0.0561	5.61	0.81	0.64	1.28	0.33
Direct Impact	2.3 UB	5	266	26600	0.0615	6.15	0.72	0.58	1.35	0.01
Direct Impact	2.3 UC	5	178	17800	0.0514	5.14	0.77	0.59	1.36	0.02
Direct Impact	2.4 LA	6	25	2500	0.0081	0.81	1.55	0.93	2.41	0.61
Direct Impact	2.4 LB	7	120	12000	0.0146	1.46	1.25	0.29	0.82	0.09
Direct Impact	2.4 LC	2	2	200	0.00001	0.001	1.44	1.00	1.00	0.00
Direct Impact	2.4 MA	4	275	27500	0.0201	2.01	0.53	0.58	1.15	0.06
Direct Impact	2.4 MB	6	240	24000	0.0176	1.76	0.91	0.38	0.98	0.06
Direct Impact	2.4 MC	10	200	20000	0.0195	1.95	1.70	0.49	1.63	-0.01
Direct Impact	2.4 UA	2	3	300	0.0177	1.77	0.91	0.92	0.92	0.63
Direct Impact	2.4 UB	5	104	10400	0.1231	12.31	0.86	0.65	1.51	0.28
Direct Impact	2.4 UC	5	251	25100	0.0281	2.81	0.72	0.56	1.29	-0.15
Indirect Impact Nth	1.8 LA	4	7	700	0.0067	0.67	1.54	0.92	1.84	0.48
Indirect Impact Nth	1.8 LB	4	5	500	0.0006	0.06	1.86	0.96	1.92	0.37
Indirect Impact Nth	1.8 LC	2	2	200	0.0004	0.04	1.44	1.00	1.00	0.97
Indirect Impact Nth	1.8 MA	4	80	8000	0.0115	1.15	0.68	0.33	0.66	0.06
Indirect Impact Nth	1.8 MB	5	241	24100	0.0258	2.58	0.73	0.50	1.16	0.06
Indirect Impact Nth	1.8 MC	2	25	2500	0.0021	0.21	0.31	0.90	0.90	-0.11
Indirect Impact Nth	1.8 UA	3	5	500	0.0171	1.71	1.24	0.96	1.52	0.70
Indirect Impact Nth	1.8 UB	6	220	22000	0.0777	7.77	0.93	0.75	1.94	0.33
Indirect Impact Nth	1.8 UC	3	62	6200	0.0232	2.32	0.48	0.88	1.39	0.33
Indirect Impact Nth	1.9 LA	3	11	1100	0.0094	0.94	0.83	0.78	1.24	0.32
Indirect Impact Nth	1.9 LB	2	3	300	0.00002	0.002	0.91	0.92	0.92	-0.22
Indirect Impact Nth	1.9 LC	1	1	100	0.0002	0.02	-	-	0.00	0.00
Indirect Impact Nth	1.9 MA	3	18	1800	0.0065	0.65	0.69	0.51	0.80	-0.21
Indirect Impact Nth	1.9 MB	6	215	21500	0.0221	2.21	0.93	0.41	1.05	-0.03
Indirect Impact Nth	1.9 MC	3	89	8900	0.0119	1.19	0.45	0.75	1.18	0.04
Indirect Impact Nth	1.9 UA	2	34	3400	0.0725	7.25	0.28	0.94	0.94	0.57
Indirect Impact Nth	1.9 UB	6	231	23100	0.0780	7.80	0.92	0.25	0.65	-0.05
Indirect Impact Nth	1.9 UC	4	43	4300	0.0146	1.46	0.80	0.38	0.76	-0.18

Area	Sample	Numbers of Taxa	Numbers of Individuals		Biomass (AFDW g)		Margalef's d	Pielou's J	Shannon's H	AFDW ABC w stat
			per 0.01 m²	per 1 m²	per 0.01 m²	per 1 m²				
Indirect Impact Sth	1.1 LA	3	41	4100	0.0075	0.75	0.54	0.58	0.92	-0.09
Indirect Impact Sth	1.1 LB	3	103	10300	0.0060	0.60	0.43	0.65	1.04	0.32
Indirect Impact Sth	1.1 LC	3	10	1000	0.0112	1.12	0.87	0.94	1.49	0.63
Indirect Impact Sth	1.1 MA	2	21	2100	0.0068	0.68	0.33	0.59	0.59	-0.02
Indirect Impact Sth	1.1 MB	5	357	35700	0.0320	3.20	0.68	0.48	1.13	-0.11
Indirect Impact Sth	1.1 MC	5	86	8600	0.0412	4.12	0.90	0.74	1.71	0.30
Indirect Impact Sth	1.1 UA	2	4	400	0.0043	0.43	0.72	0.81	0.81	-0.15
Indirect Impact Sth	1.1 UB	5	49	4900	0.0110	1.10	1.03	0.67	1.56	0.31
Indirect Impact Sth	1.1 UC	1	9	900	0.0481	4.81	0.00	-	0.00	0.00
Indirect Impact Sth	1.2 LA	5	60	6000	0.0128	1.28	0.98	0.32	0.73	-0.02
Indirect Impact Sth	1.2 LB	6	35	3500	0.0014	0.14	1.41	0.82	2.13	0.23
Indirect Impact Sth	1.2 LC	2	8	800	0.0008	0.08	0.48	0.54	0.54	0.24
Indirect Impact Sth	1.2 MA	5	150	15000	0.0267	2.67	0.80	0.49	1.15	-0.28
Indirect Impact Sth	1.2 MB	8	79	7900	0.0073	0.73	1.60	0.83	2.48	0.27
Indirect Impact Sth	1.2 MC	3	52	5200	0.0129	1.29	0.51	0.23	0.37	0.00
Indirect Impact Sth	1.2 UA	0	0	0	0.0000	0.00	-	-	0.00	-
Indirect Impact Sth	1.2 UB	4	32	3200	0.0014	0.14	0.87	0.80	1.59	0.32
Indirect Impact Sth	1.2 UC	3	48	4800	0.0647	6.47	0.52	0.37	0.58	0.03

Table 4. Values of biological parameters for each site (0.01m²) at Cherry Cobb Sands.

Area	Sample	Numbers of Taxa	Numbers of Individuals		Biomass (AFDW g)		Margalef's d	Pielou's J	Shannon's H	AFDW ABC w stat
			per 0.01 m²	per 1 m²	per 0.01 m²	per 1 m²				
Control North	N1 U2	7	109	10900	0.1970	19.70	1.28	0.80	2.24	0.46
Control North	N1 UA	7	324	32400	0.3208	32.08	1.04	0.59	1.67	0.24
Control North	N1 UB	10	116	11600	0.0447	4.47	1.89	0.51	1.69	0.12
Control North	N1 UC	5	45	4500	0.0085	0.85	1.05	0.87	2.02	0.56
Control North	N1 MA	4	67	6700	0.0922	9.22	0.71	0.78	1.57	0.35
Control North	N1 MB	6	114	11400	0.2647	26.47	1.06	0.77	1.99	0.39
Control North	N1 MC	5	64	6400	0.0605	6.05	0.96	0.96	2.22	0.73
Control North	N1 LA	7	66	6600	0.0132	1.32	1.19	0.67	1.74	0.25
Control North	N1 LB	1	1	100	0.0055	0.55	-	-	0.00	0.00
Control North	N1 LC	2	4	400	0.0001	0.01	0.72	0.81	0.81	0.34
Control North	N2 U2	8	254	25400	0.1462	14.62	1.26	0.60	1.80	0.24
Control North	N2 UA	9	48	4800	0.4843	48.43	2.07	0.65	2.06	0.30
Control North	N2 UB	3	6	600	0.0626	6.26	0.56	0.65	0.65	0.33
Control North	N2 UC	6	77	7700	0.0873	8.73	1.15	0.77	2.00	0.42
Control North	N2 MA	7	422	42200	0.0959	9.59	0.99	0.45	1.28	0.12
Control North	N2 MB	7	168	16800	0.3485	34.85	1.17	0.43	1.20	0.02
Control North	N2 MC	8	66	6600	0.0879	8.79	1.67	0.74	2.23	0.37
Control North	N2 LA	7	156	15600	0.0649	6.49	1.19	0.61	1.71	-0.03
Control North	N2 LB	6	46	4600	0.0053	0.53	1.31	0.42	1.08	0.14
Control North	N2 LC	6	13	1300	0.0265	2.65	1.56	0.92	2.13	0.56
Control North	N4 U2	7	50	5000	0.1232	12.32	1.53	0.72	2.01	0.31
Control North	N4 UA	4	45	4500	0.0941	9.41	0.79	0.85	1.71	0.57
Control North	N4 UB	6	132	13200	0.1478	14.78	1.02	0.76	1.96	0.37
Control North	N4 UC	5	73	7300	0.2037	20.37	0.93	0.86	2.01	0.55
Control North	N4 MA	5	39	3900	0.1357	13.57	1.09	0.96	2.23	0.79
Control North	N4 MB	9	61	6100	0.0943	9.43	1.95	0.84	2.68	0.48
Control North	N4 MC	6	138	13800	0.1263	12.63	1.01	0.47	1.23	0.07
Control North	N4 LA	8	267	26700	0.0289	2.89	1.25	0.66	1.98	0.16
Control North	N4 LB	8	45	4500	0.0019	0.19	1.58	0.64	1.81	0.25
Control North	N4 LC	5	8	800	0.0013	0.13	1.92	0.97	2.25	0.59
Control South	S1 UA	5	71	7100	0.2016	20.16	0.94	0.41	0.95	0.15
Control South	S1 UB	6	117	11700	0.2287	22.87	1.05	0.71	1.84	0.23
Control South	S1 UC	5	78	7800	0.1404	14.04	0.92	0.85	1.98	0.28
Control South	S1 MA	6	94	9400	0.0910	9.10	1.10	0.73	1.88	-0.03
Control South	S1 MB	8	125	12500	0.2294	22.94	1.45	0.74	2.23	0.29
Control South	S1 MC	7	161	16100	0.1679	16.79	1.18	0.66	1.87	0.24
Control South	S1 LA	5	12	1200	0.0256	2.56	1.61	0.94	2.19	0.43
Control South	S1 LB	5	14	1400	0.0059	0.59	1.52	0.89	2.07	0.39
Control South	S1 LC	2	2	200	0.0041	0.41	1.44	1.00	1.00	0.45
Control South	S2 UA	9	112	11200	0.1509	15.09	1.70	0.72	2.28	0.30
Control South	S2 UB	8	237	23700	0.1855	18.55	1.28	0.50	1.51	0.04
Control South	S2 UC	8	119	11900	0.1803	18.03	1.46	0.68	2.05	0.21
Control South	S2 MA	9	258	25800	0.1867	18.67	1.44	0.54	1.71	0.06
Control South	S2 MB	9	74	7400	0.0754	7.54	1.63	0.80	2.41	0.38
Control South	S2 MC	7	29	2900	0.0259	2.59	1.78	0.80	2.25	0.37
Control South	S2 LA	4	7	700	0.0247	2.47	1.54	0.92	1.84	0.66
Control South	S2 LB	3	6	600	0.00003	0.003	1.12	0.79	1.25	-0.23
Control South	S2 LC	3	3	300	0.0086	0.86	1.82	1.00	1.58	0.97
Control South	S3 UA	8	92	9200	0.1053	10.53	1.55	0.85	2.55	0.42
Control South	S3 UB	9	118	11800	0.1661	16.61	1.68	0.62	1.97	0.12
Control South	S3 UC	9	196	19600	0.1393	13.93	1.52	0.78	2.48	0.32
Control South	S3 MA	10	91	9100	0.1625	16.25	2.00	0.71	2.35	0.22
Control South	S3 MB	5	13	1300	0.0302	3.02	1.56	0.82	1.91	0.53
Control South	S3 MB2	3	12	1200	0.0489	4.89	0.80	0.75	1.19	-0.02
Control South	S3 MC	6	15	1500	0.0353	3.53	1.48	0.80	1.86	0.46
Control South	S3 LA	7	20	2000	0.0071	0.71	2.00	0.83	2.32	0.39
Control South	S3 LB	2	3	300	0.00003	0.003	0.91	0.92	0.92	-0.09
Control South	S3 LC	2	5	500	0.00003	0.003	0.62	0.72	0.72	-0.34

3.3 Species Composition at the Survey Areas

3.3.1 North Killingholme

A summary of the dominant taxa by abundance and biomass has been provided based on $0.01m^2$ core data collected at each site. The average abundances and AFDW biomass for the entire survey area have been scaled up to numbers and weights per m^2 across and these are provided in Table 5. In total 25 taxa were recorded during the survey including a number of terrestrial (insect) taxa which have been included as they were particularly indicative of upper shore areas adjacent to saltmarsh.

In terms of total abundance the most dominant taxa were *Corophium volutator* and *Tubificoides benedii* which accounted for 84% of the total abundance and were recorded at the majority of sites (88% and 84% respectively). *Hediste diversicolor* was also common and recorded at 47% of the sites whilst *Streblospio shrubsolii*, Nematoda spp. and *Macoma balthica* were also widely recorded in somewhat lower numbers. Moderate numbers of other oligochaetes (*Tubificoides* agg. and Enchytraeidae sp.) were also recorded at a lower number of sites. In terms of biomass larger species such as *Hediste diversicolor* dominated the biomass (65% of total) along with *Corophium volutator, Tubificoides benedii* and *Macoma balthica* which collectively accounted for the majority of the biomass (98% of total).

Table 5. Ranked average abundance and biomass for the full survey area at North Killingholme (per m^2).

Taxa	Mean Abundance per m^2	% of sites	% of Total	Taxa	Mean AFDW Biomass (g) per m^2	% of sites	% of Total
Corophium volutator	6517.9	88	54.7	Hediste diversicolor	2.06381	47	64.6
Tubificoides benedii	3460.7	84	83.7	Corophium volutator	0.74226	88	87.8
Hediste diversicolor	521.4	47	88.1	Tubificoides benedii	0.17490	84	93.3
Streblospio shrubsolii	445.5	52	91.9	Macoma balthica	0.15903	43	98.2
Nematoda	344.1	46	94.7	Streblospio shrubsolii	0.01463	52	98.7
Enchytraeidae	192.4	6	96.4	Scrobicularia plana	0.01109	1	99.0
Macoma balthica	184.8	43	97.9	Nematoda	0.00995	46	99.3
Collembola sp.	63.4	6	98.4	Eteone longa/flava agg.	0.00441	19	99.5
Tubificoides swirencoides	37.2	7	98.8	Diptera larvae	0.00426	7	99.6
Pygospio elegans	35.9	21	99.1	Nephtys hombergii	0.00421	2	99.7
Eteone longa/flava agg.	27.6	19	99.3	Tharyx sp.	0.00199	7	99.8
Tubificoides (pseudogaster) agg.	26.2	6	99.5	Coleoptera sp.	0.00184	3	99.9
Diptera larvae	20.0	7	99.7	Nemertea	0.00086	6	99.9
Tharyx sp.	12.4	7	99.8	Pygospio elegans	0.00083	21	99.9
Manayunkia aestuarina	7.6	3	99.8	Tubificoides (pseudogaster) agg.	0.00074	6	99.9
Nemertea	5.5	6	99.9	Enchytraeidae	0.00070	6	100.0
Heterochaeta costata	3.4	1	99.9	Tubificoides swirencoides	0.00037	7	100.0
Coleoptera sp.	2.8	3	99.9	Nereididae	0.00035	1	100.0
Nephtys hombergii	2.1	2	100.0	Diptera sp.	0.00019	1	100.0
Arachnida (Acarina)	2.1	2	100.0	Collembola sp.	0.00010	6	100.0
Scrobicularia plana	1.4	1	100.0	Heterochaeta costata	0.00004	1	100.0
Arachnida (Linyphiidae)	0.7	1	100.0	Manayunkia aestuarina	0.00004	3	100.0
Diptera sp.	0.7	1	100.0	Arachnida (Acarina)	0.00003	2	100.0
Nereididae	P	1		Spionidae sp.	0.00001	1	100.0
Spionidae sp.	P	1		Arachnida (Linyphiidae)	0.00001	1	100.0

3.3.2 Cherry Cobb Sands

In terms of characteristic species from the CCS survey the dominant taxa across the survey area (mean abundance and AFDW biomass per m^2) are given in Table 6. A similar range of taxa were recorded at CCS in comparison to NKM with the exception of *Corophium volutator* which is largely absent in this area although the total number of taxa recorded (28 taxa) is greater which reflects wider range of habitats present. The dominant taxa at CCS (in terms of numbers of individuals) are Nematoda spp*., Tubificoides benedii,* Enchytraeidae oligochaetes, *Macoma balthica, Hediste diversicolor and Pygospio elegans* which account for 90% of the total abundance and were recorded at the majority of sites. In terms of biomass *Hediste diversicolor* and *Macoma balthica* account for over 90% of the total.

Table 6. Ranked average abundance and biomass for the full survey area at Cherry Cobb Sands (per m^2).

Taxa	Mean Abundance per m^2	% of sites	% of Total	Taxa	Mean AFDW Biomass (g) per m^2	% of sites	% of Total
Nematoda	2225.9	71	25.3	Hediste diversicolor	6.63620	66	64.1
Tubificoides benedii	2139.7	59	49.6	Macoma balthica	2.71476	72	90.4
Enchytraeidae	1122.4	50	62.3	Scrobicularia plana	0.46822	9	94.9
Macoma balthica	1048.3	72	74.2	Nephtys hombergii	0.18734	21	96.7
Hediste diversicolor	950.0	66	85.0	Tubificoides benedii	0.09129	59	97.6
Pygospio elegans	436.2	55	90.0	Hydrobia ulvae	0.08603	38	98.4
Hydrobia ulvae	227.6	38	92.5	Nephtyidae	0.05516	3	99.0
Manayunkia aestuarina	191.4	19	94.7	Nereididae	0.02451	5	99.2
Eteone longa/flava agg.	105.2	48	95.9	Eteone longa/flava agg.	0.01796	48	99.4
Tubificoides (pseudogaster) agg.	103.4	3	97.1	Pygospio elegans	0.01650	55	99.5
Collembola sp.	96.6	21	98.2	Diptera larvae	0.01466	28	99.7
Diptera larvae	43.1	28	98.7	Nematoda	0.01133	71	99.8
Nephtys hombergii	37.9	21	99.1	Abra tenuis	0.00497	10	99.8
Bathyporeia sp.	15.5	5	99.3	Cyathura carinata	0.00411	7	99.9
Abra tenuis	13.8	10	99.4	Tubificoides (pseudogaster) agg.	0.00325	3	99.9
Scoloplos armiger	10.3	7	99.5	Enchytraeidae	0.00276	50	99.9
Streblospio shrubsolii	10.3	2	99.7	Retusa obtusa	0.00255	2	99.9
Scrobicularia plana	8.6	9	99.8	Bathyporeia sp.	0.00240	5	100.0
Cyathura carinata	6.9	7	99.8	Manayunkia aestuarina	0.00105	19	100.0
Polydora cornuta	3.4	2	99.9	Abra sp.	0.00076	2	100.0
Nemertea	1.7	2	99.9	Scoloplos armiger	0.00054	7	100.0
Copepoda	1.7	2	99.9	Collembola sp.	0.00028	21	100.0
Corophium volutator	1.7	2	99.9	Nemertea	0.00004	2	100.0
Eurydice pulchra	1.7	2	100.0	Polydora cornuta	0.00003	2	100.0
Retusa obtusa	1.7	2	100.0	Copepoda	0.00003	2	100.0
Abra sp.	1.7	2	100.0	Streblospio shrubsolii	0.00003	2	100.0
Nereididae	P	5		Corophium volutator	0.00003	2	100.0
Nephtyidae	P	3		Eurydice pulchra	0.00002	2	100.0

3.3.3 Spatial Trends

The summaries of dominant taxa (mean abundance and AFDW biomass per m^2) within the different shore levels in each survey area are provided in Tables 7 to 9 for NKM and 10 to 12 for CCS and the spatial distribution of key taxa (*Hediste diversicolor*, *Macoma balthica*, *Corophium volutator, Streblospio shrubsolii, Pygospio elegans* and oligochaetes) in terms of mean numbers per m^2 at each site are provided in a series of charts in Figures 30 to 41. These results highlight the influence of shore level on the distribution of infaunal communities and also indicate that the differences between specific survey areas are less pronounced for NKM but more so for CCS where differences in species composition to some extent reflect the greater variation in sediment types. For example at NKM taxa such as *Corophium volutator*, *Tubificoides benedii* and to a lesser extent S*treblospio shrubsolii* generally dominate numerically in varying degrees in all areas along with other taxa such as *Hediste diversicolor* and *Macoma balthica* although species such as *Streblospio shrubsolii* were generally more prevalent on the low shore whilst *Hediste diversicolor* is more common in upper shore sites and *Macoma balthica* more restricted to mid shore areas. The maps shown in Figures 30 to 41 also highlight the widespread coverage by *Corophium volutator* although numbers are generally lower at the southern indirect impact area. *Macoma balthica* is widely distributed in varying densities throughout the area with perhaps a slight increase in numbers on the mid shore and in the direct impact zone. Higher numbers of *Hediste diversicolor* are generally confined to more upper shore areas with lower numbers in the southern direct impact area and slightly higher numbers within the impact area although the increased survey intensity within the direct impact area may also influence observed patterns. Upper shore sites with greater elevation at NKM adjacent to saltmarsh e.g. at the control area and southern indirect impact area tended to have relatively impoverished communities with higher numbers of *Tubificoides* agg. (*pseudogaster*) and terrestrial insect taxa with. As expected *Hediste diversicolor*, *Macoma balthica*, *Corophium volutator* and *Tubificoides* spp. dominate in terms of biomass across all the areas at NKM.

At CCS more pronounced spatial differences were evident which reflects the variation in sedimentary regime and some differences in key taxa were also noted between CCS and NKM. Modest numbers of taxa were present at low shore areas (particularly at the southern control area) with *Tubificoides benedii,* Nematoda*, Macoma balthica, Nephtys hombergii and Pygospio elegans* characteristic at the southern area and Nematoda, *Tubificoides benedii*, Enchytraeidae and *Macoma balthica* dominant at the northern area. On the mid shore Nematoda, Enchytraeidae, *Tubificoides benedii*, *Macoma balthica* and are numerically dominant to the north whilst the southern control area was dominated by *Tubificoides benedii*, *Macoma balthica*, *Pygospio elegans* and *Hediste diversicolor*. Upper shore habitats tended to be characterised by oligochaetes and *Hediste diversicolor* with the northern control area dominated by Nematoda and Enchytraeidae along with *Hediste diversicolor*, *Tubificoides benedii* and *Manayunkia aestuarina* with *Tubificoides* agg. (*pseudogaster*) occasionally common in saltmarsh influenced areas. The southern control areas were dominated by *Tubificoides benedii* and *Hediste diversicolor* along with *Macoma balthica, Hydrobia ulvae* and *Pygospio elegans* and with the latter more prevalent in the southern area. Whilst a similar range of taxa were recorded at CCS in comparison to NKM some differences are apparent and Figures 34 and 35 highlight the relative absence of *Corophium volutator* at CCS whilst it is abundant at NKM. This may reflect sedimentological differences although the distribution of *Corophium volutator* in the Humber is known to exhibit high levels of temporal and spatial variability. Slightly higher numbers of *Hediste diversicolor* were recorded at CCS in comparison to NKM and this taxa also had a slightly wider distribution at CCS whereas at NKM this species tended to be more prevalent on the upper shore. Densities of *Macoma balthica* on the upper and mid shore also tended to be higher at CCS than at NKM with average mid shore densities ranging from 1156 to 2270 per m^2 at CCS as opposed to 183 to 657 per m^2 at NKM.

Table 7. Average ranked abundance and biomass (per 1m^2) for the low shore sites at North Killingholme.

Control North Low Shore			Direct Impact Low Shore			Indirect Impact North Low Shore			Indirect Impact South Low Shore		
Taxa	Mean Abundance per m^2	% of sites	Taxa	Mean Abundance per m^2	% of sites	Taxa	Mean Abundance per m^2	% of sites	Taxa	Mean Abundance per m^2	% of sites
Corophium volutator	4333	78	Corophium volutator	5356	85	Corophium volutator	183	50	Corophium volutator	2883	100
Nematoda	689	44	Streblospio shrubsolii	1252	81	Tubificoides benedii	150	83	Nematoda	433	17
Tubificoides benedii	678	78	Tubificoides benedii	844	96	Macoma balthica	67	67	Tubificoides benedii	350	67
Streblospio shrubsolii	522	56	Nematoda	241	63	Eteone longa/flava agg.	33	33	Streblospio shrubsolii	300	33
Macoma balthica	133	67	Tubificoides swirencoides	174	22	Pygospio elegans	33	17	Macoma balthica	167	67
Eteone longa/flava agg.	22	22	Eteone longa/flava agg.	70	52	Nephtys hombergii	17	17	Tubificoides swirencoides	100	50
Nemertea	11	11	Pygospio elegans	30	22				Pygospio elegans	33	17
Hediste diversicolor	11	11	Macoma balthica	15	15				Hediste diversicolor	17	17
Manayunkia aestuarina	11	11	Nephtys hombergii	7	7						
Heterochaeta costata	11	11	Tharyx sp.	7	7						
Tubificoides (pseudogaster) agg.	11	11	Nemertea	4	4						
Enchytraeidae	11	11	Hediste diversicolor	4	4						
Nereididae	P	11	Scrobicularia plana	4	4						
			Coleoptera sp.	4	4						
			Collembola sp.	4	4						

Control North Low Shore			Direct Impact Low Shore			Indirect Impact North Low Shore			Indirect Impact South Low Shore		
Taxa	Mean AFDW Biomass (g) per m^2	% of sites	Taxa	Mean AFDW Biomass (g) per m^2	% of sites	Taxa	Mean AFDW Biomass (g) per m^2	% of sites	Taxa	Mean AFDW Biomass (g) per m^2	% of sites
Macoma balthica	0.5766	67	Corophium volutator	0.5811	85	Macoma balthica	0.2358	67	Corophium volutator	0.3795	100
Corophium volutator	0.5017	78	Macoma balthica	0.0843	15	Corophium volutator	0.0285	50	Macoma balthica	0.2257	67
Tubificoides benedii	0.0227	78	Streblospio shrubsolii	0.0393	81	Eteone longa/flava agg.	0.0086	33	Hediste diversicolor	0.0228	17
Hediste diversicolor	0.0207	11	Tubificoides benedii	0.0302	96	Nephtys hombergii	0.0058	17	Tubificoides benedii	0.0209	67
Streblospio shrubsolii	0.0185	56	Nephtys hombergii	0.0213	7	Tubificoides benedii	0.0057	83	Streblospio shrubsolii	0.0096	33
Nereididae	0.0056	11	Eteone longa/flava agg.	0.0059	52	Pygospio elegans	0.0030	17	Nematoda	0.0009	17
Nematoda	0.0049	44	Coleoptera sp.	0.0027	4				Tubificoides swirencoides	0.0003	50
Nemertea	0.0020	11	Hediste diversicolor	0.0021	4				Pygospio elegans	0.0002	17
Eteone longa/flava agg.	0.0011	22	Tubificoides swirencoides	0.0019	22						
Manayunkia aestuarina	0.0002	11	Scrobicularia plana	0.0017	4						
Heterochaeta costata	0.0001	11	Nematoda	0.0012	63						
Tubificoides (pseudogaster) agg.	0.0001	11	Pygospio elegans	0.0010	22						
Enchytraeidae	0.0001	11	Tharyx sp.	0.0006	7						
			Nemertea	0.0001	4						
			Collembola sp.	0.0001	4						

Table 8. Average ranked abundance and biomass (per 1m²) for the mid shore sites North Killingholme.

Control North Mid Shore			Direct Impact Mid Shore			Indirect Impact North Mid Shore			Indirect Impact South Mid Shore		
Taxa	Mean Abundance per m²	% of sites	Taxa	Mean Abundance per m²	% of sites	Taxa	Mean Abundance per m²	% of sites	Taxa	Mean Abundance per m²	% of sites
Corophium volutator	7244	100	Corophium volutator	11939	96	Corophium volutator	8100	100	Tubificoides benedii	6250	100
Tubificoides benedii	2111	100	Tubificoides benedii	5725	100	Tubificoides benedii	2433	100	Corophium volutator	4883	83
Hediste diversicolor	567	67	Macoma balthica	657	82	Macoma balthica	283	67	Collembola sp.	400	17
Nematoda	378	33	Nematoda	621	71	Nematoda	217	50	Hediste diversicolor	350	100
Streblospio shrubsolii	256	33	Streblospio shrubsolii	525	89	Hediste diversicolor	67	33	Macoma balthica	183	50
Macoma balthica	211	100	Pygospio elegans	121	71	Streblospio shrubsolii	33	33	Nematoda	183	33
Pygospio elegans	11	11	Eteone longa/flava agg.	57	32				Streblospio shrubsolii	83	33
Manayunkia aestuarina	11	11	Tharyx sp.	57	29				Pygospio elegans	33	17
Tubificoides (pseudogaster) agg.	11	11	Hediste diversicolor	54	36				Diptera larvae	33	17
Enchytraeidae	11	11	Nemertea	21	25				Tubificoides (pseudogaster) agg.	17	17
Coleoptera sp.	11	11	Collembola sp.	18	7						
			Enchytraeidae	7	7						
			Tubificoides (pseudogaster) agg.	4	4						
			Tubificoides swirencoides	4	4						
			Coleoptera sp.	4	4						

Control North Mid Shore			Direct Impact Mid Shore			Indirect Impact North Mid Shore			Indirect Impact South Mid Shore		
Taxa	Mean AFDW Biomass (g) per m²	% of sites	Taxa	Mean AFDW Biomass (g) per m²	% of sites	Taxa	Mean AFDW Biomass (g) per m²	% of sites	Taxa	Mean AFDW Biomass (g) per m²	% of sites
Hediste diversicolor	1.4915	67	Corophium volutator	1.1333	96	Corophium volutator	0.9773	100	Hediste diversicolor	0.8647	100
Corophium volutator	0.9017	100	Tubificoides benedii	0.3103	100	Hediste diversicolor	0.1627	33	Corophium volutator	0.7595	83
Macoma balthica	0.6411	100	Macoma balthica	0.1950	82	Tubificoides benedii	0.1228	100	Tubificoides benedii	0.3790	100
Nematoda	0.1400	33	Hediste diversicolor	0.1188	36	Macoma balthica	0.0668	67	Macoma balthica	0.1048	50
Tubificoides benedii	0.1082	100	Streblospio shrubsolii	0.0167	89	Nematoda	0.0009	50	Diptera larvae	0.0048	17
Streblospio shrubsolii	0.0103	33	Eteone longa/flava agg.	0.0149	32	Streblospio shrubsolii	0.0005	33	Tubificoides (pseudogaster) agg.	0.0020	17
Coleoptera sp.	0.0082	11	Tharyx sp.	0.0097	29				Streblospio shrubsolii	0.0008	33
Manayunkia aestuarina	0.0002	11	Nemertea	0.0038	25				Nematoda	0.0006	33
Pygospio elegans	0.0001	11	Pygospio elegans	0.0025	71				Collembola sp.	0.0002	17
Tubificoides (pseudogaster) agg.	0.0001	11	Nematoda	0.0017	71				Pygospio elegans	0.0002	17
Enchytraeidae	0.0001	11	Coleoptera sp.	0.0010	4						
			Collembola sp.	0.0001	7						
			Enchytraeidae	0.00004	7						
			Tubificoides swirencoides	0.00004	4						
			Tubificoides (pseudogaster) agg.	0.00002	4						

Table 9. Average ranked abundance and biomass (per $1m^2$) for the upper shore sites North Killingholme.

Control North Upper Shore			Direct Impact Upper Shore			Indirect Impact North Upper Shore			Indirect Impact South Upper Shore		
Taxa	Mean Abundance per m^2	% of sites	Taxa	Mean Abundance per m^2	% of sites	Taxa	Mean Abundance per m^2	% of sites	Taxa	Mean Abundance per m^2	% of sites
Corophium volutator	3478	89	Tubificoides benedii	8507	85	Corophium volutator	6500	100	Tubificoides benedii	717	17
Enchytraeidae	2244	33	Corophium volutator	7119	89	Enchytraeidae	1217	33	Collembola sp.	700	33
Hediste diversicolor	1044	78	Hediste diversicolor	1852	93	Hediste diversicolor	933	100	Corophium volutator	533	67
Nematoda	433	33	Streblospio shrubsolii	237	48	Tubificoides benedii	550	50	Hediste diversicolor	200	50
Tubificoides (pseudogaster) agg.	278	22	Nematoda	148	37	Nematoda	517	33	Diptera larvae	133	33
Collembola sp.	189	22	Diptera larvae	22	11	Tubificoides (pseudogaster) agg.	117	17	Nematoda	67	33
Tubificoides benedii	133	44	Macoma balthica	15	11	Streblospio shrubsolii	33	17	Arachnida (Acarina)	17	17
Diptera larvae	133	33	Heterochaeta costata	15	4	Macoma balthica	17	17			
Manayunkia aestuarina	78	11	Collembola sp.	11	4	Arachnida (Linyphiidae)	17	17			
Pygospio elegans	33	11	Tubificoides (pseudogaster) agg.	7	7	Diptera larvae	17	17			
Macoma balthica	22	22	Manayunkia aestuarina	7	4						
Arachnida (Acarina)	22	22	Eteone longa/flava agg.	4	4						
Spionidae sp.	P	11	Scrobicularia plana	4	4						
			Coleoptera sp.	4	4						
			Diptera sp.	4	4						

Control North Upper Shore			Direct Impact Upper Shore			Indirect Impact North Upper Shore			Indirect Impact South Upper Shore		
Taxa	Mean AFDW Biomass (g) per m^2	% of sites	Taxa	Mean AFDW Biomass (g) per m^2	% of sites	Taxa	Mean AFDW Biomass (g) per m^2	% of sites	Taxa	Mean AFDW Biomass (g) per m^2	% of sites
Hediste diversicolor	5.1521	78	Hediste diversicolor	7.2668	93	Hediste diversicolor	3.7593	100	Hediste diversicolor	1.8049	50
Corophium volutator	0.4052	89	Corophium volutator	0.8921	89	Corophium volutator	0.9128	100	Corophium volutator	0.2496	67
Macoma balthica	0.0607	22	Tubificoides benedii	0.4025	85	Tubificoides benedii	0.0246	50	Tubificoides benedii	0.0694	17
Diptera larvae	0.0215	33	Scrobicularia plana	0.0578	4	Diptera larvae	0.0075	17	Diptera larvae	0.0339	33
Tubificoides (pseudogaster) agg.	0.0099	22	Streblospio shrubsolii	0.0087	48	Streblospio shrubsolii	0.0059	17	Nematoda	0.0006	33
Tubificoides benedii	0.0086	44	Diptera larvae	0.0055	11	Enchytraeidae	0.0043	33	Collembola sp.	0.0005	33
Enchytraeidae	0.0081	33	Coleoptera sp.	0.0034	4	Macoma balthica	0.0018	17	Arachnida (Acarina)	0.0002	17
Nematoda	0.0016	33	Diptera sp.	0.0010	4	Nematoda	0.0012	33			
Collembola sp.	0.0006	22	Nematoda	0.0007	37	Tubificoides (pseudogaster) agg.	0.0006	17			
Arachnida (Acarina)	0.0003	22	Macoma balthica	0.0003	11	Arachnida (Linyphiidae)	0.0002	17			
Spionidae sp.	0.0002	11	Heterochaeta costata	0.0002	4						
Manayunkia aestuarina	0.0002	11	Manayunkia aestuarina	0.0001	4						
Pygospio elegans	0.0001	11	Collembola sp.	0.0001	4						
			Eteone longa/flava agg.	0.0001	4						
			Tubificoides (pseudogaster) agg.	0.00004	7						

Table 10. Average ranked abundance and biomass (per 1m^2) for the low shore sites at Cherry Cobb Sands.

Control North Low Shore			Control South Low Shore		
Taxa	Mean Abundance per m^2	% of sites	Taxa	Mean Abundance per m^2	% of sites
Nematoda	2578	78	Tubificoides benedii	156	44
Tubificoides benedii	1544	44	Nematoda	122	33
Enchytraeidae	1433	78	Macoma balthica	111	44
Macoma balthica	600	100	Nephtys hombergii	89	44
Hediste diversicolor	222	22	Pygospio elegans	89	33
Pygospio elegans	133	44	Eteone longa/flava agg.	67	33
Eteone longa/flava agg.	44	33	Bathyporeia sp.	44	22
Nephtys hombergii	33	22	Scoloplos armiger	33	22
Collembola sp.	33	22	Enchytraeidae	22	22
Manayunkia aestuarina	22	22	Hediste diversicolor	11	11
Scoloplos armiger	22	11	Manayunkia aestuarina	11	11
Polydora cornuta	22	11	Copepoda	11	11
Diptera larvae	22	11	Eurydice pulchra	11	11
Cyathura carinata	11	11	Hydrobia ulvae	11	11
Scrobicularia plana	11	11	Collembola sp.	11	11
Nereididae	P	22			
Nephtyidae	P	11			

Control North Low Shore			Control South Low Shore		
Taxa	Mean AFDW Biomass (g) per m^2	% of sites	Taxa	Mean AFDW Biomass (g) per m^2	% of sites
Hediste diversicolor	0.5122	22	Nephtys hombergii	0.5625	44
Macoma balthica	0.3169	100	Hediste diversicolor	0.1281	11
Nephtyidae	0.2839	11	Macoma balthica	0.1004	44
Scrobicularia plana	0.2728	11	Hydrobia ulvae	0.0331	11
Nephtys hombergii	0.1324	22	Bathyporeia sp.	0.0078	22
Tubificoides benedii	0.0764	44	Pygospio elegans	0.0057	33
Nematoda	0.0123	78	Tubificoides benedii	0.0030	44
Diptera larvae	0.0121	11	Eteone longa/flava agg.	0.0024	33
Cyathura carinata	0.0115	11	Scoloplos armiger	0.0014	22
Pygospio elegans	0.0046	44	Nematoda	0.0006	33
Enchytraeidae	0.0040	78	Copepoda	0.0002	11
Eteone longa/flava agg.	0.0008	33	Manayunkia aestuarina	0.0002	11
Scoloplos armiger	0.0004	11	Eurydice pulchra	0.0002	11
Manayunkia aestuarina	0.0004	22	Collembola sp.	0.0002	11
Nereididae	0.0003	22	Enchytraeidae	0.0001	22
Collembola sp.	0.0003	22			
Polydora cornuta	0.0002	11			

Table 11. Average ranked abundance and biomass (per 1m^2) for the mid shore sites at Cherry Cobb Sands.

Control North Mid Shore			Control South Mid Shore		
Taxa	Mean Abundance per m^2	% of sites	Taxa	Mean Abundance per m^2	% of sites
Nematoda	5800	89	Tubificoides benedii	3790	70
Enchytraeidae	1722	89	Macoma balthica	2270	100
Tubificoides benedii	1389	56	Pygospio elegans	1130	90
Macoma balthica	1156	67	Hediste diversicolor	440	50
Hediste diversicolor	1144	100	Hydrobia ulvae	340	70
Manayunkia aestuarina	500	44	Nematoda	290	70
Pygospio elegans	489	67	Eteone longa/flava agg.	220	70
Collembola sp.	289	22	Nephtys hombergii	90	50
Hydrobia ulvae	67	33	Bathyporeia sp.	50	10
Diptera larvae	44	22	Abra tenuis	30	30
Eteone longa/flava agg.	33	22	Scrobicularia plana	20	20
Cyathura carinata	11	11	Scoloplos armiger	10	10
Scrobicularia plana	11	11	Cyathura carinata	10	10
			Retusa obtusa	10	10
			Collembola sp.	10	10
			Diptera larvae	10	10
			Nereididae	P	10
			Nephtyidae	P	10

Control North Mid Shore			Control South Mid Shore		
Taxa	Mean AFDW Biomass (g) per m^2	% of sites	Taxa	Mean AFDW Biomass (g) per m^2	% of sites
Hediste diversicolor	11.1043	100	Macoma balthica	7.3356	100
Scrobicularia plana	2.5787	11	Hediste diversicolor	1.9577	50
Macoma balthica	0.6784	67	Nephtys hombergii	0.4449	50
Tubificoides benedii	0.0587	56	Hydrobia ulvae	0.1725	70
Nematoda	0.0386	89	Tubificoides benedii	0.1599	70
Pygospio elegans	0.0202	67	Nereididae	0.1418	10
Hydrobia ulvae	0.0165	33	Scrobicularia plana	0.1393	20
Diptera larvae	0.0052	22	Nephtyidae	0.0644	10
Eteone longa/flava agg.	0.0042	22	Pygospio elegans	0.0562	90
Manayunkia aestuarina	0.0034	44	Retusa obtusa	0.0148	10
Enchytraeidae	0.0032	89	Eteone longa/flava agg.	0.0131	70
Collembola sp.	0.0003	22	Diptera larvae	0.0127	10
Cyathura carinata	0.0002	11	Bathyporeia sp.	0.0069	10
			Cyathura carinata	0.0050	10
			Abra tenuis	0.0032	30
			Scoloplos armiger	0.0016	10
			Nematoda	0.0013	70
			Collembola sp.	0.0001	10

Table 12. Average ranked abundance and biomass (per 1m^2) for the upper shore sites at Cherry Cobb Sands.

Control North Upper Shore			Control South Upper Shore		
Taxa	Mean Abundance per m^2	% of sites	Taxa	Mean Abundance per m^2	% of sites
Nematoda	3608	92	Tubificoides benedii	5678	100
Enchytraeidae	2975	83	Macoma balthica	2244	89
Hediste diversicolor	1783	100	Hediste diversicolor	1878	100
Tubificoides benedii	608	42	Hydrobia ulvae	889	78
Manayunkia aestuarina	525	33	Pygospio elegans	767	78
Tubificoides (pseudogaster) agg.	500	17	Nematoda	711	56
Collembola sp.	208	50	Eteone longa/flava agg.	189	89
Diptera larvae	100	67	Enchytraeidae	89	22
Macoma balthica	92	42	Diptera larvae	67	44
Hydrobia ulvae	92	33	Streblospio shrubsolii	67	11
Eteone longa/flava agg.	75	42	Abra tenuis	22	22
Pygospio elegans	58	25	Nephtys hombergii	22	11
Abra tenuis	25	8	Nemertea	11	11
Abra sp.	8	8	Corophium volutator	11	11
			Cyathura carinata	11	11
			Scrobicularia plana	11	11

Control North Upper Shore			Control South Upper Shore		
Taxa	Mean AFDW Biomass (g) per m^2	% of sites	Taxa	Mean AFDW Biomass (g) per m^2	% of sites
Hediste diversicolor	15.5056	100	Hediste diversicolor	8.1727	100
Macoma balthica	0.3432	42	Macoma balthica	7.7913	89
Hydrobia ulvae	0.0395	33	Hydrobia ulvae	0.2605	78
Tubificoides benedii	0.0278	42	Tubificoides benedii	0.2355	100
Diptera larvae	0.0246	67	Eteone longa/flava agg.	0.0792	89
Tubificoides (pseudogaster) agg.	0.0157	17	Diptera larvae	0.0303	44
Nematoda	0.0140	92	Abra tenuis	0.0214	22
Eteone longa/flava agg.	0.0110	42	Nephtys hombergii	0.0181	11
Enchytraeidae	0.0078	83	Pygospio elegans	0.0131	78
Abra tenuis	0.0053	8	Scrobicularia plana	0.0111	11
Abra sp.	0.0037	8	Cyathura carinata	0.0093	11
Manayunkia aestuarina	0.0021	33	Nematoda	0.0014	56
Collembola sp.	0.0007	50	Nemertea	0.0002	11
Pygospio elegans	0.0003	25	Streblospio shrubsolii	0.0002	11
			Corophium volutator	0.0002	11
			Enchytraeidae	0.0001	22

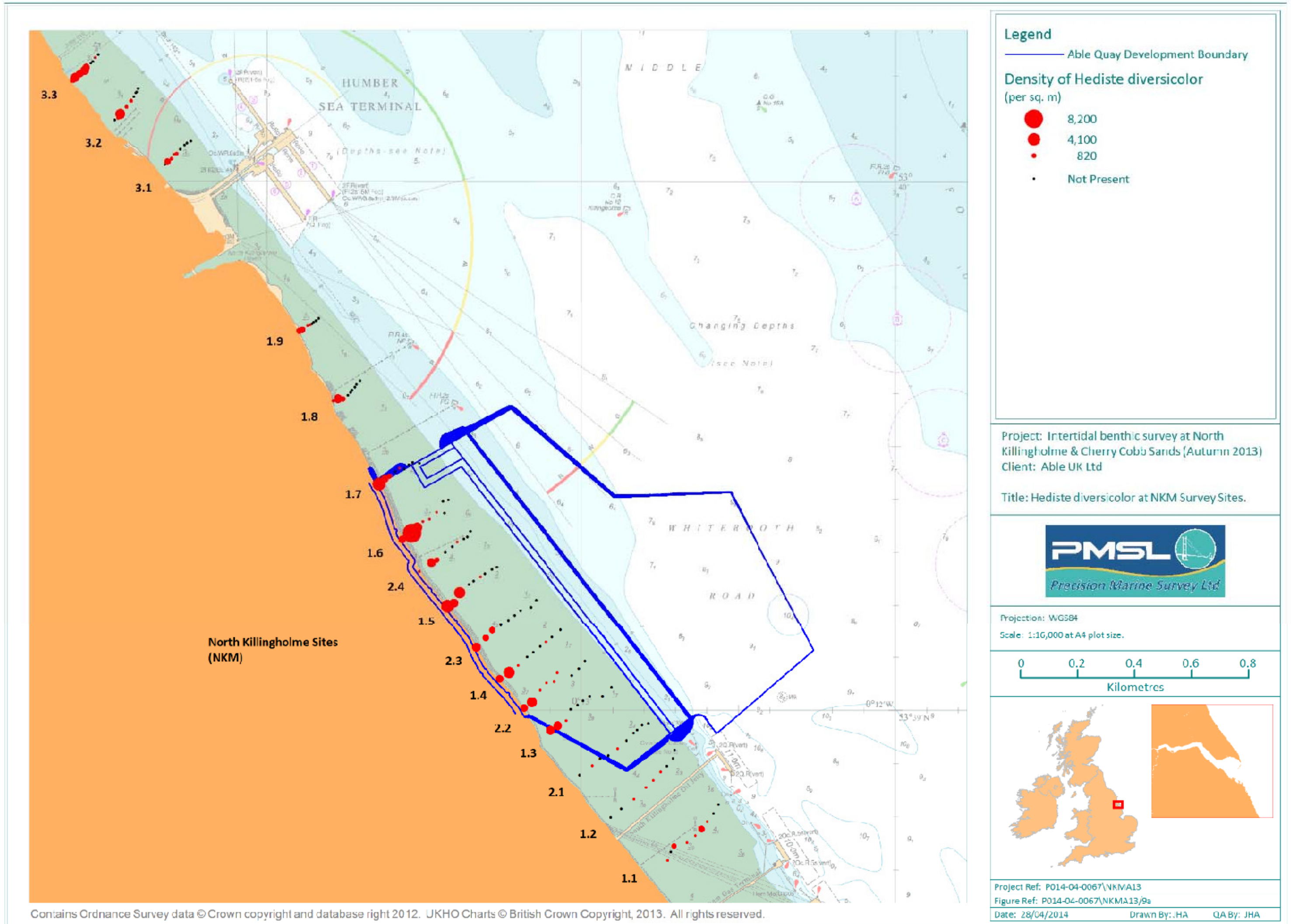

Figure 30. Spatial distribution in numbers of *Hediste diversicolor* at North Killingholme (per $1m^2$).

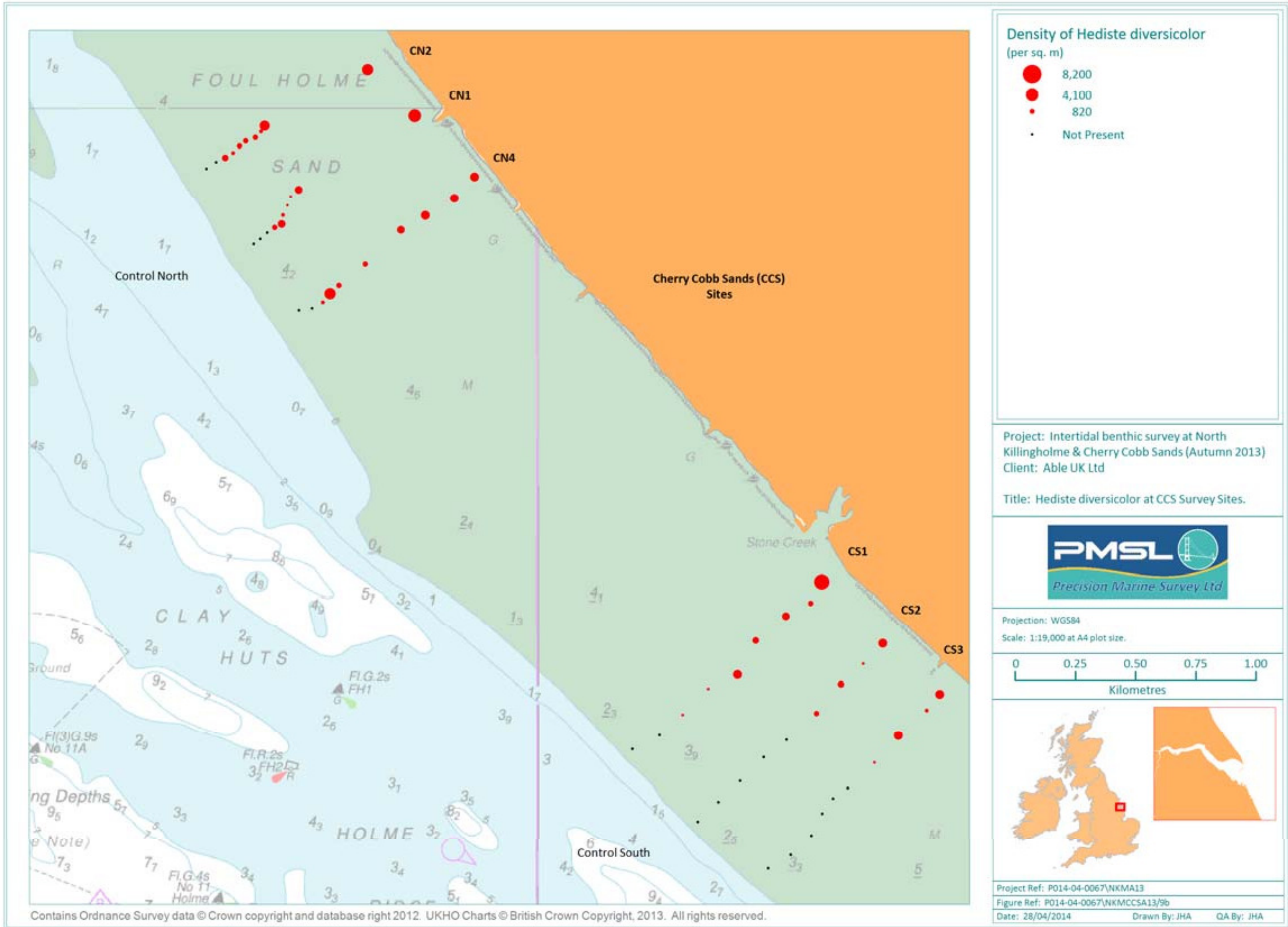

Figure 31. Spatial distribution in numbers of *Hediste diversicolor* at Cherry Cobb Sands (per 1m^2).

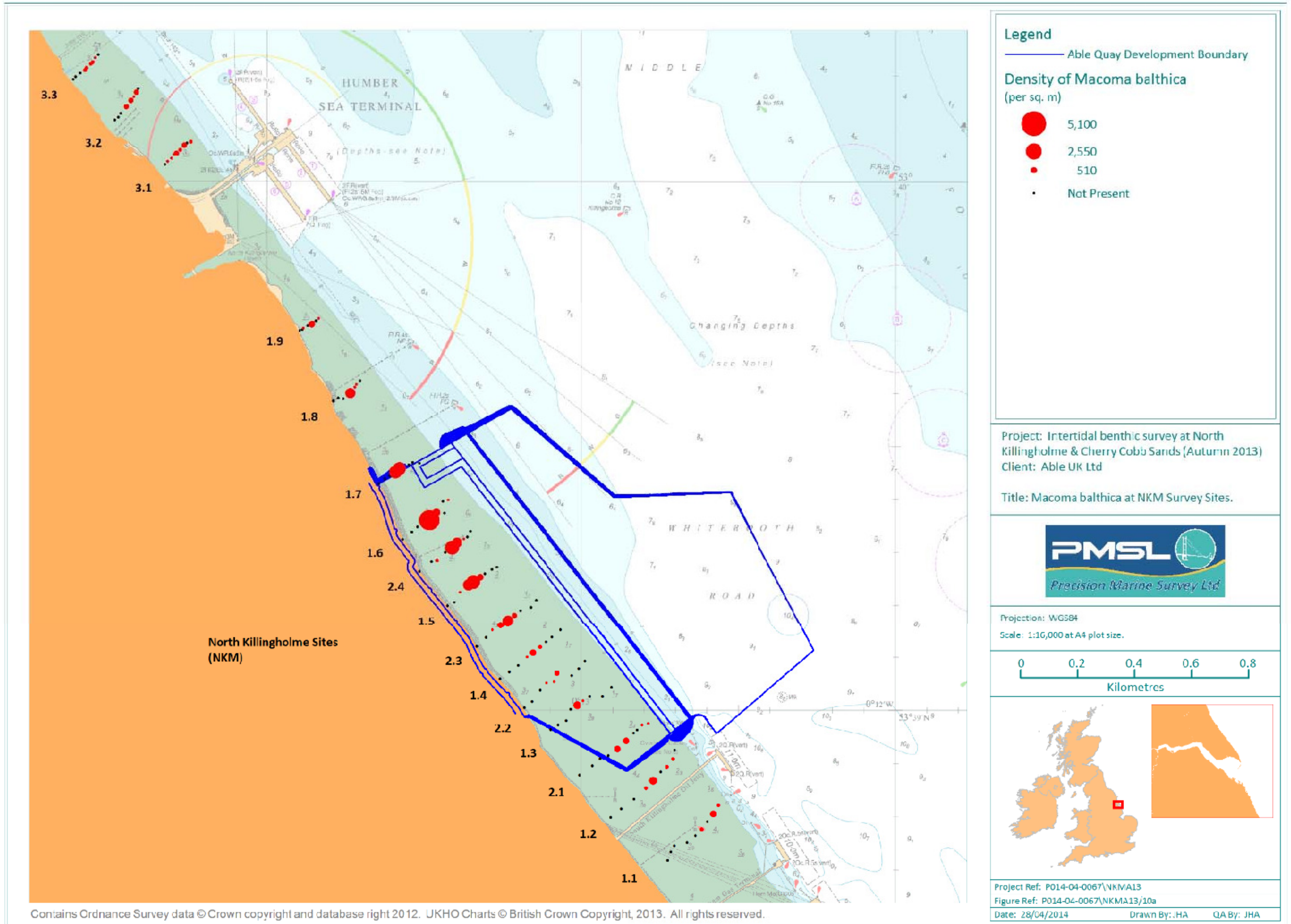

Figure 32. Spatial distribution in numbers of *Macoma balthica* at North Killingholme (per 1m²).

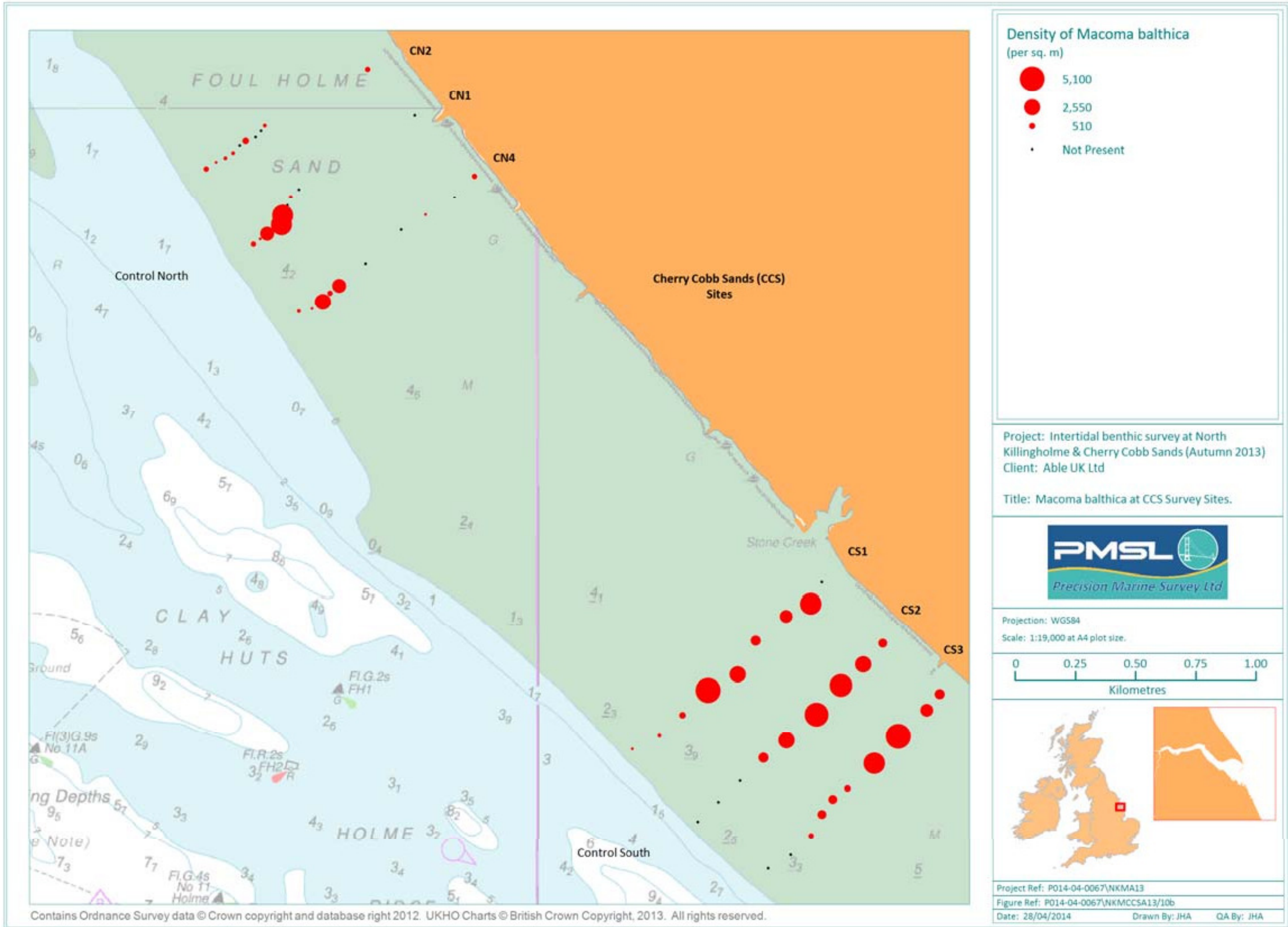

Figure 33. Spatial distribution in numbers of *Macoma balthica* at Cherry Cobb Sands (per 1m^2).

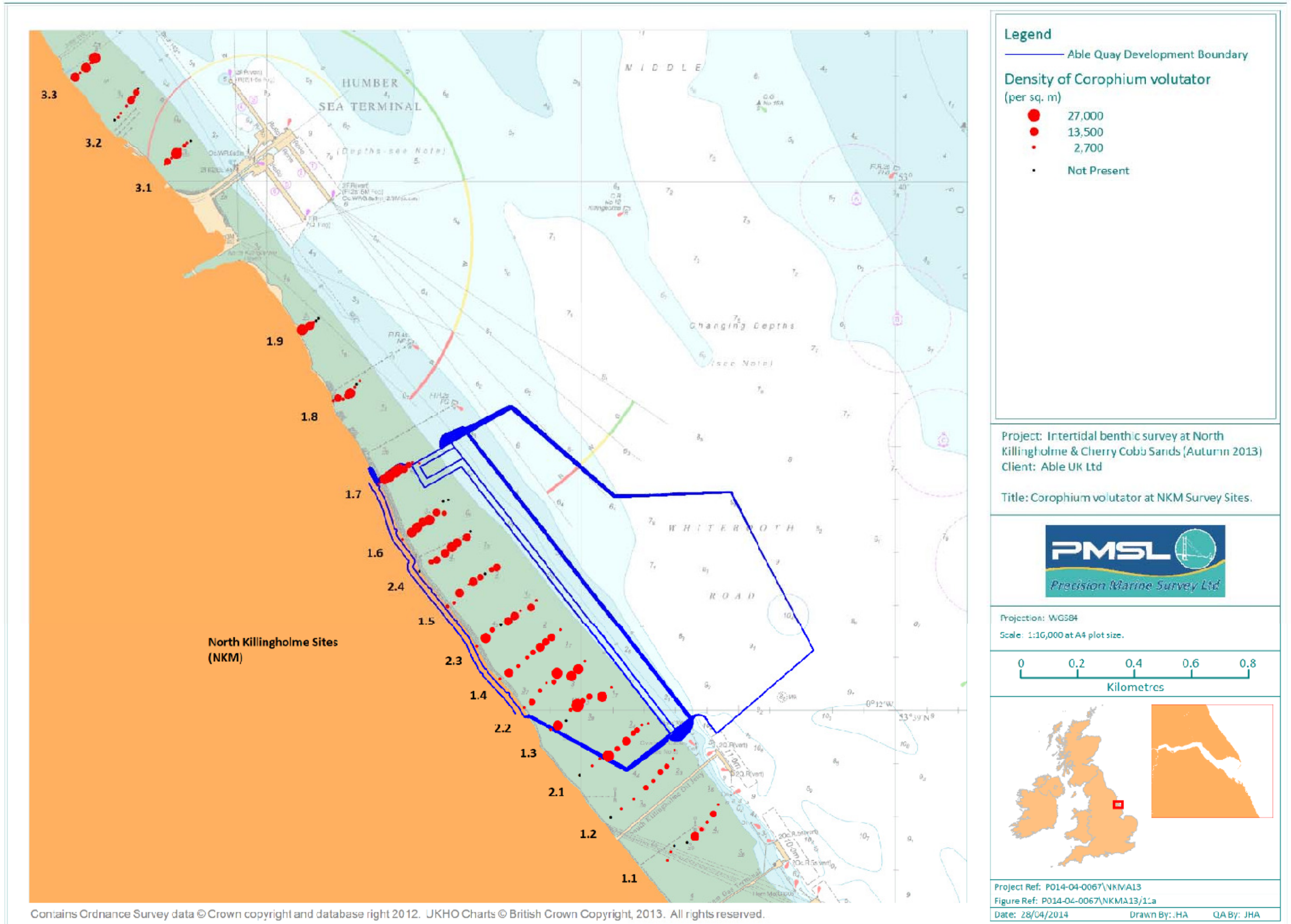

Figure 34. Spatial distribution in numbers of *Corophium volutator* at North Killingholme (per $1m^2$).

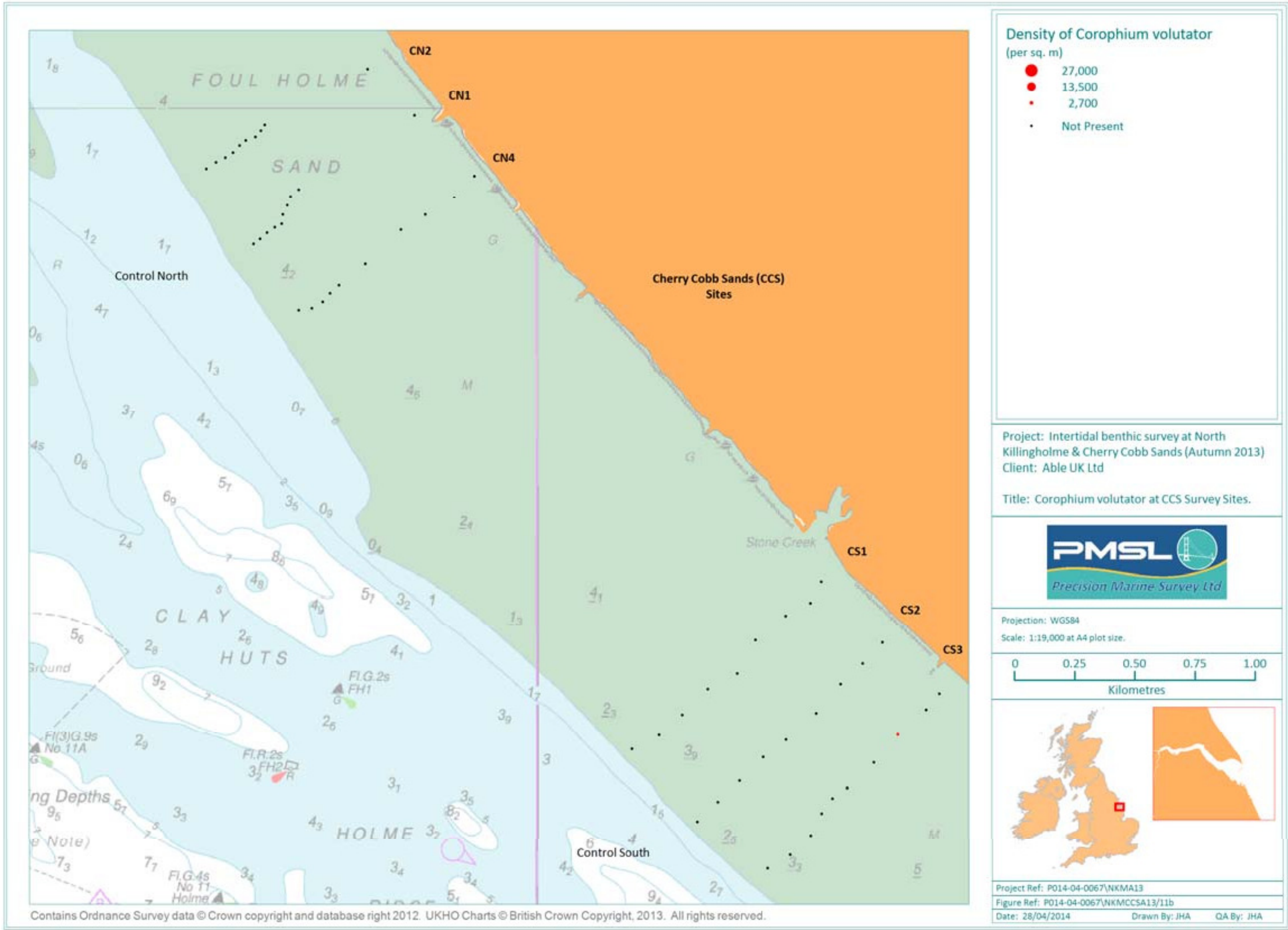

Figure 35. Spatial distribution in numbers of *Corophium volutator* at Cherry Cobb Sands (per $1m^2$).

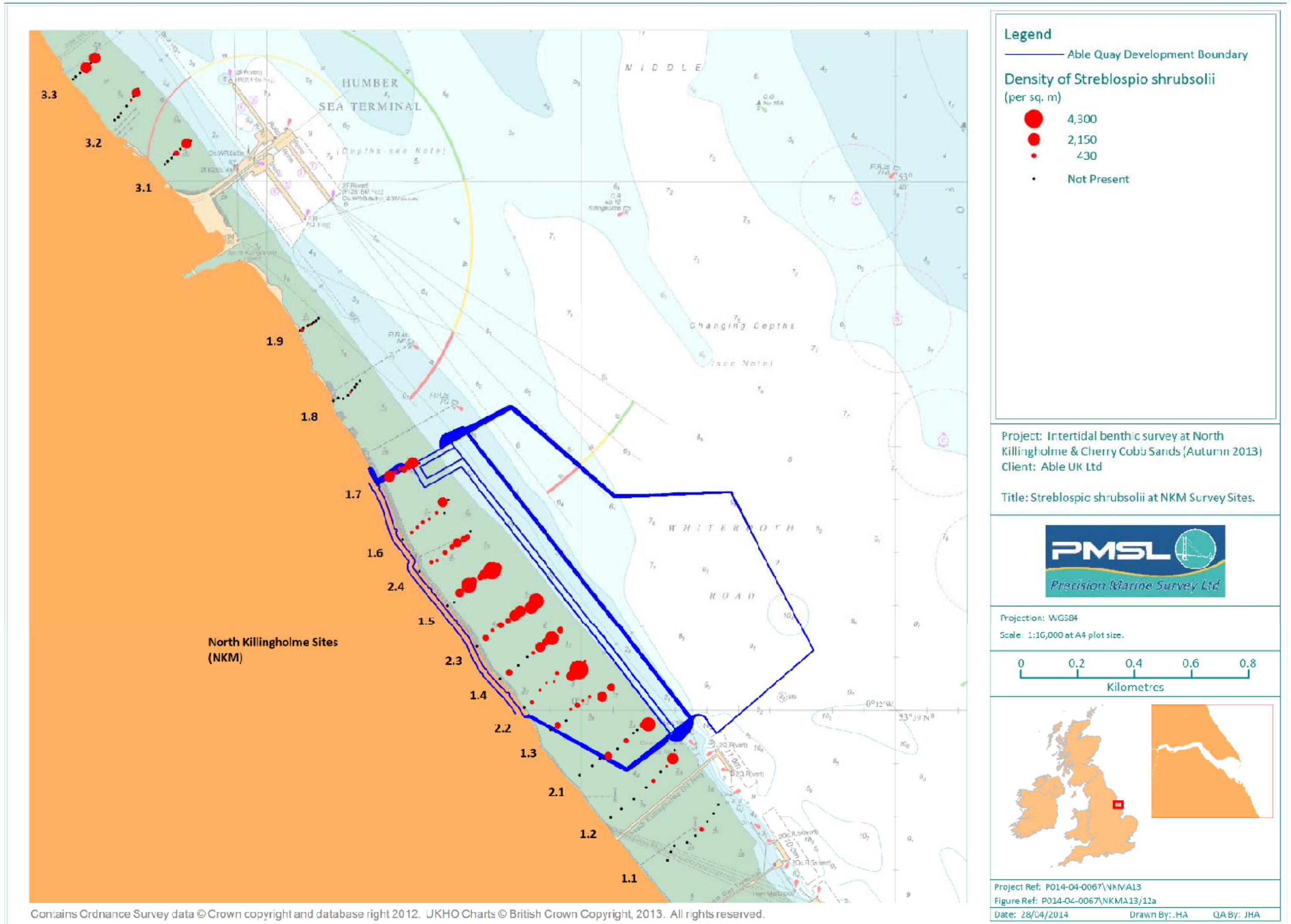

Figure 36. Spatial distribution in numbers of *Streblospio shrubsolii* at North Killingholme (per 1m^2).

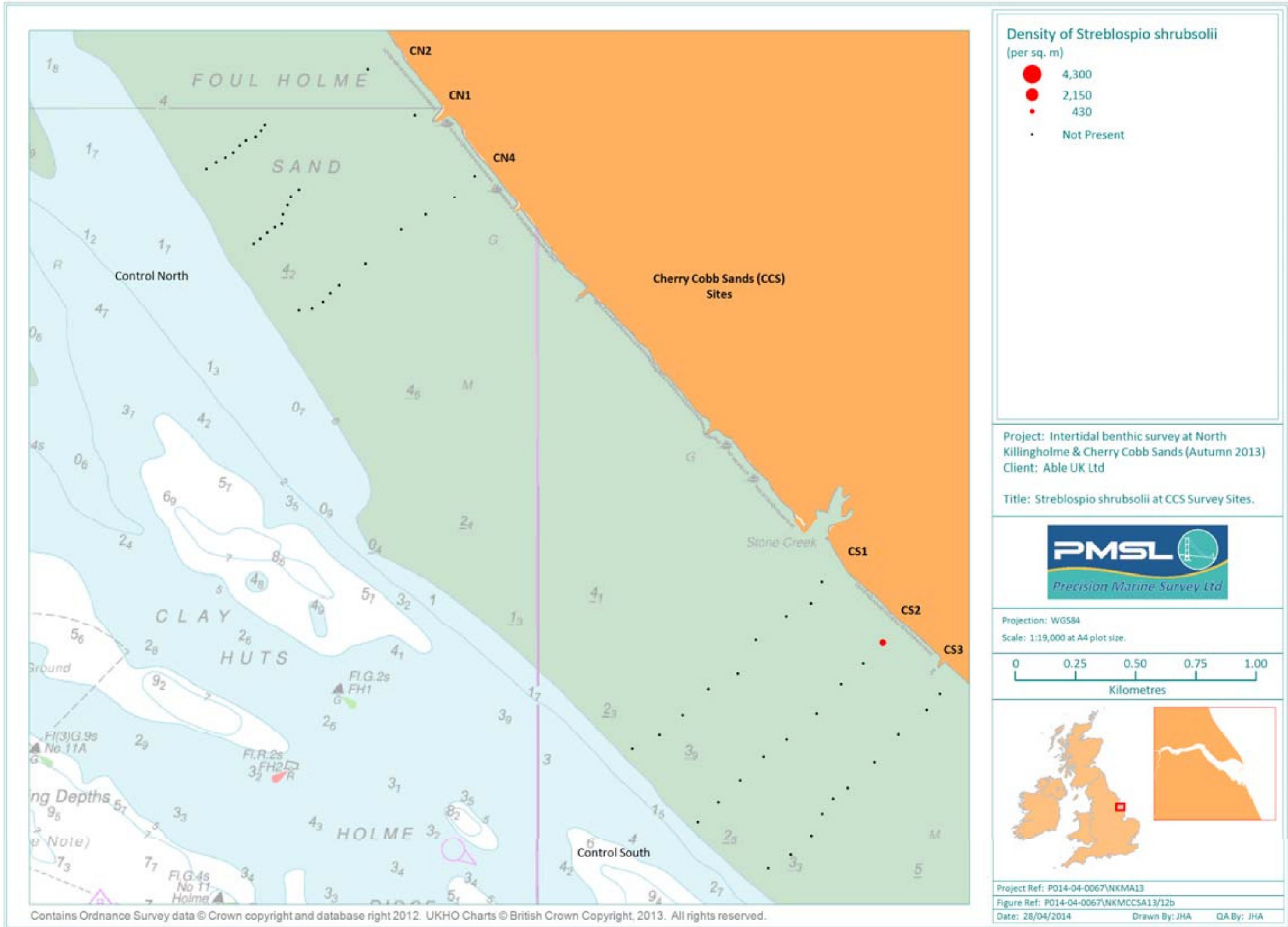

Figure 37. Spatial distribution in numbers of *Streblospio shrubsolii* at Cherry Cobb Sands (per 1m²).

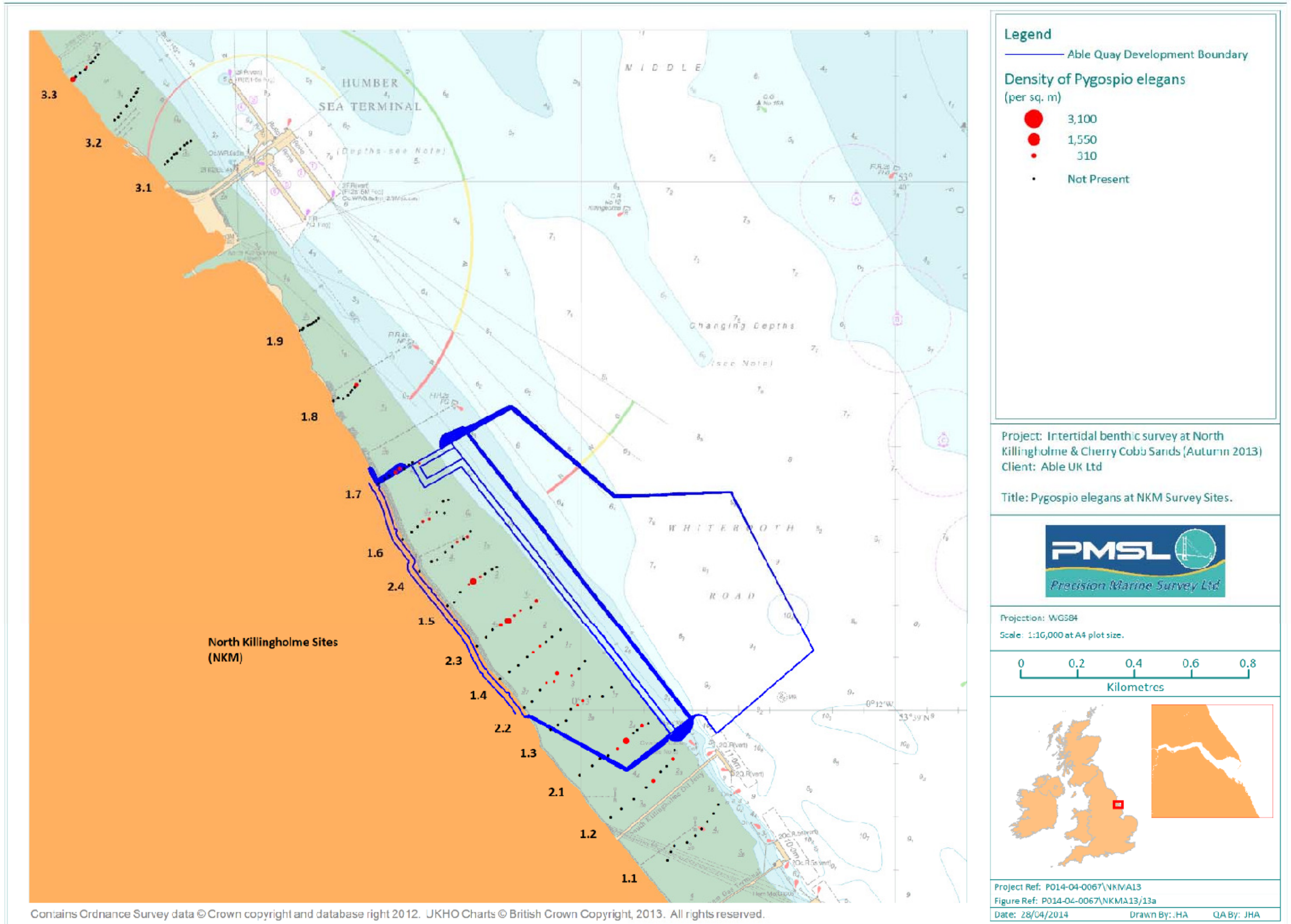

Figure 38. Spatial distribution in numbers of *Pygospio elegans* at North Killingholme (per 1m^2).

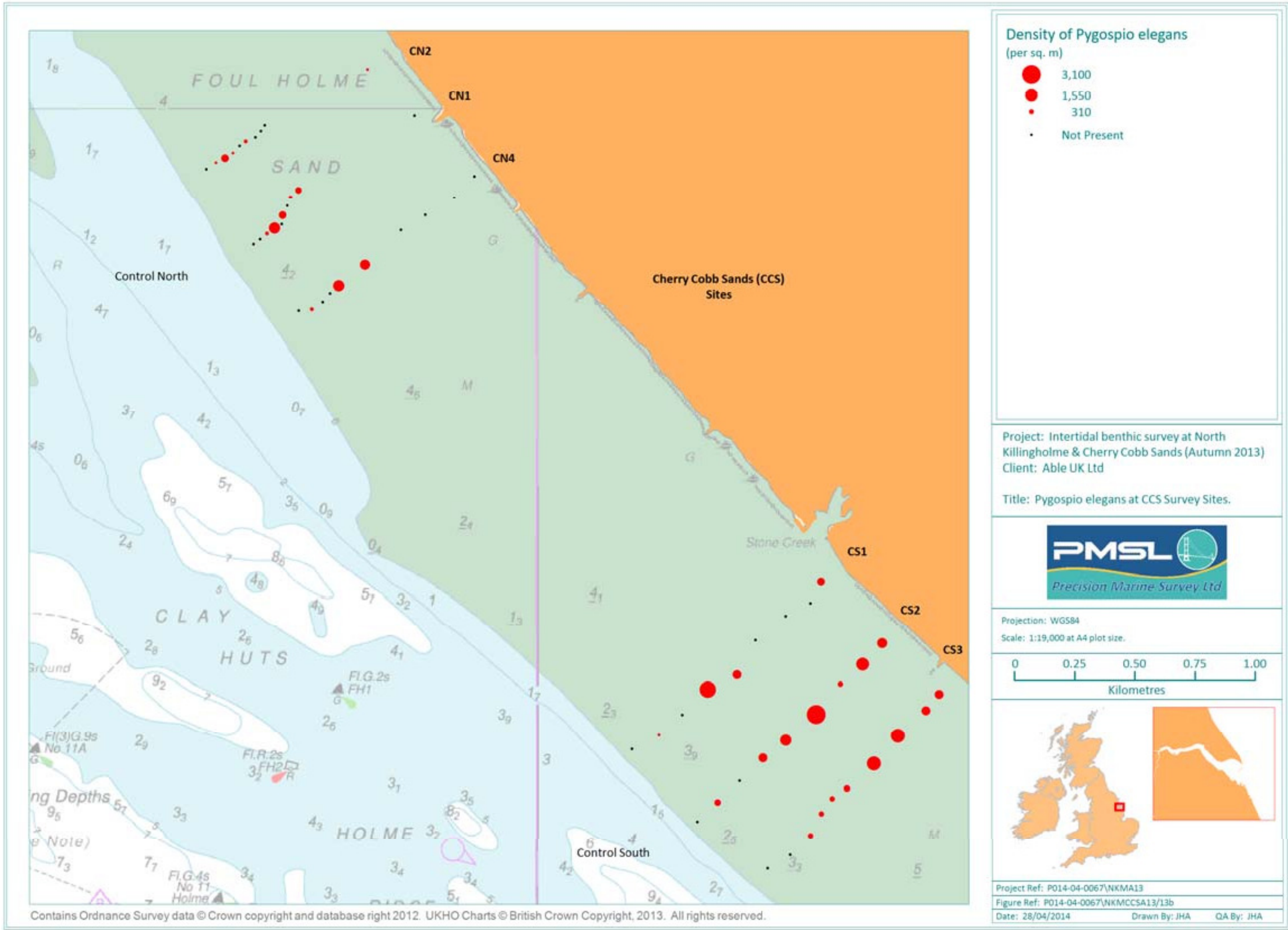

Figure 39. Spatial distribution in numbers of *Pygospio elegans* at Cherry Cobb Sands (per 1m^2).

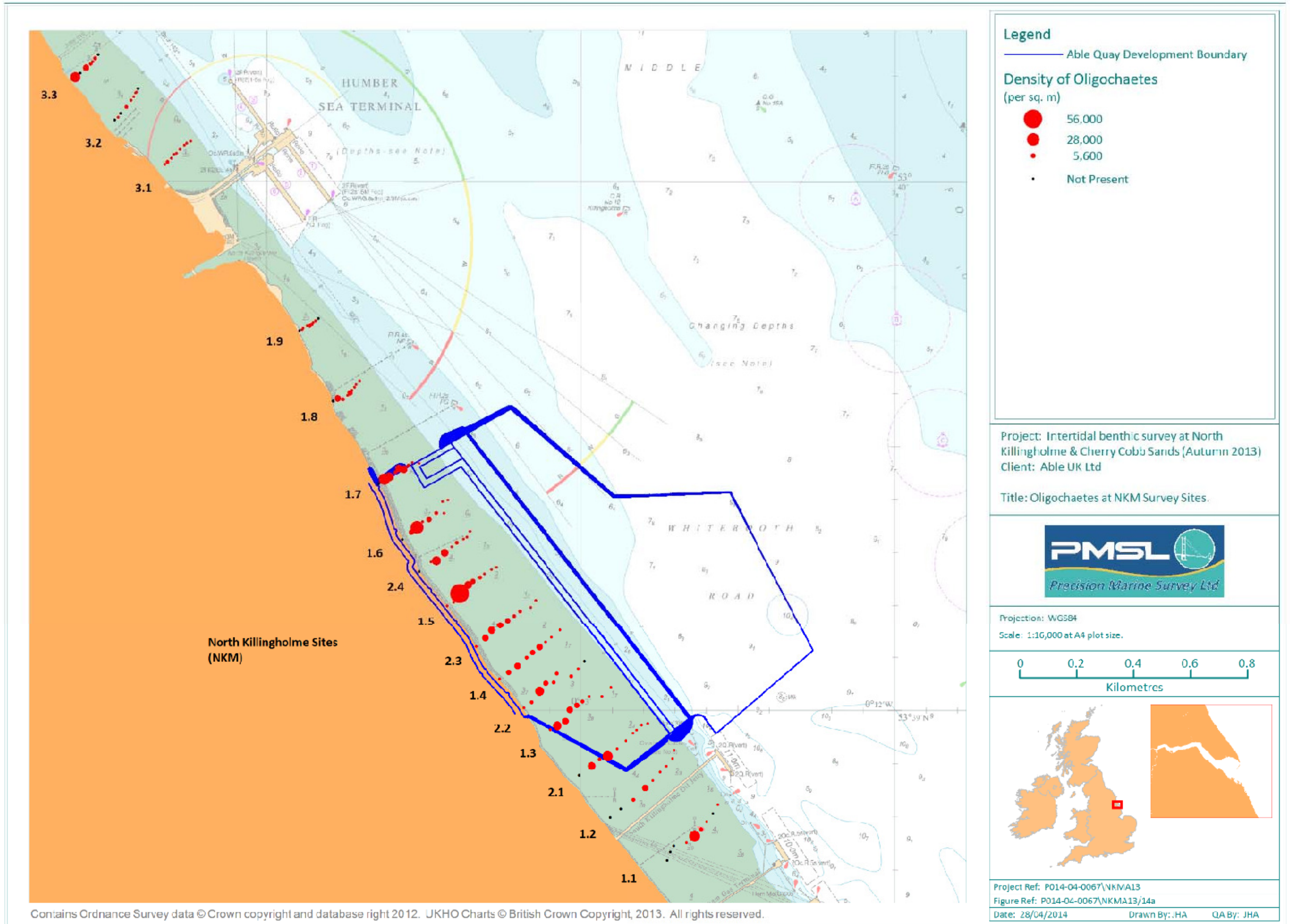

Figure 40. Spatial distribution in numbers of oligochaete taxa at North Killingholme (per 1m²).

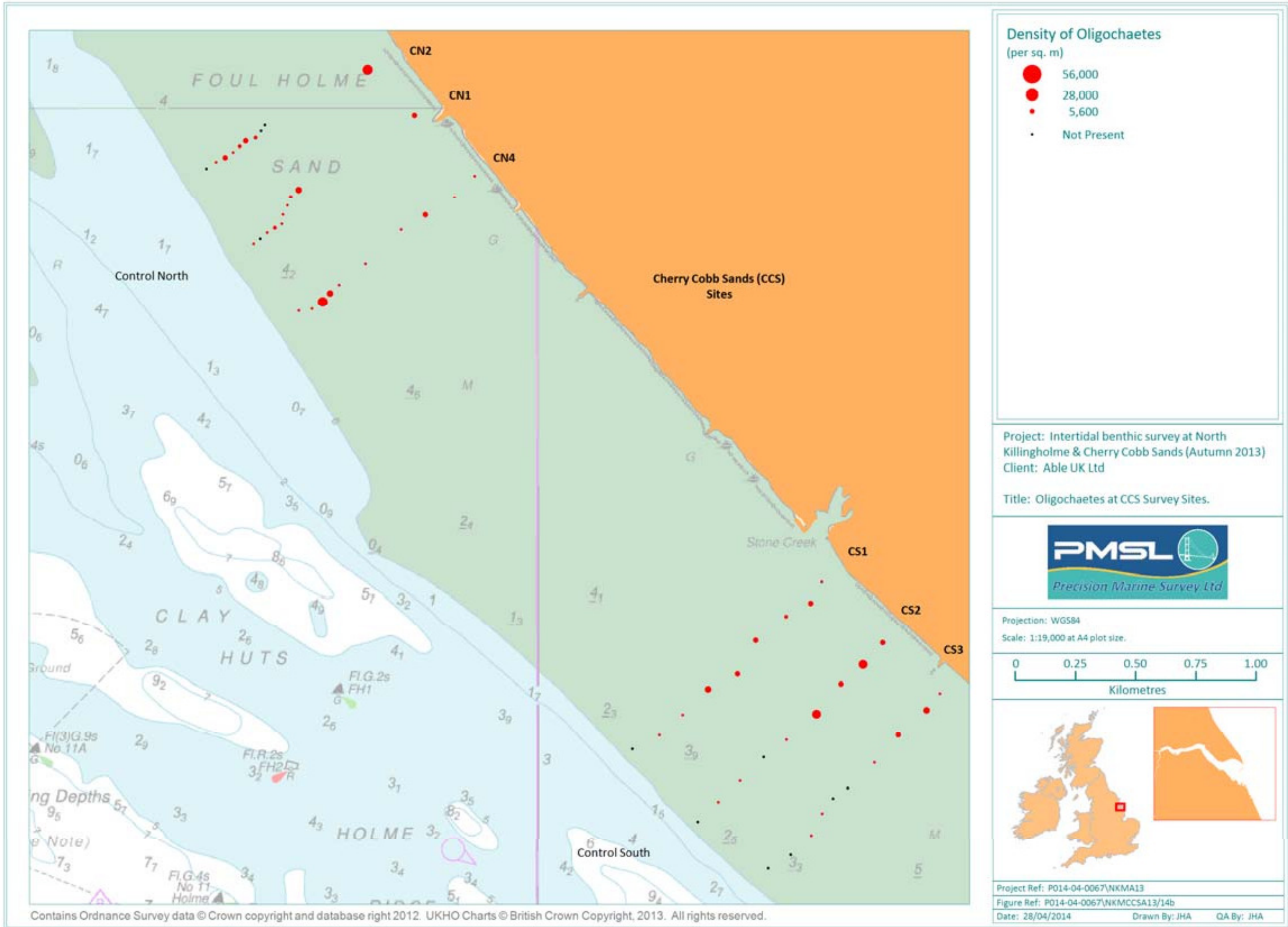

Figure 41. Spatial distribution in numbers of oligochaete taxa at Cherry Cobb Sands (per 1m^2).

3.4 Multivariate Analysis of Community Structure

Multivariate analysis of the abundance data (following square root transformation) was carried out in order to describe the main patterns and assemblages within the area. Classification (cluster analysis) of the data was undertaken using the Bray-Curtis similarity coefficient and grouped average (UPGMA) clustering technique followed by a non-metric MDS (multi-dimensional scaling) ordination both using the PRIMER package (Clarke & Warwick, 2001). Cluster analysis is used to display graphically the similarity between sites based upon their species composition whereby the similarity between sites is calculated (in this case using the Bray-Curtis similarity coefficient) to produce a similarity matrix showing the percent similarity of sites (0% indicating no species in common and 100% indicating an identical community).

These values were then used to plot a dendrogram or tree diagram in which sites are linked at their respective similarity to other sites and consequently it is possible to define groups of sites with similar species composition at a predefined level of similarity. Non metric MDS graphically displays the (rank) similarity between sites as a 2 dimensional plot in which the distances between sites indicates the level of similarity between them. The stress value associated with an MDS plot indicates the how faithful the plot is in representing the similarity between sites with low values (below 0.2) generally indicating a good fit. The site groupings derived from cluster analysis have subsequently been superimposed onto the MDS plots and input into GIS and the dominant species and mean environmental and biological parameters for each group calculated. Site groupings were derived using the similarity profile test (SIMPROF) within the PRIMER package. Characteristic taxa within each group were assessed using the SIMPER routine in PRIMER along with calculations of mean abundance and the % of sites at which the species occurred and the BEST routine was used to correlate patterns in community structure (site similarity) and environmental parameters.

The results of cluster analysis on the NKM and CCS data are shown in Figures 42 to 44 which show the dendrogram with symbols to show SIMPROF group (Figure 42), survey location (Figure 43) and shore level (Figure 44). The spatial distribution of cluster groups and derived biotopes are provided in Figures 45 to 48 whilst the results of nMDS (with separate plots to highlight group, survey area and shore level) are provided in Figures 49 to 51. A high level of variability between sites is present with similarities between sites varying from 0% to over 90% and SIMPROF derived 20 site groups including a number of single site groups (outliers) predominantly those with few or no taxa. The results of cluster analysis and ordination highlight a degree of separation between survey areas (particularly between NKM and CCS sites) whilst differences based on shore level were also relatively well defined.

The characteristic taxa at the sites in each group are highlighted in Table 13 which includes contribution to group similarity (from SIMPER analysis) along with mean abundance (per $0.01m^2$ and $1m^2$) and the frequency of occurrence (% of sites) for each species. Also provided are the list of sites in each group and a summary of sedimentary parameters.

Groups a to g are outlier groups containing individual sites with similarities to the remaining groups ranging from 0% to 10% and include sites with few or no taxa. Groups a to d include individual sites from the upper or lower shore at NKM which contain no taxa whilst groups e and f each contain one rather impoverished sandy or slightly muddy sandy site from the low shore in the southern control area CCS (S2 LC and S2 LC) characterised by *Nephtys hombergii*, Copepoda and *Bathyporeia* sp. (group e) and Pygospio elegans, Enchytraeidae and Collembola sp. (group f). Group g includes two lower shore sites from CCS in muddy sand (S3 LB) or sandy mud (N2 LC) which were also relatively impoverished and characterised by low numbers of *Scoloplos armiger*, Nematoda spp., *Macoma balthica*, *Polydora cornuta* and Collembola sp.

Groups h and i include the majority of the CCS sites along with a few NKM sites and are connected at around 35% similarity and separated from the remaining groups at around 25% similarity. Group h forms a well-defined group of mid or upper shore sites from CCS (average similarity 63%) which are from areas of sandy mud characterised by moderately high numbers of *Tubificoides benedii*, *Macoma balthica*, *Hediste diversicolor* and Nematoda spp. along with lower numbers of taxa such as *Pygospio elegans*, *Eteone longa/flava* agg. and *Hydrobia ulvae*. Group i is less well defined with a number of more discrete sub-groups present (average similarity 49.45%) with sites from the upper, mid and low shore at CCS and some upper shore sites from NKM. These sites were predominantly sandy muds (or occasionally mud or muddy sand) and characterised by high numbers of Nematoda spp. and Enchytraeidae and *Hediste diversicolor* along with moderate numbers of taxa such as *Pygospio elegans*, *Macoma balthica*, *Manayunkia aestuarina*, *Tubificoides benedii* and Collembola sp. which have a more variable or patchy distribution.

Group j comprises of a small group of sites from the upper shore at NKM in mud or sandy mud (average similarity 63%) characterised by moderately high numbers of *Corophium volutator* and terrestrial taxa such as Collembola sp. and also nematode worms with occasional other taxa such as Diptera larvae, *Hediste diversicolor*, Arachnida (Acarina) sp., *Tubificoides benedii*, *Macoma balthica* and *Tubificoides* (*pseudogaster*) agg. Groups k and l form a series of small groups separated at around 55% similarity from the low shore at NKM in sandy mud. Both groups were characterised by moderate numbers of *Streblospio shrubsolii* along with *Tubificoides benedii*, Nematoda, *Eteone longa/flava* and *Corophium volutator* (group k) or *Corophium volutator*, *Tubificoides benedii*, *Tubificoides swirencoides*, *Pygospio elegans* and Eteone longa/flava (group k). Both groups also include occasional sites with *Macoma balthica* and/or *Nephtys hombergii*.

Groups m and n comprise of a large number of sandy mud sites from NKM from a range of shore heights. The two groups are separated at around 50% similarity with quite high within group similarities (average similarities of 70.27% for group m and 67.27% for group n). Both groups were characterised by high numbers of *Corophium volutator* along with *Tubificoides benedii Streblospio shrubsolii* and Nematoda (group m) or *Tubificoides benedii* (group n). Species such as *Hediste diversicolor* and *Macoma balthica* were present in moderate abundance in both groups but only occurred in approximately 50% of sites along with other taxa such as *Pygospio elegans*, *Eteone longa/flava* agg., and *Streblospio shrubsolii.* Group o is linked to groups m and n at around 45% similarity and includes a series of sites in mud or sandy mud from the mid and upper shore at NKM which were characterised by high numbers of *Tubificoides benedii*. Other taxa such as *Corophium volutator*, *Hediste diversicolor* and *Macoma balthica* are present in moderate numbers at some sites.

Groups p to s form a series of somewhat variable and loosely associated groups connected at around 30% similarity which contain small numbers of sites often with relatively few taxa from the low shore (group p) or upper shore (groups q, r and s) at NKM or CCS in mud or sandy mud. Group p is characterised by *Corophium volutator* whilst group q is characterised by *Hediste diversicolor.* Group r includes a larger number of upper shore sites and is characterised by high numbers of *Hediste diversicolor* and *Corophium volutator* whilst group s includes two upper shore sites at CCS and is dominated by high numbers of *Hediste diversicolor* along with Diptera larvae, *Eteone longa/flava* and *Manayunkia aestuarina* or *Pygospio elegans*. A number of the upper shore sites in these groups include examples of terrestrial taxa such as Diptera larvae and Collembola sp. (springtails).

Group t includes a series of sites from low shore areas at NKM and low or lower mid shore areas at CCS with sites from the two areas largely separated into separate sub-groups. This group includes sandy mud sites at NKM and muddy sand, sands or sandy muds at CCS and are characterised by a variable assemblage of taxa (average similarity 33.37%) usually in low abundances with relatively few taxa most notably *Tubificoides benedii* and *Macoma balthica* with occasional other species such as *Corophium volutator*, *Pygospio elegans*, *Nephtys hombergii*, *Eteone longa/flava* agg., Nematoda, *Hydrobia ulvae*, Enchytraeidae and *Bathyporeia* sp. which occur sporadically on the lower shore.

In general the observed patterns in species composition at NKM and CCS are broadly similar to the communities recorded during the spring 2013 survey and whilst inherently variable many of the observed differences in invertebrate communities are rather subtle rather than distinct changes in assemblage. Aside from differences in relation to shore level multivariate analysis also highlighted differences between survey areas most notably between NKM and CCS. However, such differences are likely to reflect differences in sediment type and particularly at CCS where there is much greater variation in key sedimentary parameters. The BEST routine in Primer was used to identify correlations between sediment type and shore level (distance from high water) and the patterns in community structure. The results of the BEST routine indicated that all parameters had some correlation to the species data with the distance down the shore having the best correlation (0.417) followed by sediment sorting (0.362), % sand and % mud (0.344), mean/median phi grain size (0.342 and 0.322 respectively) and kurtosis (0.314). Somewhat lower correlations were exhibited by other parameters (% LOI: 0.28; skewness: 0.195; % gravel: 0.117). The best combination of parameters to correlate with the patterns in species data were sorting, kurtosis and distance down the shore which collectively exhibited a correlation of 0.504.

At a biotope level many of the observed communities appear to be variants of typical estuarine biotopes as classified under the current UK classification (Connor et al. 2004) and largely follow those identified during the spring 2013 survey (Figures 47 and 48). Areas of upper shore sandy mud at both NKM and CCS which have greater elevation and often in closer proximity to saltmarsh (e.g. groups o to r) are usually characterised by *Tubificoides* spp. (including *T. pseudogaster* in some areas) and/or *Corophium volutator* along with variable densities of *Hediste diversicolor* or other polychaetes and insect taxa. These appear to be either impoverished *LS.LMu.MEst* biotopes or somewhat transitional mid estuarine, upper shore variants of biotopes more commonly found in upper estuarine areas namely *LS.LMu.Uest (Polychaete/oligochaete-dominated upper estuarine mud shores) or*

LS.LMu.UEst.Hed (Hediste diversicolor in littoral mud). In certain upper shore areas at NKM or CCS these resemble somewhat transitional variants of sub-biotopes such as*, LS.LMu.UEst.Hed.Ol (Hediste diversicolor and oligochaetes in littoral mud)* or *LS.LMu.UEst.Tben (Tubificoides benedii and other oligochaetes in littoral mud)* depending on the level of dominance by oligochaetes or *Hediste diversicolor*. Extremely impoverished upper or low shore sites with few or no taxa (e.g. groups a to g) have also been classified as *LS.LMu.MEst, LS.LMu.Uest* or *LS.LSa.MuSa* depending on shore height and sediment type.

The main site groups from CCS (groups h and i) and NKM (groups m and n) tend to be the most diverse areas with a variety of taxa including varying abundances of taxa such as *Macoma balthica*, *Tubificoides benedii*, *Hediste diversicolor*, *Pygospio elegans,* Enchytraeidae and *Manayunkia aestuarina* at CCS or *Corophium volutator*, *Tubificoides benedii*, *Streblospio shrubsolii*, Nematoda, *Macoma balthica* and *Hediste diversicolor* at NKM. The majority of sites in these groups appear to be variants of *LS.LMu.MEst.HedMac (Hediste diversicolor and Macoma balthica in littoral sandy mud*) although the mid shore habitats from CCS in groups h and i tend to form the more typical examples of this biotope with higher abundances of *Macoma balthica* and *Hediste diversicolor* and a relatively diverse infaunal assemblage*.* Certain sites at CCS (group i) and NKM (sites in groups m and n) are more variable with a patchier distribution of *Macoma balthica* and *Hediste diversicolor* and may be a transitional form of the *LS.LMu.MEst.HedMac* biotope. Upper shore sites in groups m and n may be transitional between *LS.LMu.MEst.HedMac* and upper estuarine biotopes such as *LS.LMu.UEst.Hed* whilst sites further down the shore which lack *Macoma balthica* but have higher numbers of *Streblospio shrubsolii* are potentially transitional forms of *LS.LMu.UEst.Hed.Str (Hediste diversicolor and Streblospio shrubsolii in littoral sandy mud*.

Further down the shore at or around low water at NKM (e.g. groups k and l) a poorly defined infaunal community is present which potentially indicates sediment instability in these areas of very soft mud or sandy mud. These habitats tend to be relatively impoverished and characterised by low to moderate numbers of *Streblospio shrubsolii*, and *Tubificoides benedii* with occasional *Macoma balthica*, *Nephtys hombergii* and *Corophium volutator*. These are classified as *LS.LMu.MEst* biotopes but are potentially variants of *LS.LMu.MEst.NhomMacStr (Nephtys hombergii, Macoma balthica and Streblospio shrubsolii in littoral sandy mud)* or are perhaps a lower shore continuation of transitional *LS.LMu.MEst.HedMac* or the *LS.LMu.UEst.Hed.Str* variant described above which is subject to sediment instability leading to the development of a reduced faunal assemblage. Overall the majority of the NKM infaunal communities are rather variable and include a number of communities which are rather poorly defined in terms of the biotope classification and often exhibit transitional forms of typical mid or upper estuarine biotopes.

The impoverished muddy sands or sands on the lower shore at CCS or lower shore sandy muds at NKM in group t have a variable but generally species poor assesmblage and tend to have few taxa from which to derive biotopes with any certainty and at CCS these have been defined as *LS.LSa.MuSa (Polychaete/bivalve-dominated muddy sand shores)* with some sites verging on examples of *LS.LSa (Littoral Sand)* and presumably reflect relatively dynamic environments. A small sub-group in group t at the southernmost transect at CCS includes an area of muddy sand on the lower mid shore which were characterised by species such as *Macoma balthica*, *Pygospio elegans* and *Nephtys hombergii* and fall under the biotope

LS.LSa.MuSa.MacAre (Macoma balthica and Arenicola marina in littoral muddy sand). Variable populations of *Arenicola marina* were evident in this area from observations of surface casts (usually up to 5 to 10 per m^2) but this taxa was not picked up during core sampling due to their patchy distribution. The poorly defined or impoverished low shore habitats in group t from NKM have been classified as *LS.LMu.MEst* (Polychaete/bivalve-dominated mid estuarine mud shores).

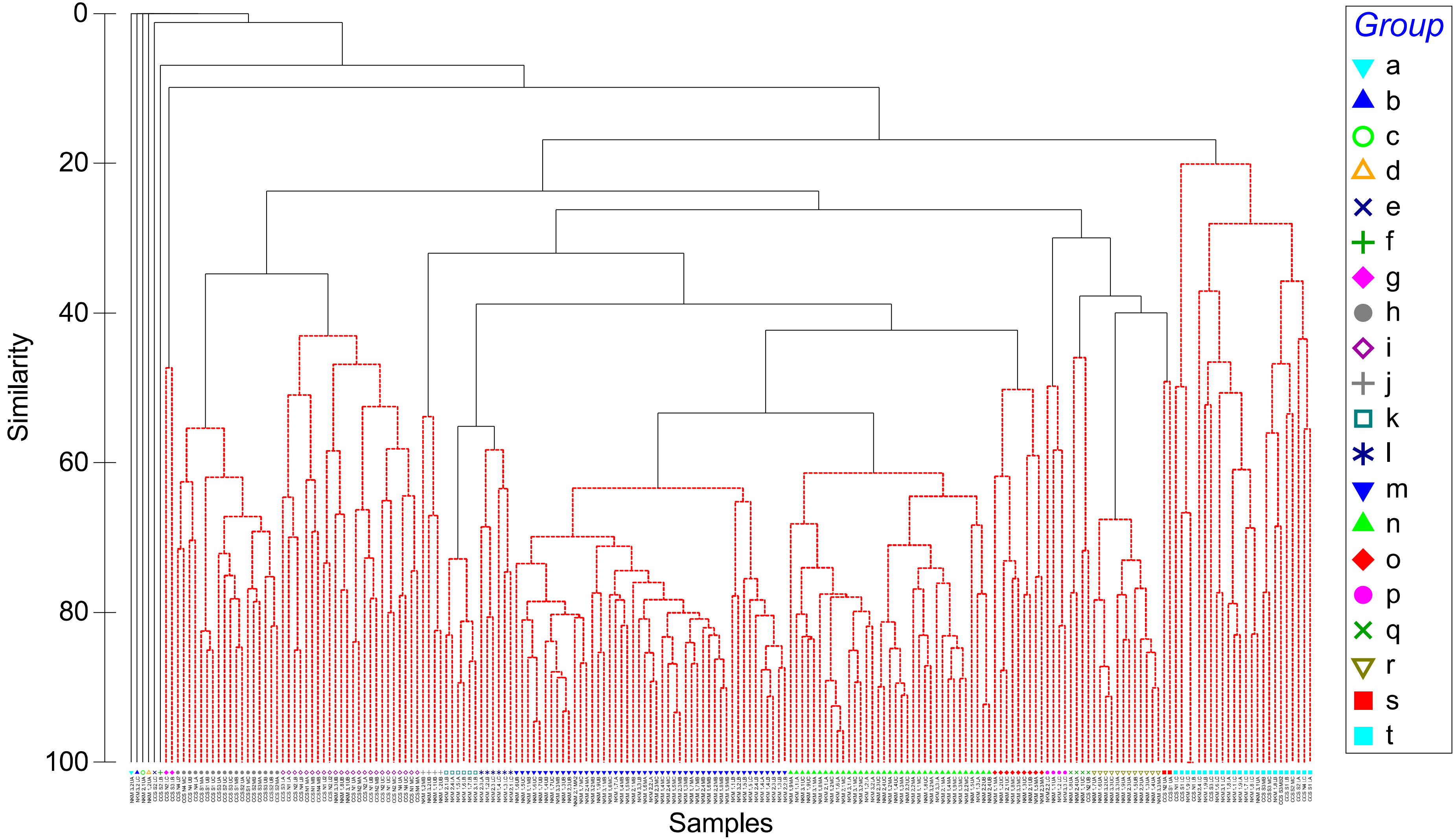

Figure 42. Results of cluster analysis on sites from North Killingholme & Cherry Cobb Sands (samples highlighted by group).

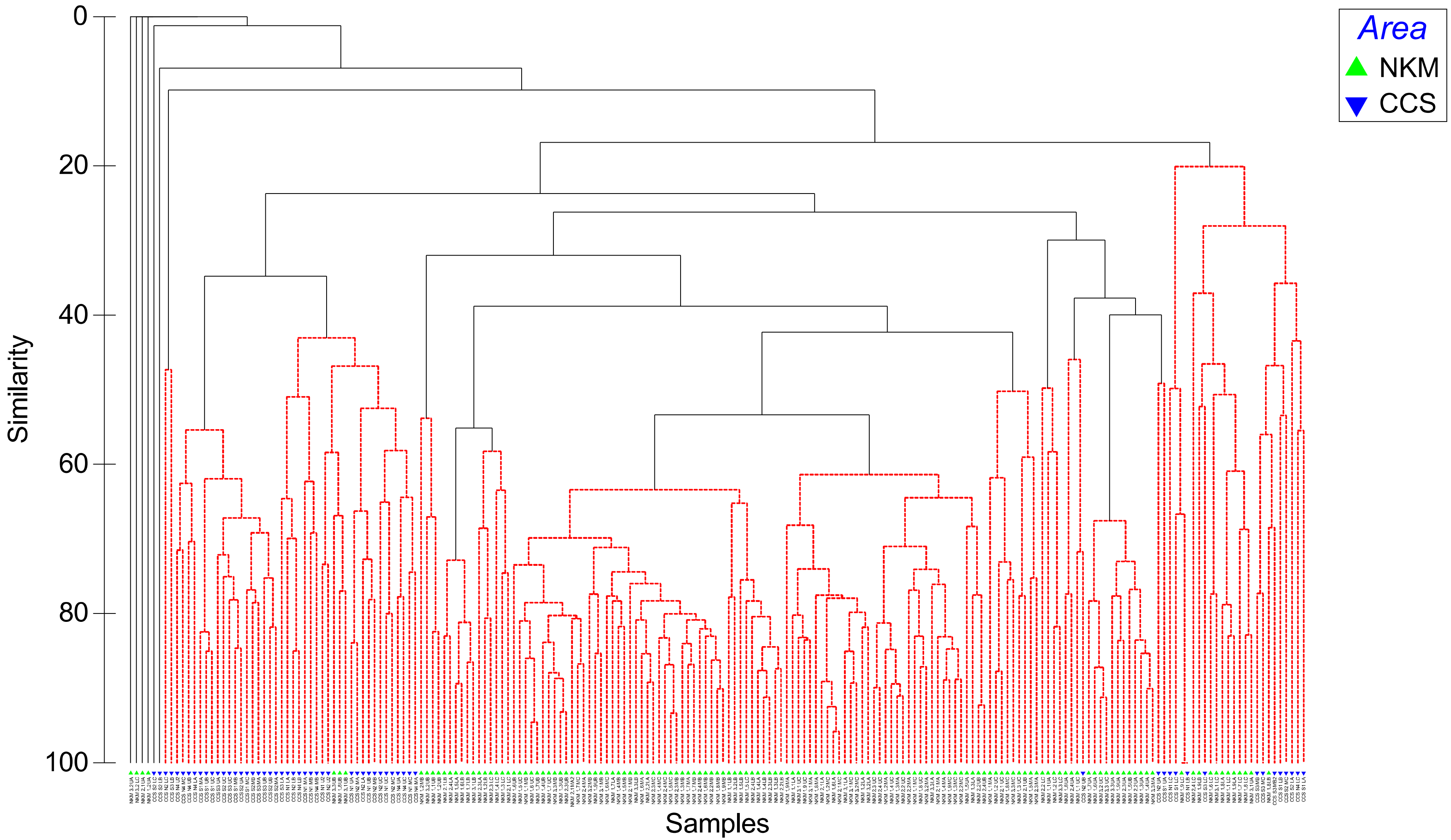

Figure 43. Results of cluster analysis on sites from North Killingholme & Cherry Cobb Sands (samples highlighted by area).

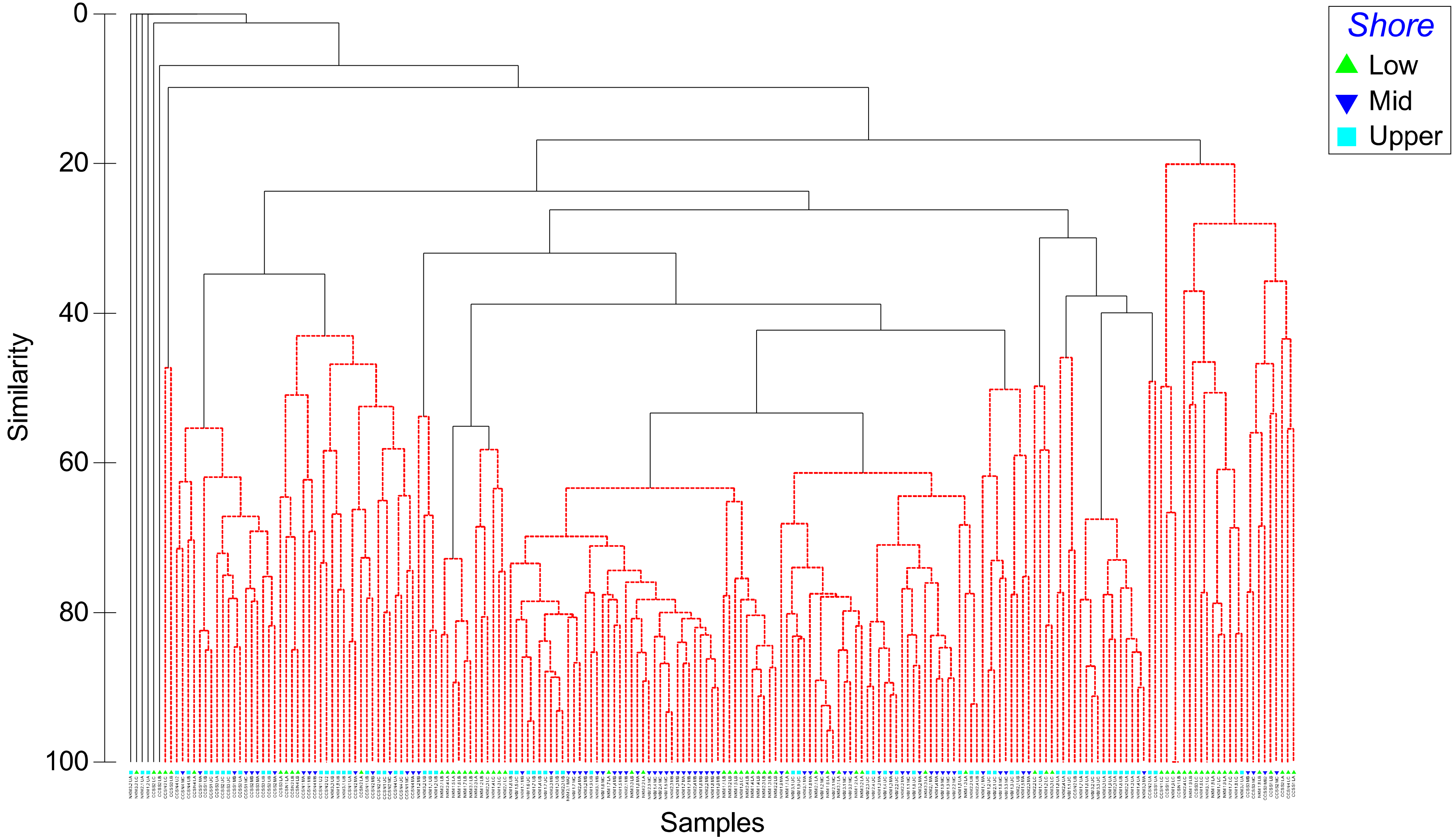

Figure 44. Results of cluster analysis on sites from North Killingholme & Cherry Cobb Sands (samples highlighted by shore).

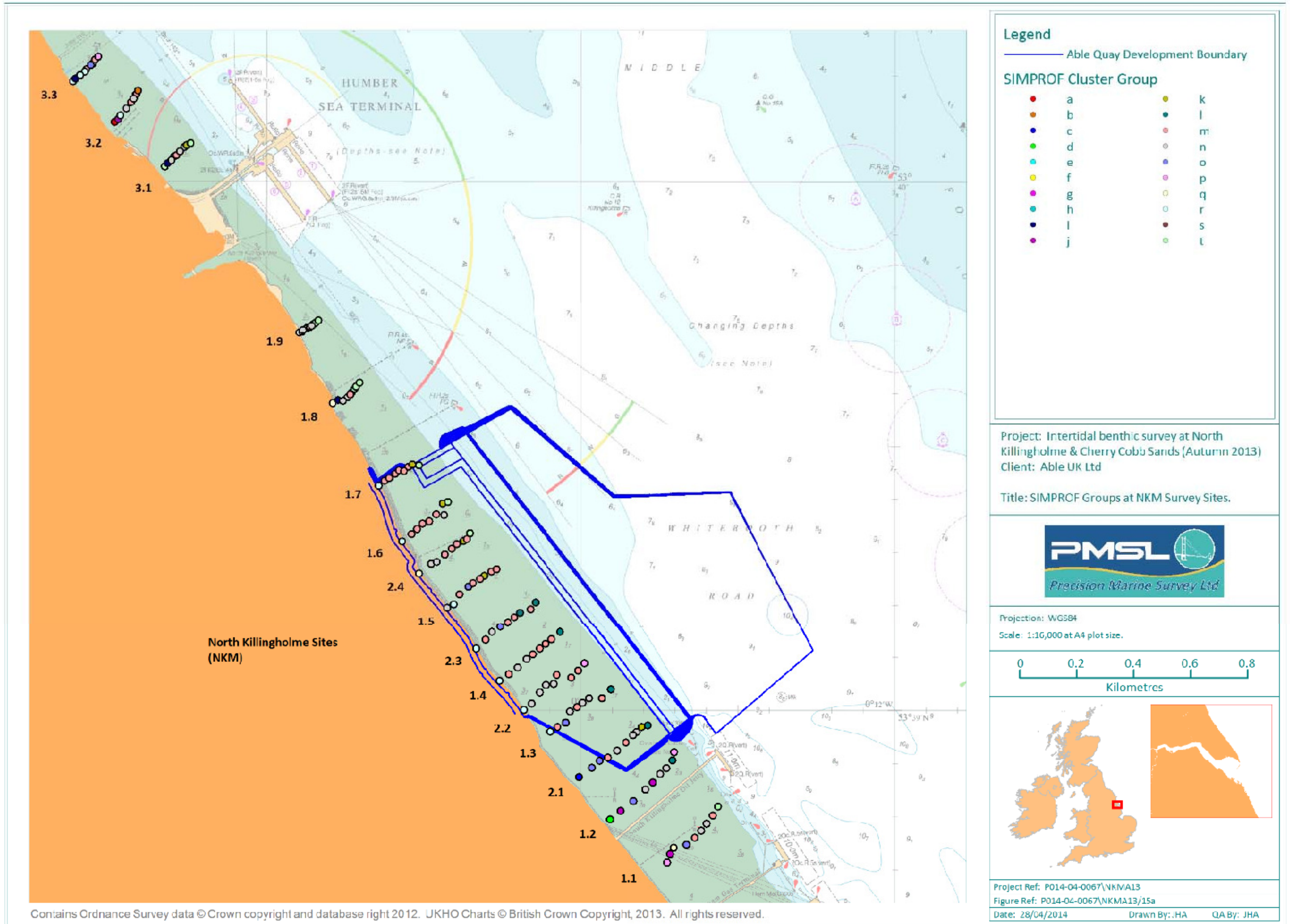

Figure 45. Spatial distribution of site groups from cluster analysis (North Killingholme).

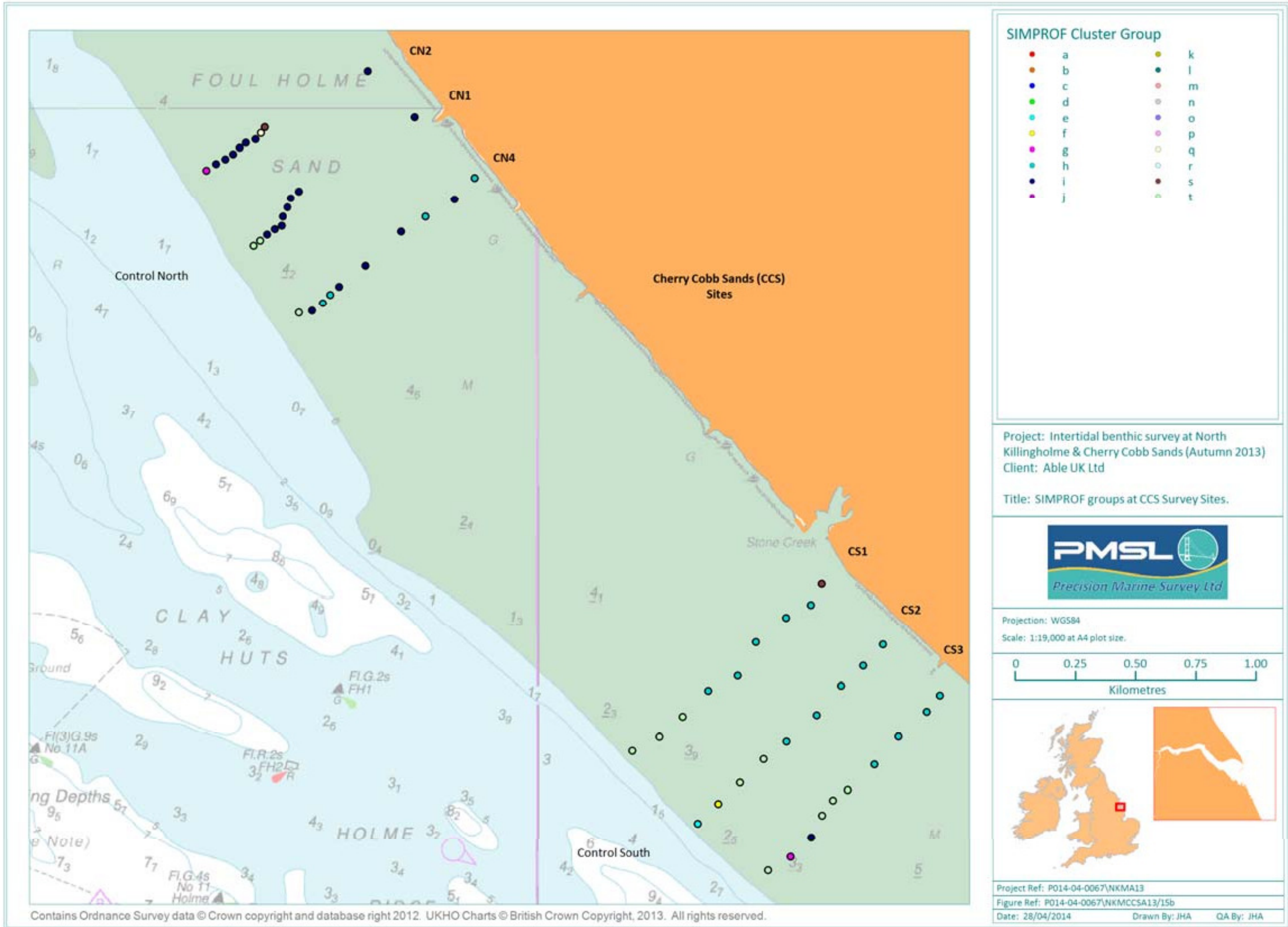

Figure 46. Spatial distribution of site groups from cluster analysis (Cherry Cobb Sands).

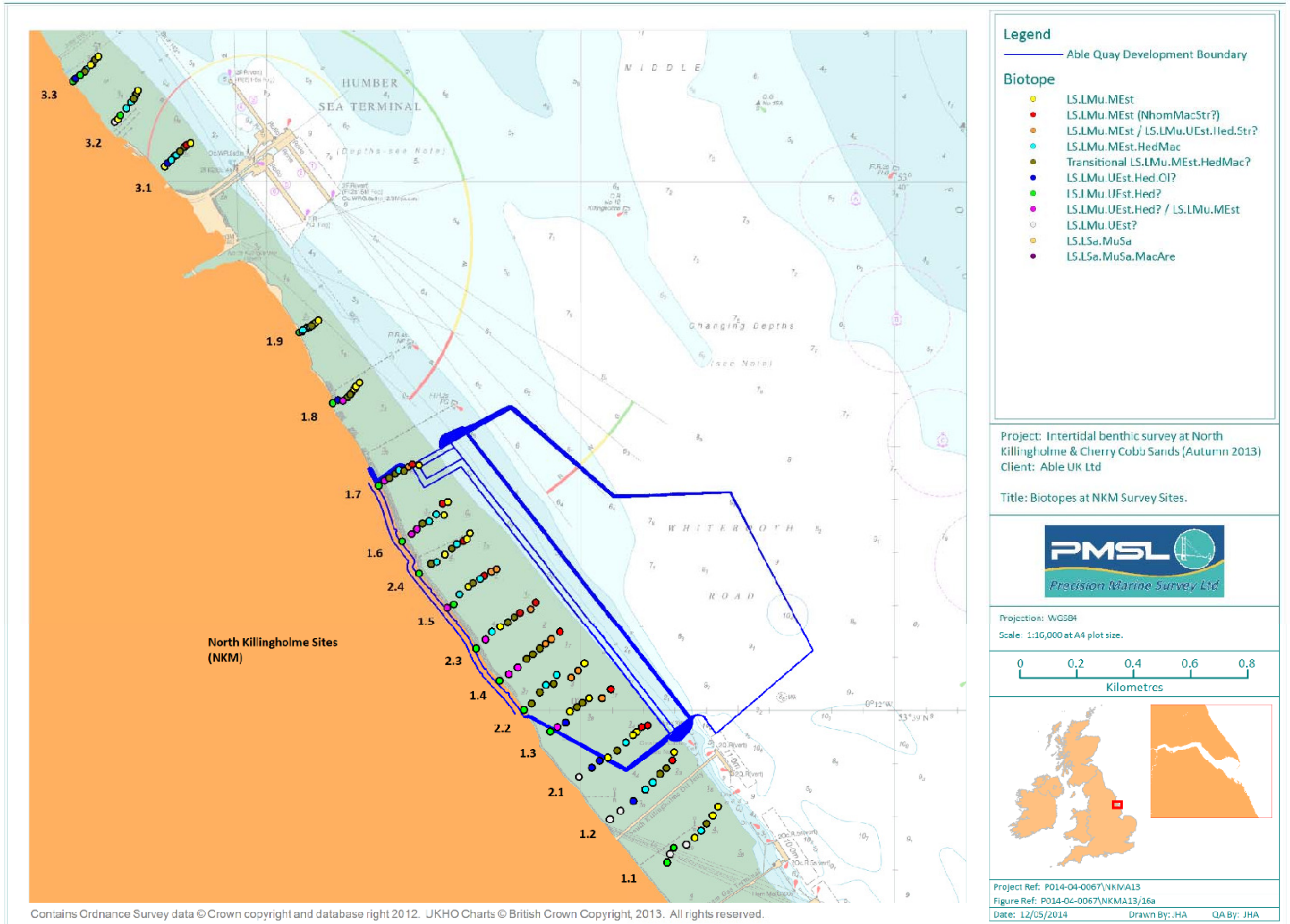

Figure 47. Distribution of biotopes at North Killingholme.

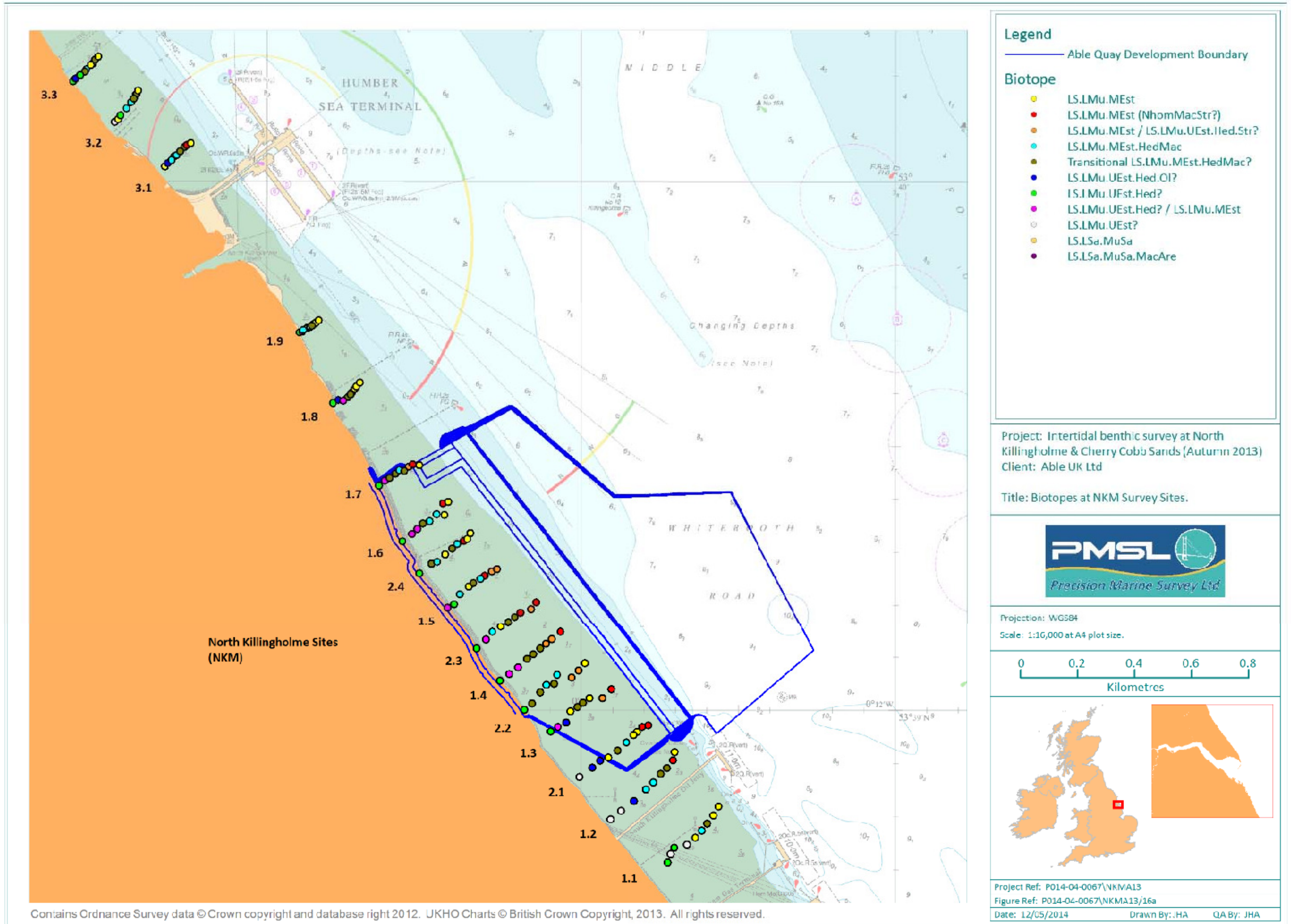

Figure 48. Distribution of biotopes at Cherry Cobb Sands.

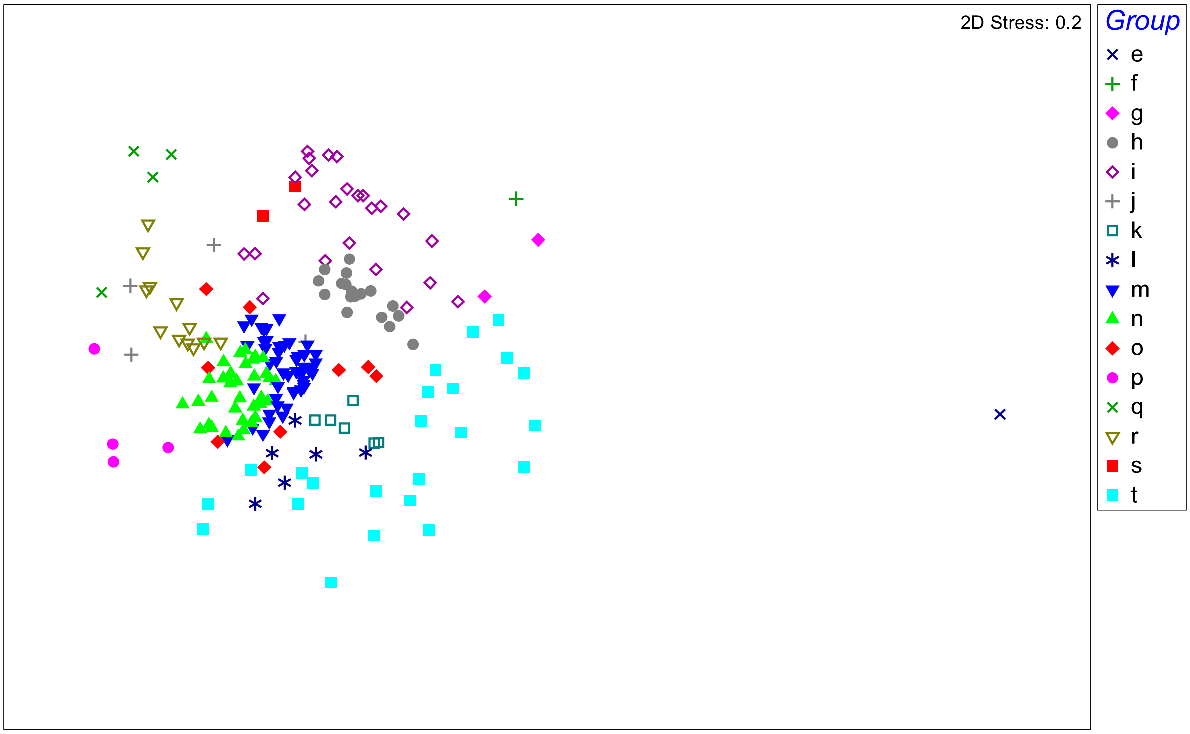

Figure 49. Results of nMDS on site data (North Killingholme & Cherry Cobb Sands) with samples highlighted by group. Samples with no taxa (groups a to d) excluded.

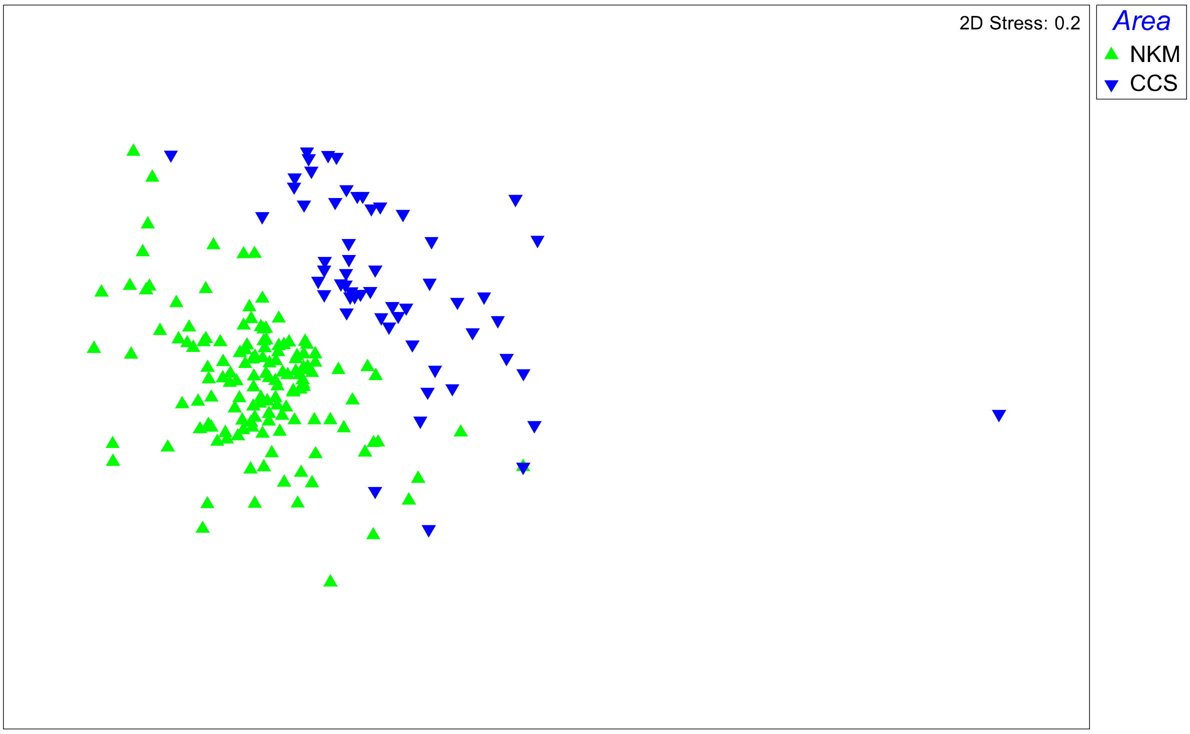

Figure 50. Results of nMDS on site data (North Killingholme & Cherry Cobb Sands) with samples highlighted by area. Samples with no taxa (groups a to d) excluded.

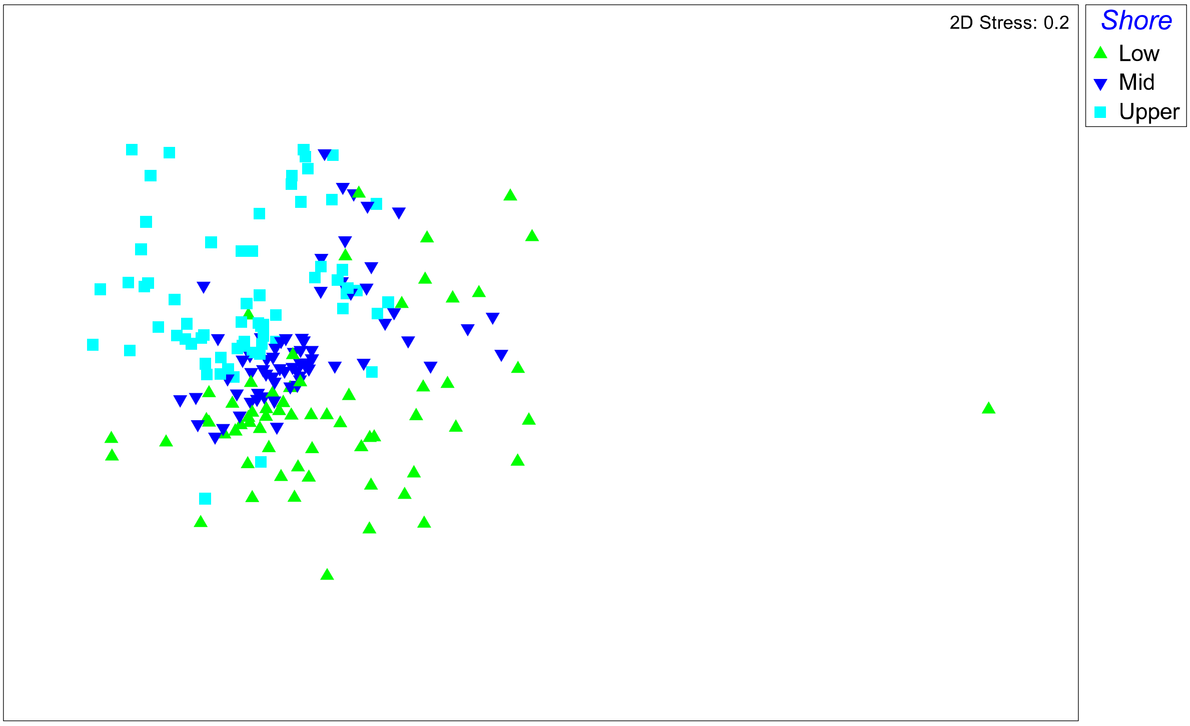

Figure 51. Results of nMDS on site data (North Killingholme & Cherry Cobb Sands) with samples highlighted by shore level. Samples with no taxa (groups a to d) excluded.

Table 13. Characteristic taxa from SIMPER analysis of groups derived from cluster analysis for North Killingholme & Cherry Cobb Sands.

Group a						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
NKM 3.2 UA	Mud	6.646	0.00	5.23	94.77	9.99
	Species	**Abundance (per 0.01m²)**	**Abundance (per 1m²)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	No Taxa	-	-	-	-	-

Group b						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
NKM 3.2 LC	Mud	6.253	0.00	7.37	92.63	8.54
	Species	**Abundance (per 0.01m²)**	**Abundance (per 1m²)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	No Taxa	-	-	-	-	-

Group c						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
NKM 2.1 UA	Mud	6.619	0.00	9.07	90.93	10.33
	Species	**Abundance (per 0.01m²)**	**Abundance (per 1m²)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	No Taxa	-	-	-	-	-

Group d						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
NKM 1.2 UA	Sandy Mud	6.441	0.00	10.06	89.94	9.32
	Species	**Abundance (per 0.01m^2)**	**Abundance (per 1m^2)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	No Taxa	-	-	-	-	-

Group e						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
CCS S2 LC	Sand	2.604	0.00	97.89	2.11	1.39
	Species	**Abundance (per 0.01m^2)**	**Abundance (per 1m^2)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	Nephtys hombergii	1	100	-	-	-
	Copepoda	1	100	-	-	-
	Bathyporeia sp.	1	100	-	-	-

Group f						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
CCS S2 LB	Slightly Gravelly Sand	2.824	0.004	91.17	8.83	1.35
	Species	**Abundance (per 0.01m^2)**	**Abundance (per 1m^2)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	Pygospio elegans	4	400	-	-	-
	Enchytraeidae	1	100	-	-	-
	Collembola sp.	1	100	-	-	-

Group g (Average similarity: 47.29%)						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
CCS N2 LC	Sandy Mud	4.086	0	47.98	52.02	4.39
CCS S3 LB	Muddy Sand	3.091	0	77.39	22.61	2.23
	Species	**Mean Abundance (per 0.01m^2)**	**Mean Abundance (per 1m^2)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	Scoloplos armiger	2.00	200	100	58.58	58.58
	Nematoda	3.00	300	100	41.42	100
	Macoma balthica	1.50	150	50	0	100
	Polydora cornuta	1.00	100	50	0	100
	Collembola sp.	0.50	50	50	0	100

Group h (Average similarity: 63.02%)						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
CCS N4 U2	Sandy Mud	5.30	0.00	21.80	78.20	5.53
CCS N4 UB	Sandy Mud	5.83	0.00	15.27	84.73	7.98
CCS N4 MC	Sandy Mud	4.22	0.00	43.04	56.96	5.18
CCS N4 LA	Sandy Mud	5.08	0.00	26.90	73.10	5.41
CCS S1 UB	Sandy Mud	4.60	0.00	31.34	68.66	4.01
CCS S1 UC	Sandy Mud	5.32	0.00	19.56	80.44	4.97
CCS S1 MA	Sandy Mud	5.22	0.00	20.96	79.04	4.57
CCS S1 MB	Sandy Mud	4.75	0.00	28.46	71.54	4.82
CCS S1 MC	Sandy Mud	4.70	0.00	31.98	68.02	3.89
CCS S2 UA	Sandy Mud	5.23	0.00	21.31	78.69	6.73
CCS S2 UB	Sandy Mud	4.60	0.00	29.86	70.14	4.69
CCS S2 UC	Sandy Mud	4.89	0.00	25.06	74.94	5.24
CCS S2 MA	Sandy Mud	4.74	0.00	29.76	70.24	4.32
CCS S2 MB	Sandy Mud	4.33	0.00	40.54	59.46	3.81
CCS S3 UA	Sandy Mud	5.36	0.00	19.61	80.39	6.55
CCS S3 UB	Sandy Mud	4.58	0.00	32.34	67.66	4.18
CCS S3 UC	Sandy Mud	4.66	0.00	31.95	68.05	4.69
CCS S3 MA	Slightly Gravelly Sandy Mud	4.16	0.04	44.65	55.31	3.41
	Species	**Mean Abundance (per 0.01m^2)**	**Mean Abundance (per 1m^2)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	Tubificoides benedii	65.56	6556	100	37.68	37.68
	Macoma balthica	23.78	2378	100	20.31	57.99
	Hediste diversicolor	13.39	1339	94	15.32	73.31
	Nematoda	10.22	1022	78	7.42	80.73
	Pygospio elegans	8.72	872	61	6.18	86.91
	Eteone longa/flava agg.	2.22	222	89	5.71	92.62
	Hydrobia ulvae	6.22	622	67	5.14	97.76
	Enchytraeidae	4.33	433	28	0.82	98.58
	Diptera larvae	0.44	44	33	0.57	99.16
	Abra tenuis	0.28	28	28	0.36	99.51
	Nephtys hombergii	0.50	50	22	0.32	99.83
	Scrobicularia plana	0.17	17	17	0.13	99.96
	Cyathura carinata	0.11	11	11	0.04	100
	Streblospio shrubsolii	0.33	33	6	0	100
	Collembola sp.	0.11	11	6	0	100
	Corophium volutator	0.06	6	6	0	100
	Manayunkia aestuarina	0.06	6	6	0	100
	Nemertea	0.06	6	6	0	100
	Retusa obtusa	0.06	6	6	0	100

Group i (Average similarity: 49.45%)						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
NKM 1.8 UB	Sandy Mud	6.04	0.00	13.86	86.14	8.84
NKM 3.1 UB	Sandy Mud	5.45	0.00	17.06	82.94	6.76
NKM 3.3 UB	Mud	6.39	0.00	7.94	92.06	8.35
CCS N1 U2	Sandy Mud	5.67	0.00	18.83	81.17	8.05
CCS N1 UA	Slightly Gravelly Sandy Mud	5.22	0.003	25.46	74.53	7.00
CCS N1 UB	Sandy Mud	5.04	0.00	25.48	74.52	5.99
CCS N1 UC	Slightly Gravelly Sandy Mud	5.54	0.40	20.33	79.26	7.23
CCS N1 MA	Slightly Gravelly Sandy Mud	5.38	0.15	22.69	77.16	6.12
CCS N1 MB	Sandy Mud	4.72	0.00	31.94	68.06	4.43
CCS N1 MC	Sandy Mud	4.78	0.00	29.97	70.03	5.18
CCS N1 LA	Sandy Mud	4.52	0.00	35.15	64.85	4.63
CCS N2 U2	Sandy Mud	5.79	0.00	17.78	82.22	9.09
CCS N2 UC	Sandy Mud	5.27	0.00	21.47	78.53	6.61
CCS N2 MA	Sandy Mud	5.03	0.00	27.20	72.80	7.07
CCS N2 MB	Sandy Mud	5.09	0.00	22.97	77.03	5.73
CCS N2 MC	Sandy Mud	4.92	0.00	26.06	73.94	5.68
CCS N2 LA	Sandy Mud	5.12	0.00	26.40	73.60	6.22
CCS N2 LB	Sandy Mud	4.86	0.00	31.49	68.51	5.53
CCS N4 UA	Sandy Mud	6.06	0.00	12.05	87.95	7.60
CCS N4 UC	Sandy Mud	5.63	0.00	15.88	84.12	7.02
CCS N4 MA	Sandy Mud	5.43	0.00	18.61	81.39	5.48
CCS N4 MB	Sandy Mud	5.67	0.00	20.85	79.15	7.60
CCS N4 LB	Muddy Sand	3.99	0.00	50.48	49.52	5.38
CCS S3 LA	Sandy Mud	4.11	0.00	47.32	52.68	4.56
	Species	**Mean Abundance (per 0.01m^2)**	**Mean Abundance (per 1m^2)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	Nematoda	48.21	4821	96	34.62	34.62
	Enchytraeidae	34.83	3483	100	31.25	65.87
	Hediste diversicolor	11.17	1117	83	16.12	81.99
	Pygospio elegans	2.75	275	58	4.91	86.9
	Macoma balthica	5.46	546	54	4.32	91.22
	Manayunkia aestuarina	4.54	454	42	1.91	93.13
	Tubificoides benedii	1.83	183	42	1.74	94.87
	Collembola sp.	2.17	217	33	1.21	96.08
	Diptera larvae	0.63	63	38	1.17	97.24
	Hydrobia ulvae	0.67	67	25	0.8	98.05
	Eteone longa/flava agg.	0.42	42	25	0.68	98.73
	Corophium volutator	14.17	1417	13	0.63	99.36
	Tubificoides (pseudogaster) agg.	3.58	358	17	0.53	99.89
	Nephtys hombergii	0.13	13	8	0.05	99.94
	Cyathura carinata	0.08	8	8	0.03	99.97
	Scrobicularia plana	0.08	8	8	0.03	100
	Arachnida (Acarina)	0.04	4	4	0	100
	Arachnida (Linyphiidae)	0.04	4	4	0	100

Group j (Average similarity: 62.99%)						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
NKM 1.1 UB	Sandy Mud	6.23	0.00	11.69	88.31	9.37
NKM 1.2 MB	Sandy Mud	5.69	0.00	14.94	85.06	7.03
NKM 1.2 UB	Mud	6.52	0.00	9.18	90.82	11.70
NKM 3.2 UB	Mud	6.35	0.00	7.97	92.03	9.35
	Species	**Mean Abundance (per 0.01m^2)**	**Mean Abundance (per 1m^2)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	Collembola sp.	20.25	2025	100	40.61	40.61
	Corophium volutator	17.5	1750	100	32.13	72.75
	Nematoda	3.5	350	100	13.23	85.97
	Diptera larvae	4.5	450	75	10.81	96.78
	Hediste diversicolor	1.75	175	50	1.69	98.47
	Arachnida (Acarina)	0.5	50	50	1.53	100
	Tubificoides benedii	2.75	275	25	0	100
	Macoma balthica	1.75	175	25	0	100
	Tubificoides (pseudogaster) agg.	1.5	150	25	0	100
	Enchytraeidae	1.25	125	25	0	100
	Streblospio shrubsolii	0.75	75	25	0	100
	Pygospio elegans	0.5	50	25	0	100

Group k (Average similarity: 77.74%)						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
NKM 1.5 LA	Sandy Mud	5.39	0.00	18.11	81.89	6.19
NKM 1.6 LB	Sandy Mud	5.70	0.00	16.88	83.12	6.04
NKM 1.7 LB	Sandy Mud	5.63	0.00	16.71	83.29	6.18
NKM 2.1 LB	Sandy Mud	5.47	0.00	19.16	80.84	6.05
NKM 2.4 LA	Sandy Mud	5.65	0.00	16.38	83.62	6.42
NKM 3.1 LB	Sandy Mud	5.84	0.00	16.69	83.31	6.06
	Species	**Mean Abundance (per 0.01m^2)**	**Mean Abundance (per 1m^2)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	Streblospio shrubsolii	11.50	1150	100	33.72	33.72
	Tubificoides benedii	7.83	783	100	26.55	60.28
	Nematoda	4.50	450	100	22.08	82.35
	Eteone longa/flava agg.	1.33	133	100	11.5	93.85
	Corophium volutator	2.00	200	67	5.45	99.3
	Macoma balthica	0.33	33	33	0.7	100
	Pygospio elegans	0.33	33	17	0	100
	Collembola sp.	0.17	17	17	0	100
	Tharyx sp.	0.17	17	17	0	100

Group l (Average similarity: 62.90%)						
Sites	Sediment Type	Median Phi	% Gravel	% Sand	% Mud	% LOI
NKM 1.2 LB	Sandy Mud	5.28	0.00	21.76	78.24	6.01
NKM 1.3 LC	Sandy Mud	5.67	0.00	17.88	82.12	6.67
NKM 1.4 LC	Sandy Mud	6.08	0.00	11.73	88.27	7.74
NKM 2.1 LC	Sandy Mud	6.11	0.00	13.37	86.63	7.54
NKM 2.3 LA	Sandy Mud	5.32	0.00	18.78	81.22	6.28
NKM 2.3 LC	Sandy Mud	5.66	0.00	15.57	84.43	4.78
	Species	Mean Abundance (per 0.01m^2)	Mean Abundance (per 1m^2)	% of Sites Recorded	% Contribution to similarity	Cumulative % Contribution
	Streblospio shrubsolii	17.17	1717	100	37.1	37.1
	Corophium volutator	8.33	833	100	23.31	60.4
	Tubificoides benedii	10.67	1067	100	17.15	77.55
	Tubificoides swirencoides	8.00	800	83	17.11	94.67
	Pygospio elegans	0.83	83	50	2.37	97.04
	Eteone longa/flava agg.	0.67	67	33	0.86	97.9
	Nematoda	0.67	67	33	0.71	98.61
	Nephtys hombergii	0.33	33	33	0.71	99.32
	Macoma balthica	0.50	50	33	0.68	100

Group m (Average similarity: 70.27%)						
Sites	Sediment Type	Median Phi	% Gravel	% Sand	% Mud	% LOI
NKM 1.1 LB	Sandy Mud	4.97	0.00	24.62	75.38	6.00
NKM 1.1 MB	Mud	6.32	0.00	9.96	90.04	10.65
NKM 1.3 LB	Sandy Mud	5.45	0.00	18.52	81.48	5.64
NKM 1.3 MB	Mud	6.36	0.00	9.67	90.33	8.37
NKM 1.3 UB	Mud	6.48	0.00	8.23	91.77	9.96
NKM 1.4 LA	Sandy Mud	5.81	0.00	14.53	85.47	6.45
NKM 1.4 LB	Sandy Mud	5.62	0.00	15.55	84.45	5.80
NKM 1.4 MB	Sandy Mud	5.48	0.00	16.89	83.11	5.62
NKM 1.4 MC	Sandy Mud	4.67	0.00	31.52	68.48	6.32
NKM 1.4 UB	Mud	6.30	0.00	8.59	91.41	6.98
NKM 1.5 LB	Sandy Mud	5.21	0.00	23.09	76.91	6.60
NKM 1.5 LC	Sandy Mud	5.49	0.00	19.34	80.66	4.84
NKM 1.5 MB	Sandy Mud	5.38	0.00	19.29	80.71	5.98
NKM 1.5 MC	Sandy Mud	5.60	0.00	15.47	84.53	6.70
NKM 1.5 UC	Sandy Mud	5.77	0.00	15.13	84.87	8.29
NKM 1.6 MA	Sandy Mud	6.19	0.00	10.38	89.62	7.62
NKM 1.6 MB	Sandy Mud	5.69	0.00	13.81	86.19	7.12
NKM 1.6 MC	Sandy Mud	5.41	0.00	17.11	82.89	6.16
NKM 1.6 UB	Sandy Mud	6.01	0.00	12.67	87.33	9.07
NKM 1.6 UC	Sandy Mud	5.76	0.00	14.23	85.77	7.43
NKM 1.7 LA	Sandy Mud	5.41	0.00	19.24	80.76	5.31
NKM 1.7 MA	Sandy Mud	5.29	0.00	19.06	80.94	6.87
NKM 1.7 MB	Sandy Mud	5.13	0.00	21.45	78.55	5.33

Group m (Average similarity: 70.27%)						
Sites	Sediment Type	Median Phi	% Gravel	% Sand	% Mud	% LOI
NKM 1.7 MC	Sandy Mud	5.15	0.00	20.23	79.77	5.85
NKM 1.7 UB	Mud	6.36	0.00	9.65	90.35	9.30
NKM 1.7 UC	Sandy Mud	5.96	0.00	13.53	86.47	7.89
NKM 1.8 MB	Sandy Mud	5.53	0.00	15.13	84.87	6.69
NKM 1.9 MB	Mud	6.34	0.00	9.50	90.50	5.35
NKM 1.9 UB	Mud	6.42	0.00	8.41	91.59	7.42
NKM 2.1 MA2	Mud	6.57	0.00	9.18	90.82	9.71
NKM 2.1 MB	Sandy Mud	4.64	0.00	31.09	68.91	5.68
NKM 2.2 LA	Sandy Mud	5.65	0.00	17.62	82.38	6.29
NKM 2.2 LB	Sandy Mud	5.45	0.00	19.42	80.58	6.54
NKM 2.2 MB	Sandy Mud	5.71	0.00	16.28	83.72	6.11
NKM 2.3 LB	Sandy Mud	5.75	0.00	16.56	83.44	5.69
NKM 2.3 MB	Sandy Mud	5.69	0.00	14.93	85.07	6.67
NKM 2.3 MC	Sandy Mud	5.47	0.00	19.95	80.05	6.33
NKM 2.3 UB	Sandy Mud	6.15	0.00	10.47	89.53	8.69
NKM 2.4 LB	Sandy Mud	5.47	0.00	22.33	77.67	5.94
NKM 2.4 MA	Sandy Mud	5.66	0.00	13.39	86.61	7.21
NKM 2.4 MB	Sandy Mud	5.49	0.00	16.07	83.93	5.46
NKM 2.4 MC	Sandy Mud	5.46	0.00	16.88	83.12	5.59
NKM 3.1 MB	Sandy Mud	4.95	0.00	25.48	74.52	4.04
NKM 3.2 LB	Sandy Mud	5.67	0.00	15.20	84.80	6.17
NKM 3.2 MB	Sandy Mud	5.14	0.00	22.32	77.68	5.06
NKM 3.3 LB	Sandy Mud	5.59	0.00	15.04	84.96	5.21
NKM 3.3 MB	Sandy Mud	6.38	0.00	11.00	89.00	8.68
	Species	Mean Abundance (per 0.01m^2)	Mean Abundance (per 1m^2)	% of Sites Recorded	% Contribution to similarity	Cumulative % Contribution
	Corophium volutator	153.19	15319	100	55.95	55.95
	Tubificoides benedii	67.64	6764	98	20.47	76.42
	Streblospio shrubsolii	8.79	879	96	9.4	85.82
	Nematoda	7.94	794	94	8.76	94.58
	Macoma balthica	3.98	398	53	2.38	96.96
	Hediste diversicolor	6.00	600	49	1.78	98.74
	Pygospio elegans	0.64	64	36	0.65	99.39
	Eteone longa/flava agg.	0.38	38	26	0.32	99.71
	Tharyx sp.	0.34	34	17	0.13	99.84
	Nemertea	0.13	13	13	0.07	99.91
	Enchytraeidae	0.17	17	11	0.05	99.96
	Tubificoides (pseudogaster) agg.	0.06	6	6	0.01	99.97
	Manayunkia aestuarina	0.09	9	6	0.01	99.99
	Tubificoides swirencoides	0.06	6	4	0.01	99.99
	Collembola sp.	0.11	11	4	0	100
	Coleoptera sp.	0.04	4	4	0	100
	Diptera larvae	0.04	4	2	0	100

Group n (Average similarity: 67.27%)						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
NKM 1.1 LA	Sandy Mud	5.47	0.00	20.17	79.83	6.20
NKM 1.1 MC	Sandy Mud	5.89	0.00	14.49	85.51	7.36
NKM 1.2 LA	Sandy Mud	4.89	0.00	28.14	71.86	5.37
NKM 1.2 MA	Sandy Mud	5.79	0.00	15.46	84.54	6.61
NKM 1.2 MC	Sandy Mud	4.83	0.00	28.68	71.32	4.14
NKM 1.3 LA	Sandy Mud	5.41	0.00	20.30	79.70	5.68
NKM 1.3 MA	Sandy Mud	6.10	0.00	12.45	87.55	8.03
NKM 1.3 MC	Sandy Mud	5.81	0.00	15.96	84.04	8.14
NKM 1.4 MA	Sandy Mud	5.81	0.00	13.11	86.89	7.33
NKM 1.4 UC	Sandy Mud	6.04	0.00	12.01	87.99	8.44
NKM 1.5 UA	Mud	6.52	0.00	8.48	91.52	10.01
NKM 1.6 LA	Sandy Mud	5.39	0.00	19.80	80.20	6.53
NKM 1.8 MA	Sandy Mud	5.86	0.00	13.59	86.41	6.35
NKM 1.8 UC	Sandy Mud	5.42	0.00	16.36	83.64	6.13
NKM 1.9 MA	Sandy Mud	5.58	0.00	19.08	80.92	7.31
NKM 1.9 MC	Sandy Mud	5.99	0.00	14.50	85.50	7.91
NKM 1.9 UC	Sandy Mud	6.08	0.00	12.30	87.70	7.48
NKM 2.1 LA	Sandy Mud	5.29	0.00	21.58	78.42	5.96
NKM 2.1 MA	Sandy Mud	6.13	0.00	11.63	88.37	9.46
NKM 2.1 MC	Sandy Mud	5.26	0.00	22.30	77.70	6.12
NKM 2.2 MA	Sandy Mud	6.09	0.00	11.03	88.97	7.88
NKM 2.2 MC	Sandy Mud	5.72	0.00	15.09	84.91	6.69
NKM 2.2 UB	Sandy Mud	6.01	0.00	13.06	86.94	9.98
NKM 2.2 UC	Sandy Mud	6.07	0.00	11.23	88.77	7.32
NKM 2.3 UC	Sandy Mud	5.77	0.00	15.28	84.72	8.22
NKM 2.4 UB	Mud	6.26	0.00	9.09	90.91	9.40
NKM 2.4 UC	Sandy Mud	5.96	0.00	11.86	88.14	8.21
NKM 3.1 LA	Sandy Mud	5.10	0.00	23.13	76.87	5.81
NKM 3.1 MA	Sandy Mud	5.27	0.00	18.42	81.58	5.45
NKM 3.1 MC	Sandy Mud	5.17	0.00	21.79	78.21	5.27
NKM 3.1 UC	Sandy Mud	5.36	0.00	17.73	82.27	6.18
NKM 3.2 LA	Sandy Mud	5.73	0.00	12.85	87.15	7.35
NKM 3.2 MA	Slightly Gravelly Sandy Mud	5.39	0.43	19.18	80.40	5.52
NKM 3.2 MC	Sandy Mud	5.25	0.00	20.54	79.46	6.16
NKM 3.3 LA	Sandy Mud	5.33	0.00	17.08	82.92	6.27
	Species	**Mean Abundance (per 0.01m^2)**	**Mean Abundance (per 1m^2)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	Corophium volutator	44.06	4406	100	60.94	60.94
	Tubificoides benedii	32.03	3203	100	28.73	89.67
	Hediste diversicolor	4.57	457	57	4.51	94.17
	Macoma balthica	1.06	106	60	4.05	98.22
	Streblospio shrubsolii	0.66	66	40	1.42	99.64
	Eteone longa/flava agg.	0.11	11	11	0.1	99.74
	Nematoda	0.11	11	11	0.09	99.84
	Pygospio elegans	0.11	11	11	0.09	99.92
	Tubificoides (pseudogaster) agg.	0.09	9	9	0.04	99.97
	Nemertea	0.06	6	6	0.02	99.98
	Scrobicularia plana	0.06	6	6	0.02	100
	Heterochaeta costata	0.03	3	3	0	100
	Tharyx sp.	0.03	3	3	0	100
	Tubificoides swirencoides	0.03	3	3	0	100

Group o (Average similarity: 58.20%)						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
NKM 1.1 MA	Sandy Mud	6.10	0.00	13.28	86.72	10.27
NKM 1.2 UC	Mud	6.49	0.00	9.18	90.82	11.45
NKM 1.3 UC	Sandy Mud	6.09	0.00	10.74	89.26	8.38
NKM 1.5 MA	Sandy Mud	5.84	0.00	13.31	86.69	7.23
NKM 1.8 MC	Sandy Mud	4.86	0.00	25.07	74.93	5.19
NKM 2.1 UB	Mud	6.42	0.00	8.88	91.12	10.11
NKM 2.1 UC	Mud	6.55	0.00	8.50	91.50	9.76
NKM 2.3 MA	Sandy Mud	5.44	0.00	17.80	82.20	6.43
NKM 3.3 MC	Sandy Mud	5.36	0.00	18.28	81.72	6.01
	Species	**Mean Abundance (per 0.01m^2)**	**Mean Abundance (per 1m^2)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	Tubificoides benedii	60.44	6044	100	83.01	83.01
	Corophium volutator	4.22	422	67	11.07	94.08
	Hediste diversicolor	0.78	78	44	3.01	97.09
	Macoma balthica	2.22	222	33	1.28	98.37
	Nematoda	1.56	156	33	0.91	99.28
	Streblospio shrubsolii	3.78	378	22	0.51	99.79
	Pygospio elegans	0.33	33	22	0.21	100
	Collembola sp.	0.33	33	11	0	100
	Eteone longa/flava agg.	0.33	33	11	0	100
	Coleoptera sp.	0.11	11	11	0	100
	Diptera larvae	0.11	11	11	0	100

Group p (Average similarity: 57.94%)						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
NKM 1.1 UA	Mud	6.37	0.00	9.76	90.24	10.87
NKM 1.2 LC	Sandy Mud	5.66	0.00	17.75	82.25	7.65
NKM 2.2 LC	Sandy Mud	5.82	0.00	15.58	84.42	6.16
NKM 3.3 LC	Mud	6.13	0.00	9.83	90.17	7.63
	Species	**Mean Abundance (per 0.01m^2)**	**Mean Abundance (per 1m^2)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	Corophium volutator	5.75	575	100	100	100
	Eteone longa/flava agg.	0.25	25	25	0	100
	Hediste diversicolor	0.25	25	25	0	100
	Nematoda	0.25	25	25	0	100
	Streblospio shrubsolii	0.25	25	25	0	100
	Tubificoides swirencoides	0.25	25	25	0	100

Group q (Average similarity: 55.47%)						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
NKM 1.1 UC	Mud	6.33	0.00	9.65	90.35	9.23
NKM 1.8 UA	Mud	6.40	0.00	8.57	91.43	9.25
NKM 2.4 UA	Mud	6.51	0.00	6.78	93.22	7.80
CCS N2 UB	Sandy Mud	5.78	0.00	14.90	85.10	7.74
	Species	**Mean Abundance (per 0.01m^2)**	**Mean Abundance (per 1m^2)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	Hediste diversicolor	4.5	450	100	90.37	90.37
	Diptera larvae	0.5	50	50	9.63	100
	Corophium volutator	0.5	50	25	0	100
	Collembola sp.	0.25	25	25	0	100

Group r (Average similarity: 72.94%)						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
NKM 1.3 UA	Sandy Mud	6.26	0.00	11.04	88.96	9.02
NKM 1.4 UA	Sandy Mud	6.33	0.00	10.31	89.69	10.15
NKM 1.5 UB	Sandy Mud	6.14	0.00	10.90	89.10	8.41
NKM 1.6 UA	Mud	6.56	0.00	7.58	92.42	10.25
NKM 1.7 UA	Slightly Gravelly Mud	6.49	0.33	8.82	90.85	10.39
NKM 1.9 UA	Sandy Mud	6.36	0.00	10.41	89.59	9.21
NKM 2.2 UA	Mud	6.31	0.00	9.89	90.11	8.84
NKM 2.3 UA	Mud	6.21	0.00	8.79	91.21	9.25
NKM 3.2 UC	Sandy Mud	6.18	0.00	10.12	89.88	8.45
NKM 3.3 MA	Sandy Mud	6.28	0.00	10.08	89.92	6.80
NKM 3.3 UA	Sandy Mud	6.03	0.00	13.13	86.87	10.40
NKM 3.3 UC	Sandy Mud	6.21	0.00	11.94	88.06	8.92
	Species	**Mean Abundance (per 0.01m^2)**	**Mean Abundance (per 1m^2)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	Hediste diversicolor	19.58	1958	100	59.49	59.49
	Corophium volutator	13.08	1308	100	35.75	95.24
	Tubificoides benedii	2.00	200	50	4.76	100
	Diptera larvae	0.33	33	8	0	100
	Heterochaeta costata	0.33	33	8	0	100
	Pygospio elegans	0.25	25	8	0	100
	Macoma balthica	0.17	17	8	0	100
	Diptera sp.	0.08	8	8	0	100

Group s (Average similarity: 49.13%)						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
CCS N2 UA	Sandy Mud	5.67	0.00	18.71	81.29	8.22
CCS S1 UA	Sandy Mud	4.95	0.00	27.91	72.09	4.38
	Species	**Mean Abundance (per 0.01m^2)**	**Mean Abundance (per 1m^2)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	Hediste diversicolor	43.5	4350	100	68.67	68.67
	Diptera larvae	2	200	100	18.35	87.02
	Eteone longa/flava agg.	1.5	150	100	12.98	100
	Manayunkia aestuarina	4	400	50	0	100
	Pygospio elegans	3	300	50	0	100
	Abra tenuis	1.5	150	50	0	100
	Tubificoides benedii	1.5	150	50	0	100
	Macoma balthica	1	100	50	0	100
	Abra sp.	0.5	50	50	0	100
	Hydrobia ulvae	0.5	50	50	0	100
	Nematoda	0.5	50	50	0	100

Group t (Average similarity: 33.37%)						
Sites	**Sediment Type**	**Median Phi**	**% Gravel**	**% Sand**	**% Mud**	**% LOI**
NKM 1.1 LC	Sandy Mud	5.10	0.00	23.35	76.65	5.51
NKM 1.6 LC	Sandy Mud	6.02	0.00	17.86	82.14	6.70
NKM 1.7 LC	Sandy Mud	5.63	0.00	19.21	80.79	5.01
NKM 1.8 LA	Sandy Mud	5.42	0.00	17.85	82.15	6.40
NKM 1.8 LB	Sandy Mud	5.66	0.00	15.57	84.43	5.18
NKM 1.8 LC	Sandy Mud	5.01	0.00	20.94	79.06	5.31
NKM 1.9 LA	Sandy Mud	5.78	0.00	15.18	84.82	5.98
NKM 1.9 LB	Sandy Mud	5.67	0.00	18.01	81.99	5.86
NKM 1.9 LC	Sandy Mud	5.68	0.00	16.94	83.06	6.16
NKM 2.4 LC	Sandy Mud	5.42	0.00	23.03	76.97	4.46
NKM 3.1 LC	Sandy Mud	5.92	0.00	12.85	87.15	6.98
NKM 3.1 UA	Sandy Mud	6.22	0.00	11.78	88.22	9.64
CCS N1 LB	Muddy Sand	3.69	0.00	65.38	34.62	3.52
CCS N1 LC	Muddy Sand	3.65	0.00	61.30	38.70	3.21
CCS N4 LC	Sandy Mud	4.90	0.00	36.05	63.95	5.14
CCS S1 LA	Sandy Mud	4.51	0.00	35.55	64.45	3.76
CCS S1 LB	Muddy Sand	3.22	0.00	70.09	29.91	1.86
CCS S1 LC	Muddy Sand	3.05	0.00	76.65	23.35	2.23
CCS S2 MC	Muddy Sand	3.23	0.00	86.10	13.90	1.67
CCS S2 LA	Muddy Sand	3.64	0.00	63.02	36.98	4.20
CCS S3 MB	Muddy Sand	3.68	0.00	62.05	37.95	3.35
CCS S3 MB2	Sand	3.04	0.00	91.31	8.69	1.41
CCS S3 MC	Muddy Sand	3.61	0.00	62.70	37.30	3.16
CCS S3 LC	Sand	2.64	0.00	91.64	8.36	1.73
	Species	**Mean Abundance (per 0.01m²)**	**Mean Abundance (per 1m²)**	**% of Sites Recorded**	**% Contribution to similarity**	**Cumulative % Contribution**
	Tubificoides benedii	1.75	175	71	44.38	44.38
	Macoma balthica	2.25	225	71	38.88	83.25
	Corophium volutator	0.71	71	25	4.92	88.17
	Pygospio elegans	0.96	96	29	4.31	92.48
	Nephtys hombergii	0.42	42	25	2.7	95.18
	Eteone longa/flava agg.	0.42	42	25	2.59	97.78
	Nematoda	0.21	21	17	1.09	98.87
	Hydrobia ulvae	0.13	13	13	0.59	99.46
	Enchytraeidae	0.08	8	8	0.24	99.7
	Bathyporeia sp.	0.33	33	8	0.18	99.88
	Scoloplos armiger	0.08	8	8	0.12	100
	Coleoptera sp.	0.04	4	4	0	100
	Collembola sp.	0.04	4	4	0	100
	Eurydice pulchra	0.04	4	4	0	100
	Hediste diversicolor	0.04	4	4	0	100
	Tubificoides swirencoides	0.04	4	4	0	100

4. Fish Survey Results

Beam trawl and seine netting surveys were carried out in Autumn 2013 within and immediately adjacent to the development area and also at control sites further upstream. The location of sampling stations are given in Figure 38 and for the beam trawl and seine netting surveys four stations were positioned within the likely impact area with a further four stations positioned upstream to act as controls. For the otter trawl surveys four stations were located within the impact zone and four control stations located upstream (control north) and downstream (control south).

4.1 Beam Trawl Survey

Two replicate beam trawls were undertaken at each sampling station, producing 8 beam trawl samples within the impact zone (development area) at sites BT1 to BT4 and 8 samples at the control stations (BT5 to BT8). A total of 11 species of fish were captured during the survey with gobies (particularly common goby), flounder and Dover sole dominating the fish assemblage. Eighteen invertebrate taxa were also recorded, which largely comprised of crustacean taxa and most notably *Crangon crangon* (Table 14).

Table 14. Beam trawl species richness and abundance matrix.

Scientific Name	BT 1		BT 2		BT 3		BT 4		BT 5		BT 6		BT 7		BT 8	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Nematoda	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Sagartia sp. Indet	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hediste diversicolor	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Mysidacea sp. Indet	3	0	0	0	0	1	2	1	1	0	1	0	0	1	0	1
Gastrosaccus spinifer	2	1	1	0	2	5	0	0	0	1	0	1	1	1	0	0
Neomysis integer	0	0	3	1	1	0	1	0	0	0	0	0	0	0	0	0
Praunus flexuosus	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Gammarus sp. Indet	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Corophium volutator	6	0	1	0	1	3	3	2	0	1	3	1	0	1	0	0
Diastylis rathkei	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Palaemonetes varians	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Pandalus montagui	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0
Juvenile *Crangonidae* sp.	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Crangon allmanni	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Crangon crangon	127	128	195	221	84	107	103	140	87	43	107	141	64	127	71	122
Carcinus maenas	1	0	3	2	0	1	3	1	1	0	4	4	0	1	2	1
Macoma balthica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Gastropoda	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anguilla anguilla	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Clupeidae sp. indet	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Clupea harengus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Sprattus sprattus	2	0	0	0	1	0	1	0	0	0	1	0	0	0	1	0

Scientific Name	BT 1		BT 2		BT 3		BT 4		BT 5		BT 6		BT 7		BT 8	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Ciliata mustela	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0
Gadus morhua	1	0	3	3	1	2	1	0	0	0	0	2	0	0	0	0
Merlangius merlangus	0	0	0	0	0	0	0	0	1	4	0	0	1	0	0	1
Agonus cataphractus	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Liparis liparis	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0
Zoarces viviparous	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Pomatoschistus spp.	1	0	0	0	0	2	0	0	0	0	1	0	0	0	2	0
Pomatoschistus microps	29	31	31	22	8	9	6	8	9	17	3	9	9	12	2	8
Pomatoschistus minutus	0	1	0	0	0	0	1	2	1	3	1	0	0	0	0	0
Psetta maxima	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Pleuronectidae sp. Indet	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Limanda limanda	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Microstomus kitt	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Platichthys flesus	8	12	18	10	6	1	8	1	2	0	3	3	10	5	1	5
Pleuronectes platessa	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Solea solea	3	1	20	4	5	4	7	5	3	0	4	3	2	2	1	0
Total abundance	185	178	280	268	111	136	141	163	105	70	132	167	87	153	83	143
Species Diversity	13	9	12	11	11	11	15	10	8	6	14	9	6	10	10	9

The beam trawl stations within the development and impact zone (BT1 – BT4) exhibited moderately low species richness in terms of fish taxa with 5 to 8 species of fish per trawl (Figure 52), with beam trawl station BT4a recording the highest number of species (eight species). Sampling at the control stations (BT5 – BT8) indicated a similar range of taxa but slightly greater variability with species richness ranging from 4 to 9 species. The largest number of fish species were recorded at BT6a (9 species).

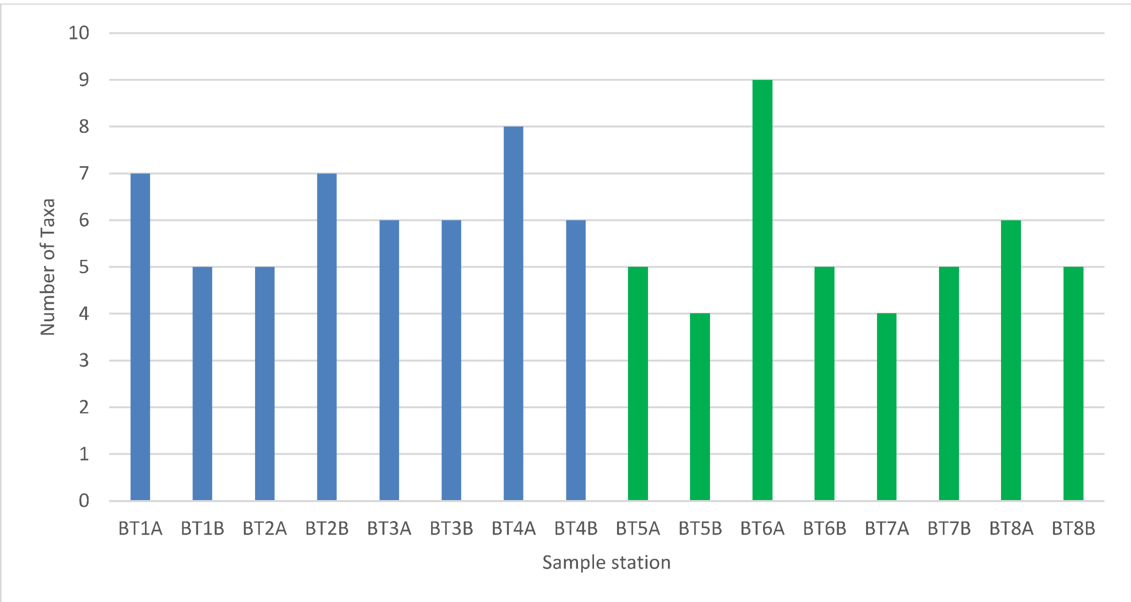

Figure 52. Fish species richness for beam trawls.

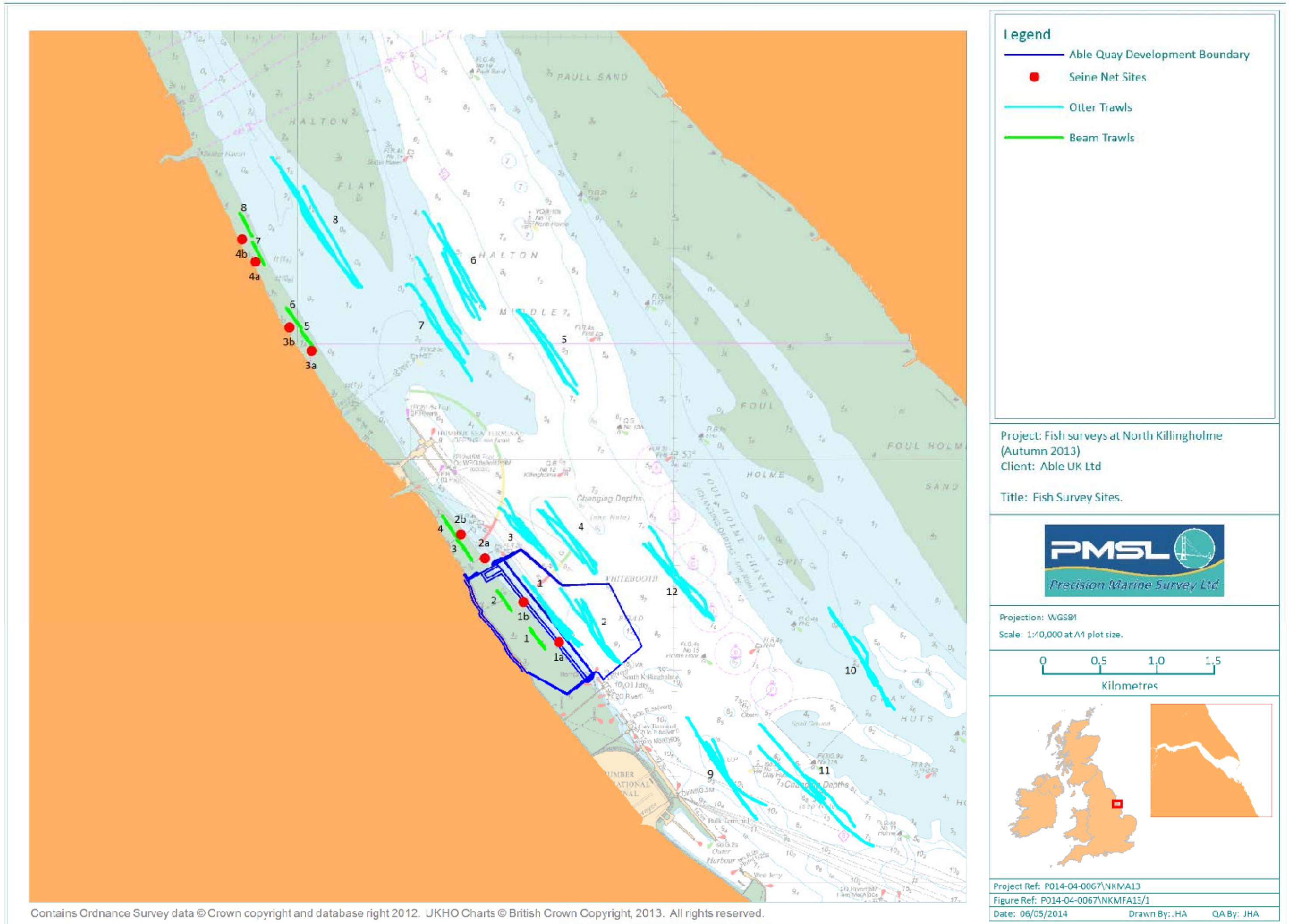

Figure 53. Location of fish survey sites.