Humber Gateway Offshore Windfarm Biotope & Cobble Reef Report

Report to Environmental Resources Management Ltd

Institute of Estuarine and Coastal Studies
University of Hull

February 2008

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Report: ZBB693-CR- F-2008

Client: Environmental Resources Management Ltd

Report title: **Humber Gateway Offshore Windfarm Biotope & Cobble Reef Report**

February 2008

Reference No: ZBB693-CR-F-2008

For and on behalf of the Institute of Estuarine and Coastal Studies	
Approved by:	_____
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Position:	_____
Date:	_____

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1. INTRODUCTION

1.1 General

This report provides a brief assessment of the subtidal biotopes and areas of cobble habitat and potential Annex 1 reefs present within the subtidal areas off the Holderness coast, directly within and adjacent to the proposed development of an offshore wind farm, 8km from Easington. The proposed development will comprise up to 80 turbines, sited within a development area of 35km^2 (Figure 1).

The Institute of Estuarine and Coastal Studies (IECS) were commissioned by Environmental Resources Management (ERM), on behalf of the developer (E.ON UK Renewables), to carry out an evaluation of the marine ecology within the area, and as part of this study areas potential of biogenic reef were identified. Within and adjacent to the wind farm footprint large areas of moderately diverse cobble/stony habitats were identified which also included two species of reef forming polychaete (*Sabellaria spinulosa* and *S. alveolata*). These species can form reef like structures on the seabed and consequently are of conservation interest and protected under the EC Habitats Directive.

A previous report to ERM clarified the status of these species in the area and it was concluded that over the majority of the area abundances of *Sabellaria* were generally not high enough to be considered as examples of *Sabellaria* reef although some areas (particularly inshore from the wind farm) had moderately high numbers of *S. alveolata* or *S. spinulosa and* may comprise examples of the more typical encrusting form of the *Sabellaria* biotopes SS.SBR.PoR.SspiMx (*Sabellaria spinulosa* on stable circalittoral mixed sediment) or SS.SBR.PoR.SalvMx (*Sabellaria alveolata* on variable salinity sublittoral mixed sediment).

As part of the assessment of *Sabellaria* communities in the wind farm area it was noted that due to the moderately rich epifaunal component in some areas and the high proportion of pebbles and cobbles evident from the video surveys it was considered that certain areas may be classified as a cobble reef habitat. Such habitats are likely to form an important component of forthcoming offshore SAC designations and this report provides further information on the distribution and status of such habitats in the region of wind farm and in the wider geographic context.

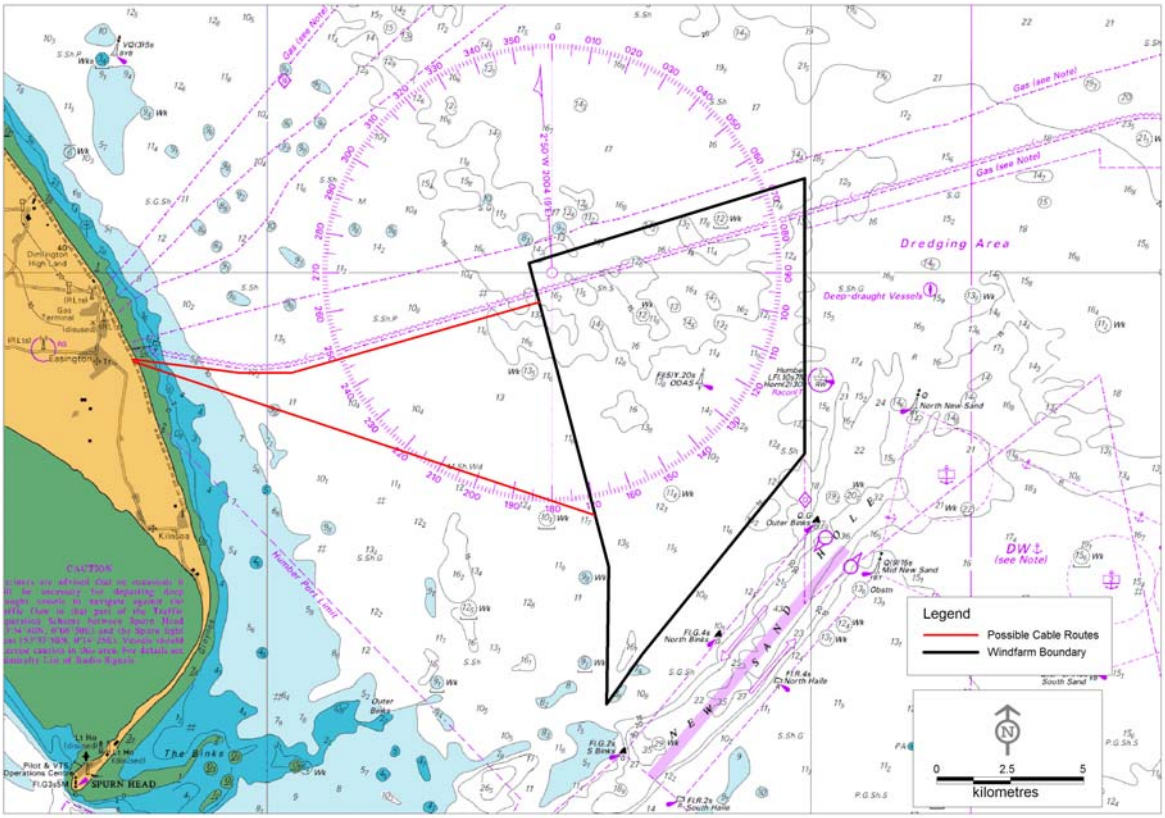

Figure 1. Location of proposed wind farm.

1.2 Definitions of Reefs in UK waters

Reefs are one of the UK marine habitats defined under Annex 1 of the EC Habitats Directive and may be broadly divided into reefs which comprise of animals and plants growing on rock protruding from the seabed, and those where the reef structure is created by the species themselves (biogenic reefs). In particular, cobble reef habitats are increasingly becoming included as habitats of conservation importance and will be a key component the forthcoming offshore SAC designations.

At present precise definitions of what constitutes a cobble reef as opposed to cobble habitat are unclear and conservation bodies such as JNCC and Natural England are currently reviewing existing data in order to clarify definitions. At present, definitions of reefs (including cobble reef) follow guidance in the Habitats Directive although these do not specifically address the precise characteristics of cobble reefs. A number of studies have given generic definitions of biogenic reefs and these are often applied (with some modification) to instances of cobble reef.

The recent (2007) revision to the EU habitat definitions classifies reefs as either biogenic concretions or those of geogenic origin (reefs formed by non biogenic substrata). Reefs are hard compact substrata on solid and soft bottoms arising from the sea floor in the sublittoral and littoral zone. Reef structures may support a zonation of benthic communities of algae and animal species in addition to concretions and corallogenic concretions. The term “Hard

compact substrata" includes rocks (including soft rock, e.g. chalk), boulders and cobbles (generally >64 mm in diameter). Such hard substrata that are covered by a thin and mobile veneer of sediment are classed as reefs if the associated biota is dependent on the hard substratum rather than the overlying sediment. Biogenic concretions are defined as concretions, encrustations, corallogenic concretions and bivalve mussel beds originating from dead or living animals, i.e. biogenic hard bottoms which supply habitats for epibiotic species.

The UK marine SACs Biogenic Reef report (Holt *et al.* 1998) uses the following criteria in defining biogenic reefs:

- the unit should be substantial in size (generally of the order of a metre or two across as a minimum, and somewhat raised, mainly in order to disqualify nodule like aggregations such as may be formed by *S. spinulosa* and scattered small aggregations such as occurs with many of the species under consideration);

- and should create a substratum which is reasonably discrete and substantially different to the underlying or surrounding substratum, usually with much more available hard surfaces and crevices on and in which other flora and fauna can grow.

They further classify biogenic reefs as follows:

"*Solid, massive structures which are created by accumulations of organisms, usually rising from the seabed, or at least clearly forming a substantial, discrete community or habitat which is very different from the surrounding seabed. The structure of the reef may be composed almost entirely of the reef building organism and its tubes or shells, or it may to some degree be composed of sediments, stones and shells bound together by the organisms.*"

In the UK, the most important biogenic reefs in inshore waters are those comprised of *Sabellaria alveolata*, *S. spinulosa*, *Mytilus edulis*, *Modiolus modiolus* and *Serpula vermicularis.* Statutory protection in the UK for intertidal reefs may occur as sub-features of non-reef Annex 1 habitats (e.g. 'intertidal mudflats and sandflats' or 'Sandbanks which are slightly covered by seawater all the time'). Biodiversity Action Plans (BAPs) have also been defined for a number of biogenic reefs.

A recent JNCC publication (Gubbay, 2007) based on the findings of a workshop into the definitions of *Sabellaria spinulosa* reef defined such habitats (in the context of the Habitats Directive) as an area of *Sabellaria spinulosa* which is elevated from the seabed and has a large spatial extent. Colonies may be patchy within an area defined as reef and show a range of elevations. This report outlined some suggested criteria for 'reefiness' in the context of *Sabellaria spinulosa* as follows:

Measure of 'reefiness'	NOT a REEF	LOW	MEDIUM	HIGH
Elevation (cm) (average tube height)	<2	2-5	5-10	>10
Area (m^2)	<25	25-10,000	10,000 – 1,000,000	> 1,000,000
Patchiness (% cover)	<10%	10-20	20-30	>30

Whilst these criteria relate specifically to *Sabellaria spinulosa* reefs a similar approach could be applied to cobble reef using measures of area, elevation, coverage, proportion of cobbles in sediment and the range/diversity of encrusting organisms.

COBBLE REEF DEFINITIONS

Specifically with regard to cobble reef a number of criteria are currently being considered as follows:

- The Habitats Directive specifies reefs as being structures which arise from the seafloor. In terms of cobble reef this may be difficult to assess in many cases so it is likely that this will be interpreted as areas of reef that are topographically distinct. In other words areas of cobble forming a distinct habitat compared to areas of adjacent seabed. This could be interpreted as being detectable using Hi Res Side-Scan Sonar (HRSSS).

- A certain proportion of the habitat will need to include sediments above 64mm (the boundary for cobble as per the Wentworth scale). The precise proportion of cobble required is currently under review and is likely to change depending on the type of habitat and the surrounding seabed. For example, if the surrounding sediments are soft then a higher proportion of cobble may be required, whereas, if the surrounding sediment is hard, then a lower cobble percentage might be required.

- No specific size limit subject to the reef being of sufficient size to maintain its structure and function i.e. is considered a stable seabed habitat (as opposed to more transient areas of cobble sometimes covered or uncovered by sand for example).

- Reef fauna (encrusting hydroids, bryozoans, sponges etc.) must be present.

It is likely that the criteria above will be modified following further research and survey of the structure and dynamics of cobble reefs. Certain problems arise in terms of defining the boundaries and characteristics of cobble reef not least because a number of sublittoral biotopes could potentially be included within the definition. In addition, wide areas of mixed sediments exist offshore which often have a cobble component. It is often difficult to ascribe a specific proportion of the seabed habitat as cobble when mixed in with a mosaic of sands, gravels and pebbles. The boundaries of such habitats may be defined from sidescan survey or AGDS (relative to other areas of softer sediments) although such techniques will not necessarily allow a precise definition of cobble content in an area. Even if cobble habitats are identified further clarification is required as to what constitutes a 'reef' in terms of conservation objectives.

Furthermore, areas of cobble habitat may also include communities which can form biogenic reef (e.g. mussel beds or *Sabellaria spinulosa* or *S. alveolata*). Where such communities are sufficiently developed to be considered biogenic reefs they may develop within wider areas of cobble habitat leading to a mosaic of both biogenic and cobble reef. In such areas more detailed survey work is required to define such habitats a consistent fashion.

Benthic grab surveys are commonly used to characterise the benthic communities and seabed sediments with sediment samples taken for particle size analysis (PSA) in

conjunction with samples for faunal analysis. However, samples taken for PSA are likely to underestimate the cobble content of surficial sediments (particularly with regard to larger cobbles) and the relatively small grabs used for standard benthic surveys ($0.1m^2$) will only take a relatively small sample for the seabed (from which a sub-sample is taken for PSA) which may not represent the cobble fraction over the wider area. Underwater video or photography is often used to survey such habitats and particularly where concerns arise over the use of invasive sampling. Fixed viewpoint video/photography may be used (with subsequent photogrammetric analysis) to assess cobble content whilst towed or drop down video will give an overview of the habitat and allow a qualitative assessment of sediment type which helps put information from grab samples into context. It is anticipated that further research and development into monitoring of cobble reef habitats will provide more detailed guidance on the characterisation of such habitats in the future.

At a generic level there are also inherent difficulties in defining biotopes and boundaries in heterogeneous areas which comprise of a mosaic of habitats/biotopes and also difficulties in marrying biotopes based on infaunal data to those which are more readily identified from video (or in areas where an epibiotic biotope overlays the infaunal assemblage sampled by grab sampling). Natural England (and JNCC) have identified a need to review and clarify the definition for stony/cobble reefs although this is unlikely to be produced in time to influence the proposed wind farm development.

As mentioned previously a number of biotopes may potentially fall into the category of cobble reef. These include a number of soft mixed sediment biotopes and sublittoral rock biotopes. The following list outlines the main biotopes under consideration for cobble reefs although these are likely to be further clarified in the future. In particular further development of the offshore section of the biotope classification is required as cobble reef habitat is not currently adequately covered by existing biotopes.

- CR.HCR.XFA.FluHocu: Flustra foliacea and Haliclona oculata with a rich faunal turf on tide-swept circalittoral mixed substrata
- CR.MCR.CFAVS.CuSpH.As: Cushion sponges and hydroids on turbid tide-swept sheltered circalittoral rock
- CR.MCR.CFAVS.CuSpH.VS: Cushion sponges and hydroids on turbid tide-swept variable salinity sheltered circalittoral rock
- CR.HCR.XFA.SpNemAdia: Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata
- SS.SMx.CMx.FluHyd: *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment

In the context of the current study the distinction is drawn between *cobble habitats* i.e. areas of seabed which are characterised by a significant proportion of cobbles and boulder (usually intermingled with sands, gravels and pebbles) and *cobble reefs* which are areas of cobble habitat which fall under the definition of reefs given above i.e. topographically distinct with sufficient reef fauna (hydroids, bryozoans, sponges etc) present. In this instance biogenic reefs specifically relate to *Sabellaria spinulosa* and *S. alveolata* reefs.

2. METHODOLOGY

Prior to this study, a number of baseline surveys within and adjacent to the proposed wind farm site were carried out as part of the scoping process. The methodologies for the baseline benthic surveys followed DEFRA Guidance note for Environmental Impact Assessment in respect of FEPA and CPA requirements (Version 2 – June 2004) and all methodologies were agreed with CEFAS prior to initiation. These have been reported elsewhere but are summarised here:

- Geophysical Survey: Sidescan Sonar (105 kHz & 309 kHz), Sub-bottom profiler, magnetometer and echosounder (bathymetric) survey of wind farm site and proposed cable routes.

- Baseline benthic survey: 54 stations sampled by Hamon grab.

- Baseline Epibenthic survey: 27 stations sampled by 2m beam and 4m otter trawl.

- Drop down video survey of sites with potential *Sabellaria* communities (primarily outside the wind farm site. This was combined with a limited AGDS (Acoustic Ground Discrimination System) survey.

On the basis of the results of these surveys it was agreed that further consideration of the sublittoral biotopes (based on the benthic grab survey) would be useful which in conjunction with the available video footage could be used to provide a preliminary assessment of the potential distribution of cobble habitats in the survey area. For the purposes of this review data from the benthic survey was used to derive biotope codes for each site. This information was then used with information derived from the video surveys and available PSA data to derive preliminary maps of the main habitat types highlighting areas of cobble habitat which may contain examples of cobble reef.

3. RESULTS

3.1. Geophysical Survey

Full results of the geophysical survey are given in a separate report, but of relevance to this study is the description seabed features derived from the side-scan survey (Figure 2). Over the majority of the wind farm site and the proposed cable routes the seabed comprises of a veneer of sandy gravel and gravelly sand with pebbles, cobbles and boulders and from a sedimentary point of view could fall into the category of cobble habitat. This veneer derives from erosion products of the underlying Pleistocene Bolders Bank Formation comprised of boulder clay. The coarser material has also been formed into localised ridges of gravel and cobbles which run NW-SE across the area. To the south-eastern edge of the wind farm and at the nearshore end of the cable route, the seabed comprises of sand sometimes forming patches or ribbons.

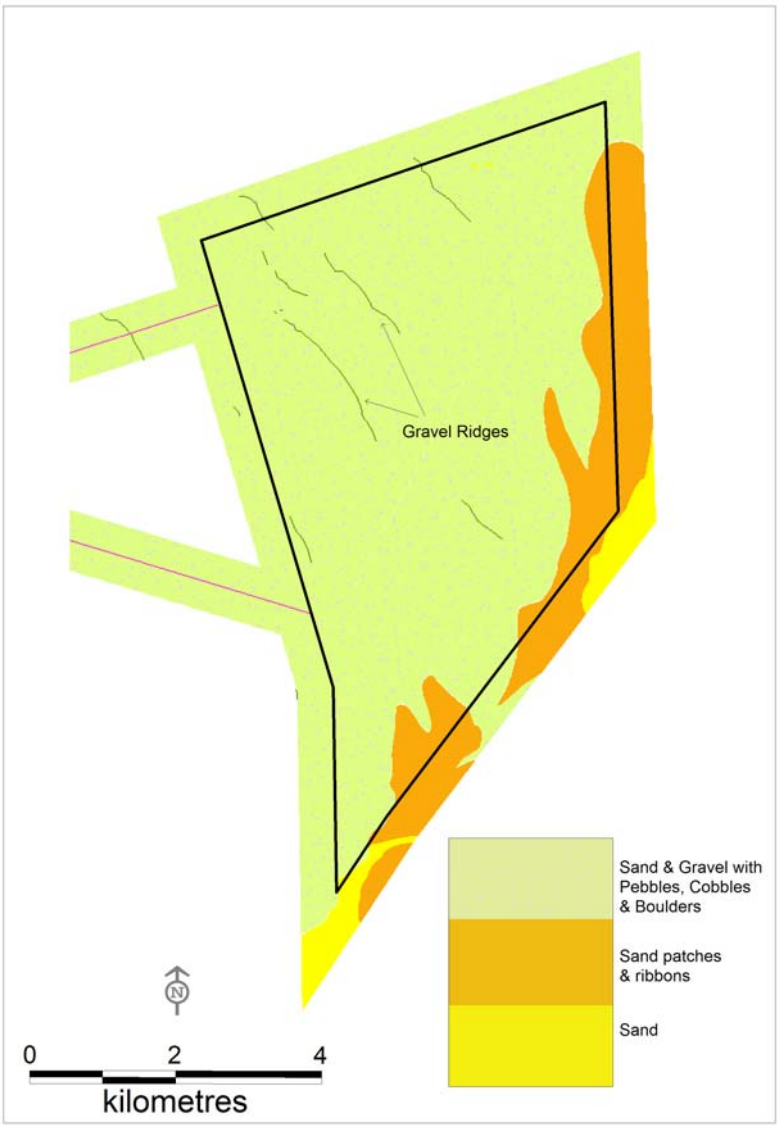

Figure 2. Seabed Features of proposed wind farm site from geophysical survey.

3.2. Benthic Surveys

3.2.1. SUMMARY OF SEDIMENT TYPES

The sediment characteristics derived from particle size analysis of the samples from the benthic surveys are illustrated in Figure 3. The sediment characteristics were highly variable across the area although the sediments were generally very coarse comprising of coarse sands (<1φ) and gravels / pebbles / cobbles (-1 to -4 φ). The finest sediments were found at stations 18, 27, 28, 30, 50, 51 and 52, where median phi values ranged from -0.94 to 0.45 φ (<2 mm), with the coarsest sediment being found at stations 6, 12, 23, 31 and 40 where median phi values were all less than -3 φ (>8 mm). The sorting coefficient (SD) ranged from 1.06 to 2.9, indicating poorly sorted sediments composed of a range of particle sizes. All the sites contained a relatively high proportion of gravel (including pebbles and some cobble) and Figure 3 illustrates the proportion of various grades of gravel/pebble content. Only three sites (sites 18, 28 and 52) had PSA samples containing sediments of cobble size (shown as blue circles on Figure 3) although as stated previously the PSA samples are likely the underestimate the proportion if cobbles across the area (as confirmed by video). All the sites contained sediment fractions above 8mm (small stones/pebbles) with 36 sites having sediments with at least 30% pebbles/stones.

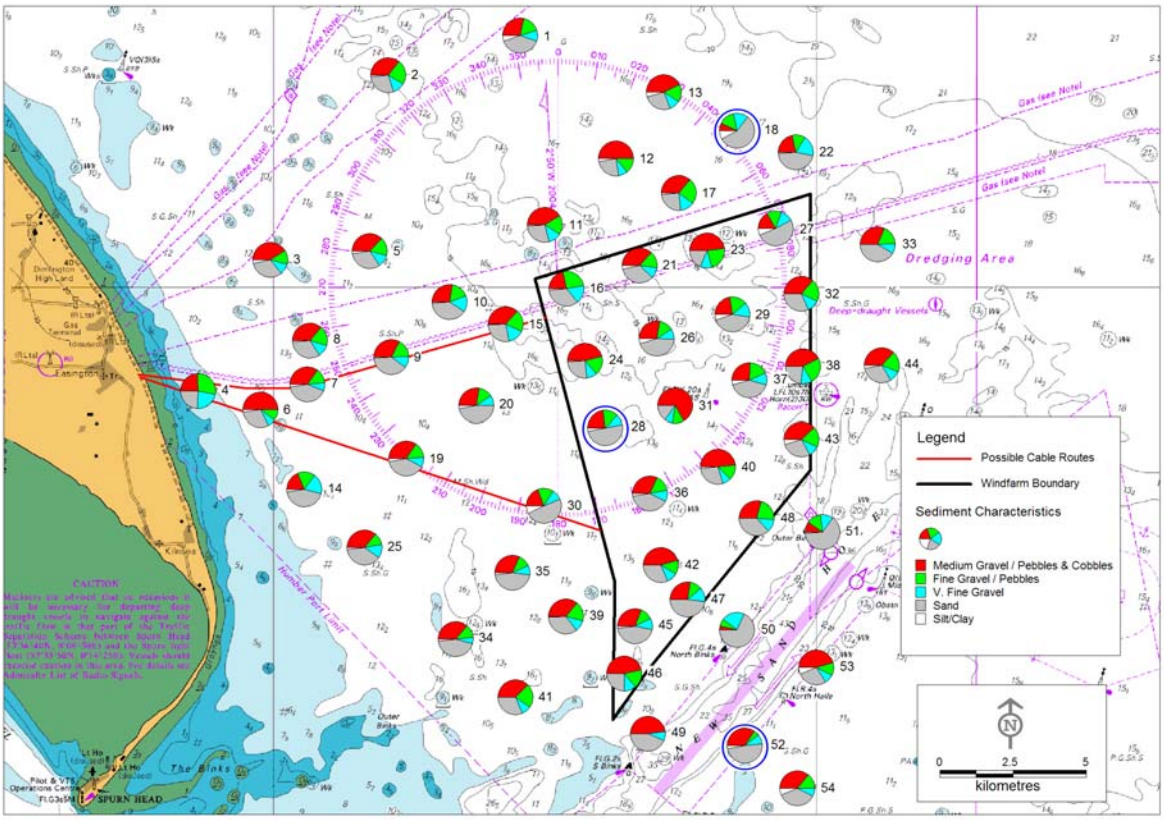

Figure 3. Sediment characteristics obtained from benthic samples.

3.2.2. SUMMARY OF MAIN COMMUNITY TYPES

Analysis of the benthic samples has been reported separately so the main findings are summarised here. In total of 357 species were recorded from the survey area although 80% of the community (in terms of abundance) was composed of only 44 species. Of these 11 taxa dominated and accounted for 50% of the total abundance namely *Pisidia longicornis*, *Sabellaria alveolata, Salmacina dysteri,* Nematodes*, Mediomastus fragilis, Sabellaria spinulosa, Galathea intermedia, Leptocheirus hirsutimanus, Hiatella arctica, Achelia echinata* and *Spio armata.* The most abundant species overall was the long clawed porcelain crab *Pisidia longicornis* which was present in 41 samples and the dominant species in 17 samples, representing between 13.5% and 45% of the community. Cluster analysis of the benthic data derived 13 groups at varying levels of similarity and the dominant taxa within these groups are given in Table 1.

Groups 1 to 3 and groups 11 to 13 comprised of a small number of sites in coarse mixed sediments (<3 sites per group) with somewhat variable species composition and similarities of less than 40%. The remaining groups were effectively sub-groups of a larger group of more closely associated sites. These sites exhibited similarities of over 40% and generally had a number of species in common such as *Pisidia longicornis*, *Mediomastus fragilis* and *Leptocheirus hirsutimanus*. Species such the reef building polychaete *Sabellaria alveolata* were particularly common in groups 4 (inshore sites) whilst *Sabellaria spinulosa* was recorded in a number of groups at low abundances. Whilst somewhat variable the majority of sites displayed broadly similar communities typically found in coarse (or slightly muddy) mixed sediments with pebbles, cobbles and sand or gravel.

A wide range of taxa were collected from the epifaunal trawls and whilst no clear spatial trend was evident hydroids and bryozoans were well represented throughout the area. Table 2 shows the proportion of sites at which a species occurred with species given which occurred at least 25% of the sites. Hydroid and bryozoan species such as *Crisia eburnea, Amathia lendigera Diphasia* sp. *Flustra foliacea, Crisidia cornuta, Scrupocellaria reptans* Sertularia argentea and Electra pilosa tended to dominate the epifaunal assemblage whilst the poriferan *Hymeniacidon perleve* was also relatively common. The quantitative component of the epifaunal community was dominated by crustaceans, echinoderms & molluscs with a few species dominating the assemblage. The crustacean assemblage was dominated by the pink shrimp (*Pandalus montagui*), the livid swimming crab (*Liocarcinus holsatus*) and the velvet swimming crab (*Necora puber*) which together accounted for 78% of the total abundance whilst the echinoderm and mollusc assemblages were dominated by *Echinus esculentus* and *Musculus discors* respectively.

The results of the video survey highlighted the relatively coarse nature of the seabed sediments as evident from the benthic surveys. As described previously, the seabed within and adjacent to the proposed wind farm site is characterised by relatively rough ground comprising of a mixture of gravel, pebbles, cobble, shell (usually mussel shell) and occasional boulders with sand and some silt. Sediments appeared to be more heterogeneous inshore with larger patches of sand/gravel evident between the cobbles/pebbles at some of the more inshore sites such as site 14 or site 52 adjacent to New Sand Hole. Within the wind farm site, seabed sediments appeared to have a lower silt content (possibly due to their greater distance from the Humber Plume) with sediments appearing to be a relatively compact veneer of stones, pebbles and cobbles in sand and

gravel with areas of larger boulders mixed within it. A range of biota was evident on the seabed bed including a variety of hydroids (e.g. *Nemertesia* sp. and *Sertularia* sp.), bryozoans (particularly *Flustra foliacea*) and soft corals such as *Alcyonium digitatum*, sponges such as *Suberites* sp. Other taxa included including numerous species of crab (e.g. *Liocarcinus* sp., *Necora* sp.), echinoderms (e.g. *Crossaster papposus*, *Asterias rubens*), mussels and occasional anemones (e.g. *Urticina* sp and *Sagartia* sp.). Areas of *Sabellaria* were generally low-lying encrusting forms, with relatively low tube density although certain sites (e.g. site 14 or site 52) exhibited larger and more extensive formations of *Sabellaria* typically present as clumps, hummocks or sheets on cobbles and boulder.

Table 1. Summary of site groups derived from cluster analysis.

1	Mean A	% of sites	2	Mean A	% of sites	3	Mean A	% of sites
Chone filicaudata	3.00	100.00	Sphaerosyllis bulbosa	5.78	100.00	Mediomastus fragilis	11.00	100.00
Glycera lapidum	2.00	100.00	Nematoda spp. indet	3.56	100.00	Chone filicaudata	9.00	100.00
Copepoda	2.00	100.00	Leptocheirus hirsutimanus	2.89	100.00	Spio armata	8.00	100.00
Nematoda spp. indet	1.00	100.00	Eumida sanguinea	2.00	100.00	Nematoda spp. indet	6.00	100.00
Pisione remota	1.00	100.00	Sphaerosyllis hystrix	2.00	66.67	Polycirrus (norvegicus)	5.00	100.00
Goniada maculata	1.00	100.00	Goodalia triangularis	1.78	33.33	Sphaerosyllis hystrix	3.00	100.00
Ehlersia cornuta	1.00	100.00	Juv. Mytilacea	1.56	33.33	Protodorvillea kefersteinia	3.00	100.00
Sphaerosyllis bulbosa	1.00	100.00	Aonides paucibranchiata	1.44	66.67	Timoclea ovata	3.00	100.00
Leptocheirus hirsutimanus	1.00	100.00	Juv. Leptocheirus sp. indet	1.44	33.33	Exogone hebes	2.00	100.00

4	Mean A	% of sites	5	Mean A	% of sites	6	Mean A	% of sites
Sabellaria alveolata	107.19	100.00	Pisidia longicornis	35.00	100.00	Nematoda spp. indet	6.00	100.00
Sabellaria spinulosa	11.59	100.00	Musculus discors	12.00	50.00	Leptocheirus hirsutimanus	5.13	90.00
Hiatella arctica	8.22	100.00	Typosyllis armillaris	6.50	100.00	Pomatoceros lamarcki	3.57	100.00
Mytilus edulis	6.07	88.89	Heteranomia squamula	6.50	100.00	Pisidia longicornis	2.73	100.00
Pisidia longicornis	5.59	77.78	Polycirrus (norvegicus)	5.00	50.00	Mediomastus fragilis	2.43	90.00
Pomatoceros lamarcki	4.78	100.00	Pomatoceros lamarcki	4.50	100.00	Galathea intermedia	2.33	90.00
Mediomastus fragilis	4.74	88.89	Achelia echinata	4.50	100.00	Spio armata	2.17	90.00
Nematoda spp. indet	4.41	88.89	Nematoda spp. indet	4.50	50.00	Protodorvillea kefersteinia	2.17	60.00
Lepidonotus squamatus	4.11	88.89	Gibbula tumida	4.00	100.00	Sphaerosyllis bulbosa	1.93	70.00

7	Mean A	% of sites	8	Mean A	% of sites	9	Mean A	% of sites
Pisidia longicornis	10.83	100.00	Pisidia longicornis	95.92	100.00	Pisidia longicornis	107.67	100.00
Sabellaria spinulosa	9.17	100.00	Salmacina dysteri	87.25	50.00	Achelia echinata	14.52	100.00
Mediomastus fragilis	4.42	75.00	Nematoda spp. indet	13.42	100.00	Heteranomia squamula	12.19	85.71
Lepidonotus squamatus	4.25	100.00	Galathea intermedia	11.58	100.00	Galathea intermedia	12.00	100.00
Nematoda spp. indet	4.17	75.00	Mediomastus fragilis	9.00	100.00	Mediomastus fragilis	9.57	100.00
Achelia echinata	3.75	100.00	Nucula nucleus	6.58	50.00	Nematoda spp. indet	9.52	100.00
Rissoa parva	3.33	75.00	Ophiopholis aculeata	6.25	100.00	Gibbula tumida	8.71	100.00
Juv. Harmothoe sp. Indet	2.33	75.00	Juv. Leptocheirus sp. indet	6.08	50.00	Juv. Harmothoe sp. Indet	7.00	100.00
Galathea intermedia	2.08	75.00	Amphipholis squamata	5.67	100.00	Polycirrus (norvegicus)	6.10	100.00

10	Mean A	% of sites	11	Mean A	% of sites	12	Mean A	% of sites
Pisidia longicornis	55.67	100.00	Leptocheirus hirsutimanus	27.50	50.00	Sabellaria spinulosa	6.00	100.00
Nematoda spp. indet	11.07	100.00	Chone filicaudata	6.00	50.00	Lanice conchilega	4.67	33.33
Mediomastus fragilis	7.40	80.00	Mediomastus fragilis	5.50	50.00	Mediomastus fragilis	3.33	66.67
Juv. Leptocheirus sp.	6.80	40.00	Amphipholis squamata	5.50	50.00	Leptocheirus hirsutimanus	2.00	33.33
Galathea intermedia	6.33	100.00	Spio armata	5.00	100.00	Spio armata	1.67	100.00
Spio armata	5.27	100.00	Polycirrus sp. Indet	4.50	100.00	Hiatella arctica	1.67	66.67
Ophiothrix fragilis	4.80	80.00	Phoronis	4.50	100.00	Galathea intermedia	1.33	100.00
Cheirocratus sp. Indet	4.60	100.00	Pomatoceros lamarcki	4.00	100.00	Pomatoceros lamarcki	1.33	66.67
Gibbula tumida	4.40	100.00	Typosyllis sp. A	3.00	100.00	Spisula solida	1.33	33.33

13	Mean A	% of sites
Protodorvillea kefersteinia	8.50	100.00
Glycera lapidum	2.00	100.00
Mediomastus fragilis	1.50	50.00
Nemertea	0.67	50.00
Eteone longa/flava	0.50	50.00
Microphthalmus sp. Indet	0.50	50.00
Sphaerosyllis hystrix	0.50	50.00
Nephtys cirrosa	0.50	50.00
Ophryotrocha gracilis	0.50	50.00

Table 2. Summary of dominant epifaunal taxa.

Taxa	% of sites	Taxa	% of sites
Crisia eburnea	84	Tubulipora sp.	41
Amathia lendigera	84	Beania mirabilis	41
Diphasia sp.	81	Lafoea dumosa	38
Flustra foliacea	78	Scrupocellaria sp.	38
Crisidia cornuta	75	Mytilus edulis	38
Scrupocellaria reptans	66	Verruca stroemia	34
Sertularia argentea	59	Balanus crenatus	34
Hymeniacidon perleve	56	Bicellariella ciliata	34
Electra pilosa	56	Escharella immersa	34
Necora puber	56	Cancer pagurus	34
Eupolymia sp.	53	Campanulariidae sp.	31
Celleporella hyalina	53	Obelia geniculata	31
Omalosecosa ramosus	50	Nolella sp.	31
Ascidiacea spp.	50	Bugula sp.	28
Pandalus montagui	50	Dendrodoa grossularia	28
Crisia aculeata	47	Echinus esculentus	28
Musculus discors	47	Hydrallmania falcata	25
Phaeostachys spinifera	44	Cyclostomata spp.	25
Liocarcinus holstatus	44	Alcyonidium mytili	25
Sertularella rugosa	41	Bowerbankia gracilis	25

3.3. Definition of Biotopes

Biotopes have been defined for the benthic samples based on the results of multivariate analysis summarised above and also from interpretation of ranked species abundance data for each site and video data where available. Biotope classifications are based on the 2004 Marine Habitat Classification (Connor *et al*. 2004). Biotope definitions are largely based on infaunal quantitative data with subsequent assessment of potential cobble or biogenic reef type based on visual observations from video footage. Given the lack of clear guidance on cobble reef definitions at present and the limited video surveys carried out to date (particularly in the wind farm site) the current assessment is considered a preliminary description of cobble habitats/biotopes to highlight potential areas of impact.

Figure 4 shows the biotopes derived for each sampling site whilst Figure 5 gives an overview of the area of biotopes in relation to habitat type. A number of biotopes are present in the area including coarse sediment biotopes such as SS.SCS.CCS.MedLumVen (*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel), SS.SCS.CCS.Pkef (*Protodorvillea kefersteini* and other polychaetes in impoverished circalittoral mixed gravelly sand) or occasionally SS.SCS.CCS.PomB (*Pomatoceros triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles). The majority of the area comprises of a mosaic of mixed sediments (including pebbles, cobbles and boulders) and a number of biotopes have been identified which may fall under the definition of cobble reef. In particular, much of the area has been tentatively classified as SS.SMx.CMx.FluHyd (*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment) which in some areas is combined with areas of *Sabellaria* biotopes such as SS.SBR.PoR.SspiMx (*Sabellaria spinulosa* on stable circalittoral mixed sediment) or SS.SBR.PoR.SalvMx (*Sabellaria alveolata* on variable salinity sublittoral mixed sediment) (although generally not in reef form). Some inshore habitats appear to have a somewhat more diverse epibiota which in some areas bear some resemblance to rocky biotopes such as CR.HCR.XFa.SpNemAdia (Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata). Selected photographs of these pebble/cobble habitats are given in Figures 6 to 9 with additional photographs in Appendices 1 to 3.

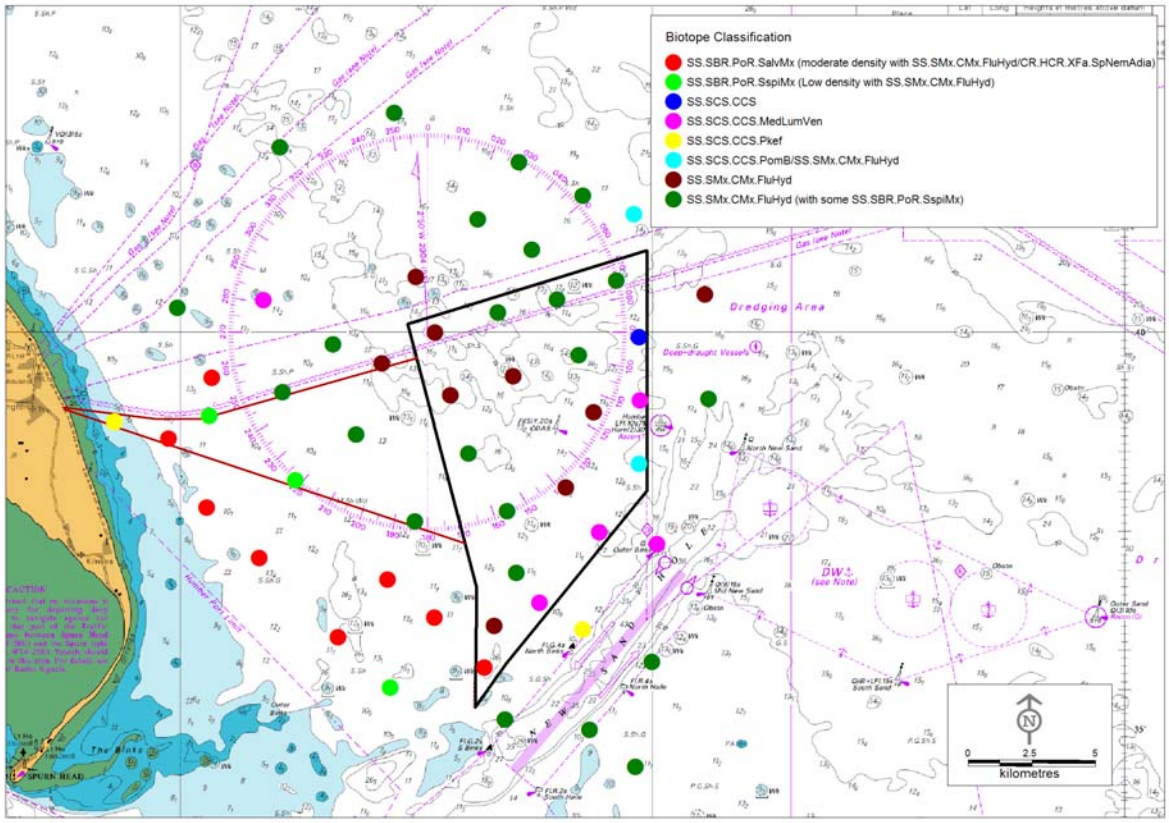

Figure 4. Map showing biotopes at benthic sampling sites.

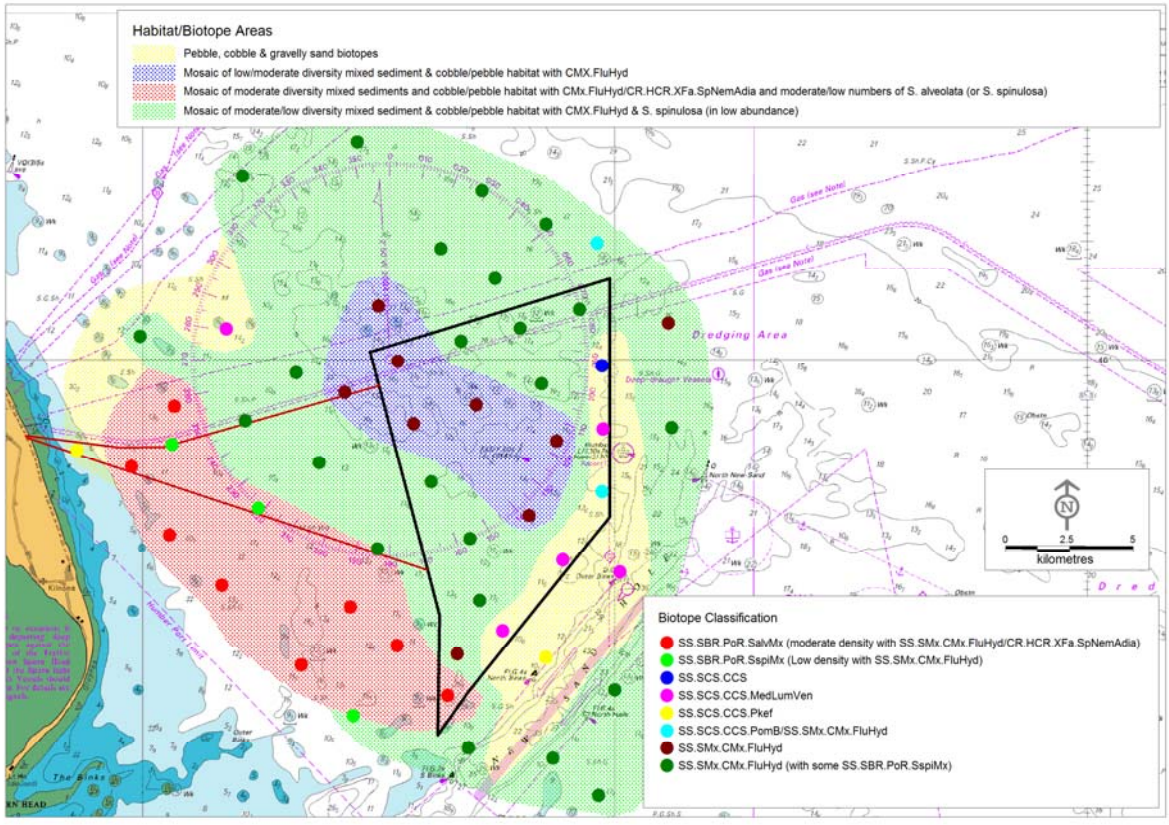

Figure 5. Map showing biotopes and habitats at benthic sampling sites.

Figure 6. Photographs of cobble habitats outside the wind farm site.

Figure 7. Pebble/cobble and mixed sediment habitats with *Sabellaria* spp.

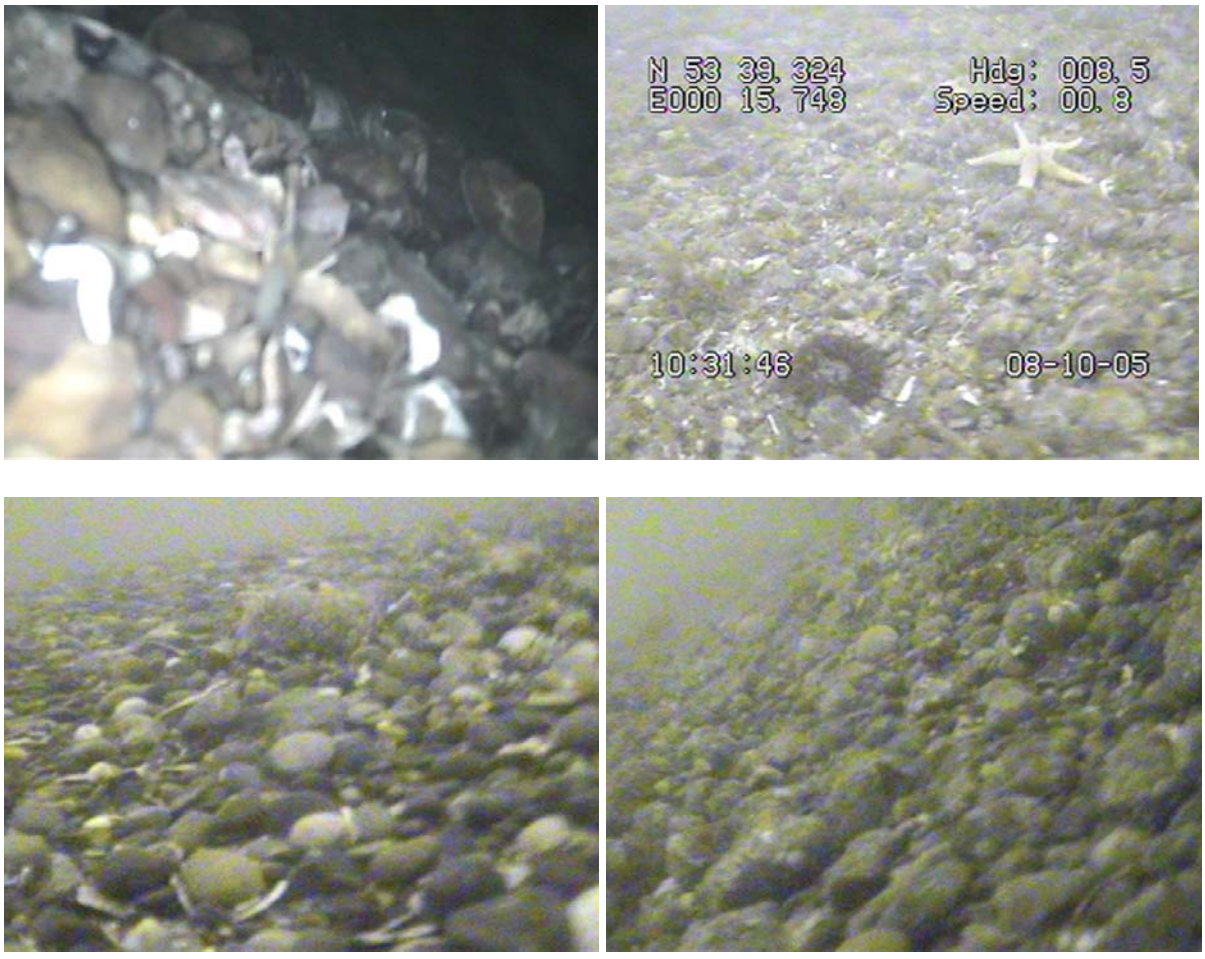

Figure 8. Pebble/cobble habitats inside the wind farm site.

4. ASSESSMENT OF COBBLE HABITATS & POTENTIAL IMPACTS

On the basis of the surveys carried out to date a range of biotopes have been defined for the wind farm area and these have subsequently been used to highlight areas of cobble habitat which could include areas of reef. The results of benthic sampling, video and geophysical surveys indicate that the majority of the area within and outside the wind farm site comprise of relatively coarse sediments comprising of stones, pebbles, cobble and boulder in mixed sands and gravels. Whilst information derived from particle size analysis only highlights a number of sites with a specific cobble content (>64mm) such data is likely to underestimate the proportion of cobble habitat in the area. Furthermore, sediment samples from almost all the sites have a significant pebble content which is likely to support similar communities to those found in cobble habitats. Video footage also indicates that the majority of the survey area contains a relatively high proportion of cobbles often with a range of encrusting fauna particularly hydroids and bryozoans.

Overall the area appears to be comprised of a mosaic of coarse or mixed sediment biotopes with a moderate to high pebble/cobble content which provides a suitable habitat for a varied epibiota. Inshore habitats (outside the wind farm) tend to be more heterogeneous with a slightly higher silt content and often form a mosaic of the encrusting form of the *Sabellaria* biotopes (*S. spinulosa* or *S. alveolata*) mixed with a relatively diverse pebble/cobble habitat in mixed sediment characterised by hydroids and bryozoans e.g. SS.SMx.CMx.FluHyd (*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment) or in some areas possibly CR.HCR.XFa.SpNemAdia (Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata). Whilst somewhat variable, the majority of the inshore area includes areas of cobble habitat and a number of sites within this area have been classified as biotopes which may be considered under the cobble reef definition (in addition to some areas of moderately well developed *Sabellaria*).

Further offshore within the wind farm site sediments are somewhat cleaner and comprise predominantly of pebbles and cobbles in sandy gravel with occasional areas of boulder. *Sabellaria spinulosa* is widespread (but in relatively low abundances) and the majority of wind farm site aside from the south eastern edge comprises of the mixed/coarse sediment biotope SS.SMx.CMx.FluHyd with a moderately diverse coverage of hydroids, bryozoans and a number of other encrusting species (e.g. barnacles and *Pomatoceros* spp.). As described for the inshore area the majority of the wind farm site may be considered a mosaic of mixed coarse sediments with sufficient cobble and pebble to qualify as a cobble habitat. As described above due to the relative lack of video footage within the wind farm site (and detailed guidance on cobble reef biotopes) definitions and classifications of potential cobble reef are tentative.

Based on the video surveys carried out to date it is evident that pebble/cobble habitat are widespread throughout the area. However, it is difficult to define precise boundaries for any areas which may be defined specifically as cobble reef or derive more detailed biotope maps from spot benthic samples and the limited video survey data (which was primarily aimed at defining the baseline benthic invertebrate communities and clarifying the status of *Sabellaria* in the area) particularly as only a selection of sites within the wind farm site had video footage.

However, the information obtained from the surveys carried out to date does allow a preliminary assessment of biotopes and identify areas of cobble habitat in which examples of reef may be present. The majority of the inshore area and wind farm site comprise of a mosaic of cobble habitats and mixed coarse sediments and the proposed wind farm is situated at the southern end of an extensive (and more diverse) area of cobble reef habitat which occurs north of the Humber extending some distance offshore and up the Holderness coast. On the basis of the data (and guidance available) it is doubtful that the whole wind farm area could be considered topographically distinct or that the cobble habitats within the wind farm will satisfy all the criteria to qualify as reef although as stated previously examples of reef may be present (particularly in the inshore area).

As stated above video surveys from adjacent areas of similar sediments off the Holderness coast (Allen in prep 2007) indicate a range of much more diverse cobble/pebble reef habitats with a rich and varied epibiota (see Figure 9). Some of these habitats are likely to be considered good examples of cobble reef whilst the cobble habitats in the wind farm site appear to be relatively impoverished, possibly due to the presence of the Humber plume which presumably has influenced the development of *Sabellaria* communities in this area. However, it is possible that areas within and adjacent to the Humber wind farm are examples of silt-influenced cobble reef systems and further video surveys will inform future characterisation of the area.

For the purpose of the current study, the available video footage has been used to assess whether the sea bed habitats at those sites surveyed may be considered as Annex 1 reef habitats. A summary of this information is provided in Table 3 which gives a preliminary assessment of the presence of cobble habitat and reef status for each of the sites surveyed by video. The status of the remaining sites with regard to Annex 1 reef habitats remains uncertain and will be addressed during future surveys. Habitats within the wind farm site appear to have sufficiently high cobble content to qualify as a cobble habitat although in many areas the seabed comprises of a relatively flat veneer of pebbles, stone and cobble on, or in, gravel and sand with relatively limited epibiota in comparison with the richer areas of cobble reef further up the Holderness coast. As such these are unlikely to be good examples of Annex 1 cobble reef and it is uncertain whether they could be considered topographically distinct. However, some sites which have a somewhat richer epibiota (primarily hydroid and bryozoan turf) may potentially be examples of silt influenced cobble reef. Outside the wind farm the seabed is somewhat more variable with some areas of larger cobble and boulder which often have quite diverse epibiota (although generally still somewhat impoverished in comparison with those further north) and some of these sites may qualify as either silt influenced cobble reef or *Sabellaria* reef (or form a mosaic of the two).

Table 3. Assessment of Annex 1 reef status.

INSIDE WINDFARM			
Site	**video**	**Cobble Habitat Present**	**Annex 1 Reef Status (preliminary assessment)**
16	No	?	?
21	No	?	?
23	No	?	?
24	Yes	YES	UNLIKELY (RELATIVELY LIMITED EPIBIOTA & PRIMARILY SMALL PEBBLES/COBBLES)
26	No	?	?
27	No	?	?
28	No	PROBABLE*	?
29	Yes	YES	POTENTIAL AREAS OF SILT INFLUENCED COBBLE REEF
32	Yes	YES	UNLIKELY (RELATIVELY LIMITED EPIBIOTA & PRIMARILY SMALL PEBBLES/COBBLES)
36	No	?	?
37	No	?	?
38	Yes	YES	UNLIKELY (RELATIVELY LIMITED EPIBIOTA & PRIMARILY SMALL PEBBLES/COBBLES)
40	No	?	?
42	No	?	?
43	Yes	YES	POTENTIAL AREAS OF SILT INFLUENCED COBBLE REEF
45	No	?	?
46	Yes	YES	? (BUT POTENTIAL AREAS OF SILT INFLUENCED COBBLE REEF)
47	No	?	?
48	No	?	?
OUTSIDE WINDFARM			
Site	**video**	**Cobble Habitat Present**	**Annex 1 Reef Status (preliminary assessment)**
1	No	?	?
2	No	?	?
3	No	?	?
4 #	No	?	NO
5	No	?	?
6 #	Yes	YES	NO (PATCHY LOW LEVEL SABELLARIA BIOTOPES)
7 #	Yes	YES	NO (PATCHY LOW LEVEL SABELLARIA BIOTOPES)
8	Yes	YES	YES - POTENTIAL AREAS OF SILT INFLUENCED COBBLE REEF
9 #	No	?	?
10	No	?	?
11	No	?	?
12	No	?	?
13	No	?	?
14	Yes	YES	YES - POTENTIAL SABELLARIA REEF
15 #	No	?	?
17	No	?	?
18	No	PROBABLE*	?
19 #	Yes	YES	YES - POTENTIAL AREAS OF SILT INFLUENCED COBBLE REEF
20	No	?	?
22	No	?	?
25	Yes	YES	YES - POTENTIAL SABELLARIA REEF OR SILT INFLUENCED COBBLE REEF
30 #	Yes	YES	UNCERTAIN BUT POTENTIAL AREAS OF SILT INFLUENCED COBBLE REEF
33	No	?	?
34	Yes	YES	UNCERTAIN BUT POTENTIAL AREAS OF SILT INFLUENCED COBBLE REEF
35	Yes	YES	UNCERTAIN BUT POTENTIAL AREAS OF SILT INFLUENCED COBBLE REEF
39	Yes	YES	?
41	No	?	?
44	No	?	?
49	No	?	?
50	No	?	NO
51	No	?	NO
52	Yes	YES	YES - POTENTIAL SABELLARIA REEF OR SILT INFLUENCED COBBLE REEF
53	No	?	?
54	No	?	?

* PSA data indicated presence of cobble. # Sites along possible cables routes

As the wind farm area exhibits naturally high suspended sediment loads (due to the Humber plume and transport of material down the Holderness coast) it is unlikely that construction impacts due to sediment disturbance are will be a significant issue. The main potential impact to the sublittoral biotopes and areas of cobble habitat would be from direct loss of the habitat during construction. Figure 10 shows the biotopes and different areas of cobble habitat with the turbine array and cable corridor overlain. Moderately rich areas of mixed sediment or pebble/cobble habitats and *Sabellaria alveolata* (and to a lesser extent *S. spinulosa*) are found inshore from the wind farm and these habitats will potentially be impacted from the placement, trenching and installation of the cables to the wind farm as they would traverse the inshore area where these habitats are located. Within the wind farm footprint, much of the area aside from the south eastern edge comprise of a mosaic of coarser mixed sediments and pebbles/cobbles (as highlighted by the geophysical surveys) although in the context of the wider area (and the Holderness coast) such habitats generally appear relatively impoverished.

It is acknowledged that the surveys carried out to date, whilst fit for purpose in terms of describing the baseline environment, are not necessarily the optimal techniques for surveying and classifying cobble reef habitats. The relative lack of video footage also limits the level of analysis and interpretation possible in terms of defining the full range and distribution of potential cobble reef biotopes although the data collected to date does allow a preliminary assessment of the distribution of cobble habitats with sites surveyed by video given a tentative Annex 1 reef classification. Further survey work is required to clarify the status of these habitats and it is emphasised that such work will be carried as appropriate and in agreement with the statutory bodies (JNCC and Natural England) and future guidance which may be forthcoming on the status of cobble reefs. As such, further survey (e.g. video and acoustic survey techniques) are planned prior to construction to define any areas of cobble reef by which time further guidelines on the status and definition of cobble may be available. Given that pre-construction surveys will also be required to assess the distribution of *Sabellaria* it is anticipated that a single pre-construction survey is carried out which will further define the distribution and status of both cobble reef and Sabellaria reef. Such an approach is beneficial given the overlap in the distribution of such habitats as it is likely that cobble reef and *Sabellaria* reef form a mosaic of habitats within the broader cobble habitat. Such an approach is likely to assist definitions of both reef habitats in the area and avoid replication of results and survey time. The results of this survey work (in conjunction with additional guidance from JNCC/Natural England) will clarify any areas of potential conservation importance (*Sabellaria* or cobble reef) and good examples of such habitats could then be avoided through micrositing of the turbine locations and microrouteing of the cable route. Such an approach should mitigate against significant disturbance or direct habitat loss to any extensive areas of reef.

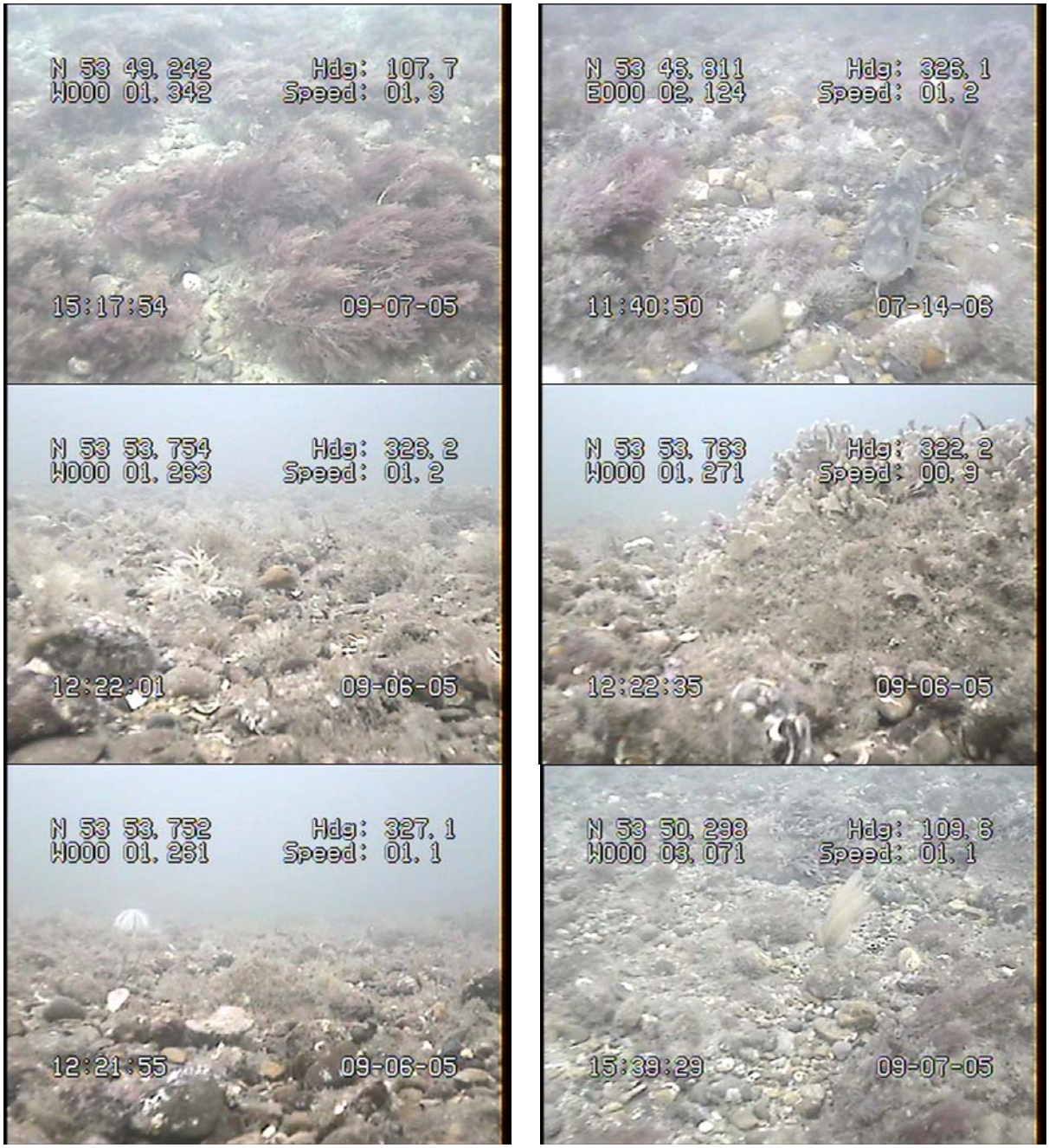

Figure 9. Examples of potential cobble reef along the Holderness coast (Allen in prep 2007).

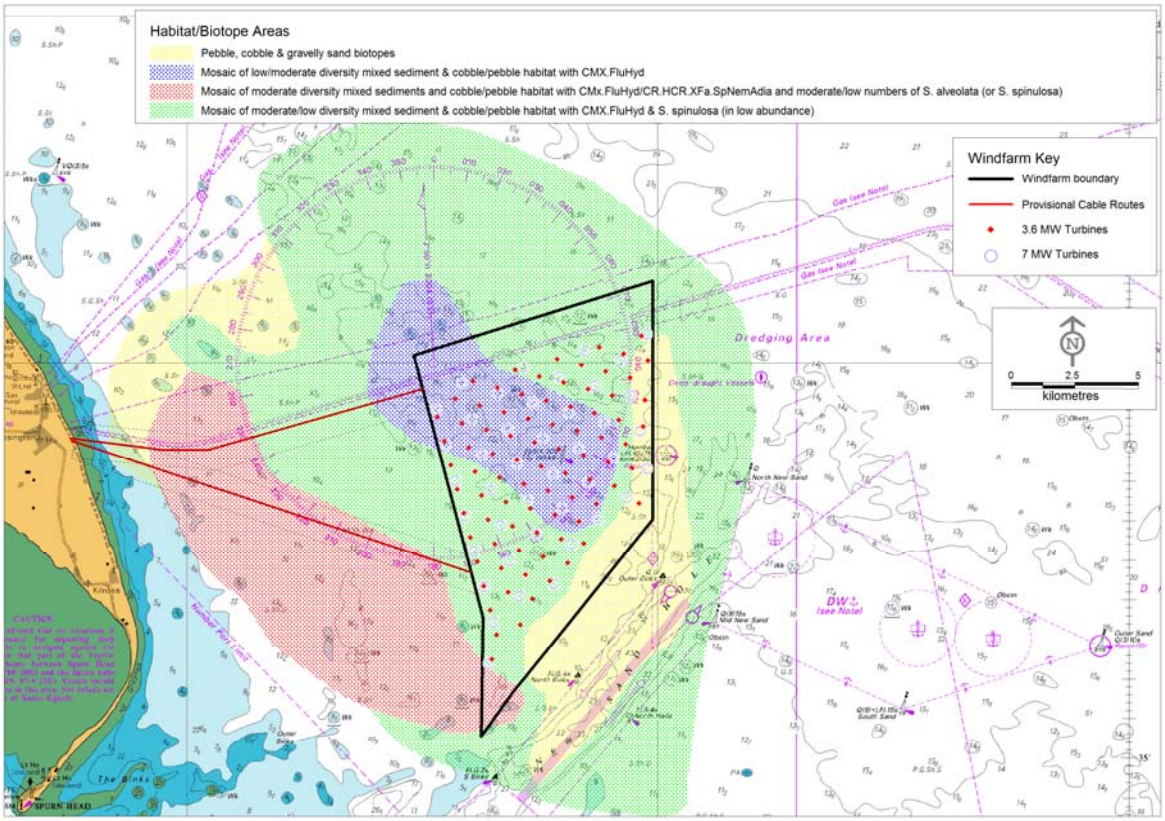

Figure 10. Biotopes and habitats with wind farm turbines and cable route corridors.

5. CONCLUSIONS

- A combination of geophysical, grab, trawl, AGDS and video surveys have been carried out in the area to assess seabed characteristics, associated biota and distribution of potential reef habitats (cobble or *Sabellaria* reef).

- The seabed is generally characterised by rough ground with a mixture of cobbles/pebbles and boulders on sand/gravel. However, particle size analysis of the sediment samples taken show relatively few sites with a cobble fraction although this approach is likely to severely underestimate the proportion of cobbles in the area (as evident from the video footage). The PSA data does indicate that the majority of sites have a high proportion of stones and pebbles.

- The definitions and characteristics of cobble reef habitats are currently in development which precludes against a definitive assessment of cobble reef status in the area.

- A range of biotopes have been identified from the benthic samples and video surveys. Much of the area comprises of a mosaic of mixed sediment biotopes and includes biotopes such as SS.SMx.CMx.FluHyd (or occasionally CR.HCR.XFa.SpNemAdia) which may fall under the definition of cobble reef. Within these areas are also examples of the *Sabellaria* biotopes although these tend to be in encrusting rather than reef form. However, the lack of video footage in some areas means that there may be additional biotopes (cobble reef or otherwise) within the area which have yet to be identified.

- Whilst cobble habitats cover much of the area it is uncertain whether the majority of these would qualify as Annex 1 reef habitats. However, certain sites (with a more diverse epibiota) have been tentatively classified as possible examples of *Sabellaria* or silt influenced cobble reef. Areas of cobble habitat are understood to be relatively widespread in this area but those within the wind farm are somewhat impoverished compared with similar habitats further north along the Holderness coast.

- The major potential impact to the species is considered to be habitat loss due to construction, particularly along the cable route where more diverse areas of cobble habitat and *Sabellaria* are evident.

- The surveys carried out to date are not optimal for defining cobble reef habitats and relatively little video work has been carried out to date within the wind farm. Further survey work will be carried out prior to construction to assess the distribution and status of cobble reef in more detail and identify any areas of high quality or pristine reef in order to mitigate against damage to any well established communities.

- Given the nature of the biogenic reefs in the area and their relative diversity in comparison with other adjacent areas of similar habitats, it is considered that following further survey work and successful microrouteing/micrositing of the cables/turbines, any direct impact to cobble reef habitats should be minimised to an acceptable level.

6. REFERENCES

Holt, T.J., Rees, E.I., Hawkins, S.J. & Seed, R. (1998). Volume IX. *Biogenic reefs: an overview of dynamic and sensitivity characteristics for conservation management of marine SACs*. Scottish Association for Marine Science (UK Marine SACs Project).

David W. Connor, James H. Allen, Neil Golding, Kerry l. Howell, Louise M. Lieberknecht, Kate O. Northen and Johnny B. Reker (2004). The Marine Habitat Classification for Britain and Ireland Version 04.05 JNCC, Peterborough. ISBN 1 861 07561 8 (internet version).

Gubbay, S. (2007). JNCC Report No. 405: Defining and managing Sabellaria spinulosa reefs: Report of an inter-agency workshop 1-2 May, 2007.

APPENDIX 1. VIDEO STILLS OUTSIDE THE WINDFARM SITE

6 West

8

8

14 West

8

14 West

8

14 West

14

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14

25

14 West

25 East

14 West

25 East

34

52 East

35

52 East

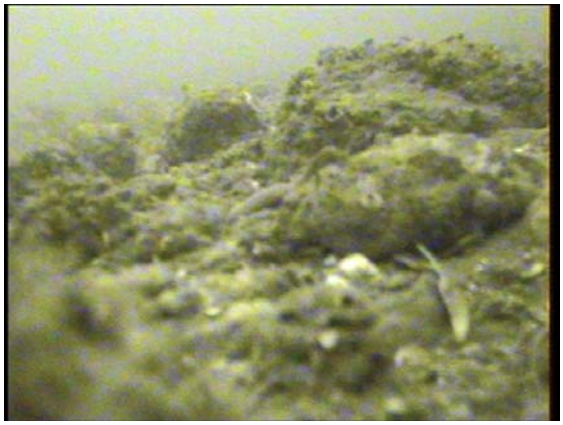
39 West

52 East

39 West

APPENDIX 2. VIDEO STILLS FROM SITES ALONG THE CABLE ROUTE

7 West



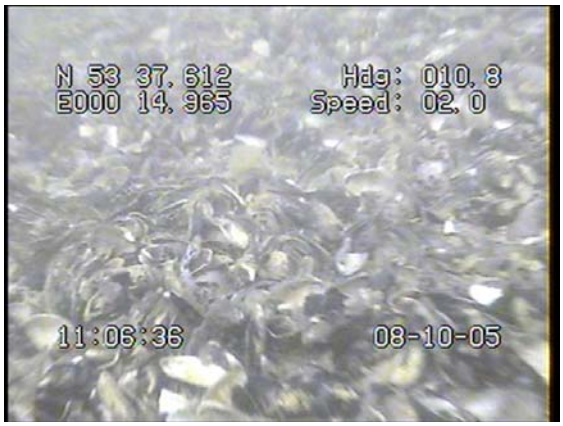
19 East

7 East

19 East

19 East

30



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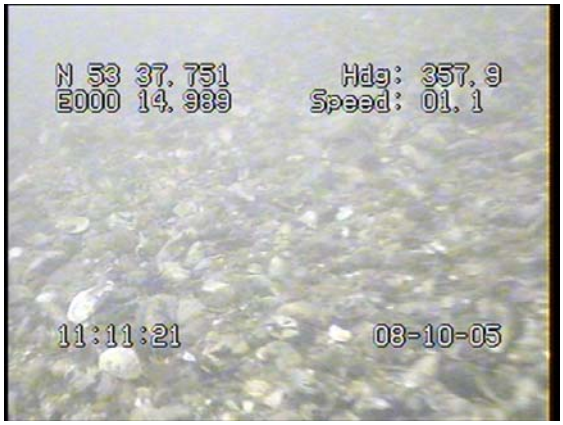

APPENDIX 3. VIDEO STILLS FROM INSIDE THE WIND FARM

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24 West

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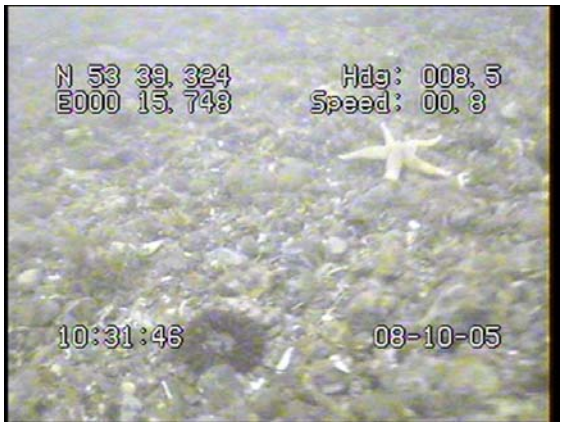

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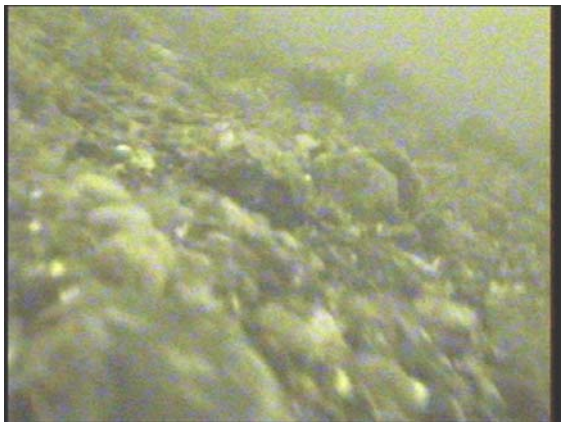
29 West



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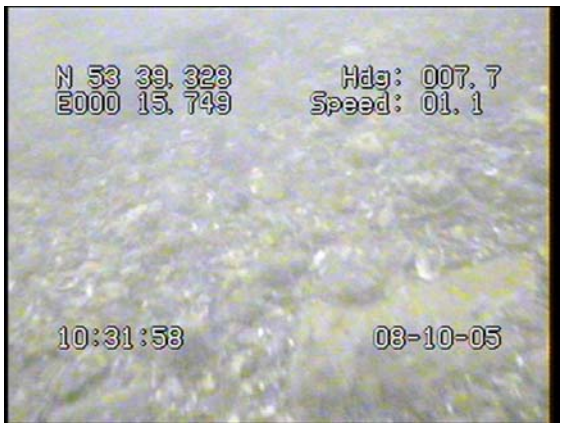

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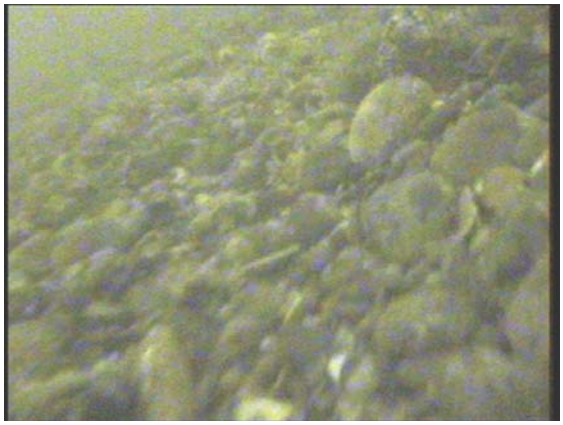
29 East



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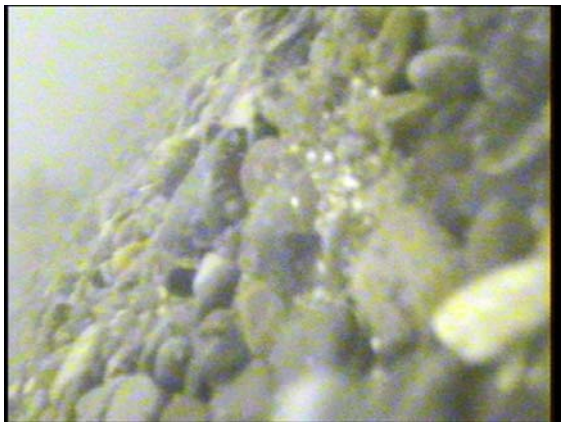
29 East

32 West



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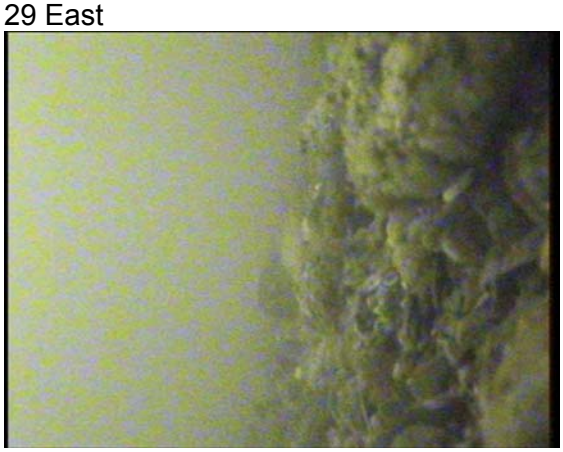

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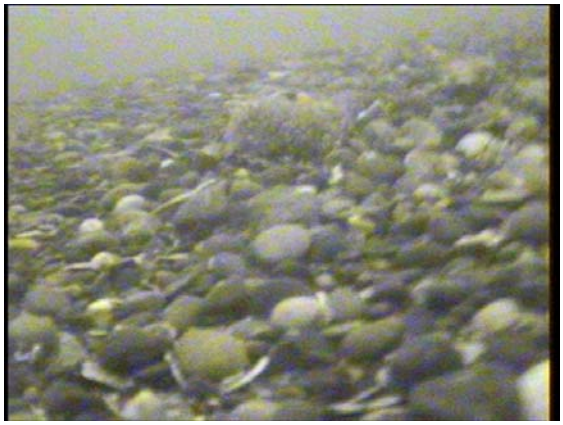

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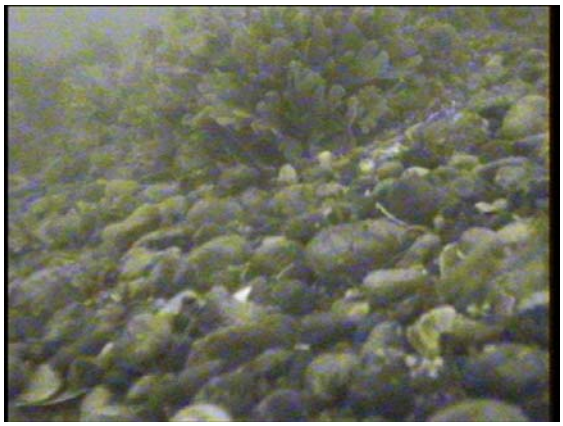

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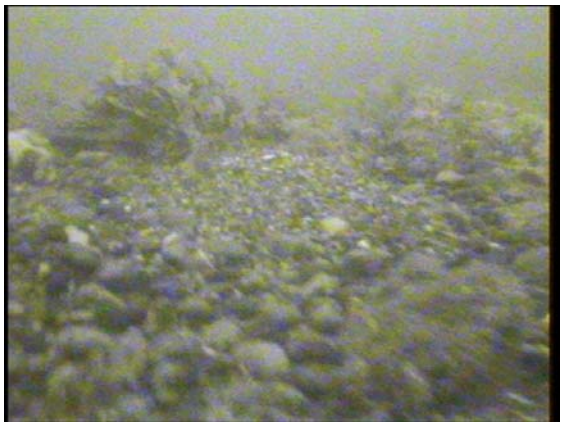

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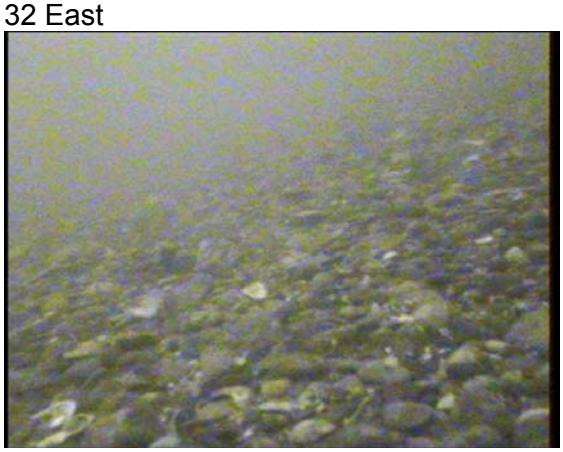

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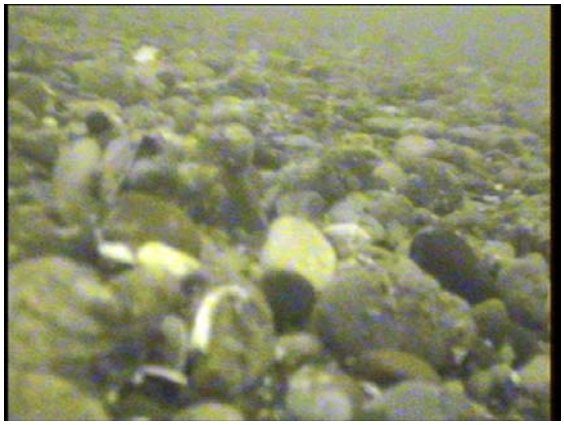

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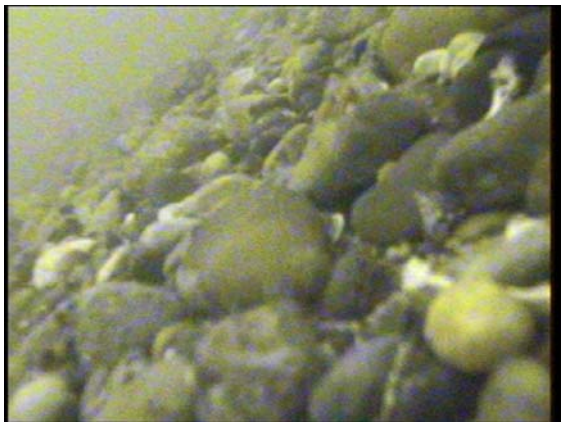

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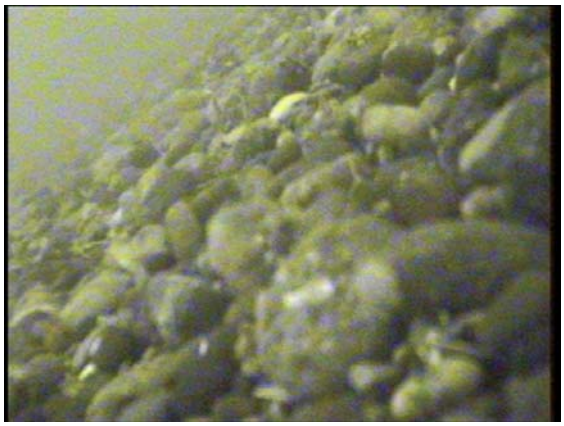

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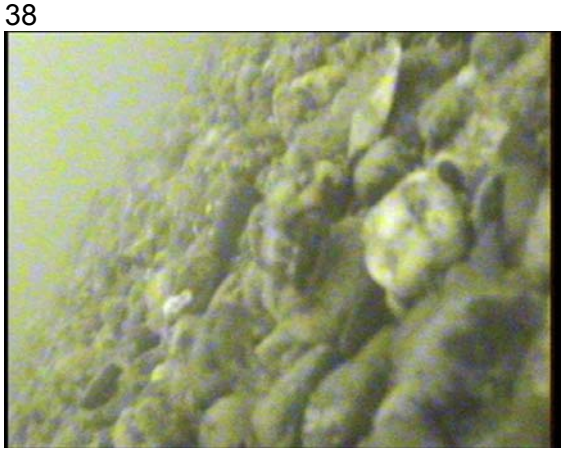

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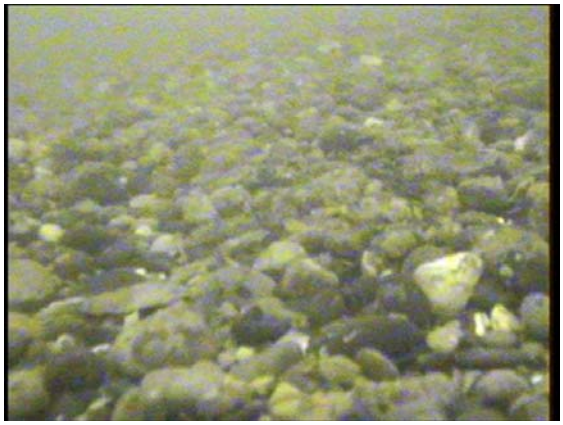
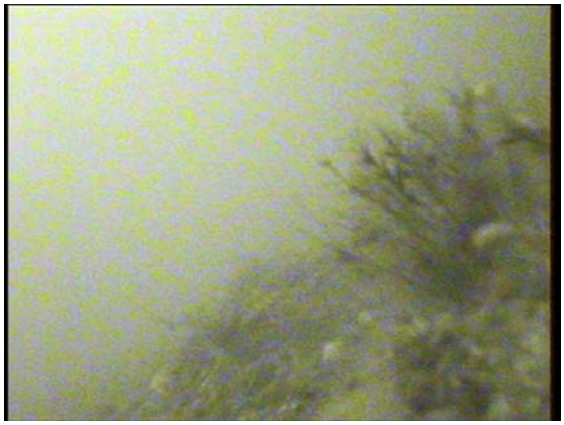


43 West



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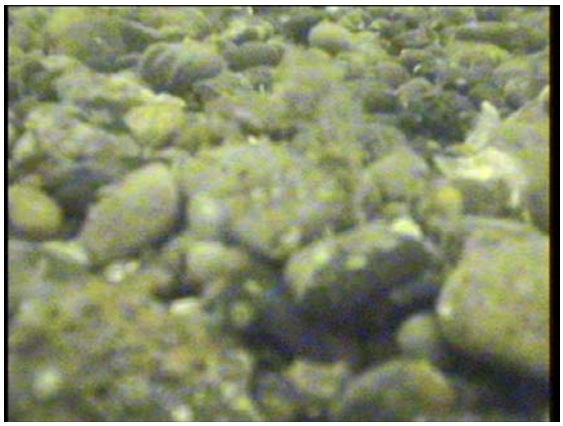

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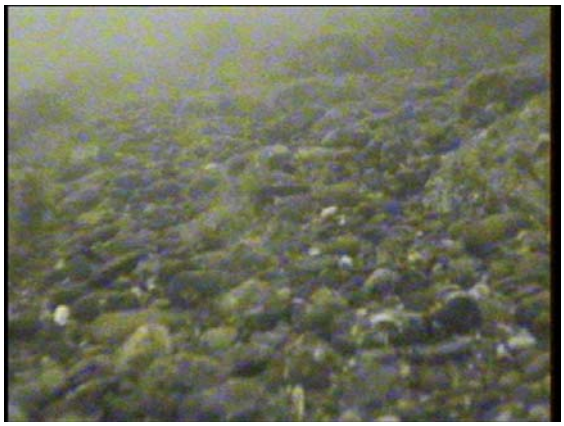

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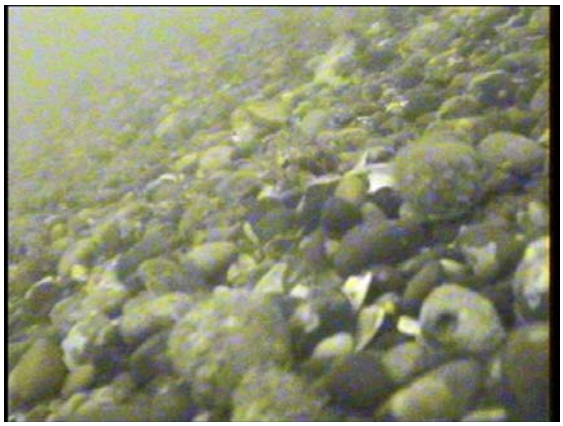

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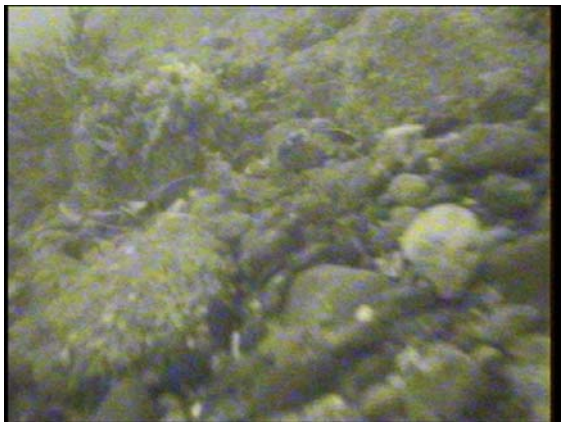

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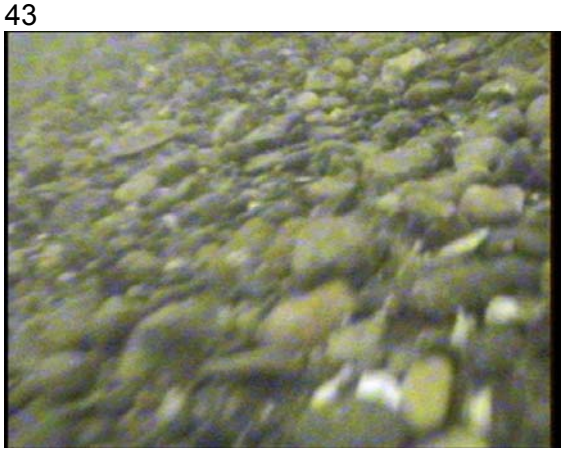

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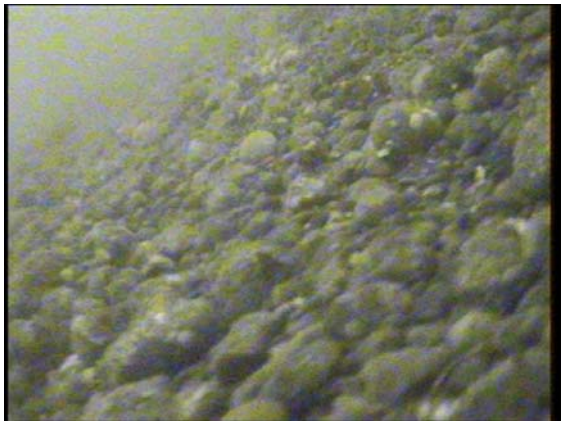
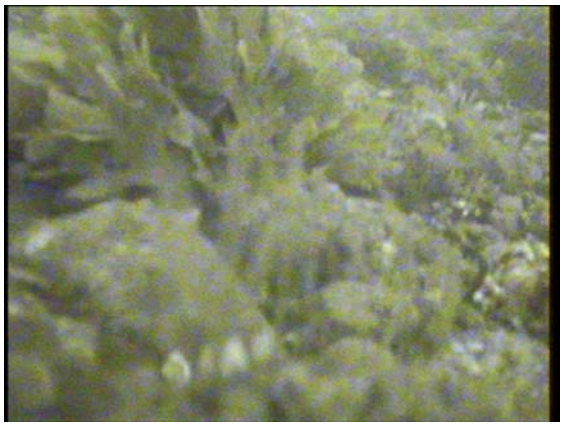


43 East

46

43 East



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