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Identification of marine habitats relevant to Special Areas of Conservation

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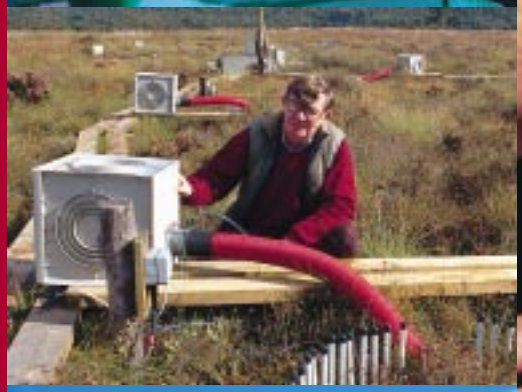

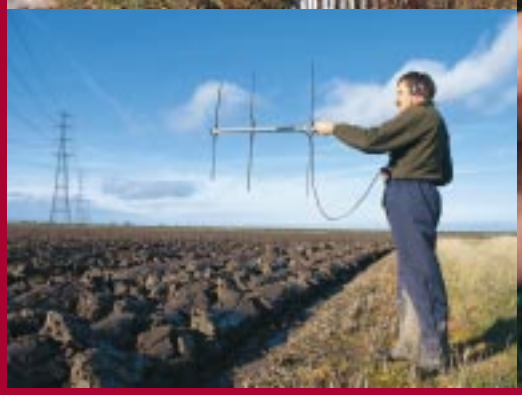

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English Nature Research Reports

Number 659

Identification of marine habitats relevant to Special Areas of Conservation

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1. Introduction

The 1992 Directive on the Conservation of natural habitats and of wild fauna and flora (92/43/EEC), more commonly known as the 'Habitats Directive' was implemented into UK law by the Conservation (Natural Habitats &c.) Regulations 1994 and the Conservation (Natural Habitats &c.) (Northern Ireland) Regulations 1995. One of the requirements of the Habitats Directive is the selection and subsequent designation of Special Areas of Conservation (SACs) for a range of habitats and species listed in Annexes I and II of the Directive respectively. Of the current SAC series in the seas around England, all sites are inshore and attached to the coast.

Implementation of the Habitats Directive was originally restricted to Territorial Waters within the UK. A court judgement in 1999 resulted in the UK being required to implement the Habitats Directive out to 200 nautical miles. The Joint Nature Conservation Committee have therefore been undertaking work (in close collaboration with the country conservation agencies) to identify possible SACs (and SPAs) in UK offshore waters between 12 and 200 nautical miles (referred to herein as the 'JNCC-led work'). Because of the relative lack of data on habitats and species within this area, this work necessitated different methods of SAC identification than those employed hitherto for inshore SACs. So far, broad scale geophysical seabed information has been used to identify the distribution of habitat, and available biological data collated to provide brief descriptions. This work is presented in Johnston and others (2002).

The new methods necessary for the identification of offshore SACs developed by JNCC and the country conservation agencies, and the availability of new seabed geological information for English waters, provided new evidence for the widespread existence of possible Annex I habitat. This has highlighted the potential gap in the SAC site series between the coast and 12 nautical miles. This gap was particularly evident for English Territorial Waters, where the seaward boundary of most of the existing SACs does not extend far out into the marine environment.

In view of this, and with the support of Defra, English Nature is working towards identifying possible additional SACs for certain marine habitats (Reef and Sandbanks) within English Territorial Waters, building on the methodology developed in the JNCC-led work and data they have collated. As a first step towards this English Nature commissioned the British Geological Survey (BGS) to produce a GIS and database of seabed habitats and features largely based on geological and sediment information held by the BGS (Poulton and others 2002).

In order to progress site identification further, English Nature commissioned BMT Cordah to take the maps derived from data provided by Poulton and others (2002) and refine and complete them, for English Territorial Waters[1]. The purpose of this was to show the distribution of relevant habitats, provide summary description of relevant biological information and also provide an accompanying GIS and collated dataset of geological and biological information. This report presents the findings of this project.

It should be noted that it is not intended that this work should directly result in any amendments to existing inshore SACs.

[1] The 12nm limit boundary and Territorial median lines applied in the maps were provided by DTI.

1.1 Aim and objectives

In order to facilitate English Nature's work dedicated to identifying, selecting and designating SACs in the offshore areas of English Territorial Waters, this work aimed to:

- validate the distribution of habitats derived from BGS data, amend and augment these with new information, at an appropriate scale(s);
- add information on relevant habitats not identified from the BGS data in the course of the data collation exercise;
- fill in significant spatial gaps not covered in the BGS data;
- produce a revised map showing known areas of Annex I habitat, including relevant target notes and text;
- collate biological information relevant to the habitats listed below and summarise this in brief descriptions of specific geographical areas or locations of habitat; and
- provide the findings of the study as a stand alone report and a useable GIS workspace with acquired data.

2. Habitats Directive Annex I habitats in England's inshore waters

Annex I of the Council directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (as amended by Directive 97/62/EC) lists those habitats of Community Interest whose conservation requires the designation of SACs. The Annex is split into groups and sub-groups of habitats. The only sub-groups to occur in the marine environment (below low water) are coastal and halophytic Habitats: open sea and tidal areas; and Rocky Habitats and Caves: other rocky habitats. The Interpretation Manual of European Habitats (HAB 96/2 Final – EN version 15/2 October 1999) aids the interpretation of the habitat types listed in Annex I. The habitats in the open sea and tidal areas sub-group are listed in Table 2.1.

Table 2.1 Marine habitats listed on Annex I of Council Directive 92/43/EEC as amended by Directive 97/62/Ec

EU code	Habitat name
Open sea and tidal areas	
1110	Sandbanks which are slightly covered by sea water all the time
1120	*Posidonia* beds
1130	Estuaries
1140	Mudflats and sandflats not covered by sea water at low tide
1150	Coastal lagoons
1160	Large shallow inlets and bays
1170	Reefs
1180	Submarine structures made by leaking gases
Other rocky habitats	
8330	Submerged or partially submerged sea caves

Estuaries, mudflats and sandflats not covered by seawater at low tide, large shallow inlets and bays, coastal lagoons and submerged seacaves all occur in nearshore waters and are therefore already represented by the existing suite of SACs. *Posidonia* beds are a Mediterranean habitat and do not occur in England waters. Structures made by leaking gases are not known to occur within 12nm of the shore. The remaining two habitats (reefs and sandbanks) are the only habitats that are know to occur further away from the shore. These habitats are the focus of this report and are considered further below.

2.1 Habitat definitions and interpretations

2.1.1 Sandbanks which are slightly covered by sea water all the time

Within the Interpretation Manual of European Union Habitats (European Commission 1999) sandbanks are defined as:

"Sublittoral sandbanks, permanently submerged. Water depth is seldom more than 20m below Chart Datum. Non-vegetated sandbanks or sandbanks with vegetation belonging to the *Zosteretum marinae* and *Cymodoceion nodosae*[2].

Plants: *Zostera marina* and free living species of the *Corallinaceae*[3].

Animals: Important wintering habitat for many bird species, in particular *Melanitta nigra*[4], but also *Gavia stellata* and *Gavia arctica*[5]. Resting places for seals. Invertebrate communities of sandy sublittoral (eg polychaetes)".

Further UK interpretation and clarification includes (from Johnston and others 2002):

Substratum: This habitat comprises a range of sandy sediments. In terms of Wentworth's classification it includes all types of sand (particle size range 0.0625mm to 2mm). In terms of Folk's classification used for BGS geological maps, this habitat may include all sands, sediments in the lower right quartile of the modified Folk scale triangle which equate to gravelly sands, muddy sands and sands (see Section 3.1.4).

Depth: To 20m depth contour (below chart datum).

Topography: This is variable but includes distinct banks (see below) which may arise from horizontal or sloping plains of sandy sediment. Where the areas of horizontal or sloping sandy habitat are associated with the banks, they are included within the Annex 1 type.

Size: no lower limit, subject to the sandbank being large enough to maintain its structure and function.

Sandbank types

For the purposes of this work, sandbanks have been categorised into four types (excluding intertidal sand flats), largely based on their morphology (from Poulton and others 2002).

[2] a species of seagrass.
[3] maerl.
[4] common scoter.
[5] red-throated and black throated divers respectively.

Linear Banks are elongated banks which can be up to tens of kilometres long and less than ten kilometres wide. They lie generally parallel or at a slight angle to peak tidal currents. They can be found in open seas but are also common in large estuaries such as the Thames Estuary.

Banner Banks are generally only a few kilometres in length with an elongated pear-shaped form (Dyer and Huntley 1999). They commonly lie in the lee of fixed obstacles such as headlands, islands, submerged rock shoals and gaps in rock ridges. They are sometimes paired on either side of the obstacle, with one larger than the other indicating a net direction of sand transport (Stride 1982). Banner banks may also occur in areas with rapid deepening of water away from the coast and are less evident off coasts with a low offshore slope (Dyer and Huntley 1999). Examples occur in the English Channel, Irish Sea and North Sea.

Sinuous Banks are 'S' or 'V' shaped sandbanks and are common off the Norfolk coast and in the southern North Sea. They are large scale features and may occur in extensive groups which can include linear banks. Good examples are Haisborough Bank and Winterton Shoal.

Other banks are irregular or formless and cannot be categorised.

JNCC-led offshore site identification work has identified the following:

- sandy mounds;
- three tidal current sandbank types; open shelf ridge, estuary mouth and headland associated; and
- examples that represent both 'active' and 'relict' banks as indicated by the presence and shape of sandwaves.

These types of sandbanks are encompassed in the definitions of Poulton and others (2002) as summarised above. For the purpose of this report, the definitions of Poulton and others (2002) have been used.

Shelving areas of sand have been included in the original maps (ie. Those produced by Poulton and others 2002). The differentiation between such areas of sandy seabed and definable sandbanks is often difficult, given the absence of a clear differentiation between the two and as typified by the latter category of sandbank highlighted above. The on-going development of what constitutes a sandbank in the context of the Habitats Directive reflects this difficulty as does the use of the term sandy mound by Johnston and others (2002). In this report therefore, those sandbanks that are well defined, and typically named on admiralty charts, have been the focus of specific text.

2.1.2 Reefs

The Interpretation Manual of European Habitats (European Commission 1999) defines reefs as:

"Submarine, or exposed at low tide, rocky substrates and biogenic concretions, which arise from the sea floor in the sublittoral zone but may extend into the littoral zone where there is uninterrupted zonation of plant and animal communities. These reefs generally support a

zonation of benthic communities of algae and animal species including concretions, encrustations and corallogenic concretions.

Plants: brown algae (species of the *Fucus, Laminaria* and *Cystoseira genus*, *Pilayella littoralis*), red algae (species of the Corallinaceae, Ceramiceae and Rhodomelaceae families), green algae. Other plant species: *Dictyota dichotoma*, *Padina pavonica*, *Halopteris scoparia*, *Laurenicia obtuse*, *Hypnea musciformis*, *Dasycladus claveformis*, *Acetabularia mediterranea*.

Animals: mussel beds (on rocky substrates) and invertebrate specialists of hard marine substrates (sponges, *Bryozoa andcirripedian Crustacea* for example)."

Further, UK interpretation and clarification includes (from Johnston and others 2002):

Substratum: Bedrock, boulders and cobbles (cobbles generally >64mm in diameter), including those composed of soft rock, such as chalk, biogenic concretions, ie aggregations of a species to form a hard substratum, thus enabling an epibiota community to develop. Biogenic reef-forming species include *Serpula vermicularis*, *Sabellaria* spp.[6], *Lophelia pertusa*[7], *Mytilus edulis* and *Modiolus modiolus*[8].

Depth: no depth limit.

Topography: A variety of topographic features in the subtidal zone, including vertical rock walls, horizontal ledges, overhangs, broken rock and boulder and cobble fields. Caves and cave-like features are treated separately in Annex 1. Rocky structures that are covered by a thin and mobile veneer of sediment are classed as reefs if the associated biota are dependent on the rock rather than the overlying sediment.

Size: no lower limit, subject to the reef being large enough to maintain its structure and function. Note that some biogenic reefs are inherently patchy and may contain relatively small colonies of, for example, *Serpula*.

Reef types

Bedrock includes areas of hard substrate not substantially covered by sediment. Outcrops of bedrock possess a variety of associated landforms that include vertical rock walls, ledges, overhangs, gullies and flat bedrock.

Stony Reef is considered to apply to areas of seabed where the substrate consists predominantly of particles of cobble size or greater. Iceberg ploughmarks are included in this category (see Johnston and others 2002).

Biogenic Reefs are those formed by the dense aggregation of some species that in so doing create a distinguishable habitat that is colonised by additional, and often characteristic species assemblages that in the absence of the reef-building species would not otherwise be present.

[6] tube-dwelling polychaetes.
[7] a coral.
[8] bivalve molluscs (mussels).

3. Information on Annex I habitats in England's Territorial Waters

3.1 Habitat identification

3.1.1 Scope of the study and report

This report has the spatial coverage of English Territorial Waters, from mean low water to the 12 nautical mile (nm) limit[9], as shown in Figure A (Appendix 2) With respect to sandbanks, the limit of interest extends to only 20m depth[10], except where a part of the sandbank continues into deeper water. Where areas of potential interest, for example a sandbank, extend beyond English Territorial Waters for example into Welsh Territorial Waters, Scottish Territorial Waters or beyond the 12nm limit, they too have been included in the assessment.

In addition, the intention was not to revisit the established series of SACs along the coast. Therefore the emphasis of the study was to help identify sites not connected to the coast. As such it excludes marine inlets, existing designated areas and intertidal areas.

In identifying Annex 1 habitats, English Nature will be required to take into account variations in, for example; substrate type, biogeographic location and prevailing physical regime (salinity, wave and tidal exposure, bathymetry etc). These factors have been considered in the habitat descriptions in the subsequent sections of this report.

For each of the Annex 1 habitats, concise definitions have been developed as to their character, representative fauna and flora, their physical features and depth distribution. For the habitats considered to be potentially present in English Territorial Waters, these definitions are provided below along with additional explanation as required.

3.1.2 Data acquisition and mapping

To achieve the objectives detailed in section 1.1, it was necessary to source data from a wide range of potential data holders. Where formats allowed (ie spatially referenced electronic data), the sourced data would be collated in a GIS environment, such that the original maps were populated with benthic biological and sediment characterising data. This data search included contact with the following sectors:

- government and non-government organisations;
- marine aggregates;
- offshore windfarms;
- water supply;
- oil and gas;
- cables and telecommunications;
- academia;
- environmental consultancies; and
- environmental record centres.

[9] The 12nm limit boundary and Territorial median lines applied in the maps were provided by DTI.
[10] © Metoc plc. Data licence 112002/004. All rights reserved.

The primary focus of the data searching was to populate the project GIS. Reference was made to reports and papers with inclusion of at least one spatial reference from the reported work entered manually where practical. A list of biotope names referred to in the report is collated in Appendix 3.

3.1.3 Data description

The acquired data were used to 'ground-truth' the mapped areas derived from the data provided by Poulton and others (2002) and to offer information for those areas that had no data. This was achieved by categorising the seabed type of each data record using the scheme Poulton and others (2002) had developed as illustrated in Appendix 1. Each data point was categorised and then 'tagged' using this colour coded series of symbols. Tagged data are presented on regional maps derived from original maps provided by English Nature at the onset of this project[11] (Appendix 2, Figures B – F). These maps are re-presented highlighting areas of modification that have been made as a consequence of this project and without the tagged data (See Appendix 2 CD-rom, Figures G – K). Tagged data are included on maps detailing the findings of this study and refinement of the mapped areas (Appendix 2 CD-Rom, Figures 1 to 59).

3.1.4 Seabed features classification

The work of Poulton and others (2002) discriminated the distribution of hard substrates from soft and, for the latter, applied an ecologically relevant Folk scale of classification for sediment character (Appendix 1). The Folk classification defines sediment type by grain size and also categorizes the relative mixes of sediments types. The ecologically relevant modification to the Folk scale has resulted in a simplification of the classification but now provides a level of sediment type discrimination consistent with ecological significance.

For hard substrata, there remained the need to further characterise substrate types and differentiate between bedrock and stony reef (areas of boulder and cobble). The occurrence of biogenically developed reefs was also mapped where data allowed. This work was used to produce a series of maps (Appendix 2) showing the sediment characteristics of English Territorial Waters relevant to the task of identifying SAC habitat.

All of these habitat types have been assigned a coloured symbol, to visually characterise data points on the habitat maps contained in Appendix 3.

After mapping, data points were interrogated systematically and descriptive text developed that summarises the sedimentological and biological attributes of each area and, where possible, each discrete habitat feature. This was carried out in conjunction with other reviewed literature that lacked detailed spatial information. Where sufficiency of data has allowed, conclusions have been drawn as to the presence of notable areas of seabed features and habitats of interest.

[11] Based upon BGS 1:250000 seabed sediment maps by permission of the British Geological Survey © NERC. All rights reserved (IPR/37-32c).

4. Sandbanks which are slightly covered by sea water all the time

The following subsections describe the sandy sediments and sandbank features and their biota for each Marine Natural Area. Each Marine Natural Area is subdivided to facilitate presentation of the data. The sub-areas follow those illustrated in Figure A (Appendix 2).

4.1 Mid North Sea

For the purpose of this report, the Mid North Sea Marine Natural Area has been divided into:

- Northumberland to the Tees
- The Tees to Flamborough Head

Figure B (Appendix 2) and Figures 52-61 (Appendix 2 CD-rom) show the area under discussion in this section, including: relevant habitats illustrated by maps derived from data provided by Poulton and others (2002), the tagged data points acquired for this project and the sub-area boundaries.

All places mentioned in subsections 4.1.1 – 4.1.3 are shown in Figure 1.

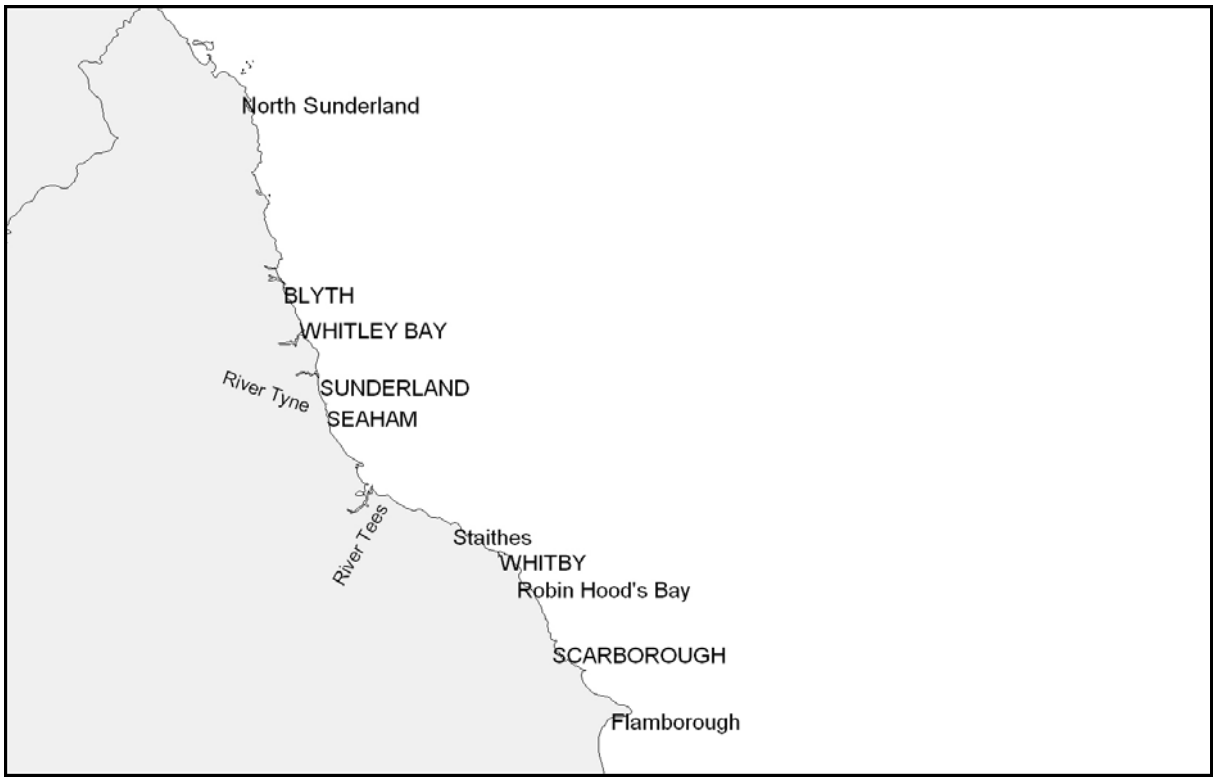

Figure 1 Map of places mentioned in the Mid North Sea text in sections 4 and 5.

4.1.1 Northumberland to the Tees

Coarser sediments, including gravelly sand, sandy gravel, gravel and diamicton (glacial sediments), are found off the coast of Northumbria (Cameron and others 1992). Areas of sand, consisting of variable types (including gravelly sand and muddy sand), run along the coast from Whitby to Sunderland, extending over an area of approximately 86 km^2. In general, MNCR records, particularly off the coast of Redcar, indicate a medium fine to very fine sand supporting *Fabulina fabula* and *Magelona johnstoni*. This does not agree with BGS's discrimination of sand and muddy sand areas in this locality. These data extend the sandy area further inshore than maps derived from data provided by Poulton and others (2002). A small gravel patch is located 7 km east of Beacon Point and a single data point indicates the presence of *Mysella* sp. (**SS.SMX.CMX.novoMysMX**). Further north a narrow area of sandy sediment runs along the coast between South Shields and Blyth extending over an area of 24 km^2.

Buchanan and Moore (1986) report the presence of a benthos belonging to Petersen's 'deeper outside edge of the *Amphiura filiformis* community' dominated by *A. filiformis* located at a sampling station 6.5 km off the Northumberland coast.

One kilometre directly southeast of Beacon Point MNCR records indicate the occurrence of rippled sand supporting *Ensis* sp., *Asterias rubens*, *Liocarcinus* spp. and *Goneplax rhomboides*. Whilst off Whitley Bay, acquired data was insufficient to refine the area of muddy sand identified to be present.

Sandy substrata stretches along the coast from the village of Lynemouth into the Berwickshire and North Northumberland coast SAC, however, it does not appear to be representative of sandbank features. Maps derived from Poulton and others (2002) indicate the presence of sand and slightly gravelly muddy sand south of the SAC. MNCR records indicate the presence of sand and fine muddy sand supporting *Fabulina fabula* and *Magelona johnstoni* but do not strongly correlate with the differentiated sand and muddy sand patches.

4.1.2 The Tees to Flamborough Head

BGS data indicates the presence of two ribbon-shaped sandy sediments between Flamborough Head and Scarborough, covering an area of just 22.5 km^2. Neither area is believed to represent shallow sandbanks. MNCR data for the most southerly sandy sediment indicates the presence of a medium to coarse rippled sand supporting *Lanice conchilega*. MNCR records for the north of this area indicate the predominance of muddy sand supporting molluscs such as *Abra alba*, *Nucula nitida* and *Corbula gibba*. Similar sediment type and species occur directly north of here. MNCR hold records for the eastern edge of the sandy sediment that identify further areas of compacted fine sand characterised by *Fabulina fabula*, *Lanice conchilega* and *Magelona johnstoni*. These data suggest that sandy sediment areas extend further into the coast and that they are probably contiguous.

Offshore from Robin Hood's Bay grain-size generally decreases with muddy sediment patches occurring in deeper waters (Jago 1981). Collated data for the shallow water soft sediments along this coastline suggest the rippled sandy sediment supports species such as *Lanice conchilega, Ensis* spp., *Asterias rubens* and *Corystes cassivelaunus* and where muddier, *Abra alba* has also been recorded

Just 5 km east of Staithes, BGS have established the presence of a patch of gravel covering just 0.28 km^2. Records indicate the presence of medium to very fine sand 7 km northeast of Staithes supporting species such as *Abra alba*, *Fabulina fabula* and *Nucula nitida*. An offshore bank has been identified by Poulton and others (2002), but no further information is available concerning either its geology or biology.

4.1.3 Mid North Sea summary

To the north of Flamborough Head, more data is available for the narrow band of shallow water than sourced for the preceding area. These data show a variable pattern of sediment type (and the frequent occurrence of reef). Sand areas are typified by the presence of *Lanice conchilega, Magelona johnstoni, Fabulina fabula* and *Ensis* spp. where it is relatively free of mud. Where it becomes muddier, *Abra alba*, *Mysella bidentata* and *Nucula nitidosa* are found. In the Scarborough and Redcar areas, sufficient data is available to justify the shoreward extension of the mapped sandy areas. A sandbank feature was noted off the coast of Whitby. Unfortunately no further data have been sourced for this site.

4.2 Southern North Sea

For the purpose of this report, the Southern North Sea Marine Natural Area has been divided into:

- Flamborough Head to North Norfolk
- South Norfolk and Suffolk
- Thames Estuary (including Essex)

Figure C (Appendix 2) and Figures 36-51 (Appendix 2 CD-rom) show the area under discussion in this section, including relevant habitat maps derived from data provided by Poulton and others (2002).

Both The Wash and The Humber are excluded as they are already SACs.

Poulton and others (2002) summarises the sandbank types and describes the Norfolk Banks which are characterised as linear and sub-parallel to the existing coastline. Reference is also made to shore-connected banks to the southern part of this group (at the southern Norfolk and Suffolk coast). The presence of isolated individual banks are also noted.

All places and sandbanks mentioned in subsections 4.2.1 – 4.2.4 are shown in Figure 2.

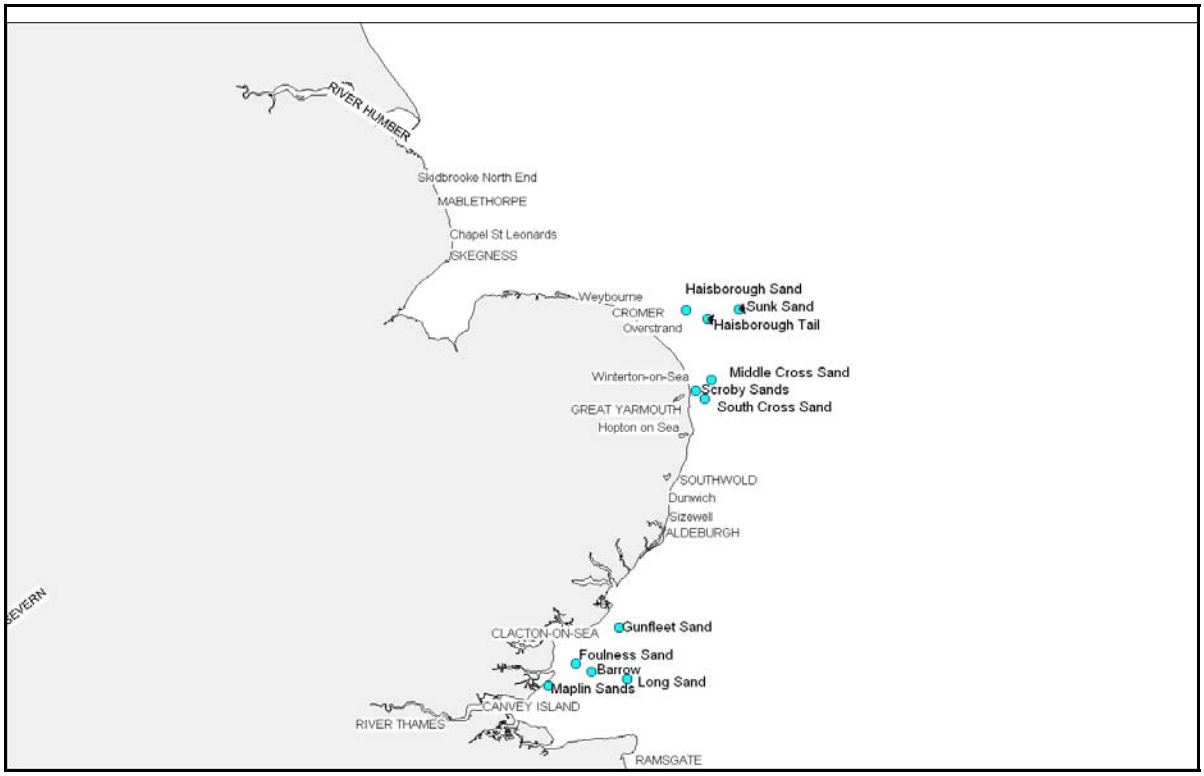

Figure 2 Map of places and sandbanks mentioned in the Southern North Sea text in sections 4 and 5.

4.2.1 Flamborough Head to North Norfolk

Gravelly sands are widespread throughout the area as can be seen from the BGS data, but despite strong tidal currents they are not generally transported any significant distance. Thin gravel sheets over sand deposits in higher seabed stress areas off or near the Norfolk coast prevent significant transport. Gravels are predominately flint but with variable components with increasing quartz and quartzite areas towards the north (Cameron and others 1992).

Maps derived from data provided by Poulton and others (2002) identifies a stretch of sandy sediment, encompassing the linear sandbanks of South Cross Sand, Scroby Sand and Middle Cross Sand, running parallel to the coast between the villages of Hopton and Winterton-on-Sea to the North of Great Yarmouth, which becomes more fragmented moving away from the coast. Scroby Sands has been noted to be subject to changes in its shape but lacks an overall direction of bank migration (Posford Duvivier 1997).

Offshore from the coast between Winterton-on-Sea and Cromer narrow ribbon-shaped sandy sediments appear to stretch approximately 38 km out to sea loosely running northeast/west direction. This series of sinuous sandbanks is referred to as Haisborough Sand (and Tail), Hewitt Ridges and Smith's Knoll. It is thought these sandbanks will in time probably split into a series of offshore linear ridges (Johnston and others 2002). The subsurface geology of these sandbanks consists of Norwich Crag which comprises of shell, sand and gravel. Chalk also occurs beneath the northwest region of Haisborough Sand. Sand banks in the region are formed of sand 20 m thick (Evans and others 1998). Between Great Yarmouth and Flamborough head, the Norfolk sandy mounds, have an underlying sediment that is comprised of till or clay. The thickness of the surface layer of sand is considered to be

variable, ranging from 40 m off the north Norfolk Coast, to as little as 1m further north (Barne and others 1995, Graham and others 2001). Fauna of these banks is characterised by the occurrence of the bivalve *Fabulina fabula* and the burrowing sea urchin *Echinocardium cordatum* and perhaps also *Lanice conchilega* and *Owenia fusiformis* (DTI 2001 2002). Some sampling has been carried out of the offshore banks (DTI 2001) but the samples, at least for within English Territorial Waters have not been processed (Q. Huggett, Geotek, *pers. comm*.) and cannot be included here. No other data has been sourced for these sandbanks

The Barne and others (1995) report describes the Pleistocene geology of the area north east of Norfolk to comprise of Upper Pleistocene lacustrine sand and mud along with Lower Pleistocene deltaic sediments. East of Norfolk, early Pleistocene shelly grey marine sands with silt parings, grey-marine clays and fine-grained sands occur. The solid geology of this offshore region, buried under sediments and drift, comprises of Upper Cretaceous fine-grained limestones with sandstone and mudstone occurring east of Norfolk.

As noted for the preceding section, there is very limited data for the shallow sandbank areas along this stretch of English Territorial Waters. Similar to the two preceding sub-areas, the bulk of the data has been provided by the offshore windfarm developers.

Of these sandbanks, only Scroby Sands, a shallow water mobile bank situated 2 – 4 km offshore of Great Yarmouth, has been described with respect to its fauna. A benthic survey carried out for the proposed offshore windfarm (PowerGen Renewables Offshore Wind Ltd 2001) was observed to support two main faunal groupings. *Bathyporeia elegans/Spiophanes bombyx,* a fairly rich species assemblage associated with fine clean sand and *Bathyporeia pelagica/Urothoe brevicornis/Ophelia borealis* associated with a more clean, medium and mobile sand.

Marine sediments sampled between inshore waters and 12 km off the Cromer coast (N. Norfolk) were predominantly coarse comprising a mix of cobble, gravel, sand and shell with some mud characterised by the numerically dominant *Sabellaria spinulosa* and *Lanice conchilega* (LPC Norfolk Offshore Wind 2002).

The Cross Sands aggregate area, located approximately 10 km off Great Yarmouth comprises poorly sorted sandy gravel and gravelly sands. Characterising species identified included polychaetes *Ophelia borealis*, *Nephtys cirrosa* (and other Nephtyidae); species indicative of the presence of gravels such as the bryozoa *Conopeum reticulum*, *Electra monostachys*, anthozoan species and hydroids; and species indicative of relatively stable substrata affected by mobile sediments such as the Ross worm *Sabellaria spinulosa* and the bryozoan *Flustra foliacea* (recorded in the trawl samples) (Emu Environmental Ltd 2002b). Though these observations refer to an area of sandy sediment in water depths in excess of 20 m, in the absence of other biological description, they might also represent species in shallower water. In the Western Docking Shoal (and encompassing Gravel Production Licence Area 107), located approximately 18 km east of Skegness, sediments comprise areas of sand with prominent sandwaves, gravelly sand and patchy rippled sand sheet. Characteristic fauna in areas comprising mobile sand include *Spio* and *Nephtys* spp., while areas of more stable sand supported sea squirts, barnacles, branching hydroids, bryozoans and tube dwelling polychaetes including *Sabellaria spinulosa* (RMC Marine 1995). The occurrence of the latter species is discussed further in Section 4.2.1. To the North of Skegness and on average 13 km out from the coast between the small town of Chapel St. Leonard's and the village of

Skidbrooke North End, Lincolnshire, numerous MNCR records indicate the predominance of coarse gravelly sand with patches of sand, muddy sand, shell debris, shingle supporting *Protodorvillea kefersteini*, *Polydora* spp. and occasional *Sabellaria spinulosa* (**SS.SCS.IGVSA.novoPkerMX**). This area represents a southern extension to a large gravel area, for which there is limited data.

At the mouth of the Humber Estuary, BGS data indicates that there is sandy sediment encompassing the Bull Sand, The Outer Banks and Haile Sand Flat banner banks while extending over an area of approximately 100 km^2. Records point to the presence of cobbles with sand and fine gravel in the southeast corner (OPRU 1987). BGS data also indicates the presence of two patches of gravel just 0.5 km north of the sandy sediment covering a total area of 7 km^2. Meanwhile some 6 km east of the sandy sediment a large area of gravel occupies 452 km^2 extending beyond the Territorial Waters. Limited MNCR records suggest a muddy gravelly seabed supporting *Polydora* sp. and *Sabellaria spinulosa* though no records strongly indicate the presence of a biogenic reef. Murray and others 1980 reports the gravelly substrates found in the area were not suitable to quantitative grab sampling.

Offshore from the Humber, sediments are predominantly sandy gravel (overall range: sand to gravel). Characteristic species found in sand included *Scoloplos armiger*, *Ophelia limacina* and *Nephtys cirrosa* and in gravel included *Balanus crenatus, Pomatoceros* sp. and *Pisidia longicornis*. *Sabellaria spinulosa* was present in many of the sandy gravel/gravel samples but not abundant or in reef-like conditions (Watson and Cooper 1994).

From north of the Humber to Flamborough Head 11 individual patches of gravel have been identified by BGS data covering a total area of just over 42 km^2. However, no further data can with any certainty be assigned to these small patches. Three individual sandy sediments have been detected along the same stretch of coast occupying a total area of 14 km^2 according to maps derived from data provided by Poulton and others (2002). Again no data is presently available that can provide biological or sediment data for these areas.

4.2.2 South Norfolk and Suffolk

Off the Suffolk coast Barne and others (1998) describes a quite shelly gravel with whole shells and shell fragments potentially making up to 30% of the gravel sediment. The report also indicates underlying sandbank bedrock consisting of Pliocene crag deposits of bioclastic limestones and shelly sandstones. Pleistocene geology associated with this region, described in Barne and others (1998), consists of early Pleistocene deposits such as shelly grey marine sands together with a thin silt covering of the Red Crag Formation, along with grey marine clays and fine-grained sands of the Westkapelle Ground Formation. Early to Middle Pleistocene deposits of the Great Yarmouth Formation occur here also.

Limited data are available to describe the characteristics and fauna of the sandbanks in this area, of which there are several that have been named. Offshore from Dunwich and Benacre Ness (approximately 10km south of Lowestoft) sediments comprise sand closer to the coast and sand and sandy gravel further offshore (Evans and others 1998). Offshore from Benacre Ness, the Norfolk sandbanks which are examples of sinuous sandbanks, are comprised of medium grained sand while the area in between is composed of sandy gravel (Evans and others 1998).

With respect to benthic faunal surveys, those carried out in the vicinity of the Sizewell power station (Bamber and Batten 1989, Bamber 1995) offer the only insight into the faunal characteristics of these various banks. Bamber and Batten (1989) noted that the Sizewell-Dunwich sandbank, a linear sandbank, was characterised by a species-poor amphipod community. Offshore of Sizewell the seabed encompasses channels together with intervening sandbanks which are stabilised in places by bedrock (Bamber 1995). Sediment types present range from muddy to clean sand on the sandbank with increasing mud in the channels. Sandbank sediment is mobile and characterised by *Lanice conchilega* (Bamber 1995). A number of gravel patches are also located along the coast between Southwold and Winterton-on-Sea (Norfolk) covering a total area of just under 50 km^2. However no other data has been sourced to describe these areas and to determine the potential relevance to this description of shallow sandbank habitat.

4.2.3 Thames Estuary

The general level of sourced data for this sub-area is very low. It is apparent that limited data currently exists for the area, being largely restricted to work carried out on offshore windfarm environmental statements (Emu Environmental Ltd/GREP 2002, GE Gunfleet 2002). Data exists in the ownership of CEFAS, the Environmental Agency and the London Gateway project but it was not possible to obtain this for this study. This is problematic for this study as the area is almost entirely covered by sandbanks of various sediment types. The following text summarises those data which were available but in no way is it able to support a refinement of the sediment distribution maps.

In general, the geology of this sub-area can be summarised as follows. Underlying bedrock in the outer Thames comprises the Eocene London Clay Formation, consisting of mudstone and infrequent phosphatic and carbonate nodules as well as volcanic ashbands, (Barne and others 1998). Sandbank sediment consists predominantly of fine grained, well sorted sand while sand waves occur on the flanks. A less well sorted sediment varying from gravel to mud is found on the channel seabed and to the north of the estuary area (Evans and others 1998 2000). Sediments in the Thames Estuary were mainly sourced from eroded beach gravels and fluvial terrace deposits, or underlying Tertiary deposits (Barne and others 1998). Strong tidal currents have resulted in the formation of large sandbanks arranged approximately parallel to the coast, the area in between comprising of winnowed ‘lag’ deposits. In deeper water north of the Straits of Dover, linear sandbanks aligned in approximately a north south direction occur (Barne and others 1998). Pleistocene geology, described in Barne and others 1998, reveals a river that has diverted courses several times, and where Quaternary deposits are restricted to the channel courses. Further, Barne and others 1998 report the presence of a discontinuous gravel belt running offshore from the Suffolk town of Aldeburgh to Clacton-on-Sea in Essex (Figure C). Gravel occurring in the outer Thames is predominantly composed of flint with pebbles such as quartzite, sandstone, phosphorite and carbonate being locally abundant (Barne and others 1998).

A recently surveyed area of the Kentish Flats off the North Kent Coast has been shown to comprised mainly of sandy sediments and gravelly sandy sediments, exhibiting well defined zonation (Emu Environmental Ltd 2002b). The study refers to sandbanks consisting of fine, well sorted sands with low levels of silt and gravel present, populated by species such as the polychaetes *Scoloplos armiger*, *Magelona johnstoni* and *Nephtys cirrosa*. The amphipod *Bathyporeia elegans* was also common. Sands containing higher gravel proportions were found in flatter, deeper waters between the sandbank areas. These sediments were found to be

more mixed and characterised by higher levels of gravel and variable silt levels. This sediment type shows richer, more diverse faunal populations, being dominated by numerous polychaetes and the bivalves *Spiophanes bombyx*, *Scoloplos armiger, Goniada maculata, Owenia fusiformis, Mysella bidentata*, *Nephtys cirrosa* and *Abra alba* (Emu Environmental Ltd 2002b). No other data were sourced for this area.

The epibenthos off the Essex coast was classified as belonging to an estuarine community, dominated by species such as hermit crabs, common starfish, brown and pink shrimp (Rees and others 1999; Jones and Franklin 2000). A similar community had previously been reported at most trawl sampling locations near the Barrow Deep sludge disposal site by. The sediments here have been reported to vary from gravel to silty sands with characteristic inshore linear sandbanks commonplace, such as Maplin Sands, Long Sand, Gunfleet, Foulness and Barrow (Portmann and Rowlett 1992, Evans and others 1998).

General findings from a number of surveys reviewed by GE Wind Energy (2002) for the Gunfleet offshore windfarm, were that the sandbanks in this part of the outer Thames consisted of clean, well-sorted sands, with a fauna adapted to cope with mobile sands such as *Nephtys cirrosa*, *Magelona johnstoni* and *Bathyporeia pelagica* (MAFF 1981 1982 and 1990; CEFAS 1997 Rees and others 1999). In the channel the sediments and associated fauna were more varied, ranging from muddy sands to coarser mixed sediments with dominant species including *Mysella bidentata* and polychaetes such as *Notomastus latericeus* and *Glycera* spp. (MAFF 1982). At the proposed offshore windfarm site itself, the benthic survey found that the majority of sites were consistent of previous observations (noted above) with the notable addition of *Scolanthus callimorphus*, a worm anemone rarely recorded in English Territorial Waters (Titan Environmental Surveys Ltd 2002c).

4.2.4 Southern North Sea summary

For a large amount of this area, sourced data is severely restricted except for those acquired for some of the proposed offshore windfarm developments, data described in MAFF and CEFAS reports (not mapped) and an offshore area of gravelly sand. As such only limited refinement of the maps has been undertaken and it has not been possible to provide a detailed narration of the faunal communities. Where the data is present, the following observations apply:

- there are numerous examples of sandbanks in the Southern North Sea. Sediment tends to be characterised as sand or gravelly sand;
- linear sandbanks arranged parallel to the shore can be characterised by species such as *Lanice conchilega*, *Magelona johnstoni* and *Bathyporeia pelagica*;
- the fauna of the sinuous banks may be characterised by *Fabulina fabula* and *Echinocardium cordatum*;
- mobile sands in the Thames Estuary are characterised by *Nephtys cirrosa, Magelona johnstoni* and *Bathyporeia* spp.;
- muddy sand and mixed sediments supported populations of *Abra alba* and *Mysella bidentata*;
- banner banks are located at the mouth of the Humber ; and
- obtained gravel bed data are very restricted.

4.3 Eastern Channel

For the purpose of this report, Eastern Channel Marine Natural Area has been divided into:

- Kent and Sussex
- Hampshire and East Dorset

Figure D (Appendix 2) and Figures 24-35 (Appendix 2 CD-rom) show the area under discussion in this section, the initial relevant habitats illustrated in maps derived from data provided by Poulton and others (2002) and the additional data sourced (and tagged) for this study.

All places and sandbanks mentioned in subsections 4.3.1 – 4.3.3 are shown in Figure 3.

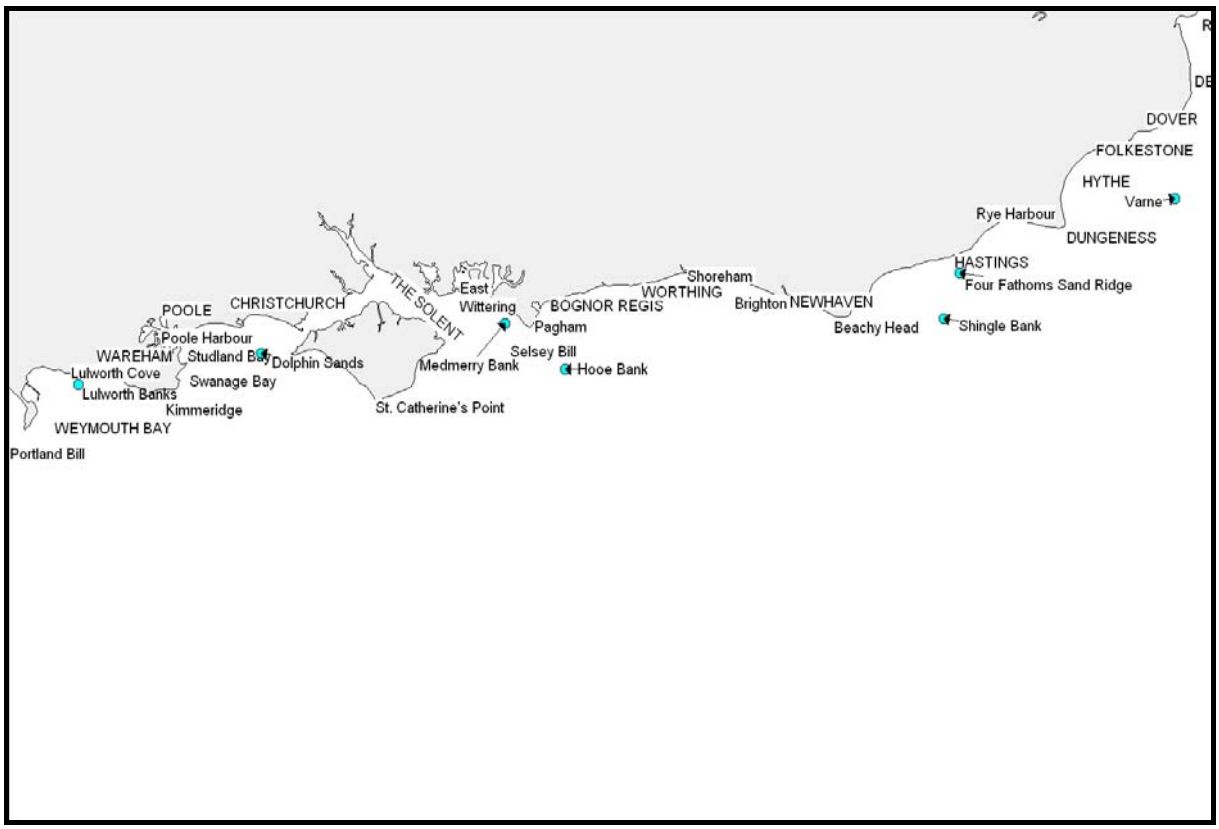

Figure 3 Map of places and sandbanks mentioned in the Eastern Channel text in sections 4 and 5.

4.3.1 Kent and Sussex

Sands dominate much of the offshore areas especially in the Southern Bight where banks, megaripples and sand wave fields (Dingle 1965) from fluvial and fluvio-glacial deposits from the early Holocene Rhine-Meuse estuarine complex are found (Nio 1976).

A general summary of the sediment characteristic of the far eastern reaches of the English Channel is given in the aggregate industry regional environmental assessment (East Channel

Association 2003). From this report it is evident that in the western part of this sub area, poorly sorted sandy gravel is the main offshore sediment type, with a 30 - 60% gravel content (mainly flint) and whole or broken shells in addition to small quantities of cobble (East Channel Association 2003). Within shallower water, the sediment is generally sandier (Figure D, Appendix 2). Sediments become increasingly sandier eastwards predominantly comprising of gravelly sand resulting in a series of sandbanks and sand waves in the Territorial Waters off the Kent coast. Flint and chalk pebbles found in the Straits of Dover were derived from Upper Cretaceous bedrock that is chalk with flint bands, and running westwards into Lower Cretaceous sediments (Barne and others 1998).

Data from the gravelly sand and sand sediments between Selsey Bill and Brighton show a patchwork of biotopes and sediment types. These data have provided the opportunity to extend the mapped areas of sand toward the coast, particularly off the coast of Brighton to Newhaven. The data also suggest that the area of gravel (Appendix 2, Figure D) off the coast from Worthing and east of Hooe Bank is better described as sand and gravely sand which the predominant sediment types. Though data cover much of this area, the linear bank (Hooe Bank) is not included. Data from Poulton and others (2002) locate Hooe Bank as a single point to the immediate north east of an extensive gravel bed. Admiralty chart bathymetry suggest that that the bank extends in an easterly direction to the gravel area south of Worthing.

Characteristic species in this area included a mix of both sand dwelling and epifaunal species including hydroids, anemones such as *Utricina felina*, *Lanice conchilega*, bryozoans such as *Flustra foliacea* and algae including *Chorda filum* and foliose red algae. Records of rocky outcrops with upper surfaces covered with sand characterised by sponges and isolated boulders exist for the southern edge of the mid west sandy sediment region. It is reasonable to apply these faunal observations to the Hooe Bank sediments as well.

Sidescan sonar and benthic grab survey of an area offshore of Shoreham (Brown and others 2001) has shown a range of habitats to be present. Cobbles with attached algae were observed in shallower waters nearer the shore. The remaining survey area was a mix of clean mobile sand with *Abra prismatica*, gravelly sand populated by *Echinocyamus pusillus* and *Psammechinus miliaris*, and separate patches of gravel and sand found further offshore. Species found to range across all substrate types in the area include *Pagurus bernhardus* and *Alcyonidium diaphanum*.

MNCR records of sandy sediment along the coast from Brighton to Beachy Head indicate an almost level seabed with rippled sand - some patches of mainly chalk pebbles, gravel and silt - supporting species such as *Echinocardium cordatum*, *Hinia* sp., *Lanice conchilega,* barnacles, hydroids, *Alcyonidium*, foliose red algae and encrusting coralline algae and hermit crabs. A small number of MNCR data revealed a band of muddy sand with shell fragments also supporting *Styela*, *Alcyonidum, Anemonia and Cerianthus* spp.

The survey of Brown and others (2001) showed that the seabed at Hastings is comprised of fine-medium sand closer inshore , changing to gravely sand with cobbles at the linear sandbank Shingle Bank, further from the coast (Brown and others 2001). This is confirmed by the mapped data, which suggest a raised bank of gravelly sand surrounded by sandy sediments. With these coarse sediments, C*aulleriella alata*, *Pomotoceros triqueter* and *Echinocyamus pusillus* were found to be abundant (Emu Environmental Ltd 2002a). Closer to the Hastings coast, the linear sandbank Four Fathoms Sand Ridge is characterised by sands

and a fauna typified by *Spiophanes bombyx* and *Magelona johnstoni,* at least where data were available. As such, data presented in this report have enabled the joining of two discretely mapped sand areas as well as two areas of gravelly sand. Data have also enabled discrimination of the fauna of two adjacent sandbank features, Shingle Bank which is a gravely sand sandbank and Four Fathoms Sand Ridge which would appear to be a linear bank consisting of just sand.

East of Dungeness in Rye Bay, Holme (1961) reports the presence of muddy sand supporting *Nucula nitidosa, Fabulina fabula, Abra abra* and *Euspira catena.*

Off Folkestone and Hythe the majority of the collated data were of clean sand and gravels in water deeper than 20m (Marine Ecological Surveys Limited 1997). Brown and others (2001) showed a wide range of substrate types to be present offshore of Dungeness from soft mud through to coarse gravel and cobbles but did not suggest the presence of sandbank. Poulton and others (2002) were unable to map near shore sediments in shallow waters east of Dungeness except for a narrow strip of sand and gravely sand. A single MNCR dataset indicates the presence of muddy sand , brittlestars, hermit crabs and whelks. This project has not been able to source additional data to fill this gap. The offshore linear bank, Varne, has no descriptive data available for its characterisation.

Approximately 14 km east of Dover, mapped data indicates the presence of a large patch of gravel (Appendix 2, Figure D) though no additional data has been sourced. Roughly 5 km east and 7 km northeast of here, maps derived from Poulton and others (2002), establishes the presence of another more fragmented patch of gravel and two smaller patches - the larger covering an area of 14.52 km^2. Again, faunal and sedimentary data are lacking for these localities and, as such, their relevance to this study (as either potential sandbank or stony reef) cannot be determined.

A fragmented stretch of sandy sediment occupying approximately 27 km^2 runs between Dover and Ramsgate. Interspersed gravel beds extend over 15 km^2 just 4 km southeast of Ramsgate and 13 km^2 approximately 10.5km east of the town of Ramsgate. Three further gravel beds are located 5.6km and 7km northwest and 2 km to the north east occupying areas of 3, 0.34 and 1.5 km^2 respectively. Quite narrow sandy sediment runs in a roughly northeast/southwest direction 8 km to the east with a CEFAS data point positioned just off its western border. Approximately 10 km to the southeast another area of sandy sediment, at 20 m BCD or less, extends beyond Territorial Waters covering a total area of 37 km^2. There are insufficient data to comment on this area or describe the fauna other than to note the presence of an unnamed narrow but very long ribbon of sand and the continuation of the complex of sandbanks and gravel beds that are seen across the English Channel approaches to the North Sea and beyond.

4.3.2 Hampshire and East Dorset

There are three valleys within the channel excised from bedrock. St. Catherine's Deep to the south west of the Isle of Wight is the deepest of these and is thought to be 60m deeper than the surrounding material. Quaternary infilling of course sands and gravels has occurred within the other valleys caused by the riverine infilling of the channel in the late Miocene, however, St Catherine's deep has only a shallow infilling of gravels and little quaternary infilling. These depressions cause strong tidal currents that limit sediment infill (Hamblen 1992). Areas of high tidal stress within the channel (Pingree 1980) cause megaripples and

gravel furrows in the West Solent and central channel areas. Sands are composed of bimodal flint gravel and medium grained coarse sand owing to coastal erosion from the Isle of Wight and Selsey Bill. Fine sands restricted to the Dungeness are the result of localised underlying Lower Cretaceous strata from which it is derived (Hamblen 1992). Hurst Spit, Shingles Bank and Dolphin Sand are derived from rapid wave cut erosion from Christchurch and Poole Bays causing the release of soft tertiary sediments and gravels from quaternary plateaus to form the features (Hamblen 1992).

In Weymouth Bay, Holme (1961) reported a biologically rich seabed supporting a mix of muddy, gravely and sandy sediments while rock and gravel deposits occur offshore of Lulworth. This is consistent with the mapped features. Numerous data points indicate that nearshore there are extensive areas of *Zostera marina*. Within this area records note the presence of *Lanice conchilega*, *Owenia fusiformis*, *Magelona johnstoni*, *Ensis* spp., *Echinocardium cordatum*, and *Spisula elliptica*. Other data in the Bay record the presence of slightly muddy sand supporting *Sabellaria spinulosa* and *Polydora* spp. (**SS.SBR.POL.SspiMx**) and also *Abra alba*, *Nucula nitida* and *Corbula gibba* (**SS.SSA.CSA.AbrNucCor**). Reference is also made to muddy gravel deposits with a fauna dominated by burrowing crustaceans, sipunculid worms, echinoderms and burrowing anemones (FSCR 1992a). In general, Weymouth Bay is dominated by sandy sediments inshore, gradually changing to mud and gravel further offshore. Further along the coast, individual species records (source: Dorset Environmental Records Centre) note a similar assemblage of species including *Lanice conchilega*, *Magelona johnstoni (*and other *Magelona* spp.*), Owenia fusiformis, Ensis* spp. and *Spisula elliptica* off the coast from Lulworth in the vicinity of Lulworth Banks. The extent and character of this sandbank is complicated by the occurrence of reef (stony and bedrock) patches and therefore records contain reef-typical species (See Section 4.3) though bathymetric data show the presence of a bank, it is one which cannot be further classified (and hence assigned to the general 'bank' category) against the definitions described in Section 2.1.

Maerl is also recorded in patches along Purbeck coast, both inshore of the Lulworth Banks and in areas mapped as reef off the coast at Kimmeridge. These data point to the presence of a species assemblage that includes: *Magelona johnstoni, Alcyonium digitatum, Zostera marina* and *Lanice* conchilega. Further east, past St Alban's Head in Swanage Bay, a large subtidal sand area had been identified by BGS. This area extended from the shoreline to approximately 3km offshore. However, all data for this area are indicative of potential reef (see Section 4.3.2), As such this area has been modified and excluded from classification as sandy substrate.

Data for Swanage and Poole Bays are noteworthy in that numerous records for *Phymatolithon calcareum* (maerl) are given across an area identified as slightly gravelly sand (Source: Dorset Environmental Records Centre). Only the most coastal data points in Swanage Bay suggest the presence of sand, as indicated by the occurrence *Lanice conchilega* and *Spisula elliptica.*

In Poole Bay and Christchurch Bay sediments comprise mainly of sandy material, ranging widely in the proportions of mud and gravel. In Poole Bay the sand area in water depths of less than 20m extends up to 9km offshore. A few local records of *Zostera*, particularly in Studland Bay, have been recorded where dense beds are known to be present (Victoria Copely, English Nature, *pers. comm*.). Epifauna has been noted to be diverse and locally abundant (Hartley 1990), dominated by the slipper limpet *Crepidula fornicata*. Holme

(1961) noted that mud sediments were uncommonly black and anaerobic. However, other mapped data indicate the fauna to be dominated by *Lanice conchilega, Ophuira* spp. and *Ensis* spp. all of which are typical of sandy sediments that are not anaerobic. Other data reports that these areas also support species characterising reef and mixed sediment habitat (see Section 4.3.2). As such, the main change to the seabed mapping of this area is the expansion of reef filling the gap in the original map derived data from Poulton and others (2002). At the same time it is acknowledged that the area is likely to be a mosaic of reef and sand and also, from these data, the nature of the reef patches (bedrock verses stony reef) is uncertain.

A linear sandbank runs parallel to the coast along Christchurch Bay. However, there are no data to describe the fauna of the sand and gravelly sand of this feature.

In Christchurch Bay, the sand and gravelly sand does not extend offshore as far as in Poole Bay, extending no further than a distance of 6km from the coast. Limited data suggests similarity with the findings in Poole Bay.

The subtidal environment around the southern and eastern sides of the Isle of Wight is already encompassed by a SAC designation and therefore not discussed further in this report. South east of the Isle of Wight and south of East Wittering small scale sediment variability exists. Heterogeneous sediments included a mix of gravel, silt/clay and sand. A high fine sediment content together with cobbles supporting epifauna was a regular feature here. Also present was consolidated rock covered by sand characterised by *Ophelia borealis* (Brown and others 2001).

Further offshore, BGS data indicate gravelly sand stretching across a wide area, characterised by *Eurypon* sp., *Dendrodoa grossularia* and *Alcyonidium* sp. Though data are somewhat widely distributed, the data suggests that the areas of gravelly sand extend and meet in areas not mapped by BGS. Also, the area of gravel within the 20m contour should be considered gravelly sand rather than gravel. However, a degree of uncertainty exists given the limited data available.

To the west of Selsey Bill, in the vicinity of Medmerry Bank, the area of sand and gravel is populated by an impoverished fauna. Species within the more sandy areas are dominated by *Ampelisca spinipes* and *Nephtys caeca*. Gravel areas are dominated by *Mytilus edulis* (Emu Environmental Ltd 1994). Additional data records reveal an almost level seabed of rippled sand with occasional pebbles and broken shells supporting burrowing bivalves and *Lanice conchilega*.

At around 6km south of Sesley Bill, MNCR data indicates the presence of sublittoral sand and gravel, the former ranging from fine to coarse, as well as some cobbles. Species characteristic of the cobble habitat include foliose red algae and hydroids. A seabed of sand, bedrock, boulders and pebbles have also been recorded as supporting hydroids such as *Sertularia* and sea anemones such as *Urticina*.

4.3.3 English Channel Summary

Substantial amounts of data have been sourced along the English Channel coast, particularly off the Dorset, Hampshire and West Sussex coasts, which has allowed description and refinement of maps derived from data provided by Poulton and others (2002). This is

particularly true of the maerl beds in Swanage and Pool Bay and a number of extensions and filling of data gaps along the Sussex coast.

A number of sandbanks have been noted and mapped. These include examples of banks of sand (Lulworth Banks, Hooe Bank) and gravelly sand (Shingle Bank) banks as well as linear banks (Four Fathoms Sand Ridge). Other banks in the area, such as Dolphin Sands and the Varne sandbank lack data for further description and comment.

The proximity of different sandbank types off the coast at Hastings might be considered to offer an opportunity for capturing a number of examples of the shallow sandbank feature under a single designation.

Of the biological communities the following are also noteworthy:

- *Zostera* beds have been noted in both Weymouth Bay and Studland Bay;
- maerl beds off the Purbeck and Swanage coasts;
- sand substrata are characterised by Lanice conchilega, Magelona johnstoni, Ensis spp., Spisula elliptica and Ophuira ophiura;
- muddy sand substrata are characterised by *Abra alba, Nucula nitidosa* and *Corbula gibba*;
- gravelly sand substrata, predominantly occurring off the Sussex and Kent coasts are characterised by *Lanice conchilega, Echinocyamus pusillus, Echinocardium cordatum, Cauleriella alata* and a number of epifaunal spp.;
- particularly along the Dorset coast, much of the shallow water areas show a mosaic of reef features and sandy sediment; and
- where the seabed is confirmed to be gravel *sensu stricto* rather than gravelly sand or stony reef, such as areas south and south east of the Isle of Wight, then it is currently not a habitat relevant in relation to the Habitats Directive and therefore will not be considered further within this project. Data, however, has not been located with respect to gravel areas offshore of east Kent.

4.4 South Western Peninsula

For the purpose of this report, the South Western Peninsula Marine Natural Area has been divided into:

- West Dorest and South Devon
- South Cornwall
- North Cornwall and North Devon
- Bristol Channel

Figure E (Appendix 2) and Figures 8-23 (Appendix 2 CD-rom) show the area under discussion in this section, including relevant habitats illustrated in maps derived from data provided by Poulton and others (2002).

A large area of mudsheet underlies Bridgewater Bay. Difficulty arises in determining the coverage of Pleistocene geology between Bristol Channel and Falmouth Bay (Barne and others 1996b). The late Devonsian ice sheet extended from south Wales to the Isles of Scilly without reaching the west coast of Devon and Cornwall though evidence suggests three large icesheets crossed the entire region (Barne and others 1996b).

According to (Barne and others 1996b) the South Western Peninsula is a basement massif surrounded by Mesozoic sedimentary basins ie English and Bristol Channel, and Celtic Sea Basin. During the early Permo-Triassic, the basins were formed with subsequent deposits of Jurassic limestones, shales and clays. Much of this was later removed through uplift and transport away, most notably from the English Channel (Barne and others 1996b).

All places and sandbanks mentioned in subsections 4.4.1 – 4.4.5 are shown in Figure 4.

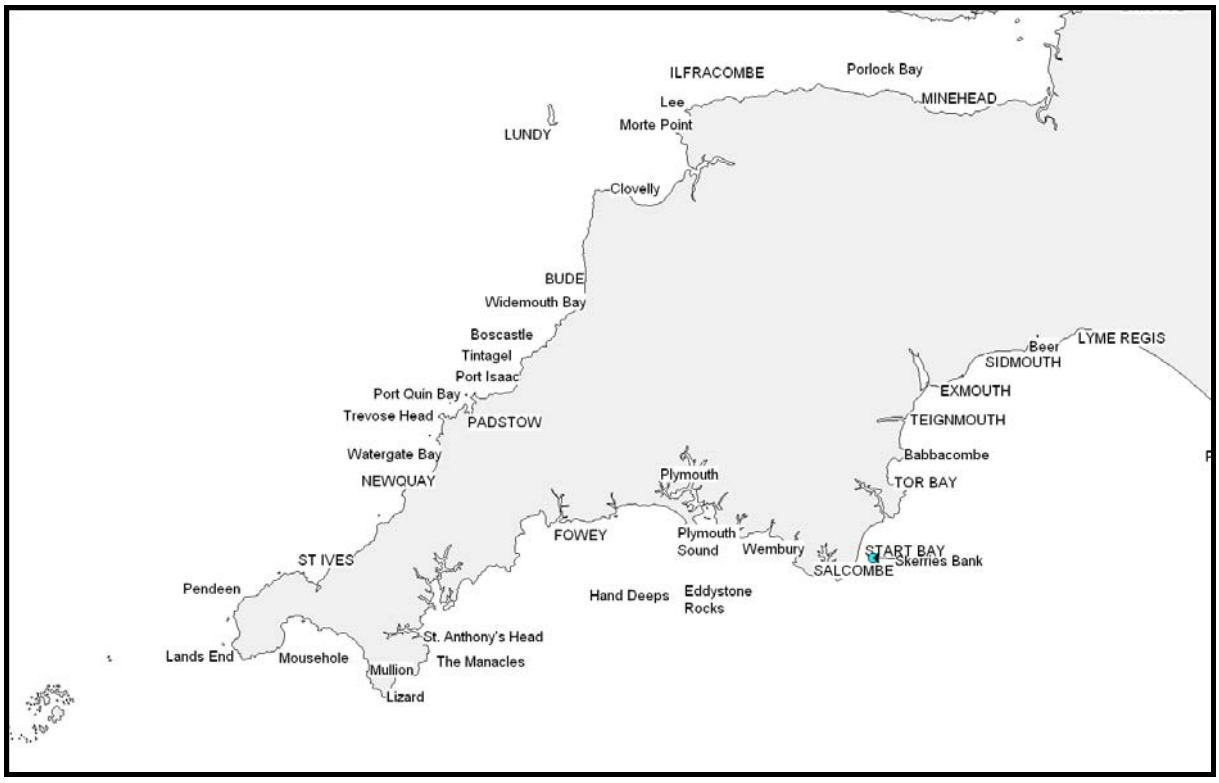

Figure 4 Map of places and sandbanks mentioned in the South Western Peninsula text in sections 4 and 5.

4.4.1 West Dorset and South Devon

For the purpose of this report, South Devon and West Dorset are defined as the area from Plymouth to Portland Bill.

Offshore shoals are uncommon due to the generally eroded nature of the seabed, however small inshore shoals of resistant Devonian strata cause small inshore shoals and rugged coastline in South Devon. This outcrop, however, does not extend beyond 8 miles of the shoreline. The offshore geology in this area largely reflects that of the coast. Resistant Devonian sediments with occasional areas of prominent igneous rocks, extend eastwards from Tor Bay. Jurassic mudstones, shales, sandstones and limestones are present off the east

Devon coast mainly Permo-Triassic sediments and breccias, from Beer Head to Hope's Nose continuing eastwards past Lyme Bay (Hamblen 1992)

Substrata off the Plymouth coast range from coarse muddy sand to fine gravel. Areas subject to scour are composed mainly of shell gravel (Hiscock 1998).

Moving eastward from Plymouth, BGS data indicate extensive reef areas. However, acquired data suggest that along the South Devon coast stretches of sand are also present. These data are insufficiently numerous to allow defining a sandbank area on the map. It should be noted that published information (Hiscock 1985) describes the seabed around Salcombe as muddy sand beyond an area of fringing rock that extends to 6m BCD (Below Chart Datum). Immediately outside of Salcombe Harbour there is an area of sandy sediment (approximately 1.2km), bisecting two large areas of potential reef. Here, 'The Bar' consists of coarse sand. In this area, MarLIN data indicate the presence of the sediment species *Lanice conchilega*. Further, just off the area known as South Sands, there are areas of coarse sand dominated by *Zostera marina* and *Lanice conchilega* (Hiscock 1985).

East of Start Point, BGS data indicate the presence of significant areas of sand, encompassing Skerries Bank, a linear or banner sandbank with localised patches of muddy sand extending largely unbroken to the Mew Stone. Characteristic species include sparse mobile fauna such as hermit crabs and decapods. Tor Bay and Babbacombe Bay as far east as Straight Point are predominantly muddy sand. There is limited biological data for these areas of sandy sediment. Holme (1961) reported a seabed of fine sand, originating from sandstones, together with patches of mud, most notably in Tor Bay. In Start Bay available data indicate the presence of relatively mobile rippled sand with a sparse fauna including hermit crabs and sand eels (SS.SSA.ISA.Mob). MarLIN records also indicate the presence of species such as L. *conchilega, Ensis* spp. and *Spisula solida* closer to shore. In Tor Bay a few data points confirm the muddy sand but also mud and indicate the characterising species of the former to include *Ensis* spp., *Cerianthus lloydii, Amphiura filiformis, Ophiura ophiura* and *Echinocardium cordatum* (**SS.SSA.IMUSA.EcorEns**). Only coastal data are available for Babbacombe Bay though unpublished Environment Agency data (Trevor Baker, *pers. comm*.) has recorded a *Melinna palmata – Abra alba* community to be present offshore of Teignmouth. Another survey off the coast from the Teign Estuary pointed to the presence of five main communities with the predominant community being a 'shallow/intermediate depth mud' characterised by *Abra alba*, *Turritella communis*, *Magelona johnstoni* and *Echinocardium cordatum* (Smith 1990).

In the vicinity of Exmouth, there is limited biological data until areas to the south east of Beer Head. Offshore of Sidmouth, the Environment Agency has in the past taken a few samples (Trevor Baker, *pers comm*.) that indicate the occurrence of fine sands and muddy sand. To the East of Beer Head there are limited records of fine sands with the king scallop *Pecten maximus* and *Asterias rubens* (**SS.SSA.CSa**), though the record notes extensive and heavy trawl damage. Another data point indicated the presence of soft gravelly sands as well as maerl (**SS.SMP.Mrl**), with *Ascidiella aspersa, Ciona intestinalis* and other fauna although these records lie just beyond the 20m contour. These few observations are at variance with the mapped sediment type (gravelly sand) but are insufficient in terms of spatially referenced locations to revise the map with any degree of confidence.

The majority of shallow water areas off Lyme Bay consist of sandy and muddy sand sediments. There are extensive areas of rocky reefs and offshore plains of sediments overlain

with cobbles (FSCR 1992a). Eagle and Hardiman (1977) described the presence of an *Echinocardium cordatum*/*Amphiura filiformis* community in the centre of Lyme Bay though the polychaetes *Chaetozone setosa* and *Magelona filiformis* were the dominant species. Infaunal sediment samples taken from Lyme Bay reveal the presence of seven distinct groups (Grist and Smith 1995; Eagle and Hardiman 1977). Mixed sediment was dominated by the amphipod *Ampelisca spinipes*, and offshore mixed sediment with stones was numerically dominated by *Lumbrinereis gracilis* and *Praxillella affinis*. Offshore slightly muddy sand was characterised by *Corbula gibba* and *Bathyporeia tenuipes* while *Bathyporeia elegans* and *Ophelia borealis* characterised offshore clean sand. Offshore of Seaton , more maerl records are present, with gravelly sand beyond. East of Lyme Regis, towards Portland Bill, sediment data indicate the presence of muddy sand with *Echinocardium cordatum* and *Lanice conchilega* (**SS.SSA.IMUSA.EcorEns**) closer to shore in muddy sand, with coarser sediment in deeper water with *Abra alba, Corbula gibba,* and *Nucula nitida* (**SS.SSA.CSA.AbrNucCor**). Admiralty charts do not indicate the occurrence of shallow water sandbanks in this area and no other data was obtained suggesting their presence.

4.4.2 South Cornwall

For the purposes of this report, South Cornwall is defined as the area from Land's End to Plymouth, extending seaward to include the Eddystone Rocks and areas out to 12 nm.

BGS data indicate the presence of a number of gravelly sand and sand areas (total area approximately 52km^2) between Land's End and Mullion. Only one dataset has been located for this area which indicates the occurrence of *Lanice conchilega* and *Ensis* spp. alongside reef species to the south of Cribba Head.

Along the coast, centred on Blackhead a further, narrow stretch of sand is indicated, again without supporting biological data. The gravelly sand located within the Fal and Helford SAC is not discussed here. There is limited supporting data for these areas. Maerl (**SS.SMP.MRL.Phy.HEc**) has been recorded from the Kennack Cove area, as well as to the north east of Dodman Point.

BGS data indicate the presence of areas of sandy sediment to the west and east of Whitsand Bay, with sandy gravel in the centre of the Bay. South of Gribbin Head (located west of Fowey) there are again limited supporting data, with MNCR records of maerl, albeit mostly dead *Phymatolithon* (**SS.SMP.MRL.Phy.HEc**). There are MarLIN records indicating the presence of *Ensis* spp. *Ophiura albida* and *Lanice conchilega* in both the centre and easternmost part of the Bay alongside other species more characteristic of reef habitats. These species data and other observations (Hiscock 1998) which noted the presence of the sand dwelling echinoderms *Leptosynapta inhaerens* and *Trachythyone elongata*, support the suggestion of sand being present, albeit alongside reef biotopes.

4.4.3 North Cornwall and North Devon

There is very little sandy sediment habitat off the coast of North Devon from the Somerset border to Ilfracombe. However, to the west of Ilfracombe, the seabed in the shallow waters off North Devon consist almost exclusively of sand. There are also smaller areas of muddy sand (in Barnstaple Bay) and gravelly sand (around Bull Point).

BGS data indicate the presence of a relatively large area (approx 185 km^2 in North Devon) of sandy sediment, more than half of which lies in less than 20m depth. There are also limited biological data in this area which support the BGS data, with muddy sand supporting *Lanice conchilega* recorded close to shore in southern Barnstaple Bay (**SS.SCS.IGVSA.Lcon**). Data from 6km offshore of the Taw indicate the presence of sandy sediment species such as *Echinocardium cordatum* and *Ophiura albida*. The area just south of the Taw estuary in Bideford Bay, is dominated by fine sand which supports polychaete worms such as *Spiophanes bombyx*, *Magelona johnstoni, Glycera* spp. and pontoporeid amphipods (May and Taylor 1992). Unpublished Environment Agency data from a short distance off the Braunton coast (Trevor Baker, *pers comm*.) confirm the presence of fine sand and a typical fauna comparable with that described by May and Taylor (1992). Based on the bathymetry of the area, the published (and unpublished data) indicate that the nature of the sandy sediment (not sandbank) in this area is one of minimal surface relief, except sandwaves, and not representing a sandbank (as defined in Section2.1).

To both the east and west of Lundy (Figure E) bordering on the existing SAC are areas of shallow water which might be considered to represent banner sandbanks. There is no sediment or biological data available for these areas and it is recommended that this area be investigated further in the future.

Maps derived from data provided by Poulton and others (2002) show an area of gravelly sand from Mead to Port Isaac. However, only one MNCR record in northern Bude Bay was sourced where clean rippled sand was recorded (**SS.SSA.ISa**), with only spider crab, *Maja squinado* noted as present. From Port Isaac to East Trevose Head the seabed comprises areas of flat plain or gently sloping sand (Hiscock 1978). This and other data records, of bedrock reef, make reference to adjacent sand but do not describe species occurring on the sand. In addition, a number of data (from MarLIN) in the Port Isaac and Portquin Bay areas indicate the presence of sand with characterising species that includes the sand mason *Lanice conchilega*, burrowing urchin *Echinocardium cordatum*, razor shells *Ensis* spp. and the brittle star *Ophiura albida*. In Padstow Bay, both sand and reef substrates are present but insufficient data exists to define the boundaries of each. Where records have identified sand, **SS.SSA.ISA.NcirBat** and **SS.SCS.IGvSa** biotopes have been noted (source: MNCR). No data or admiralty chart information (bathymetry and named seabed features) in this area point to the occurrence of shallow water sandbanks.

4.4.4 Bristol Channel

The Bristol Channel (including the Severn Estuary) is a high energy environment which supports an ever changing mix of sediments varying from mobile sand to rock (Portmann and Rowlett 1992). Its fauna is impoverished due to bed stresses and high mobility of sediments caused by the large tidal range (Mettam and others 1994). In the Inner Bristol Channel sediment thickness decreases eastwards with increasing tidal current speed, and a great deal of the seabed supports bare rock with mobile sediment confined to linear banks close to the coast (Barne and others 1996b). Communities found here include a ‘reduced hard bottom community’ and a ‘reduced soft bottom community’ (Warwick and Davies 1977). Evans (1982) reports sediment to comprise mainly of gravel, or mud or sand. Mettam and others 1994 describe the presence of eight impoverished faunal groups and associated habitats within the Severn Estuary. Tyler and Shackley (1980) report the presence of linear sandbanks including Culver Sands. Here, the fauna is dominated by a *Spisula* sub-community.

Acquired data for the upper Bristol Channel indicates the presence of significant areas of sandy sediment, in addition to that shown in themaps derived from data provided by Poulton and others (2002). MNCR data indicate the presence of a medium to fine sand. This area, which encompasses the sandbanks Middle and English Grounds, is characterised by a sparse fauna associated with estuarine and mobile sands consisting of the polychaetes *Nephtys cirrosa, and the crustaceans Neomysis integer* and *Gammarus* spp. (**SS.SSA.ESTSA.MobRS/Ncir**). There are insufficient data to indicate whether the ribbon of muddy sand indicated as running across the inner Bristol Channel is present and represents a different faunal community.

The variability of data (Poulton and others 2002) compared with that presented here supports the assertion of Portmann and Rowlett (1992) that sediment conditions are highly variable and dynamic in this area, to the point that areas vary from exposed hard substrata and sandy sediment over a period of time as dictated by mass sediment transport patterns.

In the Bridgewater Bay area, spatial data located in areas of sand (Steep Holm, Culver Sand, Flat Holm, Stert Flats and Gore Sand) are suggesting that all areas consist of clean sand rather than clean sand and gravelly sand and can therefore be extended in comparison with maps derived from data provided by Poulton and others (2002). As before, the fauna was recorded to be sparse and characterised by the occurrence of *Nephtys cirrosa*.

A number of gravel areas are present but there is insufficient data at present to rationalise these areas, at least with respect to reclassifying. A number of data points are present, some of which suggest the presence of *Sabellaria* reef (see Section 4.2.1). Others are coded CEFAS data which is not classifiable for this project.

There are a number of MNCR records close to shore, between Porlock and Lee (east of the town of Ilfracombe) which indicate the presence of bedrock and stony reef as well as patches of sediment. Apart from two small areas between Porlock and Lee to the north and just east of Minehead, there were no other areas of sandy sediment in maps derived from data provided by Poulton and others (2002).

The sediments in the shallow waters of Watergate Bay and Newquay were noted (in Poulton and others 2002), to consist of sandy gravel. Further west, from Holywell Bay to Pendeen, data derived in Poulton and others (2002) suggest a continuous stretch of gravelly sand except the bedrock around the headland to the north of St Ives Head and the sand in St Ives Bay. Unfortunately, there is no biological data mapped for these areas, with the exception of records of surrounding sandy substrata close to St Ives Head. A mobile sand biotope (**SS.SSA.ISA.Mob**) on a sand plain with irregular dunes and depressions close to Pendeen Watch. Only hermit crabs were recorded at this location.

To the south west of Land's End, the seabed around the Isles of Scilly supports a number of records for potential sandbank and reef biotopes (Figure E). However, these data all lie within the existing SAC and are therefore not discussed further.

4.4.5 South Western Peninsula summary

In the Severn Estuary, extensive areas of mobile sand are present. In the Bristol Channel, distributed patchily amongst areas of gravel and bedrock, ribbons of sand are also recorded. However, the highly energetic and dynamic nature of the area is likely to markedly change

the distribution patterns of the sandy sediments over short periods of time, for example the Middle and English Grounds. Consequently there is a high level of uncertainty concerning the current mapping of the data presented in this report, particularly with respect to the persistence of the mapped sandy sediment areas or sandbanks. Where faunal data has been obtained, the species present are sparsely distributed due to the high mobility of the sediment and characterised by *Nephtys cirrosa*. The area called Culver Sands might be considered a shallow sandbank and data suggest it is characterised by sands populated by a *Spisula* sub-community.

Along the North Devon and North Cornwall Coasts, shallow sandy sediment areas (not sandbanks) are limited to bays and close to the coast. Limited biological data points to the occurrence of species such as the polychaetes *Magelona johnstoni, Lanice conchilega* and *Spiophanes bombyx*, the bivalve mollusc *Ensis* spp. and the echinoderms *Echinocardium cordatum* and *Ophiura albida* in sand. Much of the sand has a gravel component and as such can be differentiated from that in the Severn Estuary and Bristol Channel areas.

The South Cornwall coast presents a number of sand patches across the area, separated by reefs. *Lanice conchilega*, *Ensis* spp and *Ophiura albida* were frequently noted in the data, even those that predominantly refer to bedrock and stony reef. Discrete patches of maerl were registered at three localities; in Kennack Cove located east of Black Head, near Dodman Point and also off Gribbin Head although the extent of these areas has not been resolved.

In the shallow waters off the South Devon coast, stretches of sandy sediment were characterised by *Lanice conchilega*. The Skerries Bank, the only noted sandbank feature along this stretch of coast, was thought to be characterised by sand and muddy sand with a sparse fauna including hermit crabs and sand eels (**SS.SSA.ISA.Mob)** and *L. conchilega*, *Ensis* spp. and *Spisula solida* closer to shore. Further east, as far as Lyme Bay, seabed sediments comprise of sand and muddy sand characterised by *Ensis* spp., *Cerianthus lloydii*, *Chaetozone setosa* and *Magelona filiformis*. Offshore of Exmouth and Seaton, data records revealed the presence of maerl.

4.5 Irish Sea

Dickson (1987) describes the Irish Sea as having a gravelly seabed that stretches around the UK coast from St. George's Channel northwards through the central Irish Sea and narrowing in the North Channel. The report indicates that sand occurs on either side of the gravel apart from south west of the Isle of Man, south of St. Bees Head and in Liverpool Bay. Areas of muddy sand are present in the bays and nearshore areas as well as an extensive area off the Cumbrian coast (Dickson 1987).

A great deal of the Irish Sea is underlain by till and overlain by thick muds deposited shortly after the melting of an ice sheet off the Cumbrian and Lancashire coast (Barne and others 1996a). Older sedimentary rock separates the Solway Firth Basin from the East Irish Sea Basin which is infilled by Permo-Triassic sediments while large sections of the basins overlie Carboniferous rocks. During the late Cretaceous period uplift caused much of the basin sediment to be removed (Barne and others 1996a).

For the purpose of this report, the Irish Sea Marine Natural Area has been divided into:

- Liverpool Bay
- Lancashire and Cumbria
- Solway Firth

Figure F (Appendix 2) and Figures 1-7 (Appendix 2 CD-rom) show the area under discussion in this section, including relevant habitats illustrated in maps derived from data provided by Poulton and others (2002).

All places and sandbanks mentioned in subsections 4.5.1 – 4.5.4 are shown in Figure 5

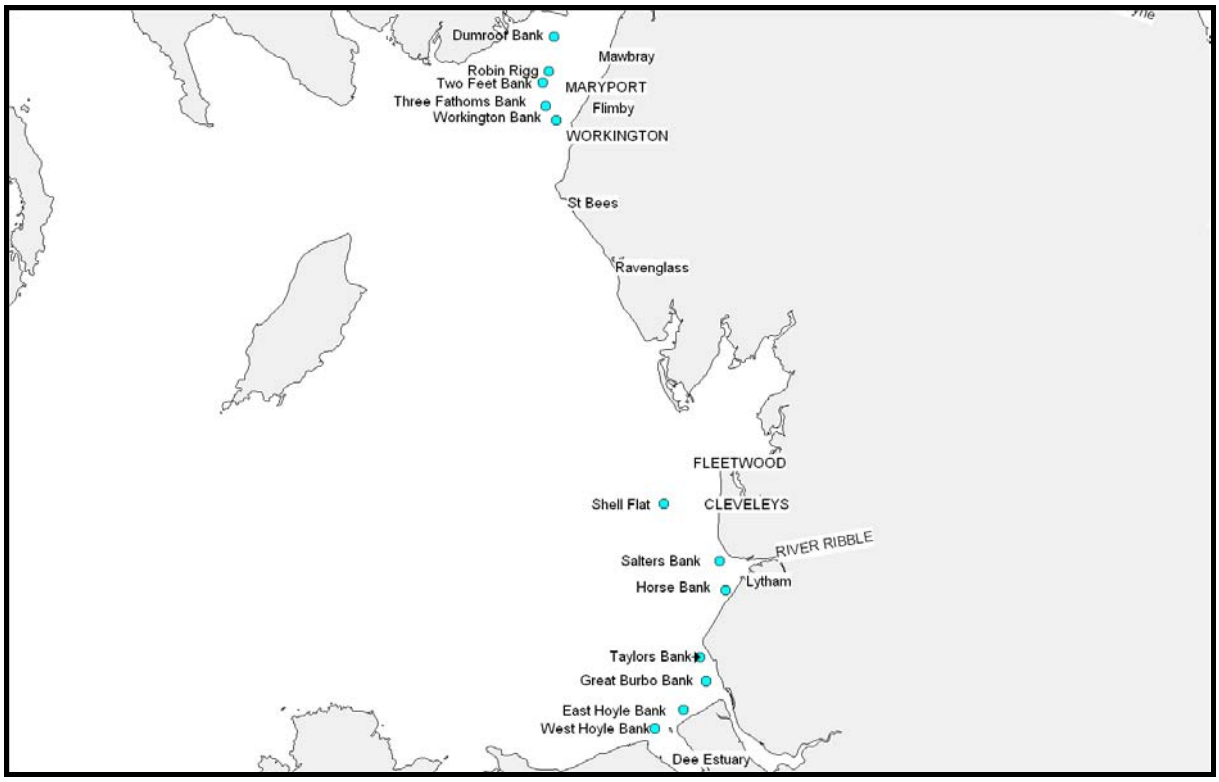

Figure 5 Map of places and sandbanks mentioned in the Irish Sea text in sections 4 and 5.

4.5.1 Liverpool Bay

Liverpool Bay is considered to include the area enclosed within a broad arc from the Fleetwood to Great Orme (Wales). The area comprises mainly sand, muddy sand and sandy mud. According to Rees and Walker (1991) Liverpool Bay supports a complex mosaic of sediment types on the micro- and meso-scales. Seabed formations (National Wind Power 2002) vary between:

- sand ribbons and patches with mega-ripple relief of less than 0.3m;
- sand wavefields, with amplitudes of around 2m and wavelengths of 10 to 20m (for example Burbo Bank (Seascape Energy 2002)); and

- individual sand waves with amplitudes of 12m and also often bearing minor transverse waves.

A number of sandbanks are noted, including Shell Flat, Salters Bank, Taylors Bank, Great Burbo Bank and the East Hoyle Bank. It is noteworthy that the majority of them are associated with the large estuaries of the area and Admiralty charts suggest a tendency toward a linear morphology. Even so, none would appear to extend for any great length (ie less than 10's of kilometres) and such, based on the definitions provided in Section 2.1, all of these sandbanks are considered to fall into the general 'bank' category.

Offshore of Cleveleys in the area of the Shell Flat proposed windfarm site, the bulk of the samples were of muddy sand with small quantities of gravel (Titan Environmental Surveys 2002b). Abundant bivalves such as *Abra alba* and *Nucula nitidosa* were common to most sampled grab sites. The shallower water samples indicate the presence of sand and supported a regular shallow water sand faunal community (biotope code, **IGS.Fas**). While samples from the south and west of the proposed windfarm showed an increase in the number of Phoronids as well as Echinoderm diversity, most notably ophiuroids mainly due to an increase in depth and muddy sediment (biotope code, **CMS AfillEcor**) (Titan Environmental Surveys 2002b). Dredge samples indicated sponges, ascidians, hydroids and bryozoans as common colonisers of the pebbles, stones and shells. Mobile fauna (polychaetes, amphipods and mysids), infaunal and burrowing fauna (*Ericthonius punctatus* and *Lagis koreni*) were frequent (biotope code, **MCR.ByH Flu.HByS**) (Titan Environmental Surveys 2002b).

In the area north of the Wirral, between the East Hoyle and Great Burbo Banks, the clean sands were populated with sparse macrofauna, dominated by the polychaete *Nephtys cirrosa* along with low numbers of other species common to clean sand habitats such as *Magelona johnstoni, Bathyporeia* spp., *Donax vittatus* and *Echinocardium cordatum* (Hobbs and Smith 1996; Eagle 1973 and 1975; Bassindale 1938; Rees and Walker 1983). In one location, where the finer sediments were sampled, the benthic populations consisted of the polychaetes *Lagis koreni* and *Owenia fusiformis* and the bivalve molluscs *Mysella bidentata* and *Macoma balthica*. Surveys of Burbo Bank, (Seascape Energy 2002), North Hoyle (National Wind Power 2002) and Rhyl Flats (Titan Environmental Surveys 2002a) located further west have reported on similarly occurring communities that can be classified in most locations as **IGS.FabMag** and **IGS.NcrBat.** At North Hoyle, however, the sediment was heterogenous and coarser than at the other study sites (being located on the gravelly sand) and was, in addition to *Echinocardium cordatum, Bathyporeia guilliamsoniana* and *Nephtys cirrosa*, populated by the bivalve molluscs *Spisula* spp. and *Gari fervensis* and classified as **IGS.Sell** and (closer to the shore) **IMS.EcorEns**.

MNCR data for the mouth of the River Ribble, specifically Salters Bank, approximately 4km south of the town of Lytham St. Anne's, indicates a well sorted fine sandbank (on Penfold Bank) characterised by sparse populations of *Cerastoderma edule*, *Arenicola marina* and *Macoma balthica*. Evidently, this location is influenced by variable salinities.

Epifaunal data (Titan Environmental Surveys 2002a and Seascape Energy 2002) highlight the occurrence of the epifauna *Metridium senile*, *Alcyonium digitatum*, *Asterias rubens* and a number of shrimps including *Philocheras trispinosus* and *Hippolyte varians*.

4.5.2 Lancashire and Cumbria

In this sub-area, considered to extend from south of Workington (excluding Workington Bank, described later) to Morecambe Bay, maps derived from data provided by Poulton and others (2002) indicate a seabed consisting almost entirely of sandy sediments. The mapped areas are contiguous throughout and extend into Liverpool Bay and Welsh Territorial Waters. Tidal currents are slower in this region than further south and north while sediments become muddier resulting in a distinctly muddier belt of sand along the south west Cumbrian coast (Barne and others 1996b).

Along the Cumbrian coast, from St Bees to the Isle of Walney, Hiscock, (1998) acknowledged that the sublittoral habitats present were not well known. On the whole, sediments appeared to comprise sand, sandy mud and muddy sand. Sandbank features have not been identified by either Poulton and others (2002) or the Irish Sea Pilot project and none are mapped on Admiralty charts outside of those in the mouth of the Ribble Estuary. Salters Bank and Horse Bank are too inshore to be considered in this study. A narrow stretch of gravelly sand, flanked by sand along the middle and northern reaches, runs from Ravenglass to Lune Deep while muddy sand dominates the offshore. This stretch of siltier sediment has also been reported by Swift (1993).

Where sediments are composed of muddy sands and sandy mud (Hobbs and Smith 1996), such as offshore of Whitehaven, fauna was characterised by *Abra alba*, *Nucula nitidosa* and the tube dwelling polychaete *Lagis koreni*. However, the areas of clean sands were numerically dominated by the polychaete *Magelona johnstoni* and bivalve mollusc *Fabulina fabula*.

A cluster of data points exist off the coast of Sellafield. These show MNCR data from a rippled sandy (sand and muddy sand) seabed characterised by *Echinocardium*, infrequently occurring *Lanice conchilega* and also *Nephtys hombergii* (**SS.SMU.CMU.AfilEcor**) situated 3km west of Sellafield.

Lune Deep, located in the mouth of Morecambe Bay, is a deep kettle hole, charted to a maximum depth of 80m (Hiscock 1998). Sediments in this area comprised heterogeneous mixtures of mud, sand and gravel, dominated by *Abra* communities (Moore and others 1994).

The muddy sands off Barrow have been reported to support a so-called *Amphiura* community (Mackie 1990), that is characterised by the echinoderms *Amphiura filiformis, Echinocardium cordatum* and the gastropod mollusc *Turritella communis*. More recent survey work at the Barrow windfarm site (Warwick Energy 2002) confirmed the continued presence of this assemblage, highlighting the presence of *Amphiura filiformis*, the bivalve mollusc *Mysella bidentata* and the polychaetes *Lumbrineris latreilli, Pholoe inornata* and *Owenia fusiformis* (**CMS.Afil.Ecar**).

4.5.3 Solway Firth

A number of sandbank features are identified in the outer Solway Firth, including Robin Rigg, Two Feet Bank, Three Fathoms Bank and Workington Bank. No banks are present, in this sub-area, along the Cumbrian coast south of Workington. These banks are evidently oriented by tidal movements though none are strongly linear. The limits of Three Fathoms and Worthington Bank would appear to be constrained, at least in part, by the gravel and

bedrock scars off the coast between Workington and Flimby (see Section 4.1.1). The association with these bedrock features suggest, that at least in the case of Workington Bank, the bank can be classified as an example of a banner bank. The other banks are thought to fall into the general 'bank' category (see Section 2.1).

Coarse sediments dominate this area, which is considered to encompass the outer Solway Firth (outside the SAC) to just south of Workington, however the nearshore seabed of the Solway is predominantly comprised of boulders with frequent outcrops of bedrock (see Section 5.5.3). Fine sand mixed with small amounts of mud in Luce Bay (Scotland) support burrowing brittlestars, sea cucumbers and the polychaete *Lanice conchilega*. (FSCR 1992b). The Solway Firth was one of three estuaries chosen by The Irish Sea Pilot to best represent the wide range of Irish Sea estuarine biotopes. These included **FVS**, **LMus**, **IFiSa**, **IMuSa**, **EstSa**, **and ISaMu**. In addition, the Solway Firth scored high in relation to species diversity (Lieberknecht and others 2003).

Cutts and Hemmingway (1996) gave an indication of what may be found in the outer Solway sandbanks, though their survey did not extend as far south as the proposed Robin Rigg offshore windfarm site. The authors found that where there was high wave exposure, sediments were coarse and the fauna dominated by burrowing amphipods, mainly *Bathyporeia* species. Where wave exposure was moderate, clean medium sands to fine sands were present and populated by polychaetes such as *Nephtys cirrosa* and *Nephtys hombergii* and the bivalves *Angulus tenuis, Mactra stultorum* and *Donax vittatus*. Typical species of fine or very fine sand included polychaetes such as *Nephtys* spp, *Scoloplos armiger*, *Arenicola marina* and the amphipod *Bathyporeia pelagica* (Cutts and Hemmingway 1996). In the northwest part of the Solway Firth, sediments were found to include muddy sand and sand supporting typical mobile estuarine species such as *Echinocardium cordatum*, *Ensis* spp., *Nephtys cirrosa* and *Bathyporeia* spp.

Sediments at the site of the proposed Robin Rigg offshore windfarm, located 14 km north east of the Cumbrian town of Maryport, comprised of mobile medium to fine well sorted sand. Well sorted fine sand was found mainly within the Robin Rigg sandbank, and medium sand found to the north of here. The site supports a characteristically impoverished benthic fauna characterised by the presence of the polychaete, *Nephtys cirrosa* and the amphipod, *Bathyporeia elegans* (**IGS.NcirBat**) (Natural Power 2002). These data can be considered to represent the fauna present on both the Robin Rigg sandbank and the adjacent Two Feet Bank, given the similarity of sediment according to Poulton and others (2002).

In the general area of Dumroof Bank, MNCR data highlight the presence of a reduced salinity infralittoral mobile coarse and gravelly sand characterized by impoverished *Nephtys cirrosa* and amphipod community (Appendix 2, Figure F)

The sandy sediment off the coast of Maryport to Workington, incorporating Workington Bank and Three Fathoms Bank lacks any data to aid characterisation and description. (Appendix 2, Figure F). However, sandy sediments in areas to the north (such as at Robin Rigg) is characterised by species as detailed in the preceding paragraphs *Nephtys cirrosa* and *Bathyporeia* spp. while areas of shallow subtidal mud sand (such as that in Scottish Territorial Waters and offshore of Harrington) support *Echinocardium cordatum* and *Ensis* spp. These data are likely to offer an acceptably accurate description of the fauna present.

Offshore of Workington, the seabed has low habitat diversity, with a fairly even and virtually horizontal terrain with only occasional boulder relief (Moore 1996). The spatial extent of this survey was probably too restrictive and close to the coast to fully appreciate whether the sediments off the coast of Worthington were part of a sandbank. On the whole, sediments appeared to comprise sand, sandy mud and muddy sand (see also Hiscock 1998). Dominant epifaunal species were attached to scattered stones and cobbles including the hydroid *Halecium halecinum* and *Abietinaria abietina*, the soft coral *Alcyonium digitatum*, the anemones *Cerianthus lloydii* and *Urticina felina* and the polychaete worms *Sabellaria spinulosa* and *Pomatoceros triqueter.*

4.5.4 Irish Sea summary

From the data presented and detailed in Figure F (Appendix 2), it is evident that the existing mapped areas remain largely unchanged with the limited and patchily distributed collated data supporting the existing mapping.

In the Solway Firth sub-area, the sandy sediments are evidently occurring in a moderate to high energy environment and are consequently populated by an impoverished and low population abundance fauna characterised by highly mobile species such as *Nephtys* polychaetes and *Bathyporeia* amphipods. The bivalve population is characterised by those species, such as *Fabulina fabula* and *Mactra stultorum*, capable of readily (and rapidly) reburying themselves if disturbed by wave and tidal action. On Workington Bank the seabed relief is negligible and the mixed substrates support hydroids, *Alcyonium digitatum,* anemones and *Sabellaria spinulosa.*

In the Cumbria, Lancashire and Liverpool Bay sub-areas, the following faunal assemblages, associated with the differing sediment types, were noted to be characterised by:

- Faunally impoverished sand, including Robin Rigg: *Nephtys cirrosa* and *Bathyporeia elegans;*
- Clean sand, including Great Burbo Bank and parts of Shell Flat: *Magelona johnstoni, Donax vittatus, Fabulina fabula* and *Nephtys cirrosa*;
- Muddy sand, including parts of the Shell Flat: *Amphiura filiformis, Echinocardium cordatum, Lags koreni, Abra alba, Mysella bidentata* and *Nucula nitidosa*;
- Gravelly sand (in Welsh Territorial Waters only): *Spisula* spp., *Gari fervensis, Echinocardium cordatum* and *Nephtys cirrosa*; and
- Mixed sediments: hydroids, *Alcyonium digitatum*, *Sabellaria spinulosa* and *Pomatoceros triqueter*.

The sandy sediment character varies across the sub-areas, with ribbon shaped areas of sandy sediment present, for example, off of Ravenglass and sand wave fields in the Liverpool Bay sub-area. The sandbanks that are present in the Solway Firth and Liverpool Bay sub-areas are generally considered to fall into the general ‘bank’ category, though Workington Bank may represent a banner bank, given that it is in the lee of a bedrock scar. Most of the sandbanks consist of sands though muddy sand is also a characteristic of locations such as Workington Bank and the lower parts of Shell Flat.

The bulk of the spatially referenced data was sourced from offshore windfarm developments and, as such, was concentrated to specific study sites and in particular some of the sanbanks

in the Liverpool Bay sub-area. However, all of these studies supported earlier published descriptions of the faunal assemblages present.

5. Reefs

The following subsections describe the reef features and their biota for each Marine Natural Area. Each Marine Natural Area is subdivided to facilitate presentation of the data. The sub-areas follow those described in and illustrated in Figure A.

5.1 Mid North Sea

For the purpose of this report, the Mid North Sea Marine Natural Area has been divided into:

- Northumberland to the Tees
- The Tees to Flamborough Head

Figure B (Appendix 2) and Figures 52-61 (Appendix 2 CD-rom) show the area under discussion in this section, including: relevant habitats illustrated in maps derived from data provided by Poulton and others (2002), the tagged data points acquired for this project and the sub-area boundaries.

All places mentioned in subsections 5.1.1 – 5.1.3 are shown in Figure 1

5.1.1 Northumberland to the Tees

From the Tees as far north as the North Northumberland and Berwickshire SAC, occasional data points indicate the presence of bedrock, boulders and cobbles characterised by *Flustra foliacea*, *Alcyonium digitatum*, *Tubularia indivisa, Pomatoceros triqueter*, *Gibbula cineraria*, *Flustra foliacea* and *Laminaria hyperborea* and hydroids. Most conspicuous of these areas is an extensive rock platform extending from the Northumberland coast (approximately 5.4 km north of the River Tyne) now highlighted in the revised maps. A second, smaller outcrop is present off of Blyth.

Further offshore, almost all MNCR records off the coast between Robin Hood Bay and Blyth, and in particular between Sunderland and Blyth, in water depth in excess of 20 m, indicate a reef substrate that is principally described as silted boulders or bedrock. Characterising species include hydroids, *Alcyonium digitatum*, *Pomatoceros triqueter*, *Sabellaria* sp. found among holdfasts of *Laminaria hyperborea*, and other algae such as *Phyllophora pseudoceranoides*, *Polysiphonia elongata* and *Chondrus crispus*. Though the data are consistent, their spatial distribution is such that suggesting the occurrence of a band of stony reef would, at present, be too tentative to justify modifying the map, even just south of Blyth.

Further north, this line of reef data points continue but identify bedrock.

Limpenny and others (1993) describe an offshore region of Seaham, Durham to comprise of rocky and stony substrates. Inshore was comprised mainly of sandy substrate while offshore comprised mainly of rocky substrate and more southerly areas covered by a layer of mud.

One data point, far offshore from the Tees indicates the presence of mussels *Mytilus edulis, Lanice conchilega, Spisula* sp. and *Echinocardium pennatifidum* . Without further data it is not possible to classify this as a biogenic reef area.

5.1.2 The Tees to Flamborough Head

All along the coast as far as the Tees Estuary, MNCR nearshore records indicate the sporadic presence of large boulders, and cobbles supporting characteristic species bryozoans such as *Flustra foliacea* and *Bugula* spp., *Pomatoceros triqueter*, *Alcyonium digitatum*, kelps such as *L. hyperborea* and occasional *Sabellaria spinulosa*. Specific locations of interest together with those indicative of areas of reef, within this generalisation are:

- Approximately 5km southeast of Robin Hood's Bay MNCR records indicate the presence of bedrock characterised by *Alcyonium digitatum, Flustra foliacea* and boulders and cobbles supporting *Sabella pavonina* and hydroids such as *Hydrallmania falcata, Abietinaria abietina* and *Thuiaria thuja*.
- In deeper water (30 - 40m BCD), boulder and cobbles are scattered across mud plains. A layer of silt covers the stony reef and is characterised by *Tubularia larynx*, *Fustra foliacea, Sertularia argentea, Hydrallmania furcata, Alcyonium digitatum* and *Bugula purpurotincta*.

Although individually representative of reef features, these data are too spatially isolated to map as a reef at present. Similarly the data indicating the occurrence of *Sabellaria spinulosa* are insufficient to indicate a biogenic reef.

5.1.3 Mid North Sea summary

This Marine Natural Area is characterised by rapidly increasing water depths away from the coast. Though BGS data have suggested soft sediments occur throughout much of the area, data obtained for the purpose of this study have also indicated that a wide scattering of bedrock and boulder reef to be present. These include isolated areas, headland-associated promontories (such as 4.5 km north of the River Tyne and also at Blyth) and a possible band of deeper water (20 to 40 m) stony reef on a mud plain (Robin Hood Bay to Blyth) or bedrock (Blyth to the North Northumberland and Berwickshire SAC).

5.2 Southern North Sea

For the purpose of this report, the Southern North Sea Marine Natural Area has been divided into:

- Flamborough Head to North Norfolk
- South Norfolk to Suffolk
- Thames Estuary (including Essex)

Figure C (Appendix 2) and Figures 36-51 (Appendix 2 CD-rom) show the area under discussion in this section, including relevant habitat maps illustrated in derived from data provided by Poulton and others (2002).

Both The Wash and Humber are excluded from this study as they have already been designated as SACs.

BGS (2002) briefly summarises the hard substrata of the southern North Sea. The report notes that offshore from the East Anglia Coast, Upper Cretaceous formations of chalk may be exposed at the seabed though they provide insufficient detail to assess with respect to the maps derived from data provided by Poulton and others (2002).

All places mentioned in subsections 5.2.1 – 5.2.4 are shown in Fig 2.

5.2.1 Flamborough to North Norfolk

Along the North Norfolk coast, the underlying bedrock consists of chalk. However, with the exception of the nearshore sublittoral off the coast between Weybourne and Overstrand, this bedrock is overlain by till which in turn is covered by gravelly sand, gravel and cobbles generally less than 1m thick (Barne and others 1995, Evans and others 1998). Consequently no potential reef areas have been identified either from the data of Poulton and others (2002) or during this study.

As noted in Section 4.2.1, the sandy sediments of the Docking Shoals are populated by *Sabellaria spinulosa*. A series of surveys carried out in the area have mapped areas where the population density is sufficiently high to constitute a biogenic reef (Foster-Smith and Hendrick 2003). Reef areas were noted to extend from within the boundaries of the Wash SAC along the Lynn Deeps northeast to areas proximate to the northern periphery of licenced aggregate area 107. The presence of *Modiolus* is also noted in this report though it is not discussed further and as such it is not possible to determine whether they constitute biogenic reefs (or areas with patches of reef). The data that mapped these sites were not available for this study and hence have not been included in the revised figures.

Offshore from the Lincolnshire coast, the majority of the bedrock consists of chalk with outcrops covered by a thin sediment layer. Sediments in the region are predominantly sandy gravel (Evans and others 1998).

South of the Humber Estuary, in an offshore area of gravel MNCR records of gravel and muddy gravel mention the occurrence of *Sabellaria spinulosa*, but do not indicate that a biogenic reef is present. As such, the area of these data points has not been considered to constitute a biogenic reef.

Offshore, from the mouth of the Humber, evidence of an area of stony reef has been noted while northeast of the mouth, the seabed sediment comprises extensive sand wave fields underlain by gravel (Evans and others 1998).

In the approaches to the Humber Estuary a small number of data points indicate the presence of reef aligned to a finger of gravelly sand. Barne and others (1995) indicate the occurrence of large areas of gravel out from the mouth of the Humber characterised by *Flustra* spp., *Modiolus* and *Sabellaria* sp. (Murray and others 1980).

As noted above, the underlying bedrock consists of chalk but this is overlain by till which in turn is covered by gravelly sand, gravel and cobbles generally less than 1m thick (Evans and

others 1998). Only at Flamborough Head is the chalk emergent. However, this area is already a SAC.

5.2.2 South Norfolk to Suffolk

Maps derived from data provided by Poulton and others (2002) have not identified any potential reef areas (Appendix 2, Figure C). Areas of gravel lack data with which to characterised them. Newell and others (2001) located *Sabellaria spinulosa* biogenic reef approximately 13 nautical miles east of Great Yarmouth, in the vicinity of South Cross Sand, stretching from offshore into Territorial Waters. In aggregate licence area 401/2 Johnston and others 2002 indicate that further areas of this habitat are likely to occur owing to the presence of stable coarse, gravelly sand in surrounding areas.

Beyond the nearshore shallow water sandy sediment areas off the coast of north Suffolk, data indicates a seabed of fine to medium grade sand along with patches of gravel, mud and shelly sand. However, no data indicate the occurrence of stony reef or other potentially relevant habitat.

5.2.3 Thames Estuary

Barne and others (1998) report the presence of a discontinuous gravel belt running offshore from Aldeburgh to Clacton-on-Sea in Essex (Appendix 2, Figure E). Gravel occurring in the outer Thames is predominantly composed of flint with pebbles such as quartzite, sandstone, phosphorite and carbonate being locally abundant (Barne and others 1998). Seabed sediments in the northern most sandbank area of the Thames are quite variable, with regions between the sandbanks comprising of complex sediment cover (Evans and others 1998). Such description, though not corroborated with other data, suggest that these gravel areas do not offer the potential for the occurrence of stony reef.

There are two isolated data points in the Thames Estuary (Appendix 2, Figure 37). One indicates a mussel bed in the mouth of the Medway estuary, the other a record of *Sabellaria spinulosa* and *Polydora* sp. (**SS.SBR.POL.SspiMx**) south east of Canvey Island. The only other data on potential reefs in this sub-area is just offshore of the Thorpeness headland (not mapped). This potential reef is of note as there is little or no other hard seabed type substrate offshore in this area (Bamber 1993). It was recorded to support some locally unusual communities. The reef comprises sand scoured, hard coralline crag rock, heavily fissured and creviced with softer sediment patches. Reef areas support dense beds of the ascidian *Molgula manhattensis*, phoronid worms and bryozoans including *Sertularia argentea* and *Bugula plumosa.* Vertical faces were characterised by *Tubularia indivisa*, *Alcyonium digitatum* and *Flustra foliacea*. It has not been possible to source data for the few small patches of gravel in this sub-area to determine where they represent stony reef.

5.2.4 Southern North Sea summary

This Marine Natural Area is characterised by its shallow soft sediments. As such there are restricted amounts of reef habitat present. Of note is the area of reef off the coast of Thorpeness which is colonised by the ascidian *Molgula manhattensis*, phoronid worms and bryozoans including *Sertularia argentea, Bugula plumosa, Flustra foliacea* and the hydroid *Tubularia indivisa*. Throughout the Southern North Sea, *Sabellaria spinulosa* is a commonly occurring species. However, detailed quantitative data is limited for English Territorial

Waters and, with the exception of the location offshore from Great Yarmouth (Aggregate Licence Area 401/2) and that mapped offshore of the wash on Docking Shoals (Aggregate Licence Area 107) (Foster-Smith and Hendrick 2003) there is insufficient evidence to indicate the occurrence of a *Sabellaria* reef. *Modiolus* are recorded in the area but reports do not specifically mention their occurrence as areas of biogenic reefs.

5.3 Eastern Channel

For the purpose of this report, Eastern Channel Marine Natural Area has been divided into:

- Kent and Suffolk
- East Dorset and Hampshire

Figure D (Appendix 2) and Figures 24-35 (Appendix 2 CD-rom)show the area under discussion in this section, including relevant habitats illustrated in maps derived from data provided by Poulton and others (2002).

Johnston and others (2002) indicate that the region of the Eastern Channel Basin supports large areas of potential reef habitat. While much of this lies beyond Territorial Waters, two large areas occur off the Isle of Wight and Sesley Bill.

All places mentioned in subsections 5.3.1 – 5.3.3 are shown in Figure 3.

5.3.1 Sussex and Kent

In the central and eastern regions of the English Channel, tidal streams are strong resulting in a scoured seabed, with a minimal covering of sediment leaving the underlying gently dipping lower tertiary rocks exposed in places (Holme and Wilson 1985; East Channel Association 2003). Flint and chalk pebbles occurring in the Straits of Dover were derived from Upper Cretaceous bedrock namely chalk with flint bands, and running westwards into Lower Cretaceous sediments (Barne and others 1998). Areas of pebbles, cobbles, boulders and rock outcrops are populated by encrusting sponges, ascidians and bryozoans whilst cobble areas covered by sand giving rise to populations of *Urticina felina*, *Flustra foliacea* and the polychaete *Sabellaria spinulosa* (Holme and Wilson 1985). Data records indicate the presence of *Mytilus edulis* reef 9.5 km south of Pagham.

Chalk occurs on the nearshore between Bognor Regis and Worthing with flint the main source of gravel arising from the chalk bedrock. Extensive areas of sandstone and clay occur south and east of the Isle of Wight. Thus, according to Evans and others (1998) the majority of the seabed between St. Catherine's Point and Shoreham is made up of bedrock and gravel deposits, with large areas of cobbles and boulders off the Isle of Wight. This is not reflected in the maps derived from data provided by Poulton and others (2002), though data collated for this project have identified a number of bedrock and stony reef patches. The moderately exposed sandstone bedrock, rocky outcrops of low lying chalk bedrock and slab-like boulders were characterised by mixed faunal turfs with epifauna such as the ascidian *Aplidium densum*, the cnidarian *Alcyonium digitatum,* sponge species, occasional anemones such as *Urticina* sp. and *Cereus pedunculatus,* bryozoans such as *Flustra foliacea*, hydroids including *Nemertesia antennaria*, encrusted calcareous algae, encrusting coralline algae, abundant foliose red algae and occasional *Laminaria* spp. These are scattered across a gravelly sand

area. This area is likely to be a mosaic of gravelly sand and isolated patches of potential boulder reef.

Offshore from Shoreham to Beachy Head, chalk and tertiary rocks occur on the seabed covered in places by sand and gravel (Evans and others 1998). Just south and east of Brighton several MNCR records indicate the occurrence of flat topped boulders with sponges surrounded by cobbles, pebbles and gravel. Characteristic species include *Alcyonium digitatum* and foliose algae. A separate cluster of records reveal the presence of chalk cliffs and outcrops supporting *Dysidea* sp. and *Flustra foliacea*. In particular, the Seaford to Beachy Head nearshore environment would appear to be dominated by bedrock and stony reef .

Maps derived from data provided by Poulton and others (2002) indicate the presence of a 22 km^2 gravel patch off the coast of Beachy Head. However no biological data have yet been identified to confirm either the habitat or the communities present.

MNCR records point to the presence of *Mytilus edulis* beds off the coast of Beachy Head and these records coincide with the edge of a potential area of gravel identified by BGS. Other data records adjacent to this potential gravel area record the presence of cobbles and boulders, which also support *M. edulis.*

Between Beachy Head and Dungeness the seabed comprises Lower Cretaceous rocks covered by either a thin layer of sand and sandy gravel or a thick layer of sand (Evans and others 1998). BGS data has identified two separate patches of potential reef along the coast between Beachy Head and Dungeness. MNCR data indicate that the reef to the west consists of bedrock, cobbles and pebbles which are encrusted with the soft coral *Alcyonium digitatum,* the sponge *Esperiopsis* sp. and foliose red algae. The eastern patch supports crabs and foliose red algae. A small cluster of MNCR data for the eastern edge of the larger patch of reef indicates a seabed of fine muddy silt. Data is insufficient to delimit the eastern patch of reef or to more adequately describe its characteristics.

Also along this stretch within the marked sandy sediment area (western extremity) MNCR records indicate the presence of sandstone reef, bedrock with some gravel and shell fragments supporting significant *Mytilus edulis* beds, starfish such as *Asterias* and brittlestars. As such, the seabed habitat has been revised to encompass these data.

To the east of Dungeness, maps derived from data provided by Poulton and others (2002) point to the presence of a number of very small patches of reef. An absence of corroborating data has meant that this area has had to be left unchanged. A few additional data points indicating the presence of stony reef (and *Sabellaria spinulosa*/bedrock communities, Marine Ecological Surveys Ltd 1997) interspersed with sand and muddy sand samples, suggest a sandy sediment with scattered patches of reef which is presumably described as stony reef.

Offshore from Folkestone and Dover, areas of potential reef are mapped and extend beyond the limits of English Territorial Waters. However, no data have been obtained for them. For the small areas of bedrock off the coast from Deal and larger areas east of Ramsgate, data is limited to nearshore data east of the Isle of Thanet, and immediately adjacent to the existing SAC. Here, MNCR data indicates areas of chalk bedrock, cobbles and pebbles overlain by a coarse cover of sand characterised by hydroids *Tubularia indivisa* and *Ectopleura dumontierii*, *Mogula manhattensis,* anemones such as *Alcyonidium diaphanum, Alcyonium*

digitatum as well as *Sagartia troglodytes* and *Flustra foliacea*. It is likely that the other areas show similar characteristics.

Approximately 14 km east of Dover indicates the presence of a large patch of gravel though no additional data has been sourced to determine whether stony reef occurs there.

5.3.2 Hampshire and East Dorset

Approximately 15 to 20 km south of Portland Bill, two areas of bedrock reef are indicated. These areas are approximately 20 km^2 and 5 km^2 respectively. However, at present there are no other point data records for this area with which BGS data can be confirmed.

Offshore from Portland Bill to Anvil Point large expanses of the seabed support exposed bedrock with thin sediment cover in places. A great deal of the seabed is formed of soft sandstones and clays, though harder sandstones and limestone occur between Portland Bill to an area south of St. Alban's Head (Evans and others 1998). Areas of exposed bedrock include the Kimmeridge Ridges (off the coast from Kimmeridge), around St. Alban's Head and Anvil Point and on the Lulworth Banks. This area has been noted to represent a biological boundary with southern species generally reaching their eastern distribution limits here (FSCR 1992a), although some such as the pink sea fan, *Eunicella verrucosa*, do extend further west (V. Copely, English Nature, *pers. comm*.). In this stretch data indicates the presence of species such as *Laminaria digitata, L. hyperborea*, *Urticina felina*, *Alcyonium digitatum,* the hydroid *Nemertesia antennaria* and *N. ramosa,* a variety of bryozoans including *Pentapora foliacea* and *Flustra foliacea* and the mussel *Modiolus modiolus*. Patches of maerl and sandy sediments have also been noted. As a consequence of compiling these data, the areas to the east of the Lulworth Banks extend the area classified as reef, notably off Kimmeridge and also to the west of Anvil Point (Appendix 2, Figures 24). The few points on the Lulworth Banks that are considered to show reef (by virtue of the species recorded) are too few and too widely separated to suggest the need to redefine this area. Instead, it is considered more appropriate to consider this area as consisting of sand (or gravelly sand) with isolated pockets of reef.

At the outer limits of Swanage Bay (in approximately 20 to 30 m of water) there is a concentration of data indicating an abundance, of *Sabellaria spinulosa*. This cluster has consequently been classified as a biogenic reef. It is understood that in this location, this biogenic reef is at least 1km wide (V. Copley, English Nature, *pers. comm.*)

In the maps derived from data provided by Poulton and others (2002), there are a few isolated areas of rock substrata in Poole Ba. Collectively the areas correspond to around 1.5 km^2 and are largely surrounded by sand and gravelly sand. MarLIN data records exist for the most centrally located area of rock substrate, indicating that kelp and other macro algae species are present, as well as *Alcyonium digitatum*, *Metridium senile, Urticina felina,* bryozoans*, Nemertesia* spp., *Ophiothrix fragilis, Caryophyllia smithii* and the jewel anemone *Corynactis viridis*. Additional data has been collated that suggest the extent of reef is greater than that suggested by the data of Poulton and others (2002). It is of an undetermined type but probably stony given that the data was likely sourced from a seabed grabbing survey (from MNCR data which indicate the source to be Jensen (1989) in the, 'The Poole Bay grid baseline benthic survey'). The Admiralty chart for Poole Bay indicates the sediment to be sand and stone, supporting the assumption that the data indeed indicate stony sediment that might be considered as stony reef.

Further offshore a number of isolated rock substratum areas are identified by BGS data but there are at present no further data records relating to these sites.

Offshore exposed rocks west of the Isle of Wight are similar to those located south west of the Isle of Wight. Seabed sediments are generally less than 0.5m thick and comprise of gravel, with cobble and boulders. The geology of the bedrock comprises mainly sandstone and clays while large areas of chalk occur south of here (Evans and others 1998). A reef of iron stone boulders extends offshore of Hengistbury Head, Christchurch for approximately 5km. The sublittoral area between Hengistbury Head and Christchurch Ledges has been surveyed and data indicate communities on sand, gravel, clay and boulder. Previously extensive mussel beds *Mytilus edulis* have been devastated by populations of the starfish *Asterias rubens* (Hiscock 1998). Chalk outcrops dominate the subtidal area between Studland Bay and Old Harry Rocks. BGS data indicates that there is a large area of mixed gravel covering an area of approximately 175km^2, some 5km south of Durlston Head at Swanage but biological data here is lacking.

The area to the south east of the Isle of Wight includes areas dominated by *Sabellaria spinulosa*, often occurring on rock and cobble areas, with occasional *Sabellaria aveolata* in higher density areas (Marine Ecological Surveys Ltd 1996). However, more recent surveys show a recent reduction in key community species such as *Sabellaria spinulosa, Pisidia longicornis, Dendrodoa grossularia,* and *Balanus crenatus* in the area (Marine Ecological Surveys Ltd 2002). In addition, approximately 11 km offshore of the southern most tip of the Isle of Wight, a large area of gravel of approximately 288 km^2 can be found. From these data, there is some suggestion that population densities of *Sabellaria* spinulosa might constitute biogenic reefs.

MNCR data for the Sussex coast between East Wittering and Sesley indicate the presence of limestone and sandstone flat and spherical boulders characterised by *Ascidiella* species and subordinate foliose red algae.

BGS data point to the occurrence of three separate areas of bedrock just off the coast by Sesley Bill covering an area of just over 6.1 km^2. MNCR data from the central area of bedrock indicate a seabed of sandstone rock, boulders, sand and shell predominantly covered by a thin layer of sand with some boulders and pebbles supporting *Halidrys siliquosa*, short kelps such as *Laminaria hyperborea* and a variety of dense foliose red seaweeds. Clay bedrock covered with sand found nearer the coast is characterised by the presence of *Pholas dactylus*. MNCR data for the edge of the western area of rock reveal spherical boulders (limestone and mudstone), the lower part of which is buried in sand. In the third and most easterly area of bedrock MNCR records list the presence of mudstone, cobbles, pebbles, clay with limestone boulders and gravel ridges with sponge dominated crests. This area is characterised by *Pomatoceros*, *Crepidula* and *Actinothoe* species. From this data one may conclude that these three areas of reef constitute a combination of bedrock and stony reef that would appear to have been mapped accurately.

At around 6 km south of Sesley Bill, MNCR data indicates the presence of sublittoral sand and gravel as well as some cobbles. Characteristic species of the cobbles include foliose red algae and hydroids, such as *Sertularia* and sea anemones such as *Urticina*.

Directly south east of Sesley Bill adjacent to the coast, gravel, pebbles, cobbles and sand characterised by *Urticina*, crustaceans, *Crepidula*, scallops and *Bugula* have been recorded (MNCR data). Approximately 3.75 km west of this location (on Medmerry Bank), clay bedrock can be found scattered with coarse sediment and shells such as oyster and other bivalves.

5.3.3 Eastern Channel summary

Along much of the coast of this area there are records of bedrock and boulder reefs, variously made from limestone, sandstone, clay, chalk and flint. The fauna is variously characterised by (inshore and west of this MNA) *Laminaria* spp., *Alaria esculentus*, *Alcyonium* spp., *Nemertesia spp., Flustra foliacea* and *Eunicella verrucosa* or faunal turfs (in deeper water and to the east of this MNA) with a wide variety of sponges, bryozoans, hydroids and ascidians. The softer sediments have been extensively bored and in places the piddock, *Pholas dactylus,* were still recorded as present. In areas such as between Lyme Regis and Beachy Head, the frequent occurrence of reef data in shallow water suggests the presence of a mosaic of small patches of boulder and bedrock amongst gravelly sand.

Along the Kent coast, east of Dungeness, small pockets of bedrock and stony reef are scattered across an area of sandy sediment. Offshore, the larger areas of reef indicated in maps derived from data provided by Poulton and others (2002), have limited data with which to characterise and delimit them.

Sabellaria spinulosa are common in this area, particularly to the south and south east of St Catherine's Point, Isle of Wight where recorded abundances suggest the potential for reef habitat, at least in 1996 when samples were collected. More certainly, the *Sabellaria* aggregation in Swanage Bay constitutes a biogenic reef and has already been recognised as such by English Nature.

Mussel beds (*Modiolus* and *Mytilus*) have also been identified, particularly the latter offshore of the Beachy Head to Dungeness coast.

5.4 South Western Peninsula

For the purpose of this report, the South Western Peninsula Marine Natural Area has been divided into:

- South Devon and West Dorset
- South Cornwall
- North Devon and North Cornwall;
- Bristol Channel

Figure E (Appendix 2) and Figures 8-23 (Appendix 2 CD-rom) show the area under discussion in this section, including the relevant habitats derived from data provided by Poulton and others (2002).

All places mentioned in subsections 5.4.1 – 5.4.5 are shown in Fig 4.

5.4.1 South Devon and West Dorset

From Plymouth Sound to Start Point, mapped data indicate the presence of a substantial area of potential reef (approximately 320 km^2). A significant number of MNCR and MarLIN data are present within these areas, although almost exclusively within the 20m contour. The data are predominantly for infralittoral and circalittoral highly exposed bedrock biotopes, supporting kelp species, red algae, various anemones, bryozoans, ascidians and corals, as well as the pink sea fan *Eunicella verrucosa* and biotopes such as **IR.HIR.KFAR.For.Dic, IR.HIR.KFAR.LsaSAC, CR.HCR.XFA.ByErSp.Eun** and **CR.HCR.XFA.CvirCri**. Around the open coast in the vicinity of Salcombe, there is a fringe of broken bedrock extending from the shore down to about 6m depth. The rock is broken with gullies, occasional tunnels and patches of sand (Hiscock 1985). At the entrance to Salcombe Harbour, rocks at Fort Charles and the Black Stone extend into the shallow sublittoral, although overall the area is characterised by soft sediments (gravelly sand). As with some other areas considered to be bedrock reef by BGS, some additional species records for sediment species are present, for example, *Ophiura albida*, *Lanice conchilega* and *Ensis* sp. These records indicate the presence of a sediment/reef mosaic but are insufficient in their spatial coverage to refine the map as derived from data provided by Poulton and others (2002).

From Start Point to Portland Bill a number of smaller inshore areas are indicated as potential reef in maps derived from data provided by Poulton and others (2002) (Figure E). These areas are mainly focussed around headlands (Froward Point, Barry Head, Hope's Nose and Portland Bill) and other areas relatively close to shore. They are typically bedrock (granite, limestone and mudstone) substrata, with some stony (boulder and cobble) reefs, supporting infralittoral and circalittoral, moderately and highly exposed biotopes. The biotopes supported a range of key species including kelps, red algae, sponges, bryozoans, *Mytilus edulis*, anemones, corals (soft and solitary hard, including the sunset coral *Leptopsammia pruvoti*), ascidians and the pink sea fan *Eunicella verrucosa*.

The horse mussel *Modiolus modiolus* has also been recorded along the eastern part of the Isle of Portland. Data on this species, however, is insufficient to categorically indicate the presence of a biogenic reef consisting of *Modiolus* and associated fauna but the number of reef data also found here, suggest the mussels are primarily growing on existing rock.

A number of potential offshore reef areas are also presented in maps derived from data provided by Poulton and others (2002), with one (approximately 7.4 km^2) some 11 km south east of Exmouth. Unlike this area, where no data are available, three similarly sized reef areas lie within Lyme Bay (Appendix 2, Figure E), that do have some supporting data available. Here, data reports the same biotopes as noted above for the coastal reefs. Additionally, data collated for this project have identified further stony reef, bedrock reef and other (undefined) areas of reef substrata most notably in the general area of the three similarly sized reefs. Characteristic fauna include *Alcyonium digitatum, Eunicella verrucosa, Asterias rubens, Cellaria* spp*., Nemertesia* spp*. and Sertularia* spp. and *Pentapora foliacea*. Grist and Smith (1995) noted that in Lyme Bay, hard substrata was dominated by red algae in shallow waters and sponges and bryozoans in more deep waters .These additional areas of reef have been included in the revised map of the bay.
Within Lyme Bay, there are two mapped gravel areas. One area of approximately 1.6km^2 lies 2 km south of Lyme Regis and is supported by data indicating the presence of boulders, cobbles, pebbles and coarse sand, populated by sponges and bryozoans. The other area (approximately 9.6 km^2) lies some 8 km to the west of Portland Bill and at present, no

additional data for this area were available and thus the mapping of these areas has not been modified.

5.4.2 South Cornwall

From Mousehole to the Lizard, there are two significant areas of potential rocky reef indicated by BGS data. The first area lies approximately 1.5 km south of Cudden Point (approximately 20 km^2), however, there are no supporting biological data for this area, with only one adjacent data record, indicating the presence of kelp on bedrock with cobbles and some sand. The second is a substantial potential reef area (approximately 86 km^2) at Lizard Point. Data records are present for shallow water within and adjacent to this potential reef area and indicate the presence of moderately and highly exposed, mainly bedrock, biotopes with some boulders to the south of Lizard Point itself and some patches of coarse sediment. These substrata support kelp (*Laminaria hyperborea* and *L. ochroleuca*), various red algae hydroids, anemones, including the jewel anemones *Corynactis viridis*, the soft coral *Alcyonium digitatum*, the solitary coral *Caryophyllia smithii,* bryozoans such as *Alcyonidium diaphanum*, *Pentapora foliacea* and *Porella compressa*, as well as ascidian and sponge species (MNCR data, Hiscock 1998). The biotopes present include **IR.MIR.KR.Ldig.Ldig, IR.HIR.KFAR.Ala.Ldig** and **CR.HCR.XFA.SpNemAdia**. From these data points, it is evident that the Lizard Point area supports appreciable areas of reef (bedrock and boulder) but the offshore extent indicated in maps derived from data provided by Poulton and others (2002), is unconfirmed.

Between the Lizard, and St. Anthony Head to the east, point data suggest the presence of several areas of potential reef. Comparison with Admiralty data indicates that these are associated with charted rocks (The Bizzies, The Manacles, The Bellows, Gwineas Rock etc.). As such, these areas have been noted in the revision of the maps. Characteristic species include *Eunicella verrucosa, Alcyonium digitatum, Pentapora foliacea, Corynactis viridis, Aglaophenia pluma* and *Scrupocellaria* sp. To the east, the next area of potential reef (5.5 km^2) lies to the south of St. Anthony Head although no supporting point data are available for further description.

Close to the Fowey Estuary, BGS data indicate another potential reef area (9 km^2) lying south of Gribbin Head. There are a few data points within or adjacent to the area and these indicate the presence of bedrock biotopes with kelp species, red algae, the soft coral *Alcyonium digitatum*, sponges, anemones such as *Corynactis viridis*, the bryozoan *Porella foliacea* and the pink sea fan *Eunicella verrucosa*. Biotopes present included **IR.MIR.KR.Ldig.Ldig IR.HIR.KFAR.CvirMsen** and **CR.FCR.FAV.Verticals**.

Approximately 16 km south of Whitsand Bay lay the Eddystone Rocks and other areas to their west, including Hand Deeps, indicated as potential reef areas by BGS and admiralty chart data. There are supporting biological data for the Eddystone Rocks, which indicate the presence of a number of highly exposed bedrock biotopes supporting various kelp species, anemones such as *Corynactis viridis*, *Sagartia elegans* and *Urticina felina*, the hydroid *Tubularia* spp., bryozoans such as *Porella foliacea* and *Flustra foliacea* and the sea fan *Eunicella verrucosa*. The following biotopes were recorded **IR.HIR.KFAR.LhypR.Ft, IR.HIR.KFAR.Ala.Ldig** and **CR.FCR.FAV.Verticals**. At the Hand Deeps, the recorded fauna and flora was comparable to Eddystone and included **IR.HIR.KFAR.LsaSAC, IR.oldEIR** and **CR.MCR.ECCR.CarSp.PenPor** biotopes characterised by species such as *Aryophyllia smithii,* sponges with *Pentapora foliacea* and *Porella compressa.*

In addition, the mussel *Modiolus modiolus* was also recorded, as well as the razor shell *Ensis* sp. and the brittlestar *Ophiura albida*, the latter two being indicative of sandy substrata and thus suggesting that the limits of the bedrock area, at least in these locations, has been well delineated by the data provided by Poulton and others (2002).

5.4.3 North Devon and North Cornwall

BGS data indicate the presence of a zone of gravel offshore, but no other potential reef areas. This gravel area lies to the north east of Hartland Point and is of approximately 1.5 km^2 at 40m depth. There were some offshore biological data available including CEFAS dredge records, for the mussel *Mytilus edulis,* to the north of Clovelly and west of Baggy Point (**CR.MCR.CMUS**), with *Metridium senile* and *Urticina* sp. also present, suggesting the presence of hard substrata in those locations. To the west of Hartland Point, further MarLIN and CEFAS data indicate the potential presence of reef (*Metridium senile* and *Echinus esculentus)* but these records alone are too inadequate to consider representing any sort of reef). Apart from these data, the bulk of records for reef biotopes and species are close to shore. These include a number of potential bedrock and boulder reef biotopes of moderate or high exposure in the circalittoral and infralittoral, including kelp and other macro algae dominated biotopes such as **IR.MIR.KR.Ldig.Ldig, IR.HIR.KSED.XKHal** and bryozoan, sponge and mixed faunal biotopes such as **CR.HCR.XFA.Mol.** The presence of these reef biotopes close to shore, combined with BGS sediment distribution data, suggest that hard reef substrata in this area give way rapidly to sediment on moving away from the coast.

From Port Isaac to East Trevose Head the seabed comprises areas of flat plain or gently sloping sand with broken reefs and rocky outcrops (Hiscock 1978). Hiscock goes on to note that bedrock communities here were not as rich as expected considering its geographic location, and concludes this may be a result of a high sand load in the water. Offshore of the North Cornwall coast extensive bedrock platforms are present, colonised by kelp forest *Laminaria ochroleuca* being the most abundant, extending to over 20 m depth. Under the kelp forest, rock is encrusted with bryozoan and hydroid turf and *Alcyonium digitatum* and *Corynactis viridus* (Hiscock 1981 1998; Poulton and others (2002)).

A gravel area is present approximately 12 km to the west of Bude Bay in water depths that are in excess of 40 m, however, no data has been identified which clarifies its character and fauna. Closer to shore, rocky biotope records are present seaward of lower Sharpnose Point and at the southern end of Widemouth Bay, with infralittoral and circalittoral mixed faunal bedrock biotopes such as **CR.HCR.XFA.Mol** again recorded.

South of Widemouth Bay to Padstow, BGS data indicate the presence of sand close to shore for much of the coast. However, there are also a number of records suggesting the presence of mainly bedrock reef, particularly in areas around Boscastle and Tintagel Head. The records are mainly infralittoral but with some extending into the circalittoral supporting kelp and larger algae species **IR.MIR.KR.Ldig.Ldig, IR.MIR.KR.Lhyp.Ft, IR.HIR.KFAR.Ala.Ldig** in addition to species rich fauna dominated biotopes such as **CR.FCR.Cv.SpCup** with various sponges and anemones. These observations reflect the information presented in Admiralty charts which show a number of rock outcrops and broken reef areas (Gulland Rock, Gurley Rock, and Chimney Rock) amongst stretches of sand between East Trevose Head and Port Isaac.

In addition, there are records of the presence of potential biogenic reef building species, *Mytilus edulis* and *Modiolus modiolus* in the area of Portquin Bay. Faunal species here include *Mytilus edulis* and the sea squirt *Dendrodoa grossularia*.

BGS data indicate a large area of rock (approximately 86 km^2) running from shore to seaward (west) from the coastline, between Rumps Point (Padstow) and Park Head extending for much of its area, from relatively close inshore, to beyond the 40m depth contour. A number of data records support the presence of reef biotopes from Portquin Bay to the southern side of Trevose Head, supporting a number of species indicative of hard substrata. The fauna recorded here include anemones, ascidians, sponges, bryozoans, corals, hydroids, the pink sea fan *Eunicella verrucosa* and various kelp species (infralittoral rock supports kelp communities (Hiscock 1998)). Biotopes recorded included **IR.HIR.KFaR.Ala.Ldig, IR.FIR.SG.CrSpAn.Tub** and **IR.HIR.KFAR.LhypR.Ft**.

Moving south along the coast, BGS data indicate an area of potential reef to the north of St. Ives Bay, off Navax Point. Although close to the coastline, the BGS data does not extend to shore and no supporting biological data have been obtained to date for this location. Further west, records close to shore in the area of St. Ives Head (boulder plains) and Browther Rock (bedrock slope) indicate the presence of potential infralittoral reef biotopes supporting kelp and red algae. It should be noted that the data may indicate discrete reef areas, rather than an extensive reef.

Further west and south, three very large areas of rock (approximately 208 km^2 in total) lie offshore from the coast between The Carracks and Land's End and include Cape Bank, while an area of gravel (approximately 43 km^2) also lies offshore from this section of coastline. Though this suggests a significant area of potential reef features, the supporting biological data for these areas is very limited, particularly offshore. As with the reef areas around Padstow, the majority of records are associated with locations close to shore and these indicate that hard substrata support an extensive range of infralittoral and circalittoral boulder and bedrock biotopes, with hydroids, bryozoans, sponges, kelp species and red algae **IR.HIR.KFAR.Sac, IR.HIR.KFAR.LhypFa, IR.HIR.KFAR.Ala.Myt, IR.HIR.KSed.XKScrR** and **CR.HCR.XFA.oldFlu.HByS**.

The most southern BGS potential reef area in the North Cornwall area extends beyond Land's End and into South Cornwall, with supporting data at just one location approximately 6 km south west of Land's End, indicating the presence of an infralittoral rock biotope supporting kelp park on bedrock and gullies.

5.4.4 Bristol Channel

The Bristol Channel (including the Severn Estuary) is a high energy environment which supports an ever changing mix of sediments varying from mobile sand to rock (Portmann and Rowlett 1992). Its fauna is impoverished due to bed stresses and high mobility of sediments caused by the large tidal range (Mettam and others 1994). In the Inner Bristol Channel sediment thickness decreases eastwards with increasing tidal current speed, and a great deal of the seabed supports bare rock with mobile sediment confined to linear banks close to the coast (Barne and others 1996b). Communities found here include a 'reduced hard bottom community' and a 'reduced soft bottom community' (Warwick and Davies 1977).

There are a number of areas within the Inner Bristol Channel, where the maps derived from data provided by Poulton and others (2002) indicate the presence of potential reef biotopes. Mettam and others (1994) proposes that areas devoid of sand or mud in the Bristol Channel support a richer community (than that of the sediments) characterised by *Sabellaria*. *S. spinulosa* dominated samples in the outer sublittoral Bristol Channel, but was replaced by *S. alveolata* in the inner Bristol Channel and Severn Estuary. The latter consists of a number of records, scattered across the inner Bristol Channel, of the reef building worm *Sabellaria alveolata* (**SBR.Pol.novoSalvMx)**. However, though Mettam and others (1994) specifically refer to *Sabellaria* reefs, other data are insufficiently detailed to determine whether these records also represent aggregations of *Sabellaria* of sufficient structure to be described as biogenic reefs.

In the middle Bristol Channel area, geological data indicate the presence of substantial areas of undifferentiated solid rock (approximately 300km^2 in the English section), as well as considerable areas of gravel (approximately 146 km^2), all of which could potentially contain reef areas, including biogenic and stony types. On the English side of the Channel, only one MNCR data point was present within an area on the maps derived from data provided by Poulton and others (2002), as undifferentiated rock. This was located to the north east of Hurlstone Point. Other MNCR records do indicate the presence of a number of potential reef biotopes, with boulders and stones recorded from the circalittoral. Some boulders supported *Sabellaria spinulosa* and *Sabellaria alveolata* **MCR.CSAB** in the infralittoral. There are some MNCR records on the Welsh side of this area, within, or adjacent to potential reef areas and although one of these sites records only sediment biotopes, a number of other records indicate the presence of moderately exposed and exposed infralittoral rock in the form of limestone reefs and boulders **MIR** and **EIR**. Moderately exposed circalittoral limestone areas, supporting mussels and anemones **MCR.CMUS.Myt.Has** were also recorded A number of these MNCR sites which record the presence of reef biotopes, are located in areas where BGS data indicated the presence of sediment.

Close to the North Devon coast there are a number of records of reef biotopes, with bedrock and boulders supporting kelp species, ascidians, hydroids and bryozoans, found close to shore for much of this coastline. However, these data do not overlap with BGS data and where they apply to subtidal habitats the maps have been amended accordingly. Recorded biotopes include a number of infralittoral and circalittoral rock biotopes including:

- Kelp biotopes such as **IR.MIR.KR.Ldig, IR.MIR.KR.Lhyp, IR.MIR.KR.Lhyp.Ft** and **IR.KFAR.LhypR.Ft**;
- Bryozoan, hydroid and ascidian dominated biotopes such as **CR.HCR.XFA.oldMolPol, CR.HCR.XFA.FluHocu** and **CR.MCR.CFAVS.CuSph**; and
- There were also records of potential biogenic reef building species, with *Sabellaria spinulosa* recorded west of Hurtstone Point as mentioned earlier and *Sabellaria alveolata* **SS.SBR.POL.novoSalvMx** recorded to the north of Greenaleigh Point.

George and Warwick (1985) describe the presence of the potential biogenic reef building species *Modiolus modiolus* and *Sabellaria spinulosa* in the central Bristol Channel. Although a position to the north east of Bull Point is given for these records, this is only provided as a general location. A more precise determination of the areas described is not possible.

In the outer Bristol Channel area, excluding the areas around Lundy which are already well studied, limited biological survey data for reef features have been obtained. Where data has been located, the overriding theme is the common occurrence of *Sabellaria spinulosa*, however, the data are generally insufficiently quantified or detailed to support the suggestion of the presence of a biogenic reef (though their presence in the Bristol Channel has been previously reported in the past and anecdotally). BGS data indicate the presence of gravel areas, with three patches (combined areas approximately 50 km^2) located north of Morte Point. Two further patches (combined areas approximately 12 km^2) are located approximately 5 km to the north east and approx 2 km south of Lundy. These areas may contain cobbles and boulders (stony reef) but the current data gap, biological or otherwise for those locations, makes it impossible to determine this with any confidence.

MarLIN database species records suggest the presence of the epifaunal species, *Metridium senile* and *Urticina feline* at locations offshore of Lundy, both 14 km to the north and midway to Bull Point. However these data are from benthic trawls and as such it is not possible to say whether they are from isolated cobbles on an otherwise sandy sediment or were associated with patches of reef. As such these data have not been categorised (tagged).

The data collated for this sub-area have allowed for some revision of the maps, principally the *Sabellaria* reefs south of Culver Sands. Data also suggests the presence of offshore bedrock, stony and biogenic reefs (including *Sabellaria* in a number of locations and *Modiolus* in the central Bristol Channel). Closer to the coast, along north Devon, a number of stony and bedrock reef areas have also been incorporated into these revised maps.

5.4.5 South Western Peninsula summary

On the basis of maps derived from data provided by Poulton and others (2002) there are a number of offshore bedrock areas throughout this Marine Natural Area, particularly in the Bristol Channel, off the North Cornwall coast. Existing data typically supports the identification of these areas at least for the nearshore and shallow water components. These data suggest the presence of various kelps, hydroids, anemones, bryozoans and corals characteristic of tide swept and exposed bedrock and occasionally stony reef. However for virtually all of these potential reef areas, data for the offshore element is lacking. Consequently, revisions to the maps with respect to reef habitat has been limited to a number of nearshore areas along the south Cornwall coast (including the Manacles), the various headlands and a number of additional reef patches in Lyme Bay. Delimiting the extensive reef areas in Mounts Bay, off Lizard Point, Gribbin Head and between Plymouth and Start Point has not been possible though it is unlikely that the areas mapped are a true reflection of the extent of hard substrata. Isolated areas of rock, sand and stones are recorded in this area on Admiralty charts (for example East Rutts, Gregory Rock and Wells Rock). The findings of the study for this area can be summarised as follows:

- in the Bristol Channel, areas of biogenic reef are reported. These consist of *Sabellaria alveolata* in the upper parts and *Sabellaria spinulosa* in the outer parts of the Bristol Channel;
- *Modiolus modiolus* and *Mytilus edulis* beds are reported. The presence of the former has been identified in the Bristol Channel and the latter in a number of locations around Devon and Cornwall;

- various areas of bedrock platforms, slopes and stony reef have been noted. These observations have supported the maps derived from data provided by Poulton and others (2002), but have not been able to improve resolution of spatial coverage nor identify additonal patches of bedrock and stony reef (particularly along the Cornwall and Devon Coast and in Lyme Bay); and
- the fauna and flora of the hard substrata typically consist of a variety of kelp, including *Laminaria* spp., and other macroalgae, anemones such as *Metriduim senile, Urticina felina* and *Alcyonium* spp (including *A. glomeratum* in deep water), the sea fan *Eunicella verrucosa*, corals such as *Corynactis viridis, Caryophyllia smithii* and *Leptopsammia pruvoti* ascidians such as Dendrodoa grossularia, bryozoans including *Pentopora foliacea, Flustra foliocea* and *Porella compressa* and the sea urchin *Echinus esculentus*.

5.5 Irish Sea

For the purpose of this report, the Irish Sea Marine Natural Area has been divided into:

- Liverpool Bay
- Lancashire and Cumbria
- Solway Firth

Figure F (Appendix 2) and Figures 1-7 (Appendix 2 CD-rom) show the area under discussion in this section, including: the relevant habitats illustrated in maps derived from data provided by Poulton and others (2002).

A map produced as part of the Irish Sea Pilot depicting marine landscapes show the presence of fine sediment plains stretching from the Solway Firth to Liverpool Bay (Golding and others 2003). The map also illustrates the presence of a shallow-water mud basin off the Cumbrian coast, high bed-stress coarse sediment plains running along the southern reaches of the Solway Firth and low bed-stress coarse sediment plains.

Dickson (1987) describes the Irish Sea as having a gravelly seabed that stretches around the UK coast from St. George's Channel northwards through the central Irish Sea and narrowing in the North Channel. The report goes on to say that sand occurs on either side of the gravel apart from south west of the Isle of Man, south of St. Bees Head and in Liverpool Bay. Areas of muddy sand are present in the bays and nearshore areas as well as an extensive area off the Cumbrian coast (Dickson 1987).

A great deal of the Irish Sea is underlain by till and overlain by thick muds deposited shortly after the melting of an ice sheet off the Cumbrian and Lancashire coast (Barne and others 1996a). Older sedimentary rock separates the Solway Firth Basin from the East Irish Sea Basin which is infilled by Permo-Triassic sediments while large sections of the basins overlie Carboniferous rocks. During the late Cretaceous uplift caused much of the basin sediment to be removed (Barne and others 1996a).

All places mentioned in subsections 5.5.1 – 5.5.4 are shown in Figure 5.

5.5.1 Liverpool Bay

From Fleetwood round to the Welsh border only a small patch of bedrock at Hilbre Islands is indicated by BGS data. MarLIN data reveals the presence of *Mytilus edulis, Balanus balanoides* and *Sabellaria alveolata* in the northern reaches of the River Ribble estuary. *Sabellaria alveolata* has also been recorded by MarLIN just over 1km south west of Hilbre Island.

5.5.2 Lancashire and Cumbria

Along the Cumbrian coast from St Bees to the Isle of Walney, Hiscock (1998) acknowledged that the sublittoral habitats present are not well known. This conclusion is supported by this study, where available reef data has been limited to a relatively small number of coastal and often intertidal data points. As such, these data are not relevant to this study and are not considered further.

Offshore from Sellafield, MNCR data indicate the presence of gravel, shallow cobble, and pebble communities supporting *Pomatoceros triqueter*, *Balanus crenatus* and bryozoan crusts on mobile circalittoral cobbles and pebbles. These limited data are considered inadequate to indicate the occurrence of a patch of stony reef.

Further south, MNCR records from Selker Rocks indicate the presence of boulders and cobbles characterised by *Aglaophenia pluma* and macroalgae such as *Halidrys*, *Laminaria hyperborea* and *Dilsea carnosa* and the peacock worm *Sabella pavonina* . This location has been determined to represent stony reef on the basis of the predominance of boulders and cobbles.

Approximately 7 km northwest off Rossall Point, Lancashire, maps derived from data provided by Poulton and others (2002) data indicates the presence of a linear area of bedrock ridge running along the northern edge of the Lune Deep and covering an area of 5 km^2 . An MNCR record at this location indicates the occurrence of a sloping seafloor with silted cobbles and boulders colonised by *Balanus crenatus*, *Nemertesia antennaria*, *Flustra foliacea* and *Urticina felina* and supports the potential presence of reef in this area. However, in the absence of further data points, more detail cannot be provided regarding topography or biology. Survey work reported by Moore and others (1994) adds to this data, for the southern edge of Lune Deep and additional sites back to Rossall Point. Hard substrata epifaunal communities present on a shallow inshore plateau were considered typical of UK tide-swept and sediment scoured habitats. These communities were characterised by the presence of hydroids, *Urticina* sp. and *Sagartia* sp., sponges such as *Halecium* spp. and *Perophora listeri*, bryozoans such as *Bugula* sp., *Flustra foliacea,* anemones such as *Urticina*, *Sagartia sp.* and *Cerianthus lloydii*.

5.5.3 Solway Firth

The Solway Firth sub-area is characterised by large expanses of sandy sediment in shallow water. However, near the coast are data points indicating the presence of bedrock and stony reef and also species with the potential to form biogenic reefs. In the outer reaches of the estuary area, forests of *Laminaria hyperborea* are present in depths of up to 20m. Deeper rocks are dominated by tunicates, sponges and potential presence of biogenic reefs of *Sabellaria spinulosa* (FSCR 1992b). Such occurrences, of *Sabellaria*, include a series of data

points adjacent to Silloth and Mawbray. These are coincidental with a series of sublittoral bedrock 'scars' running approximately parallel to the coast. Although the majority of these 'scars' lie within the SAC, a proportion lie outside the conservation site, to the southwest of Mawbray (www.solway-ems.co.uk) and at the Maryport Roads. Subtidal scar areas (boulder clay that is devoid of sand) were characterised by diverse and well developed epifaunal communities characterised by *Halichondria panicea*, *Abietinaria abietina*, *Buccinum undatum*, *Modiolus modiolus*, *Flustra foliacea* and *Sabellaria spinulosa* (Perkins 1981). Recorded biomass per unit area from scars was usually one or two orders of magnitude greater than recorded from neighbouring sands (Natural Power 2002).

5.5.4 Irish Sea summary

Maps derived from data provided by Poulton and others (2002) did not indicate the occurrence of substantial areas of potential reef features in this area and this has been borne out by the present study. In the region of the Maryport Roads and Workington Bank a series of bedrock scars have been noted and the data collated in this study used to delineate two small areas.

Elsewhere, data for Selker Rocks suggest a small stony reef. Data around the north and southern edges of the Lune Deep suggest some reef habitat is present. Overall, however, the area is characterised by sedimentary habitat with few, small and isolated patches of boulder and bedrock reef.

There are data for *Sabellaria spinulosa and S. alveolata* in a number of areas, particularly along the Cumbrian coast, and in the mouth of the Ribble and Dee estuaries. However, these are not considered to be indicative of biogenic reef features.

6. Summary

Biological and additional sedimentological data has been acquired from a broad range of sources and in general confirm the sediment mapping of maps derived from data provided by Poulton and others (2002). It has offered clarification on a number of locations and filled some data gaps with respect to seabed character. The data have allowed the characterisation of the habitats which can be summarised as follows:

- clean sand: *Magelona johnstoni, Nephtys cirrosa, Donax vittatus, Fabulina fabula*, and *Bathyporeia* spp. with some variation in species as a consequence of differing salinity regimes;
- muddy sand: *Amphiura filiformis, Echinocardium cordatum, Lags koreni, Abra alba, Mysella bidentata* and *Nucula nitidosa*;
- gravelly sand: *Sabellaria spinulosa*, *Nephtys cirrosa, Spisula* spp., *Ensis* spp*., and Echinocardium cordatum*;
- mixed sediments: hydroids, *Alcyonium digitatum*, *Sabellaria spinulosa* and *Pomatoceros triqueter*;
- bedrock and boulder reef: bryozoan and hydroid dominated biotopes or *Laminaria* dominated biotopes with species including, *Alcyonium* spp., *Metridium senile*, *Flustra foliacea, Laminaria* spp., *Urticina* spp.; and

- bedrock and boulder reef in tideswept South Western Peninsula areas (to Swanage Bay): Species such as *Caryophyllia smithii*, *Corynactis viridis* and *Eunicella verrucosa* were more frequently noted than elsewhere, if at all.

The key changes to these maps and areas of biological interest are considered to be:

- maerl beds in the vicinity of Swanage Bay;
- *Zostera* beds in Weymouth Bay and Swanage Bay;
- bedrock and boulder reef around the Manacles, South Cornwall and the Mid North Sea;
- other small or nearshore bedrock reefs in areas such as St. Ives to Pendeen (Cornwall), the Manacles and other south Cornwall headlands, Dartmouth and Torbay (South Devon), Selsey Bill and Bognor Regis and Beachy Head (Sussex), mouth of the Humber Estuary (Linclonshire), Filey (North Yorkshire), Cullercoats to Blyth (Northumberland);
- other small or nearshore stony reefs in areas such as north of Workington (Cumbria), Lune Deep (Lancashire), Lyme Bay (Dorset), Lulwoth to Swanage (the Purbeck Coast, Dorset), Selsey Bill and Bognor Regis, Brighton and Beachy Head (Sussex), Filey (North Yorkshire), Cullercoats to Blyth (Northumberland);
- *Sabellaria* reefs off north Somerset and Avon, Dorset and south east of the Isle of Wight;
- mussel beds off the coast from Port Isaac (Cornwall), east of Isle of Wight, Worthing and Eastbourne (Sussex); and
- mosaic of bedrock and boulder reef and sand in the Eastern Channel (Bognor Regis to Eastbourne).

The occurrence of biogenic interest features, including *Sabellaria* reef, mussel beds, *Zostera* beds and maerl beds have been specifically highlighted in Figure 59 to ensure clarity of their occurrence.

The localities of sandbanks marked in the maps (Appendix 2) have, where information allows, been characterised and the associated fauna identified as follows:

Linear Banks:

- Culver Sands (South West Peninsula). Coarse sand with a *Spisula* sub-community;
- Four Fathoms Sand Ridge (Eastern Channel). Sand with *Spiophanes bombyx* and *Magelona johnstoni*;
- Hooe Bank (Eastern Channel). Sand probably with *Lanice conchilega* and *Urticina felina*;
- various Thames Estuary sandbanks. Sand and gravelly sand with S. bombyx, Scoloplos armiger and Owenia fusiformis; and
- Gunfleet Sand (Thames Estuary). Sand with *Nepthys cirrosa, Magelona johnstoni* and *Bathyporeia pelagica*.

Banner Banks:

- Workington Bank (North West). Muddy sand with, probably, an impoverished fauna.

Sinuous Banks:

- Various southern North Sea banks. Sand and gravelly sand, probably with *Fabulina fabula* and *Echinocardiium cordatum*.

Banks:

- Robin Rigg (North West). Sand with impoverished fauna characterised by Nephtys cirrosa and Bathyporeia pelagica;
- Shell Flat (North West). Sand (with *Nepthys cirrosa, Magelona johnstoni, Donax vittatus and Fabulina fabula*) and muddy sand (with *Amphiura filiformis, Echinocardium cordatum,* and *Abra alba*);
- Lulworth Banks (Eastern Channel). Sand and stones with *Owenia fusiformais, Lanice conchilega, Magelona johnstoni* and *Spisula elliptica*;
- Shingle, Bramble and Medmerry Banks (Eastern Channel). Sand and mixed with various epifauna, *Ampelisca spinipes* and *Nephtys caeca*; and
- Sizewell – Dunwich (southern North Sea). Sand with and amphipod-impoverished fauna and also *Lanice conchilega*.

Other sandbanks are present throughout English Territorial Waters, including those associated with estuary mouths (for example the Ribble Estuary) but no biological data have been collated.

It is also of note that no data were obtained for cave habitats or submarine structures made from leaking gases.

Data gaps remain for a number of locations and habitats however, particularly for:

- offshore and headland reef areas in the South Western Peninsula;
- gravel areas in South West Peninsula, off of Poole Bay and in the Southern and Mid North Sea;
- sandy sediments in the South West Peninsula, Southern North Sea;
- gravel areas on the Bristol Channel and Southern North Sea; and
- spatial data for the biogenic reef features offshore of the Wash (as previously identified by Foster-Smith and Hendrick 2003).

7. Bibliography

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Appendices

Appendix 1 Sediment classification and habitat codes

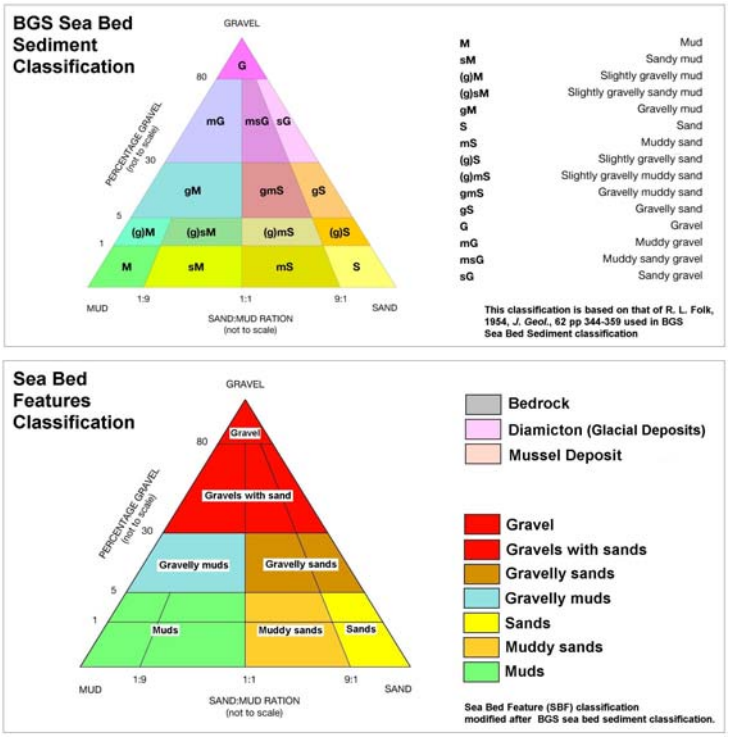

Figure 3.1 Folk scale of seabed sediment classification

Table 3.1 Habitat types and codes

Habitat	GIS Code	Map symbol
Reefs		
no further information	r	
bedrock	r1	
stony reef	r2	
Sabellaria	r3	
Modiolus/Mytilus	r4	
Sandbank		
no further info	s	
sand	s1	
muddy sand	s2	
gravelly sand	s3	
maerl	s4	
Zostera	s5	
Cave	cave	
Others		
Other habitats	ot	+
unclassified		o

Appendix 2 Maps

All figures include data under the following licencing arrangements:

Appendix 3 Full biotope names

A list of sand associated biotope codes found during the course of the project complete with full name. Biotope names were sourced from both the JNCC website corresponding to the 2003 classification (http://www.jncc.gov.uk/marine/biotopes/hierarchy.aspx), and the JNCC Report (1997) Marine Nature Conservation Review. *Marine biotope classification for Britain and Ireland. Volume 2. Sublittoral biotopes* (compiled by O Connor, D.W., Dalkin, M.J., Hill, T.O., Holt, R.H.F. and Sanderson, W.G.).

Biotope code	Biotope name
SS.SMU.CMU.AfilEcor	Sublittoral Sediment. Sublittoral mud. Circalittoral mud. *Amphiura filiformis* and *Echinocardium cordatum* in circalittoral clean or slightly muddy sand
SS.IGS.Fas	Sublittoral Sediment. Infralittoral gravels and sands. Shallow sand faunal communities.
CR.MCR.ByH Flu.HByS	Circalittoral Rock. Moderate energy circalittoral rock. *Flustra foliacea* with hydroids, bryozoans and sponges, on slightly tide-swept circalittoral mixed substrata
SS.IGS.FabMag	Sublittoral Sediment. Infralittoral gravels and sands. *Fabulina Fabula* and *Magelona mirabilis* with venerid bivalves in infralittoral compacted fine sand
SS.IGS.NcrBat	Sublittoral Sediment. Infralittoral gravels and sands. *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand
SS.IGS.Sell	Sublittoral Sediment. Infralittoral gravels and sands. *Spisula elliptica* and venerid bivalves in infralittoral clean sand or shell gravel
SS.IMS.EcorEns	Sublittoral sediment. Infralittoral muddy sands. *Echinocardium cordatum* and *Ensis* spp.
SS.SSA.ESTSA.MobRS/Ncir	Sublittoral Sediment. Sublittoral sand. Estuarine sand. Sparse fauna in reduced salinity infralittoral mobile sand / *Nephtys cirrosa*
SS.SCS.IGVSA.Lcon	Sublittoral Sediment. Sublittoral coarse sediment. Infralittoral gravel and coarse sand. Dense *Lanice conchilega* and other polychaetes in tide-swept infralittoral sand
SS.SSA.ISa	Sublittoral Sediment. Sublittoral sand. Infralittoral sand
SS.SSA.ISA.NcirBat	Sublittoral Sediment. Sublittoral sand.Infralittoral sand. *Nephtys cirrosa* and *Bathyporeia* spp.in infralittoral sand
SS.SCS.IGvSa	Sublittoral Sediment. Sublittoral coarse sediment. Infralittoral gravel and coarse sand
SS.SMP.MRL.Phy.HEc	Sublittoral Sediment. Sublittoral marcrophyte-dominated sediment. Maerl beds of *Phymatolithon calcareum* with hydroids and echinoderms in deeper infralittoral clean gravel or coarse sand
SS.SSA.ISA.Mob	Sublittoral Sediment. Sublittoral sand. Infralittoral mobile sand
SS.SSA.IMUSA.EcorEns	Sublittoral Sediment. Sublittoral sand. Infralittoral muddy sand. *Echinocardium cordatum* and *Ensis* spp.
SS.SSA.CSa	Sublittoral Sediment. Sublittoral sand. Circalittoral sand.
SS.SMP.Mrl	Sublittoral Sediment. Sublittoral marcrophyte-dominated sediment. Maerl beds
SS.SSA.CSA.AbrNucCor	Sublittoral Sediment. Sublittoral sand. Circalittoral sand. *Abra alba, Nucula nitida* and *Corbula gibba* in circalittoral muddy sand or slightly mixed sediment

Biotope code	Biotope name
SS.SBR.POL.SspiMx	Sublittoral Sediment. Sublittoal biogenic reefs. *Polydora ciliata* and *Sabellaria spinulosa* on stable circalittoral mixed sediment
SS.SCS.IGVSA.novoPkerMX	Sublittoral Sediment. Sublittoral coarse sediment. Infralittoral gravel and coarse sand. *Protodorvillea kefersteinea* in impoverished heterogenous sediment.
SS.SMX.CMX.novoMysMX	Sublittoral Sediment. Sublittoral mixed sediment. Circalittoral mixed sediment. *Mysella* sp.

A list of **reef** associated biotope codes found during the course of the project complete with full name. The majority of biotope names were sourced from the JNCC website corresponding to the 2003 classification (http://www.jncc.gov.uk/marine/biotopes/hierarchy.aspx). Some of the older biotope codes, however, were sourced from the JNCC Report (1997) Marine Nature Conservation Review. *Marine biotope classification for Britain and Ireland. Volume 2. Sublittoral biotopes* (compiled by O Connor, D.W., Dalkin, M.J., Hill, T.O., Holt, R.H.F. and Sanderson, W.G.).

Biotope code	Biotype name
SS.SCS.IPbGv	Sublittoral Sediment. Sublittoral coarse sediment. Infralittoral unstable cobble, pebble and gravel.
SS.SBR.Pol.novoSalvMx	Sublittoal sediment. Sublittoral biogenic reefs. *Polydora ciliata* and *Sabellaria alveolata* on stable circalittoral mixed sediment
CR.MCR.CSAB	Infralittoral rock. Moderate energy circalittoral rock. Circalittoral *Sabellaria* reefs
CR.MCR.CMUS.Myt.Has	Infralittoral rock. Moderate energy circalittoral rock. Circalittoral mussel beds. *Mytilus edulis* beds with hydroids and ascidians on tide-swept, exposed to moderately wave-exposed circalittoral rock
IR.MIR.KR.Ldig	Infralittoral rock. Moderate energy infralittoral. Kelp with red seaweeds. *Laminaria digitata* on moderately exposed sublittoral fringe rock
IR.MIR.KR.Lhyp	Infralittoral rock. Moderate energy infralittoral. Kelp with red seaweeds. *Laminaria hyperborea* on tide-swept rock
IR.MIR.KR.Lhyp.Ft	Infralittoral rock. Moderate energy infralittoral. Kelp with red seaweeds. *Laminaria hyperborea* forest and foliose red seaweeds on moderately exposed upper infralittoral rock
IR.KFAR.LhypR.Ft	Infralittoral rock. Kelp with cushion fauna and/or foliose red seaweeds. *Laminaria hyperborea* forest with dense foliose red seaweeds on exposed upper infralittoral rock
CR.HCR.XFA.FluHocu	Circalittoral Rock. High energy circalittoral rock. Mixed faunal turf communities. *Flustra foliacea* and *Haliclona oculata* with a rich faunal turf on tide-swept circalittoral mixed substrata
CR.MCR.CFAVS.CuSph	Circalittoral Rock. Moderate energy circalittoral rock. Circalittoral faunal communities in variable salinity. Cushion sponges and hydroids on tide-swept, turbid, sheltered circalittoral rock
CR.MCR.CMUS	Circalittoral Rock. Moderate energy circalittoral rock. Circalittoral mussel beds
LR.MLR.SAB.Salv	Littoral Rock. Moderate energy littoral rock. Littoral *Sabellaria* honeycomb worm reefs. *S. alveolata* reefs on sand-abraded eulittoral rock

Biotope code	Biotype name
IR.MIR.KR.Ldig.Ldig	Infralittoral rock. Moderate energy infralittoral. Kelp with red seaweeds. *Laminaria digitata* on moderately exposed sublittoral fringe rock
IR.HIR.KSED.XKHal	Infralittoral rock.High energy infralittoral rock. Kelp with sediment affected communities. *Halidrys siliquosa* and mixed kelps on tide-swept infralittoral rock with coarse sediment
CR.HCR.XFA.Mol	Circalittoral Rock. High energy circalittoral rock. Mixed faunal turf communities. *Molgula manhattensis* with a hydroid and bryozoan turf on tide-swept moderately wave-exposed circalittoral rock
CR.MCR.CVSFA.CuSpH.VS	Circalittoral Rock. Moderate energy circalittoral rock. Circalittoral faunal communities in variable salinity. Cushion sponges and hydroids on tide-swept, turbid, variable salinity, sheltered circalittoral rock
CR.HCR.XFA.oldMolPol	Circalittoral Rock. High energy circalittoral rock. Mixed faunal turf communities. *Molgula manhattensis* and *Polycarpa* spp. with erect sponges on tide-swept moderately exposed circalittoral rock.
CR.FCR.FAV.Verticals	Circalittoral Rock. Features of circalittoral rock.Faunal turfs (deep vertical rock)
IR.HIR.KFAR.Ala.Ldig	Infralittoral rock. High energy infralittoral rock. Kelp with cushion fauna and/or foliose red seaweeds. *Alaria Esculenta* and *Laminaria digitata* on exposed sublittoral fringe bedrock
CR.FCR.CV.SpCup	Circalittoral Rock. Features of circalittoral rock. Circalittoral caves and overhangs (deep). Sponges, cup corals and anthozoans on shaded or overhanging circalittoral rock
IR.FIR.SG.CrSpAn.Tub	Infralittoral rock. Features of infralittoral rock. Robust faunal cushions and crusts (surge gullies and caves). Sponge crusts, anemones and *Tubularia indivisa* in shallow infralittoral surge gullies
IR.HIR.KFAR.LhypR.Ft	Infralittoral rock. High energy infralittoral rock. Kelp with cushion fauna and/or foliose red seaweeds. *Laminaria hyperborea* forest with dense foliose red seaweeds on exposed upper infralittoral rock
IR.HIR.KFAR.Sac	Infralittoral rock. High energy infralittoral rock. Kelp with cushion fauna and/or foliose red seaweeds. *Saccorhiza polyschides* and other opportunistic kelps on disturbed sublittoral fringe rock
IR.HIR.KFAR.LhypFa	Infralittoral rock. High energy infralittoral rock. Kelp with cushion fauna and/or foliose red seaweeds. *Laminaria hyperborea* forest with a faunal cushion
IR.HIR.KFAR.Ala.Myt	Infralittoral rock.High energy infralittoral rock.Kelp with cushion fauna and/or foliose red seaweeds. *Alaria Esculenta, Mytilus edulis* and coralline crusts on very exposed sublittoral fringe bedrock
IR.HIR.KSed.XKScrR	Infralittoral rock. High energy infralittoral rock. Kelp with sediment affected communities. Mixed kelp with scour-tolerant and opportunistic foliose red seaweeds on scoured or sand-covered infralittoral rock
CR.HCR.XFA.oldFlu.HByS	Circalittoral Rock. High energy circalittoral rock. Mixed faunal turf communities. *Flustra foliacea* with hydroids, bryozoans and sponges on slightly tide-swept circalittoral mixed substrata

Biotope code	Biotype name
CR.HCR.XFA.SpNemAdia	Circalittoral Rock. High energy circalittoral rock. Mixed faunal turf communities. Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata
IR.HIR.KFAR.CvirMsen	Infralittoral rock.Infralittoral rock. High energy infralittoral rock. Kelp with cushion fauna and/or foliose red seaweeds. *Corynactis viridis*. *Metridium senile*
IR.HIR.KFAR.LsacSac	Infralittoral rock. Infralittoral rock. High energy infralittoral rock.Kelp with cushion fauna and/or foliose red seaweeds. *Laminaria saccharina* and/or *Saccorhiza polyschides* on exposed infralittoral rock
IR.oldEIR	Infralittoral rock. Exposed Infralittoral rock
CR.MCR.ECCR.CarSp.PenPo r	Circalittoral Rock. Moderate energy circalittoral rock. Echinoderm and crustose communities. *Caryophillia smithii* and sponges with *Pentapora foliacea, Porella compressa* and crustose communities on wave-exposed circalittoral rock
IR.HIR.KFAR.For.Dic	Infralittoral rock. High energy infralittoral rock. Kelp with cushion fauna and/or foliose red seaweeds. Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea*
CR.HCR.XFA.ByErSp.Eun	Circalittoral Rock. High energy circalittoral rock. Mixed faunal turf communities. Bryozoan turf and erect sponges. *Eunicella verrucosa* and *Pentapora foliacea* on wave exposed circalittoral rock
CR.HCR.XFA.CvirCri	Circalittoral Rock. High energy circalittoral rock. Mixed faunal turf communities. *Corynactis viridis* and a mixed turf of crisiids, *Bugula*, *Scrupocellaria* and *Cellaria*, on moderately tide-swept
SS.SBR.POL.SspiMx	Sublittoral Sediment. Sublittoal biogenic reefs. *Polydora ciliata* and *Sabellaria spinulosa* on stable circalittoral mixed sediment

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Top left: Using a home-made moth trap.
Peter Wakely/English Nature 17,396
Middle left: Co_2 experiment at Roudsea Wood and Mosses NNR, Lancashire.
Peter Wakely/English Nature 21,792
Bottom left: Radio tracking a hare on Pawlett Hams, Somerset.
Paul Glendell/English Nature 23,020
Main: Identifying moths caught in a moth trap at Ham Wall NNR, Somerset.
Paul Glendell/English Nature 24,888