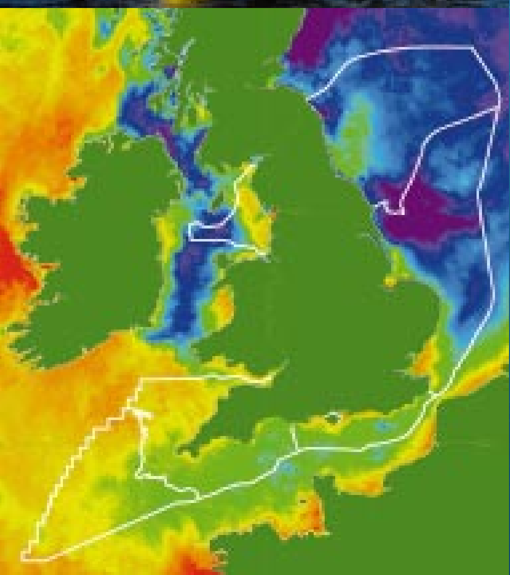
ENGLISH NATURE

The Irish Sea Marine Natural Area

A contribution to regional planning and management of the seas around England



working today
for nature tomorrow

Foreword

Over the last few years, there has been a greater recognition not only of the need to manage our maritime environment in a more holistic way, but also the ways in which this might be achieved. In their report *Safeguarding our Seas*, Defra (2002a) set out a vision and ideas to address this need, founded on an 'ecosystem-based approach'. English Nature also set out the case for such an approach in its *Maritime State of Nature* report (Covey & Laffoley 2002). Both documents emphasise that managing human activities needs to be more integrated in order to restore and maintain healthy ecosystems. This will benefit both present and future generations. The UK Government's commitment to developing this approach is reflected in various European and international statements such as the output of the World Summit on Sustainable Development. The challenge now is how to put the ecosystem approach into practice. The Marine Natural Areas concept is a positive step forward in meeting this challenge.

English Nature initially conceived the idea of 'Natural Areas' on land and in the near-shore zone. They were identified on the basis of their underlying geology, natural systems and physical processes. As wildlife is not restricted to designated sites, Natural Areas provide an essential context that helps us to better manage specific sites. They also help us to understand the nature conservation value of the wider countryside. Natural Areas provide a strategic framework for English Nature to set objectives at a broad scale, to plan action and resources to achieve these, and to bring partners on board. It was a logical step to extend the concept into the marine environment. So, English Nature has identified and described, together with the Joint Nature Conservation Committee and in consultation with other organisations, six Marine Natural Areas.

Marine Natural Areas take account of natural processes and the interaction between them, the underlying geology and wildlife. They offer a biogeographic framework within which we can develop and implement an ecosystem approach to managing human uses of the marine environment. The information contained within this report provides advice on the nature conservation value of large areas of sea. It also outlines our knowledge of where natural features are and the context this provides for a variety of human uses. This information should continue to be updated and refined. Such spatial data is essential if we are to consider tools such as sea use planning for the range of activities that occur in the marine environment.

We need to encourage new ideas and initiatives to achieve the conservation and sustainable development of our marine environment. Though the boundaries of the Marine Natural Areas reflect a number of natural factors, the boundaries only encompass the seas around England, not other parts of the UK. However, we hope that the approach set out here, together with initiatives such as the Review of Marine Nature Conservation's Irish Sea Pilot project, will help catalyse a more comprehensive approach to regional seas that incorporates areas of sea beyond England's borders.

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1 Introduction

1.1 Definition and role of Marine Natural Areas

Marine Natural Areas are areas of sea around England that have been identified using oceanographic processes, bathymetry and biogeographic characteristics to define broad natural divisions in the marine environment. Marine Natural Areas seek to identify ecologically relevant boundaries at a broad scale for which ecologically relevant objectives and targets can then be identified. Like Natural Areas identified in the terrestrial and nearshore environment[1], Marine Natural Areas emphasise the importance of natural processes, the interaction between these, geology, and wildlife. We have identified six Marine Natural Areas, as explained below.

Natural Areas offer a biogeographic framework within which to develop and implement an ecosystem approach to managing human activities (see Appendix 1) and to securing a sustainable future for the marine environment. However, we recognise that the basis of 'regional seas' is likely to evolve as interest in a regional approach to the marine environment gathers momentum. This is especially so in relation to Scotland, Wales and the Irish Sea, as the boundaries of our Natural Areas are currently restricted to England.

We hope that the Marine Natural Areas and the information presented in this document will be of use to those interested or involved in the stewardship of our seas. This includes those responsible for planning, regulating or managing human activities, other agencies, local, regional and national Government and the wider public. In particular, we hope that the Marine Natural Areas:

- provide an ecological rationale for defining broad regional units;
- suggest an appropriate scale and potential framework in which to manage and govern the seas adjacent to England;
- provide information on habitats and species, physical features and nature conservation importance across the wider marine environment, and the key human activities relevant to these;
- complement or assist other initiatives, such as the 'regional seas' approach currently being piloted in the Irish Sea under the Defra-led Review of Marine Nature Conservation[2];
- present information in a structured and easily accessible manner which can be adapted for use by others as required.

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[1] 120 Natural Areas, including 23 coastal Natural Areas, each identified by distinctive habitats, physical features and species that distinguish it from neighbouring areas. (Profiles for terrestrial and coastal Natural Areas can be found at (www.english-nature.co.uk/Science/natural/NA_search.asp)

[2] The Irish Sea Marine Natural Area is only part of the area covered by the Irish Sea Pilot (ISP). The ISP Project has dealt with some of the issues discussed in the Marine Natural Area profile in much more detail. We have published the Irish Sea Marine Natural Area Profile because it contains some information not considered by the ISP. It also highlights what could be achieved in other regional areas by building on Marine Natural Areas.

English Nature will continue to use and build on Marine Natural Areas, within the context of our developing Maritime Strategy and initiatives led by the Joint Nature Conservation Committee, Government and others. We will use them to:

- draw up objectives and targets for nature conservation at a regional scale together with key stakeholders and Government;
- promote a strategy and policies for the management of seas around England;
- manage our work and resources to achieve objectives and targets, including those under the UK's Biodiversity Action Plan.

1.2 The basis for Natural Area boundary selection

Marine Natural Areas take account of oceanographic processes, bathymetry and broad biogeographic characteristics. Using these features as a basis for delimiting the individual areas, English Nature explored options with the Joint Nature Conservation Committee to identify the six Marine Natural Areas shown in Figure 1.1.

The boundaries between adjacent Marine Natural Areas are partly based on the 50 metre isobath. This is the approximate depth at which wave action on the seabed (a mechanism for driving sedimentary processes) tends to become of minimal significance. The 50 metre isobath also marks the transition between shallow, well-mixed turbid conditions and deeper, seasonally stratified waters such as that found in the North Sea (Brampton and Evans 1998). This delineation between well-mixed and seasonally stratified water masses is significant in plankton dispersal and therefore in distinguishing between marine biological assemblages (Hiscock 1996). In addition, such transitions sometimes form 'fronts' with associated high biological productivity. For example, the location of seabird breeding colonies may indicate the distribution of important marine feeding grounds at the Flamborough front to the north east of Flamborough Head (Skov *et al* 1995).

Broad biogeographic characteristics were also used to set the boundaries between some of the Marine Natural Areas. In particular, a well established biogeographical transition has been used to derive the boundary between the English Channel and South Western Peninsula Natural Areas. The transition occurs between the relatively warmer Boreal-Lusitanean region to the west and colder Boreal region to the east. Such a transition has a marked influence on the distribution of temperature-sensitive marine species (Hayward and Ryland 1995). The boundary selected, ie a line running from Portland to Cherbourg, was recognised by Holme (1966), who divided the English Channel on the basis of differences in tidal streams and water temperature stratification either side of this boundary, and is the same as that used by Dinter (2001) in relation to the OSPAR maritime area.

The offshore extent of Marine Natural Areas is the 200 nautical mile limit or the median line of UK Controlled Waters[3].

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[3] There are clear differences in the legal and institutional frameworks within 12 nautical miles (Territorial Waters) and beyond (UK waters). For example, beyond 12 nautical miles, the remit for providing advice on nature conservation changes from English Nature to the JNCC. However, wildlife and human activities cross such artificial administrative boundaries and therefore there is a need to work closely together to address issues of common concern. For the same reason, we feel it would be inappropriate to limit MNAs to the 12-mile administrative boundary. For convenience, the term "seas adjacent to England" is used when referring to waters within and beyond 12 nautical miles.

Inshore, we have used the Mean Low Water Mark as the boundary of the Marine Natural Areas. This means that the Marine Natural Areas overlap with the previously identified coastal Natural Areas (which extend from about 6 nautical miles to above Mean Low Water). These were based on the coastal process cells and sub-cells in which sediment movement is largely contained within discrete zones. However, the Marine Natural Areas span much greater areas as they reflect other, broader scale processes and the need to take account of large areas for pelagic species.

Estuaries and inlets are generally excluded from Marine Natural Areas as they are already covered within coastal Natural Area descriptions. However, in discussing and implementing an ecosystem approach to the maritime environment, it will be essential to take account of Coastal and Marine Natural Areas together.

1.3 The audience for this document

We hope that the Marine Natural Areas and the information presented in this document will be of use to those interested or involved in the stewardship of our seas. We envisage this will include those responsible for planning, regulating or managing human activities. This document is therefore aimed at a wide audience that includes local authorities, regional Government, and the Regional Development Agencies. We hope that the Marine Natural Area will also be of interest to a wider public as well as to national Government, other agencies, marine authorities, industry and the scientific community.

1.4 The aim and structure of this document

The main product from our work on Marine Natural Areas is a series of 'profiles', documents which provide a thumbnail sketch of each Area including its physico-chemical characteristics, key habitats and species, and, in brief, relevant human activities.

These documents are not intended to be a comprehensive description of all the wildlife and human interest within each area. Rather, they aim to highlight and describe key features of each Marine Natural Area from a nature conservation perspective. The main text begins with a description of the geology, physical processes and chemical conditions of each Natural Area. This provides the 'big picture' within which to consider nature conservation and human values of the area. The next two sections briefly describe the nature conservation value of the area in terms of habitats and then species. The final descriptive section outlines significant human activities.

Whilst we are publishing paper copies of the documents, the profiles will also be provided on CD and via the Internet (www.english-nature.org.uk). This is largely to facilitate use of the text by others, eg those progressing a regional approach to managing the marine environment.

Whilst the document contains some technical information it does not attempt to go into any great level of detail on any particular topic. Therefore the reader may wish to follow up on a particular topic by referring to other technical reports such as the JNCC's *Coastal Directories,* the *Marine Nature Conservation Review* (eg Hiscock 1996), the *Joint Cetaceans Atlas* (Reid *et al* 2003), and Regulation 33 advice published by the Agencies for European marine sites designated under the Habitats and Birds Directives. Further sources of relevant information and links to websites can be found at www.english-nature.org.uk and www.jncc.gov.uk. This document also provides references to material from other organisations.

A glossary of terms used throughout this report can be found in Appendix 4.

1.5 Geographic Information System

In addition to producing the profiles, English Nature has used a Geographic Information System (GIS) to hold and display the data referred to in this document. A number of other organisations have provided the data including the British Geological Survey (BGS), Centre for Environment, Fisheries and Aquaculture Science (CEFAS), the Crown Estate and Department for Environment, Food and Rural Affairs (Defra). GIS is invaluable for viewing data on different subjects altogether, often enabling a better understanding of the interaction between them. The Marine Natural Areas GIS is no exception and allows more detailed and dynamic use of data than can be shown in document form. We hope that the data will be useful in the further development of Marine Natural Areas and the implementation of any regional seas approach. We also hope to make the data available more widely but this will require agreement with those organisations that have provided data. Such access may be facilitated by initiatives to improve data sharing and integration in response to recommendations in *Safeguarding our Seas* (Defra 2002a).

1.6 Conservation objectives

We hope that the information set out in these profiles will contribute to a more comprehensive regional seas approach. We also intend to develop nature conservation objectives relevant to each Natural Area. However, we will do this within the current debate and emerging ideas about conservation objectives for broad sea areas, particularly through the work of the Irish Sea Pilot (see Lumb *et al* 2004 for example). This work will depend on the extent to which Marine Natural Areas become part of a more comprehensive regional approach to managing the seas around the UK.

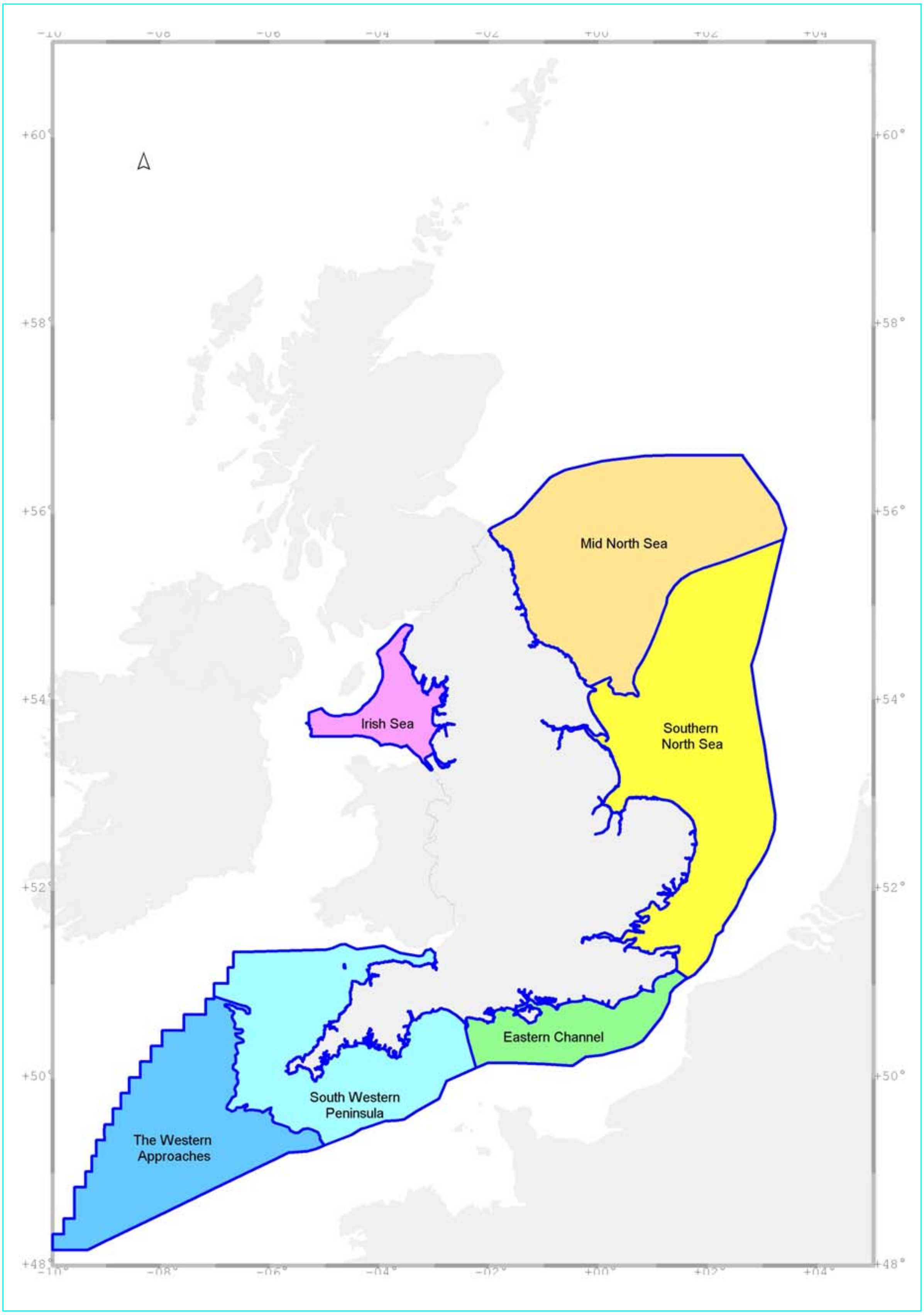

Figure 1.1 The distribution of Marine Natural Areas

2 General summary

This Marine Natural Area extends south from just outside the mouth of the Solway Firth in the north to Birkenhead in the south. The area encompasses Liverpool Bay, Morecambe Bay and the Cumbrian Coast (see Figure 2.1). The inshore boundary is delimited as the Mean Low Water mark and the offshore limit is constrained by borders with Scotland and Wales as well as the limit of UK jurisdiction. The area above Mean Low Water including the estuaries, have been described in the coastal series of Natural Area profiles (see Figure 2.1).

The Irish Sea Natural Area lies fully within the Boreal biogeographic province (Dinter 2001) which results in species associations of colder water origin and also limits the migration of warmer water species, of Lusitanean origin, into the area.

The seabed of the Irish Sea Natural Area is covered by wide range of mobile sediments ranging from the well-defined muddy-sand belt off the south-west Cumbria coast to the large areas of gravel-sand substrata which cover large areas of the seabed.

Many important species occur within the Natural Area and these include a number of species covered by the UK Biodiversity Action Plans (BAP). There is a grouped action plan for commercial marine fish, baleen whales and small dolphins. There is also a plan for harbour porpoise.

The main commercial activities within the Irish Sea Natural Area are oil and gas exploration, renewable energy exploitation and fishing. The main fish species targeted in this area are herring, plaice and cod.

During the production of this profile the Irish Sea Pilot project has completed and has gathered a wealth of other data which complements the information contained here (see particularly Lumb *et al* 2004b: www.jncc.gov.uk/irishseapilot)

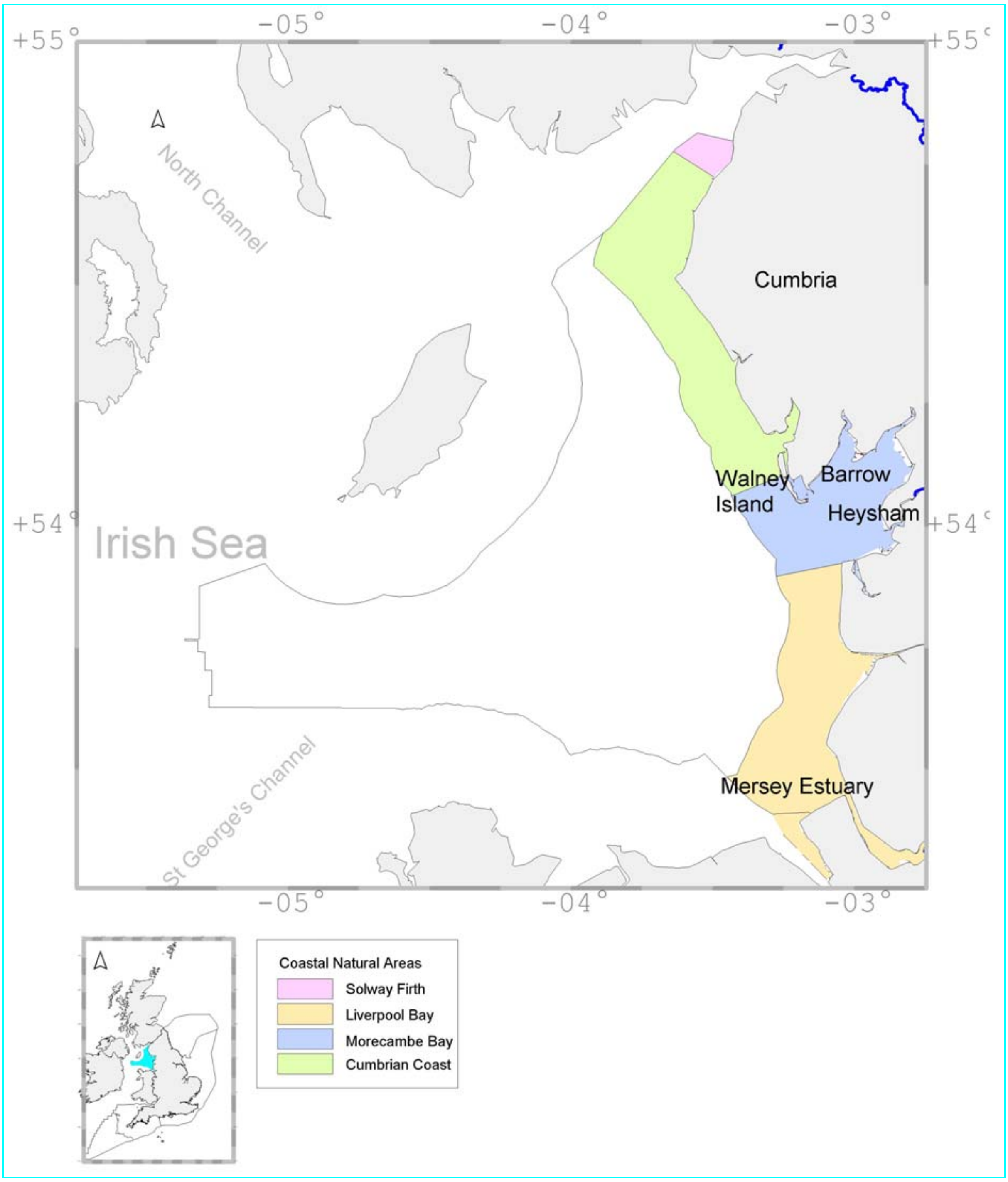

Figure 2.1 Irish Sea Marine Natural Area and adjacent Coastal Natural Areas with the names of places mentioned in the text.

3 Physical environment and character of Natural Area

This section outlines the geology, physical processes and chemical characteristics of the Natural Area. It describes the underlying processes that determine the presence of natural features and biodiversity, which in turn influence human activities. For simplicity, the human influences on physical and chemical characteristics such as water quality, are described in the same section.

3.1 Geology

The geology of the Natural Area has direct and indirect influences on the morphology of the seafloor, the distribution of seafloor sediments, and the distribution of many of the associated habitats. Many of these influences form a complex set of inter-relationships. The broader geological patterns (such as range of rock types and geological structures) were set in the early geological history of the area. But, more recent geological events (in particular the sea level changes associated with glaciation, as well as the glaciers themselves) have had a profound effect upon the distribution of modern seafloor topography and sediments. Given the complexity of the geology, the description given below is necessarily brie

The Irish Sea Marine Natural Area is dominated by a cover of Quaternary sediments concealing Palaeozoic rocks to the west and Mesozoic rocks to the east. In the Central Irish Sea Basin, to the west of the Area, a subcrop of Lower Palaeozoic rocks mark the Silurian to late Devonian closure of an ancient ocean (the Iapetus) and the bringing together of two continents during the Caledonian Orogeny. These rocks are overlain by a thick Carboniferous sequence of marine limestones and mudstones which pass into the increasingly fluvial coal measures. The east of the Area, the East Irish Sea Basin, is dominated by a Permo-Triassic sequence which includes marginal marine Permian sediments and evaporites but mainly Triassic sandstones and mudstones (this is one of the thickest Upper Triassic sequences in NW Europe and the Mercia Mudstone reaches up to 3000m thickness). Isolated Jurassic subcrops occur in the centre and north of this eastern area as does evidence for limited Tertiary igneous activity related to far more extensive outcrops in Northern Ireland (Giant’s Causeway).

The bedrock of the Irish Sea Marine Natural Area is almost entirely concealed by Quaternary sediments which extend from the Solway Firth to the North Wales Coast. The Quaternary sediments probably date back to the Mid Pleistocene but are dominated by last glacial and post-glacial sediments. In general these sediments are less than 50 m thick across the Area though occasional glacigenic incisions, such as the Lune Deep (thought to be a relict kettlehole), are filled with thicker sediments.

The Calaedonian Orogeny (closure of the Iapetus ocean) created the framework for subsequent Palaeozoic and Mesozoic basin development and tectonic activity. The Area is dominated by faulted basins (grabens and half grabens) which trend N-S and NE-SW. The East Irish Sea Basin was the largest and deepest basin in Western Britain with Carboniferous rocks nearly 10 km in depth covered by up to 5000-6000m of Permian to Lower Jurassic sediments. Despite extensive post-Mesozoic uplift and erosion the Irish Sea Basin has been re-established and the Marine Natural Area is now dominated by estuaries and coastal embayments, drowned by Holocene sea level rise, and the extensive Eastern Platform which has been planed off by repeated sea level fluctuation throughout the Quaternary.

Today the seabed is covered by a wide range of mobile sediments dominated in the east by the “Eastern Irish Sea Mudbelt” and becoming generally coarser to the west with areas of sandy gravel and gravel (see figure 3.1). With limited bedrock outcrop seabed sediments provide the primary habitat substrate, which broadly relates to sediment, morphology and depth (and temperature). For example the Lune Deep contains coarse pebbles, cobbles and boulders contrasting with the surrounding more muddy sediments of the Eastern Irish Sea Mudbelt with a resulting immediate contrast in seabed community (see section 4.2).

Economically, the Marine Natural Area contains the second largest continental shelf gas field in the UK (see section 6.2). The hydrocarbons are sourced from Carboniferous shales, mudstones and coals and hosted mainly in Triassic sandstones controlled by faulting.

3.2 Bathymetry

The Irish Sea, on the whole, is largely formed of platforms of generally less than 60m water depth, within which there are localised enclosed deeps down to 137m (Fig 3.3). One of the most notable deeps occurring within this Natural Area is the Lune Deep, a narrow channel in the entrance of Morecambe Bay. It is approximately 20 km long and 2-2.5 km wide and descends to approximately 40m below the surrounding area. The Lune Deep is thought to be a relict kettlehole, formed at the end of the last ice age, when the melting of sub-surface ice caused the surrounding moraines to collapse into a large crater (McLaren 1989). Within the Natural Area, the relief of the shelf is generally very low and has several broad, low amplitude features typically 10-15km long and 5-10 km wide with relief up to 10 m. These are thought to be the result of differential compaction of the various underlying late-Quaternary sedimentary formations (Pantin, 1977; 1978).

3.3 Tidal currents and range

Tidal currents in the Natural Area are generally weak and do not exceed 2m/sec. The low tidal currents allow mud-sand belts to accumulate within the Natural Area. These areas of deposition tend to be associated with large tidal ranges. The time between the twice-daily consecutive high waters is approximately 12 hours 25 mins in this area. The tides enter the Irish Sea from the Atlantic Ocean through both the St. George’s and North Channels, with the two paths meeting in the vicinity of the Isle of Man. The tidal range within the Natural Area varies from 6.0 m in the west to 8.0m in the east. The largest tides occur along the Lancashire and Cumbrian coasts, where the mean spring range is 8m, second only in the UK to those in the Bristol Channel.

The range may at times be influenced by tidal surges, which are produced by rapidly-moving atmospheric depressions that increase the flow of water into the Irish Sea.

3.4 Sea-level change

3.4.1 The past and present

Changes in sea level derive from the combined effect of two phenomena. The first are ‘local crustal movements’ where Scotland is rising and southern England sinking, due to the removal of the weight of ice since the last glacial period. This is also known as isostatic or post-glacial adjustment. The second is a global rise in sea level, which has been estimated as rising at between 1.5 and 2 millimetres per year (Intergovernmental Panel on Climate Change 2001). This is known as eustatic or sea-level change.

Geological evidence for sea-level change in the past may be found in the presence of fossil coastlines (raised beaches, etc) on or inland from the present shorelines, or in the presence of peat and alluvial gravels on or below the sea floor. Multiple or individual raised beaches, ie former beaches which are now higher than the contemporary shoreline or platforms, may produce a stepped or staircase profile to the coast. These features are higher than their modern equivalents, implying a higher sea level during their formation. There is also evidence for shoreline change in deposits below present sea level and this indicates where coasts have been submerged since the sediments were laid down.

Data recorded by tidal gauges in the vicinity of the Natural Area indicate that the global average represent a reliable estimate of sea-level change across the region in the medium term. Examination of tide gauge data across the region by Emery and Aubrey (1985) confirmed that absolute sea levels were rising by between 0 to 2mm/year, with the higher value in the southern part of the Irish Sea.

3.4.2 The future

As with all predictions of climate and sea-level change, the following figures carry a range of uncertainty with them. Global mean sea level increased by 1.0–1.5 millimetres per year during the 20th century. The IPCC have predicted that mean sea level would rise by 48 centimetres by 2100 and the range will vary by 9-80 centimetres, as a result of the thermal expansion of ocean water and melting ice from the poles. However, the most recent estimates predict that sea level will rise by as much as 67 cm by 2080 in the NW of England (UKCIP02 2002).

The gradual rise in sea level will have serious implications for important coastal wildlife habitats, though it is difficult to say exactly what may happen as the rate will be tempered by the rise in land level too. Habitats particularly vulnerable to ‘coastal squeeze’ (where they are trapped between an advancing sea and ‘fixed’ land defences) include shingle beaches, saltmarshes, grazing marshes and estuaries. A good source of further information is on the Proudman Oceanographic Laboratory website **(www.pol.ac.uk/ntslf/reports)**.

3.5 Water temperature

In winter the surface temperature of seawater is coldest in February and March, when it varies from 5°C to 6.5°C. At this time of year, when winter storms lead to a thorough mixing of the water column, sea bottom temperatures do not vary greatly from those at the surface. August is typically the warmest month for surface sea temperatures which vary from 14.5°C to 16°C. This variation is greater in coastal waters compared with offshore waters. In winter coastal waters are cooler than those offshore, and in summer they are warmer.

3.5.1 Predicted rises in seawater temperatures

According to UK Climate Impact Programme predictions (**www.ukcip.org.uk**), a gradual rise in seawater temperature in the coastal waters surrounding Britain and Ireland may already be occurring, and by 2100 average temperatures may be 2°C higher compared to 2000. Air temperatures are also rising. Hiscock *et al* (in prep.) report that it is most likely that seawater temperatures in inshore waters around Britain and Ireland will increase progressively over the next 50-100 years, according to the most recent predictions and historical precedents. By the 2050s, surface seawater temperatures may be as much as 2.5°C higher in summer and 2.3°C higher in winter than in 2000 (Viles 2001). It may be that, in enclosed waters especially, the rise of inshore seawater temperature may be higher than the average on the open coast.

Hiscock *et al* (in prep.) predict the effects that seawater temperature rises may have on marine wildlife. Increasing temperature may induce changes in the abundance and distribution of species, but there will not be a wholesale movement northwards of southern species, or a retreat northwards of northern species. Factors such as the hydrodynamic characteristics of water masses, the reproductive mode of species, the presence of geographical barriers and the longevity of already established species will be important in determining whether or not there is a significant change in species distribution and abundance in the next hundred years.

3.6 Salinity

The salinity of the seawater in the Natural Area decreases eastwards (from 33 – 31), owing to the increased river water input. The salinity of coastal waters may fluctuate considerably through the year with variations in river flow (see Golding *et al* 2004).

3.7 Water quality

About 80% of marine pollution comes from a variety of land-based activities (Defra 2002a). Most pollutants enter the Irish Sea through direct discharges of effluents or land run-off (mainly via rivers). The highest concentrations of contaminants, and hence the greatest effects, are therefore often found in inshore areas. Additional inputs include sources at sea (ships, offshore platforms, dumping of dredged materials) and atmospheric deposition. On entering the sea, the fate and behaviour of chemicals will vary markedly depending on their physio-chemical properties, and the physical characteristics of the receiving environment.

The following section provides a summary of the water quality in the Natural Area, including consideration of sediment and biota quality.

3.7.1 Turbidity

Turbidity is a measure of the decrease of light down through the water column and is primarily due to suspended particulate matter, including plankton; plankton is dealt with in greater detail in section 4.1.1. Turbidity can affect water quality in a number of ways especially in relation to oxygen levels, algal growth, nutrient cycling and the availability of particle reactive contaminants.

Within this Natural Area, the regions with the greatest concentration of turbidity occur nearer the coast, particularly in the vicinity of estuaries (OSPAR 2000).

3.7.2 Non-toxic contaminants

3.7.2.1 Organic matter

Organic matter can enter the Irish Sea Marine Natural Area through externally or internally derived sources. External inputs of organic matter include point source discharges of sewage and industrial effluents, and from diffuse sources such as agricultural run-off. Organic matter can enter the marine environment in both dissolved and particulate form. However, in common with most land-based sources of pollution, the effects from these inputs are more noticeable in estuaries and nearshore areas and are unlikely to be detected in offshore locations within this Natural Area. Inputs of organic matter exert an increased biochemical oxygen demand (BOD) in receiving waters, which can lead to oxygen depletion in water and sediments. Reductions in point sources of organic matter are being addressed through implementation of the Urban Waste Water Treatment Directive (91/271/EEC).

3.7.2.2 Nutrients

Nutrients (dissolved and particulate forms of nitrogen, phosphorus and silicon) play an important role in aquatic ecosystems as they form the basis for primary productivity. Nitrogen and phosphorus enter the Irish Sea predominantly from point sources, such as sewage treatment works and from diffuse sources, such as agricultural run-off. Rivers often transport nutrients from both sources. In nutrient-poor waters, atmospheric deposition of nitrogen can constitute a significant contribution of this nutrient. Silicon, essential for the growth of diatoms but of less importance for other marine organisms, enters the Irish Sea predominantly via rivers. By far the largest input of nutrients to the region's water is through the St George's channel. The residual flow northward through the Irish Sea brings with it of over 100 million tonnes of nitrogen/year and 28 million tonnes of phosphorous /year (Irish Sea Study Group 1990). Set against the inflow of organic materials from the Atlantic, the total nutrient load from domestic and industrial wastes in the region is not as great as is commonly thought (Irish Sea Study Group 1990). However, nutrient levels around point sources can be substantially elevated, particularly adjacent to widely used or heavily populated areas.

The ratio of nitrogen/phosphorus consumption for marine phytoplankton is 16:1, and under normal circumstances, nitrogen is the limiting nutrient in marine waters (North Sea Task Force 1993). Nutrient enrichment could have little or no impact on aquatic environments, depending on the influence of a number of physical, chemical and biotic factors (Scott *et al* 1999). In some cases, enrichment of marine waters with nutrients may stimulate accelerated growth of algae or other higher plant forms, and result in adverse ecological impacts. This process is known as eutrophication. Observable signs of eutrophication in the marine environment include repeated phytoplankton blooms, increased fluctuation in dissolved oxygen concentrations, increased turbidity, and increased occurrences of toxic blooms. Generally the offshore waters of the Natural Area are well mixed and seriously depressed oxygen levels are unusual. Other effects are more likely to occur in estuaries and near shore areas.

Improvements to sewage treatment under the Urban Waste Water Treatment Directive (UWWTD) is likely to reduce some point sources of nitrates. The implementation of the Nitrates Directive (91/676/EC) will also provide some controls on nitrate from diffuse agricultural sources. This Directive requires Member States to designate Nitrate Vulnerable

Zones (NVZs) and to produce action programmes to reduce nitrate run-off from agricultural areas. Those areas already identified are shown in figure 3.4. In the first instance, these measures are established to ensure that nitrate levels in rivers and groundwater are below 50 milligrams per litre (drinking water standard).

3.7.3 Toxic contaminants

3.7.3.1 Oil

The input of any petroleum hydrocarbons within this Natural Area will most likely be the result of sea-based activities (shipping and oil/gas extraction) or coastal discharges of sewage and industrial effluents. Oil spills may occur from both ships and offshore installations, and can be the result of both legal and illegal discharges or accidents. The majority of these spills consist of ship's 'bilge oil' and, increasingly, heavy fuel oil, but crude oil and lubricating oils also occur along with non-mineral oils (OSPAR Commission 2000).

Drill cuttings, produced during exploration drilling, can result in oil being released into the marine environment by the use of diesel-based drilling fluids, but this substance has been banned. Now, alternative oil-based drilling fluids can only be used if the level of oil in the cutting is less than 1%. Waste is shipped ashore for disposal or re-injected, which has the effect of reducing discharges to the marine environment. There may also be some contaminated water discharges from the oil-producing installations in the north eastern part of the Natural Area.

Statistics on oil pollution incidents in the Irish Sea have indicated that, in most cases, the amounts of oil involved were relatively small but clean up costs were often considerable (OSPAR 2000).

3.7.3.2 Trace metals

Trace metals reach the Irish Sea predominantly via rivers, direct discharges, and from some sea-based activities, such as exploitation of offshore resources and disposal of dredged materials. Highest concentrations of trace metals are found near freshwater outlets, with much lower levels in the open sea. CEFAS (1998) reported that the Irish Sea had higher levels of metals than the English Channel, corresponding with lower salinities associated with freshwater inputs.

Mercury is the only element for which the observed concentrations in this Natural Area give rise for concern (OSPAR 2000). In the Irish Sea concentrations of 0.62 – 0.85 ng/l reflect historic sources of mercury, in particular from chlor-alkali plants close to the Mersey and Wyre estuaries in north-west England. Mercury, along with some other metals, shows a strong affinity for particulates will accumulate in sediments and may be bioaccumulated up the food chain. Monitoring undertaken for the National Monitoring Programme (NMP) between 1992 and 1995 found higher concentrations of metals in sediments at estuarine sites than at offshore sites (MPMMG 1998). This report did note however that despite the history of inputs to the Mersey, not all sediment samples collected contained high concentrations of mercury.

CEFAS have monitored mercury in commercial fish species collected in Liverpool and Morecambe Bays over many years, and monitoring undertaken for the NMP indicated that fish collected from these areas contained the highest concentrations (CEFAS 1998). In 1998, mean concentrations in fish muscle were below the 0.3 mg/kg wet weight OSPARCOM derived ‘upper’ level category (CEFAS 2001). Temporal datasets also suggest a reduction in mean mercury concentrations with 1982 mean levels of 0.27 and 0.29 mg/kg in Liverpool Bay and Morecambe Bay respectively, compared with 0.16 mg/kg at both stations in 1998. (CEFAS 2001

3.7.3.3 Trace organics

It has been estimated that there are probably more than 60,000 organic pollutants present in the marine environment (Maugh 1978). The following section provides information on some of the more commonly studied groups of chemicals.

Organo-tin compounds

Tributyl tin (TBT) is widely used as an anti-fouling agent in paint for ships. Its use has been banned for vessels under 25 metres in length since 1987, since it was shown to be having a deleterious effect on species of mollusc such as dogwhelks and oysters, but it is still commonly used in vessels over this length. These vessels still act as a major input source to the marine environment. TBT concentrations in offshore waters are generally less than 1 ng/l when compared with values recorded up to 100 ng/l in frequently used waterways. The current Environmental Quality Standard (EQS) for tributyltin in seawater is 2 ng/l (Cole *et al* 1999). CEFAS (2001) could not detect TBT in water collected at stations within this natural area. Thomas *et al* (2000) could not detect TBT in sediments within this natural area (<0.002 μg/g), and concluded that there would be little accumulation of TBT in offshore sediments.

The International Maritime Organisation adopted a Convention on the Control of Harmful Anti-fouling Systems at a Conference in October 2001. Amongst other measures, this (a) prohibits the application or re-application to ships of organo-tin (TBT) compounds as biocides in antifouling systems from 1 January 2003; and (b) requires that vessels already painted with organo-tin compounds acting as biocides either remove the paint or cover it with an impermeable barrier by 1 January 2008[4].

Polychlorinated biphenyls (PCBs)

Historically, the majority of PCBs entering coastal waters have been from river inputs, whereas atmospheric deposition was a more important input to the open sea. The main source has been the disposal of electrical equipment (OSPAR Commission 1998). It is estimated that more than 90% of the total release of PCBs occurred before 1980, though low levels of release do still occur. Due to the hydrophobicity (water repellence) of these compounds, concentrations in surface waters are extremely low, and in most cases undetectable (MPMMG 1998). PCBs are persistent, will bind to sediments and can be accumulated up the food chain.

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[4] The provisions of the Convention are being implemented in Europe by two instruments:

- Directive 2002/62/EC, which amends Directive 76/769/EEC and prohibits the placing on the market of organotin compounds as biocides to prevent the fouling of all craft used in marine, coastal, estuarine and inland waterways and lakes.
- Council Regulation (EC) 782/2003 addressing vessels already treated with organo tin compounds as biocides.

Concentrations in sediment and biota are markedly higher in near-shore areas than the open sea. CEFAS (1998) analysed PCBs in sediment within this natural area and found concentrations ranging from <0.04 to 0.3 µg/kg off the Isle of Man. According to concentration guidelines defined by Wells *et al* (1989), these sediments are classified as "contamination not detected". Concentrations from stations off Morecambe Bay ranged from 1.9 to 4.9 µg/kg. These sediments are classified as "slightly contaminated". These concentrations are lower than that of dredged sediment taken from UK estuaries, which typically contain 10s of µg/kg (CEFAS 2001).

CEFAS (1998) also reported a concentration gradient for the bioaccumulation of PCBs in dab (*Limanda limanda*) liver within this Natural Area. Levels of 0.25, 0.47, and 1.0 mg/kg were detected in fish collected from SE Isle of Man, offshore Morecambe Bay, and nearshore Liverpool Bay stations respectively. Concentrations of PCBs in Liverpool Bay were the highest recorded in the study, approximately twice that found in Morecambe Bay, the second most contaminated region.

Polycyclic aromatic hydrocarbons (PAHs)

PAHs are formed during the incomplete combustion of fossil fuel, and are also components of petroleum products. They will enter the Irish Sea via industrial and sewage discharges, surface run-off, atmospheric deposition and oil spills. MPMMG (1998) found highest concentrations of PAHs in the water column were in estuaries. At sites further offshore, PAHs were undetectable. Like PCBs, most PAHs can accumulate in sediments and may accumulate up the food chain. High concentrations of PAHs have been linked with liver neoplasm and other abnormalities in bottom dwelling fish (CEFAS 1998). CEFAS (1998) reported concentrations in sediments collected within the Natural Area. A concentration gradient was observed from inshore to offshore samples. Levels of up to 26, 348, and 5236 µg/kg were detected in sediment collected from SE Isle of Man, offshore Morecambe Bay, and within the Mersey estuary stations respectively.

3.7.3.4 Endocrine disrupters

Some contaminants can act as endocrine disrupters, as they have the ability to adversely change endocrine function in fish and other animals. Known, or potential, endocrine disrupters include natural and synthetic hormones, and industrial chemicals. The Quality Status Report on the North Sea (OSPAR Commission 2000) highlighted that more research was needed into the effects of endocrine disruption in marine species. Allen *et al* (2000) reported that reliable information on the effects of endocrine disrupters in aquatic wildlife is patchy, with the most complete data available is that for on fish exposed to oestrogens and their mimics. Relatively poor information is available on other marine vertebrates such as birds and mammals. Knowledge of endocrine disruption in invertebrates is even sparser because their endocrine systems are poorly understood, although there is one example (the effects of TBT in molluscs) which is well documented.

Available information shows that the Mersey is one of the most contaminated UK estuaries (Matthiessen *et al* 1993, NRA, 1995), and it is expected that endocrine disruption is occurring. Indeed, Allen *et al* (1999 & 2000) have shown that male flounder from the Mersey are among the most strongly feminised in the UK. Feminisation has been recorded in offshore spawning populations but this is likely to be due to exposure to oestrogenic compounds in estuaries. However the possibility of contamination in the open sea cannot be excluded

(MAFF 2000). Whether the current concentrations of endocrine disruptors will have an effect on flounder populations remains to be seen. However, it should be noted that the most oestrogen-sensitive part of the flounder's life cycle (the larva undergoing gonad formation) occurs at sea where contaminant levels are relatively low.

A recent report on *Endocrine Disruption in the Marine Environment* (Defra 2002b) details the findings of a £1.5 million 3-year project involving Defra, Government agencies and the chemical industry's Long-Range Research Initiative. The project found that endocrine disruption does occur in some species at certain estuarine locations, and a range of chemicals may be implicated. There is insufficient field data currently available to assess whether such changes impact on reproductive success.

3.7.3.5 Radionuclides

For the last forty years, inputs of radionuclides to this Natural Area have been dominated by discharges from the nuclear reprocessing facilities at Sellafield on the Cumbrian Coast.

In addition to Sellafield, a number of establishments on the west coast of Great Britain are also authorised to release small amounts of radioactivity. The activities concerned include power generation, nuclear fuel production, manufacturing of medical supplies and military/naval operations. Research has established the distribution of radionuclides in sea water and subtidal and intertidal sediments, and the key processes responsible for their distribution have been investigated. Most of the input of 'soluble' radionuclides has been transported out of the Irish Sea, whereas most of the other residues (eg plutonium) reside in subtidal, muddy sediments in the eastern Irish Sea. Tides, storms, trawling and burrowing organisms mix this activity up to 1.5m down into the seabed, dilute the degree of contamination and transport sediment away from the point source. The seabed is therefore a source of sediment-bound radionuclides which are released and redistributed over time.

Reviews of available data on the effects of chronic radiation exposure on aquatic organisms indicate that the estimated dose rates to organisms in the north eastern Irish Sea, and elsewhere in the Natural Area, are unlikely to produce adverse effects at the population level. This applies even to historical dose rates that are likely to have been more than an order of magnitude greater than at present.

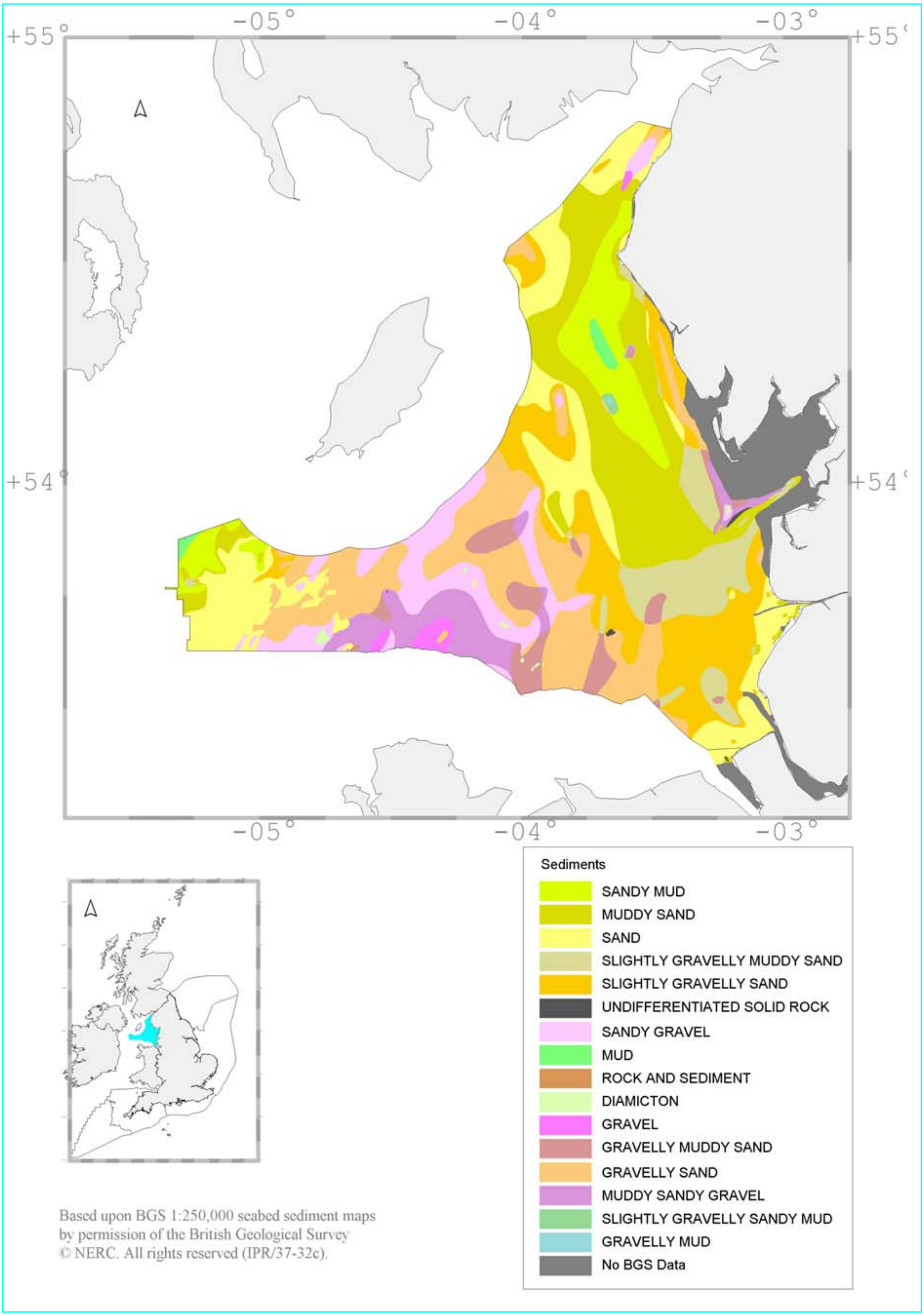


Figure 3.1 Seabed sediments of the Irish Sea Natural Area (taken from Poulton *et al* 2002). See Figure 3.2 for definitions of sediments.

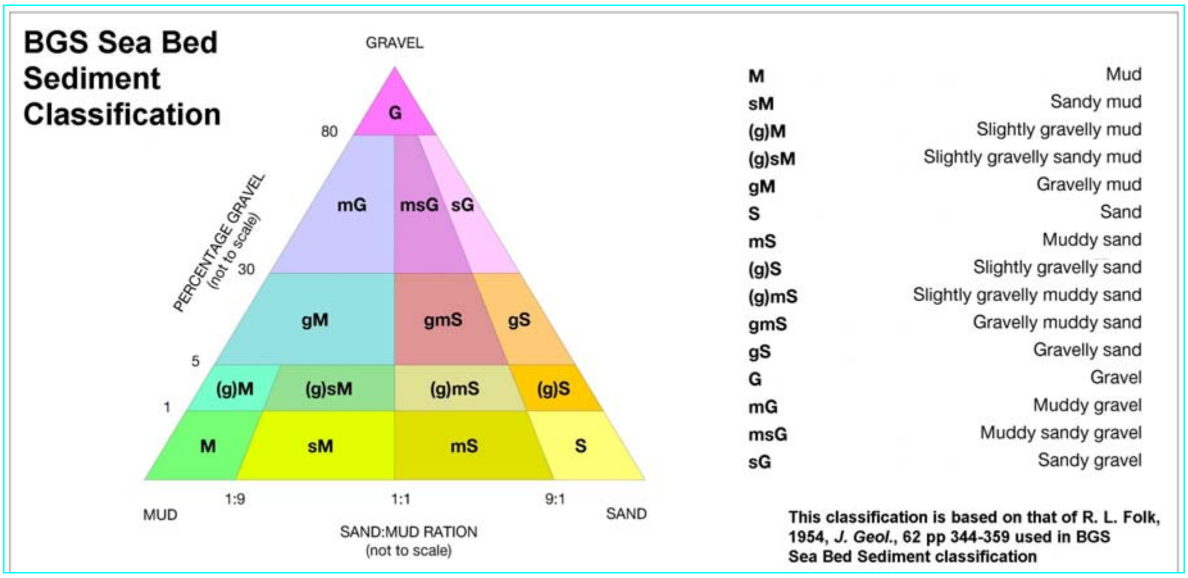


Figure 3.2 British Geological Survey seabed sediment classification taken from Poulton *et al* (2002)

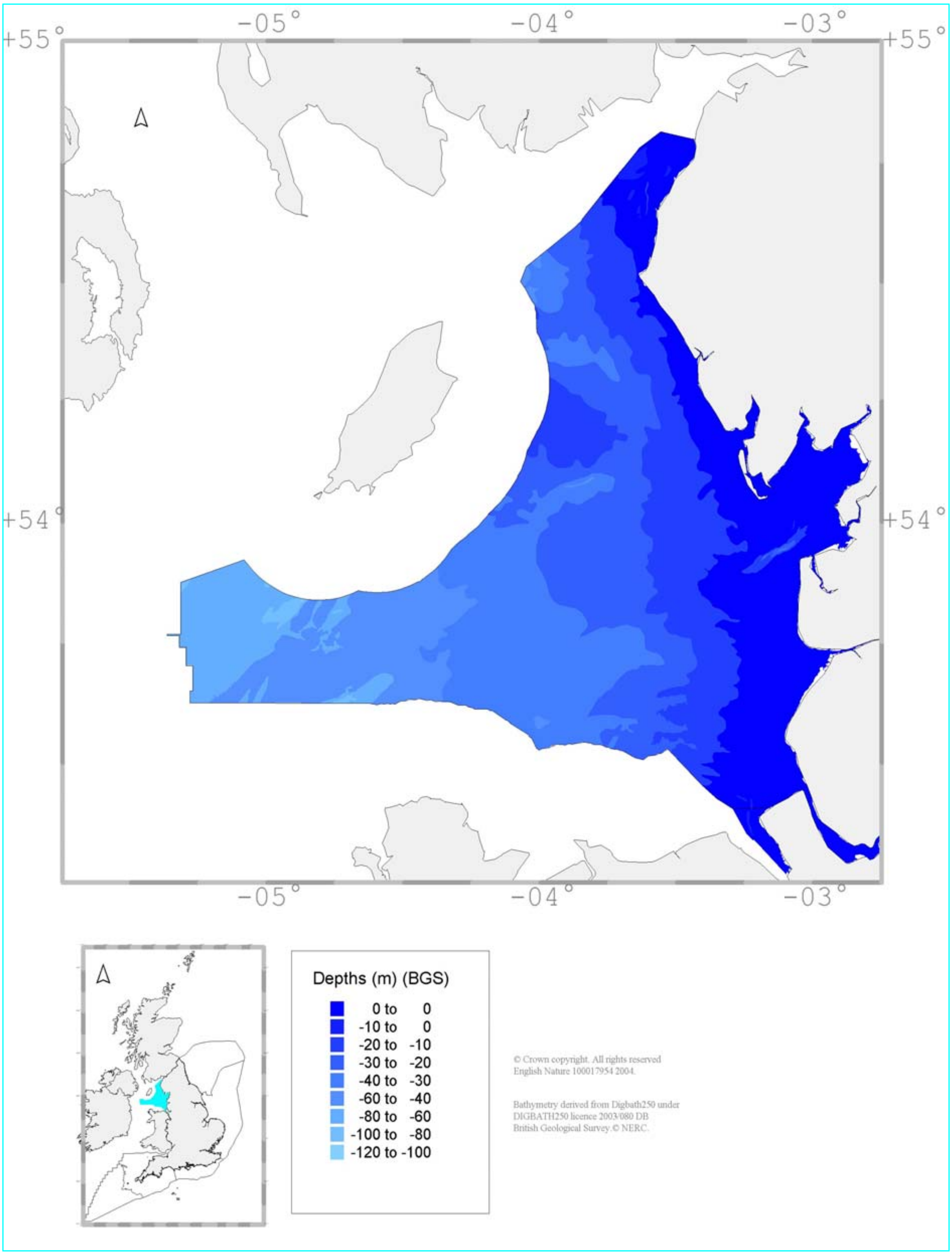


Figure 3.3 Bathymetry of the Irish Sea Natural Area

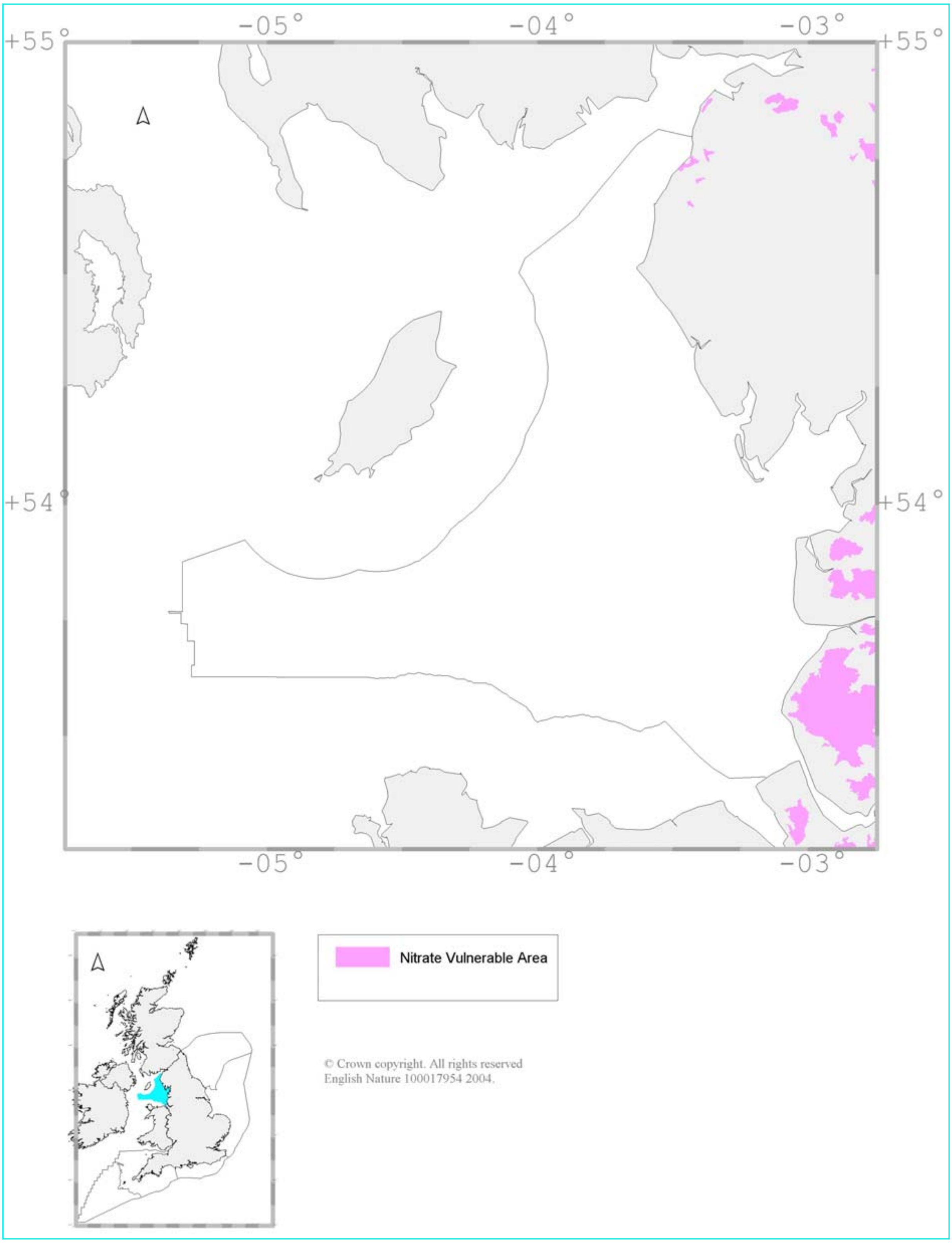


Figure 3.4 The distribution of Nitrate Vulnerable Zones adjacent to this Natural Area (map provided by Defra).

4 Key habitats

This section describes the main habitats in the Irish Sea Marine Natural Area. Different initiatives have used different ways of classifying seabed habitats (particularly the Habitats Directive and the Biodiversity Action Plan systems identified in table 4.1 and Appendix 2). Here we have taken account of both. This section gives a description of the water column (to highlight its importance), the seabed geology and the different types of sediment and rock habitat present, largely based on information provided by the British Geological Survey. However certain habitats that are formed by plants or animals are also described to highlight both their conservation and functional importance. For each feature, the main specific conservation measures currently in place are noted, to indicate the effort being made towards their protection.

The intention is to provide the 'big picture' with selected highlights rather than a detailed description of habitats which would repeat information provided elsewhere (such as designated site citations or environmental statements).

4.1 The water column

The overall water movement through the Irish Sea is from south to north, with oceanic water from the North Atlantic entering from the south and west of the region and moving northwards through the area. The incoming oceanic water is relatively (although not completely) unaffected by human activities. Oceanic fronts, which often develop during the summer months, are present at specific locations and have considerable effects on the existence and distribution of species occurring at the water surface and within the water column, of both plankton (ie organisms drifting with the currents) and nekton forms (organisms able to swim against the currents).

Plankton (both phytoplankton and zooplankton) provides a fundamental role in the food chain of pelagic (oceanic) wildlife. Plankton found in the waters of the Irish Sea made up of neritic (coastal) and intermediate (mixed water) species which can result in high concentrations being found inshore. Any stress imposed on the plankton will have consequences throughout the food chain and may affect the food available to fish, birds and marine mammals, etc (Barnes *et al* 1996). The abundance of plankton is strongly influenced by factors such as depth, tidal mixing and temperature stratification, which determine the vertical stability of the water column. The distribution of species is influenced directly by salinity, temperature and water flows, and the presence of local benthic (bottom-dwelling) communities (Edwards & John, 1996). Blooms of phytoplankton occur through late spring to early summer as daylight increases and the seawater gradually warms. Zooplankton blooms follow soon after, often dominated (up to 75%) by species of copepods. Copepods are also the group with the highest diversity in the zooplankton, with overall zooplankton biodiversity increasing away from the coast and towards the open sea. Diatoms, which largely account for the spring phytoplankton bloom, tend to predominate in inshore mixed waters, while dinoflagellates are more often found in stratified offshore waters during the summer and autumn.

Seasonal shoals of pelagic fish make extensive seasonal movements or migrations between this and adjacent sea areas. Such species include mackerel, herring and sprat. These in turn are exploited by a variety of other animals and provide a vital food resource for birds such as terns and guillemots. These waters support important commercial fisheries, with several species of fish feeding directly on plankton. In addition to these species, plankton has a fundamental role in the food chain of many species of benthic and pelagic wildlife, including jellyfish and non-exploited fish such as the basking shark.

4.1.1 Fronts

Fronts mark the boundaries between water masses and are a feature of the Irish Sea. They are transition zones between 'layered' and 'well mixed' waters, and give rise to a marked horizontal temperature gradient in the surface layers, with changes of 1 ºC per kilometre being common (Lee and Ramster 1981). The temperature change may be as much as 6 ºC over a vertical distance of as many metres. The strength of this thermocline depends on the heat input and the turbulence generated by tides and the wind. The depth of the thermocline also varies, ranging from 10 to 30 metres, typically getting progressively deeper from May to September as surface water temperatures increase. These frontal regions represent important physical, chemical, and biological boundaries. Studies have shown that these boundaries are significant in determining distributions of phytoplankton (Pingree *et al* 1975). This is because the features of frontal systems greatly influence the availability of light and nutrients to plankton. Within the frontal zone both primary and secondary production are enhanced, and this attracts fish, birds and cetaceans.

There is one front traversing this Natural Area which is situated offshore running from parallel to the Duddon Estuary in the north to the Dee Estaury in the south (Vincent *et al* 2004).

4.1.1.1 Nature conservation measures

There are no conservation measures that specifically protect fronts. However, fronts may be subject to some indirect conservation measures if they support concentrations of individuals from a species that qualifies for protection.

4.2 The seabed substrata

The benthic habitats of the Irish Sea Natural Area are defined by the substrata of the seabed. The seabed of the Natural Area is predominantly composed of varying mixtures of sand, gravel and mud (Figure 3.1). The inshore part of the Natural Area between the mouth of the Solway Firth to SW of Morecambe Bay (offshore to about 15 nm) is composed of a mosaic of muddy sand, gravelly muddy sand and mud. Further south between Sefton and the mouth of the River Dee, the seabed is dominated by sand. The area to the South East of the Isle of Man is composed of gravel, sandy gravel and muddy gravel sediment. Further West the gravelly sediments grade through from gravelly sand to sand. The seabed to the extreme west of the Natural Area, south west of the Isle of Man is composed of mud and muddy sand sediments.

At the northern end of the Natural Area, off the coast from Maryport, the Maryport 'Roads' are an important boulder and cobble scar[5] ground. They are extremely diverse with sponges, soft corals, bryozoans including *Flustra foliacea*, the red sea squirt *Dendrodoa grossularia*, hydroids and the reef-building worm *Sabellaria alveolata*.

[5] A cobble reef which is usually bordered by sediment.

Extensive areas of subtidal boulder scars are also present off the west coast of Walney Island. Here they support communities of sea mats, sea firs (hydroids) including, *Alcyonidium diaphnum* and anemones such as *Urticina felina* and dead men's fingers *Alcyonium digitatum*.

The Lune Deep (see section 3.2) at the entrance of Morecambe Bay is dominated by heavily silted boulders, cobbles and pebbles and is subject to strong tidal currents which are rich in food and which support the diverse animal communities present. These comprise a dense growth of sea firs (hydroids), particularly *Nemertesia antennina* as well as other species such *Tubularia* spp. and *Calycella syringa*, sea mats (bryozoans) such as hornwrack (*Flustra foliacea*) and *Alcyonidium diaphnum* and the erect sponge *Haliclona oculata*. Species present between boulders and cobbles include the anemones *Cerianthus lloydii*, the dahlia anemone, and the polychaete worm *Sabella pavonina*.

Macrobenthic infauna usually exhibit strong affinities with the sediment they inhabit and as a result of the mosaic of different sediment types, there are a wide variety of habitats found on the seabed of this region. Mackie (1990) has divided the seabed of the Irish Sea into nine distinctive communities of which seven occur within this Natural Area (Figure 4.1). These communities were distinguished by examining their varying affinities for sediment type, depth and temperature.

As a result of this mosaic of different sediment types there are a wide variety of habitats found on the seabed of this region. Sediments are generally classified by either the Folk (1954) or Wentworth (1922) systems (the Wentworth scales divides the Folk classes into smaller fractions). The habitats below are described using a modified version of the terms of the Folk classification, since more detailed information of the seabed sediments is currently unavailable for the whole of the Marine Natural Area. An exception to this is the 'muddy gravel' which, in terms of ecology, is closer to mud rather than gravel habitats and is therefore included with the former. As different types of sediment grade into one another, separating gravel, sand and mud habitats (as we have done here) is simply a means of dividing up what is a continuum. One outcome of using the Folk classification is that areas defined as gravel by the British Geological Society may include cobbles, boulders, pebbles, and granules (see appendix 3). Stable aggregations of boulders and cobbles may be considered to constitute reef habitat (for example under the Habitats Directive, Johnston *et al* 2002) and this is reflected in the text. For example, gravel may be referred to in the section on reefs.

The JNCC have developed the Marine Nature Conservation Review (MNCR) biotope classification system (Connor *et al* 1997)[6] which has been used here to describe the biological characteristics of each habitat type. The MNCR standardised the description of benthic communities throughout the UK and this provides a framework for assessment and future surveys. The biotope classification takes into account not only the most dominant species present but also the substrata, currents and other physical factors known to have an influence on the communities present.

The Irish Sea Pilot has explored the concept of identifying "marine landscapes" (both species and water column) and testing their ecological relevance. The seabed landscapes are derived

[6] At the time of writing, JNCC were revising the classification. Latest updates can be seen at www.jncc.gov.uk/marine/biotopes/default.htm

from a number of geophysical attributes including bathymetry, sediments, topography and other data. Examples identified include photic reefs, sediment wave/megaripple fields, deep water mud basins and low bed-stress coarse sediment plains. The ecological relevance of the derived landscapes has been tested by investigating the correlation between different biological communities (biotope complexes within the biotope classification) to determine the degree to which a particular landscape can be used as a surrogate for particular communities. In general the seabed landscapes were found to be ecologically valid. For further details see Golding *et al* 2004. There is significant potential for extending this approach to other areas around England building on the data collated for the Marine Natural Areas project.

4.2.1 Gravel habitats

The particle structure of these habitats ranges from various combinations of sand and gravel to pure gravel (Figure 4.2). The diversity and types of community associated with this habitat type are determined primarily by the sediment type, and also a variety of other physical factors such as the relative exposure of the coast, and differences in the depth, turbidity and salinity of the surrounding water.

Sublittoral sand and gravel sediments are the most common habitats found below the low water mark around the coast of the UK (UK Biodiversity Group 1999**.** Irish Sea sands and gravels tend to be formed from shell. While very large areas of seabed are covered by gravel in various mixes, much of this Natural Area has only very thin deposits over bedrock, glacial drift or mud.

The gravel habitats found in deeper offshore areas (>30 metres) generally tend to be less perturbed by natural disturbance than those found closer inshore. They are also more likely to support a diverse marine fauna that may include a wide range of anemones, polychaete worms, bivalves and amphipods, and both mobile and sessile epifauna.

Gravel tends to be found further offshore in this Natural Area (Figure 4.2). Several banks of gravel occur towards the north with sediment thickness ranging from 5-10 m thick. Mackie (1990) classified this Area as being typical of the 'Deep *Venus and* Deep *Venus/*hard community' which forms the 'Boreal offshore gravel association' (see Figure 4.1). Typical species include the urchin *Spatangus purpureus*, and bivalves *Glycimeris*, *Astarte sulcata* and *Venus* spp. In sand wave areas the communities often contain elements of both shallow (*Spisula* sub-community) and deep *Venus* communities. Of the biotopes identified in the MNCR, several may be found in the gravel substrata in this Natural Area (see Table 4.2).

4.2.1.1 Nature conservation measures

Gravel habitats are covered by a priority Habitat Action Plan[7] for sublittoral sands and gravels (UK Biodiversity Group 1999).

No provision for gravel habitats is made under the Habitats Directive. They do not meet the definition of 'Sandbanks which are slightly covered by seawater at all times' given under the Directive, since this habitat is restricted to sediments which predominantly comprise sand (0.0625-2 millimetres). However, some gravel habitat may meet the definition of 'Reefs' under the Directive, where they are predominantly composed of stable boulders and cobbles as these can form a reef-like structure

At present, all marine candidate Special Areas of Conservation (which form part of the Natura 2000 network) are adjacent to the coast. Work is underway to identify offshore sites both beyond 12 nautical miles (see Johnston *et al* 2002), and within English territorial waters. Preliminary work has been undertaken to derive areas of seabed which contain qualifying habitat. Within this Natural Area the qualifying habitat constitutes the scattered areas of 'pure' gravel shown in Figure 4.1. Further work is being undertaken to verify and refine these areas, eg to identify reef and reef-like habitat within areas of rocky or gravelly seabed. Prior to the identification of proposed Natura 2000 sites, locations supporting relevant features of interest should be treated with care to ensure that they are not damaged or altered in such a way that might affect their selection as Natura 2000 sites. However, other than for boulder/cobble components of gravel habitat, there will be no sites identified for gravel since it is currently omitted from the Habitats Directive

See Table 4.1 for a summary of the conservation measures.

4.2.2 Sand habitats

There are three distinct areas of sand within this Natural Area with the largest area being found in the South-Eastern extremity between Sefton and the mouth of the Dee (Figure 4.3 and Figure 4.4).

Due to their particle size, sands in moderate to strong currents are mobilised whereas finer muds and clays remain in suspension. Stronger currents produce seabed sediments of clean sand (and occasionally shell fragments)with little mud or silt. More mobile sand habitats tend to be characterised by robust and sometimes impoverished faunas. Venerid bivalves, amphipod shrimps and polychaete worms are particularly characteristic (see Table 4.2 for MNCR biotopes). Organisms capable of rapid burrowing, such as certain mobile polychaetes and thick-shelled bivalves, often dominate such habitats.

The communities which these sand areas support are determined by a number of factors. These include the exact nature of the sediment, the relative exposure of the coast and differences in depth, turbidity, and salinity of the surrounding water. In inshore areas, shallow sandy sediments are typically colonised by a fauna of worms, crustaceans, bivalve molluscs and echinoderms. These areas also provide important nursery grounds for young commercial fish species, including plaice *Pleuronectes platessa*, cod *Gadus morhua* and Dover sole *Solea solea* (Brown *et al* 1997). A number of sandbanks are found within this Natural Area towards the south eastern boundary. Areas of potential shallow sandbank (*sensu* Habitats Directive) as indicated by shallow sandy sediment are indicated in Figure 4.4.

Mackie (1990) identified the sandy sediments along the inshore boundary of the Natural Area the 'The shallow *Venus* community' and Jones (1950) referred to it as the 'Boreal offshore sand association' (see Figure 4.1). Such localities are in areas subjected to strong currents and the sands belong to sandbank or sand wave systems. The community is often regarded as having two sub-communities relating to their preferred sand grades/stability. The *Tellina* sub-community occurs in fine stable sands and typical species include the bivalve *Tellina fabula* and polychaete *Magelona mirabilis*. The *Spisula* sub-community occurs in medium to coarse sands subject to disturbance and typical species include the elliptical trough shell bivalve

Spisula elliptica and a common bristle worm *Nephtys cirrosa*. The shallow *Venus* bivalve community occurs to the south of the Natural Area, along sections of the inshore boundary.

As mentioned earlier, sandy sediment also forms the central part of the Natural Area and as such is included it in the 'Deep *Venus* community' and is part of the 'Boreal offshore gravel association' (Jones 1950). This community occurs in coarse sand and gravel habitats (see section 4.2) at moderate depths (40-100 m). Typical species include the urchin *Spatangus purpureus*, and bivalves *Glycimeris*, *Astarte sulcata* and *Venus* spp. In sand wave areas the communities often contain elements of both shallow and deep *Venus* communities (Mackie 1990).

There are also two banks formed of muddy gravelly sand within this Natural Area each with a sediment thickness of between 5 – 10 m. Mackie (1990) called these areas 'The *Abra* community' which form the 'Boreal offshore muddy sand association' (see Figure 4.1). This community occurs as small pockets in shallow (5-30 m) nearshore muddy sands/muds with rich organic contents. Typical species include the bivalve mollusc *Abra alba* and polychaete worm *Pectinaria koreni*. An MNCR biotope found within this habitat may be related to this offshore muddy sand association (see table 4.2).

4.2.2.1 Nature conservation measures

Sand habitats are covered by a priority Habitat Action Plan for sublittoral sands and gravels (UK Biodiversity Group 1999).

The Habitats Directive includes the habitat 'Sandbanks slightly covered by seawater all the time'. In the UK this has been interpreted as comprising a range of sandy sediments (particle size range 0.0625-2 millimetres and where sand is dominant), on distinct banks which may arise from horizontal or sloping plains of sandy sediment. Water depth for this habitat is seldom more than 20 metres below chart datum (European Commission 1999), so it excludes deeper relict sandbanks. Thus shallow sandbanks and mounds may be designated as SACs but large, flat areas of sand habitat may not be selected. Morecambe Bay SAC includes 'Sandbanks slightly covered by seawater all the time' as an interest feature.

At present, all marine candidate Special Areas of Conservation (which form part of the Natura 2000 network) are adjacent to the coast. Work is underway to identify offshore sites both beyond 12 nautical miles (see Johnston *et al* 2002), and within English territorial waters. Preliminary work has been undertaken to derive areas of seabed which contain qualifying habitat and this is shown in Figure 4.4. Further work is being undertaken to verify and refine these areas, eg sandbanks within the broad swathes of shallow sandy seabed. Prior to the identification of proposed Natura 2000 sites, locations supporting relevant features of interest should be treated with care to ensure that they are not damaged or altered in such a way that might affect their selection as Natura 2000 sites.

See Table 4.1 for a summary of conservation measures.

4.2.3 Mud habitats (including muddy gravel)

Mud habitats are predominantly found in the eastern part of this Natural Area (Figure 4.5). The sediment here is dominated by populations of the burrowing brittlestar *Amphiura filiformis* with the seapen *Vigularia mirabilis*, the burrowing shrimp *Calocaris macandrae* and the crab *Goneplax rhomboids*. Dense populations of the burrowing bivalve *Spisula subtruncata* are also thought to occur in some places.

Mackie (1990) also identified a distinct '*Amphiura*' community associated with the offshore sandy muds at shallow to moderate depths (15-100m) off the Cumbrian coast (see Figure 4.1). Typical species include the brittlestar *Amphiura filiformis*, the urchin *Echinocardium cordatum* and the tower shell *Turritella communis*.

There are two distinct areas of mud in deep water within the Natural Area (Figure 4.5), one on the western boundary of the area where water depths exceed 150 m and another offshore and adjacent to the Drigg coast. Mackie (1990) identified these areas as representing distinct '*Brissopsis*' communities. Typical species include the urchin *Brissopsis lyrifera* and brittle-star *Amphiura chiajei*. The location of this deep mud, in conjunction with the nearby *Amphiura* communities coincides with those of the *Nephrops* fisheries.

4.2.3.1 Nature conservation measures

Two types of mud habitat are covered by Habitat Action Plans, 'Sheltered muddy gravels' and 'Mud habitats in deep water'. However, the former primarily covers muddy gravels in estuaries, rias and sea lochs which do not occur in this Natural Area. The latter Action Plan applies to mud habitats below 20 to 30 metres depth, which includes some of the habitat occurring in this Natural Area. Subtidal mud habitat is not listed on the Habitats Directive but may be included as a constituent of 'Large shallow inlets and bays' habitat. The only area which meets this definition occurs within the Morecambe Bay SAC (Figure 4.6).

4.2.4 Rock habitats

Rock habitats include exposed areas of bedrock, which have a flat profile or rise from the seabed to form, together with stable areas of boulders and cobbles, reefs or reef-like habitats (often containing sea caves). The diversity of rock habitats is of considerable conservation importance as they often support sites of high biodiversity (Hill *et al* 1998). Different types of rock such as limestone or sandstone also have an effect on biotope type. There is very little rock habitat within this Natural Area. Where rock does occur it forms isolated outcrops in offshore areas (Fig 3.1).

4.2.4.1 Nature conservation measures

The Habitats Directive includes two rock habitat types for which Special Areas of Conservation (SACs) can be designated, 'Reef' and 'Submerged or partially submerged seacaves'[8]. Within the Irish Sea Natural Area there are two sites where reef habitat is included as a feature of interest under the Habitats Directive, namely the Morecambe Bay and Soway Firth SACs (see section 4.3.3.1). There are no sites selected for seacaves.

At present, all marine candidate Special Areas of Conservation (which form part of the Natura 2000 network) are adjacent to the coast. Work is underway to identify offshore sites both beyond 12 nautical miles (see Johnston *et al* 2002), and within English territorial waters. Preliminary work has been undertaken to derive areas of seabed which contain qualifying habitat. Further work is being undertaken to verify and refine these areas, eg to identify reef

[8] Defined as "Caves situated under the sea or opened to it, at least at high tide, including partially submerged sea caves…".

and reef-like habitat within areas of rocky or gravelly habitat. Prior to the identification of proposed Natura 2000 sites, locations supporting relevant features of interest should be treated with care to ensure that they are not damaged or altered in such a way that might affect their selection as Natura 2000 sites.

See Table 4.2 for a summary of the conservation measures.

4.3 Notable biogenic habitats

Animals and plants can have a profound influence on the habitats in which they reside, for example the presence of large numbers of kelp plants on flat bedrock makes for a very different habitat. This reflects their nature conservation importance but also demonstrates that there are habitats in the seas around England that are formed by plants and animals rather than simply being based on the seabed substrata.
Particular biogenic habitats are often associated with specific broad habitats, for example, maerl is usually associated with “gravel”, seagrass beds with “sand”, though reefs formed by animal such as the ross worm *Sabellaria* spp can be associated with a range of habitats such as gravel, pebbles and cobbles, and bedrock.

4.3.1 *Sabellaria* reefs

Within the Irish Sea Natural Area the main types of reefs are biogenic reefs composed of the Honeycomb reef worm *Sabellaria alveolata*. This sedentary tube-dwelling polychaete is most commonly found on rocky substrata in the lower shore and shallow subtidal zones. *Sabellaria alveolata* reefs may take the form of extensive sheets, hummocks, or more massive and extensive reefs, consisting of honeycomb masses of worms. *Sabellaria alveolata* is essentially a southern species, which reaches its northerly limit of distribution at the northern tip of this Natural Area, in the outer Solway Firth.

Along the eastern Irish Sea coast the species is found in a variety of locations, most notable at Heysham in Morecambe Bay, along the Cumbrian coast, particularly at Drigg and further north towards Silloth, and along the coasts of the Solway Firth.

At Heysham, in South Morecambe Bay, there is a well-developed reef area, where *S. alveolata* has extended on scar ground near the subtidal channel. At this location the species has developed area of extensive interlocking reef structure, though there are areas where the species is present intermittently. Well developed reef structures are also present on the lower shore along the west coast of the Isle of Walney, Nr. Barrow and on some parts of the lower shore on the South Cumbrian coast from Gutterby Spa to Tarn Point (Allen *et al* 2002)

Sabellaria alveloata exhibits natural temporal and spatial variability and there is evidence to suggest there has been a significant contraction in range on parts of the British coastline. Causes of these changes are unknown and it is difficult to assess that true significance of a decline, given the development of the species elsewhere. For example, the reefs off Heysham that have developed relatively recently now dominate around two heactares of boulder scar where the species has been absent for 30 years (Allen *et al* 2002)

Factors affecting subtidal *Sabellaria alveolata* reefs can only be guessed at but the biggest threat is likely to be from bottom-fishing activities which result can in widespread and longlasting damage (Holt *et al* 1998). Other factors known to affect *S. alveolata* include competition for space with the common mussel *Mytilus edulis* and long term burial by sand which may result from changes in sediment regime caused by shoreline development.

4.3.1.1 Nature conservation measures

Sabellaria alveolata reef has its own Habitat Action Plan.

Under the Habitats Directive the habitat "reef" includes biogenic reefs such as those formed by *Sabellari*a spp. Within the Irish Sea Natural Area there are two sites where reef habitat is included as a feature of interest under the Habitats Directive, namely the Morecambe Bay and Soway Firth SACs (Figure 4.6).

At present, all marine candidate Special Areas of Conservation (which form part of the Natura 2000 network) are adjacent to the coast. Work is underway to identify offshore sites both beyond 12 nautical miles (see Johnston *et al* 2002), and potentially within English territorial waters. Prior to the identification of proposed Natura 2000 sites, locations supporting relevant features of interest should be treated with care to ensure that they are not damaged or altered in such a way that might affect their selection as Natura 2000 sites.

Table 4.1 Summary of Nature Conservation measures

Habitat type	**EU Habitats Directive [1]**			**UK Biodiversity Action Plan[2]**		
	Sandbanks slightly covered by seawater all the times[a]	Large shallow inlets and bays	Reefs[a]	Sublittoral sands and gravels	*Sabellaria alveolata* reefs[c]	Mud habitats in deep water
Gravel habitats		•	• Boulders and cobble	•		
Sand habitats	•	•		•		
Mud habitats		•				•
Sabellaria reefs			•		•	

[1] 'Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora' is commonly known as the Habitats Directive.
[a] Annex I natural habitat of community interest whose conservation requires the designation of Special Areas of Conservation.
[2] The UK Government's plan for the protection and sustainable use of biodiversity, published in 1994. It represents a commitment to joint action nationwide through the securing and better use of resources.
[b] Priority habitat which has been identified as being rare or in sharp decline.

Table 4.2 MNCR biotopes associated with the key habitats in the Irish Sea Natural Area

Key habitat	Biotope description (& Higher/Biotope code)
Gravel	Venerid bivalves in circalittoral coarse sand or gravel (CGS.Ven) *Sabellaria spinulosa* and *Polydora* spp. on stable circalittoral mixed sediment (CMX.SspiMx) *Laminaria saccharina* and filamentous seaweeds on infralittoral mixed sediments (IMX.KSwMx)
Sand	Shallow sand faunal communities (IGS.FaS)
Mud	*Echinocardium cordatum* and *Ensis* sp. in shallow sublittoral muddy fine sand (IMS.FaMSEcorEns) *Amphiura filiformis* and *Echinocardium cordatum* in circalittoral clean or slightly muddy sand (CMS.AfilEcor) *Brissopsis lyrifera* and the brittlestar *Amphiura chiajei* (CMU.BriAchi)
Reefs	*Sabellaria spinulosa* and *Polydora* spp. on stable circalittoral mixed sediment

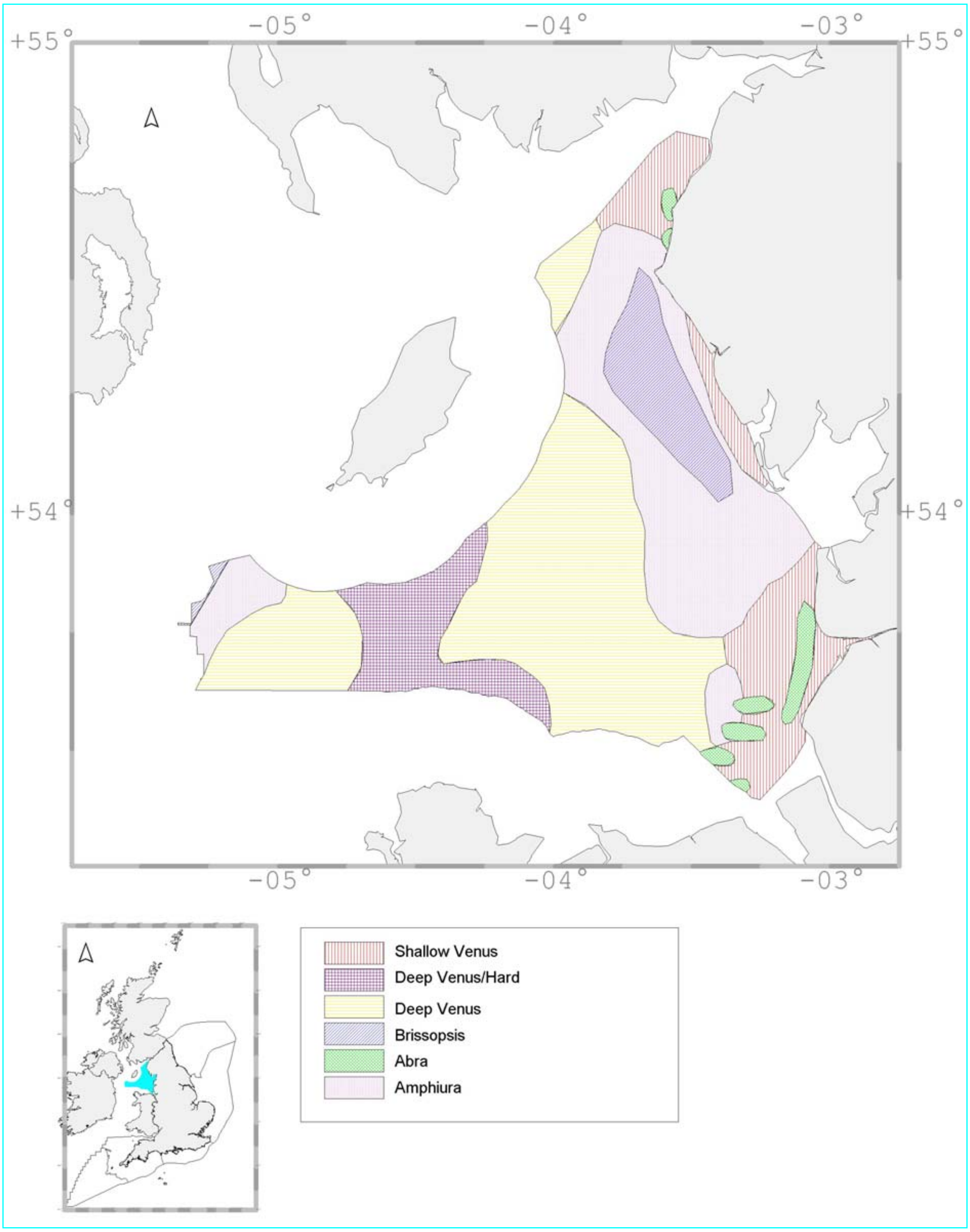


Figure 4.1 Distribution of habitats in the Irish Sea Natural Area. Source: Based on Mackie (1990).

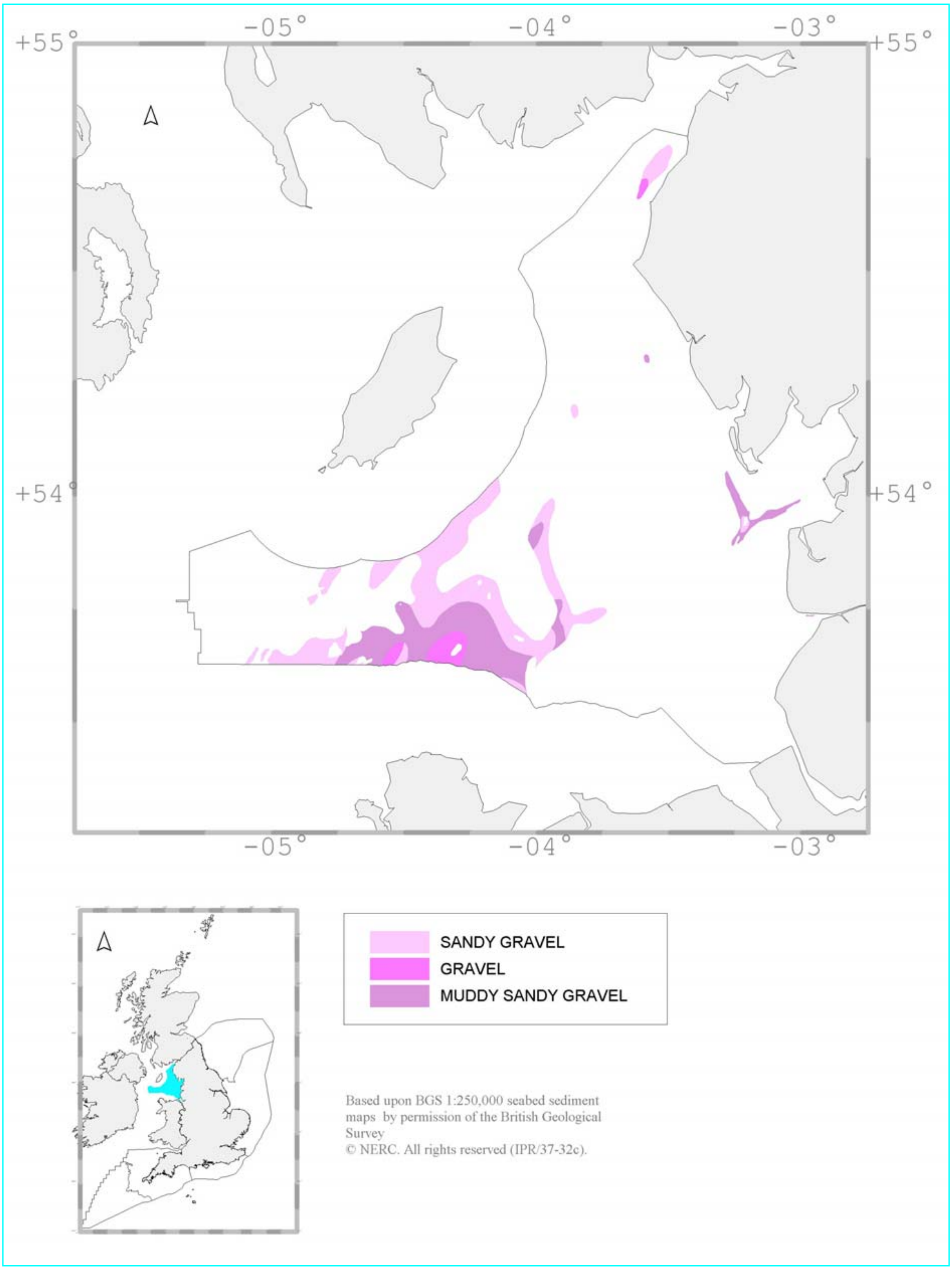


Figure 4.2 Gravel habitats in the Irish Sea Natural Area

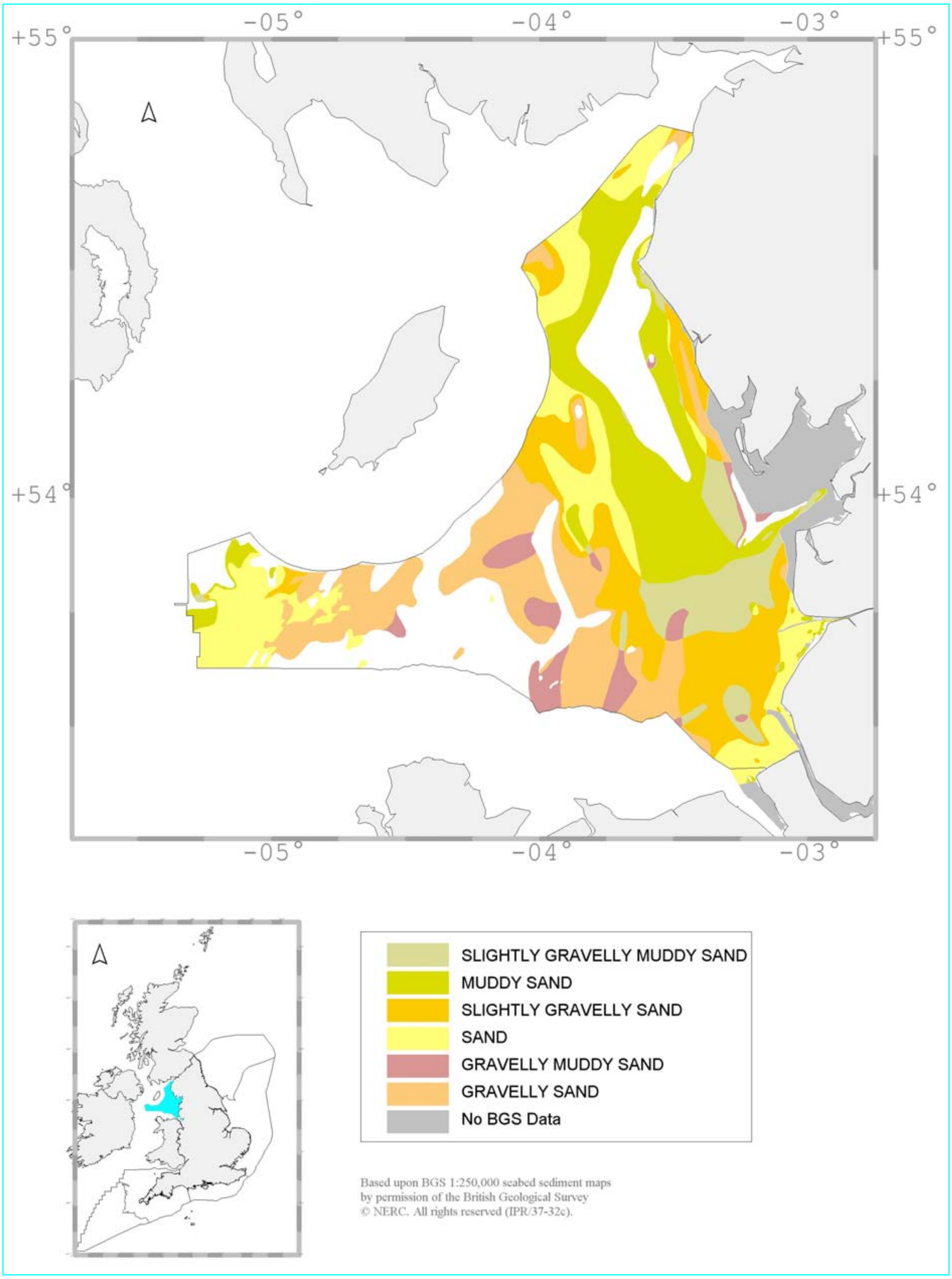


Figure 4.3 The distribution of sand habitats within the Irish Sea Marine Natural Area.

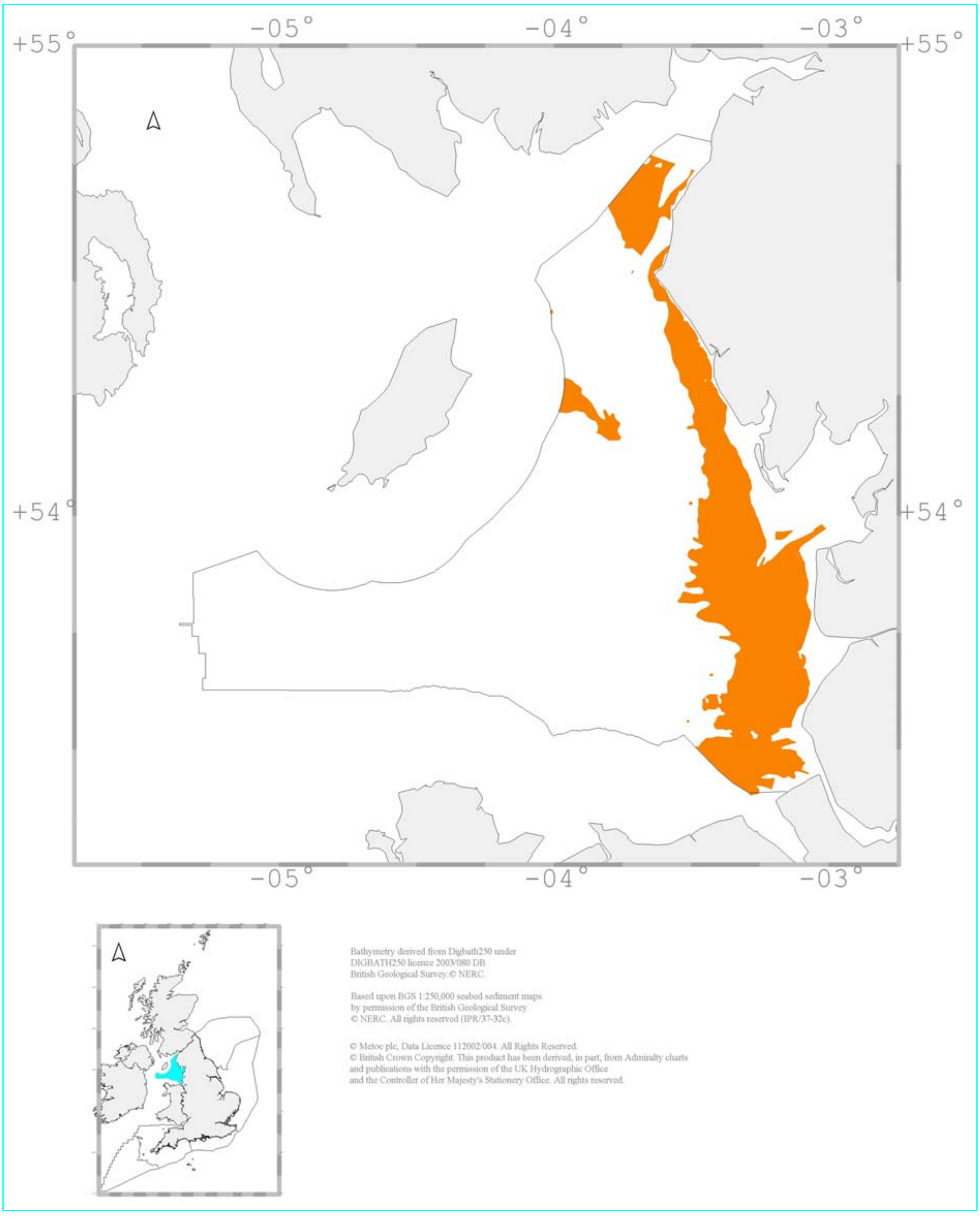


Figure 4.4 The distribution of shallow (<20 metres) sandy seabed areas, which indicates the potential location of 'Sandbanks slightly covered by sea water all the time' (*sensu* Habitats Directive) in the Irish Sea Marine Natural Area. Further refining of these areas will define seabed which qualifies as Habitats Directive habitat.

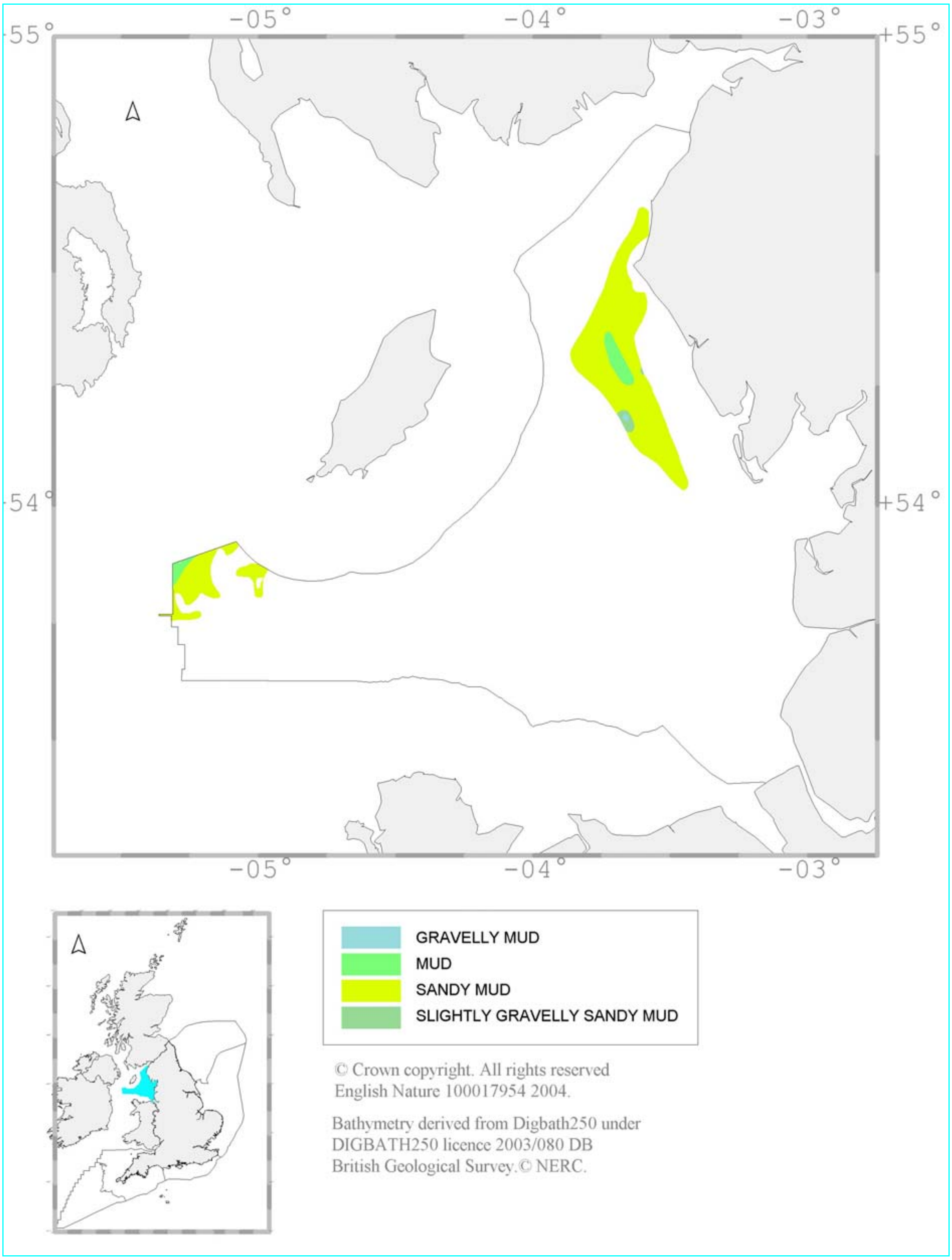


Figure 4.5 Mud habitats in the Irish Sea Natural Area

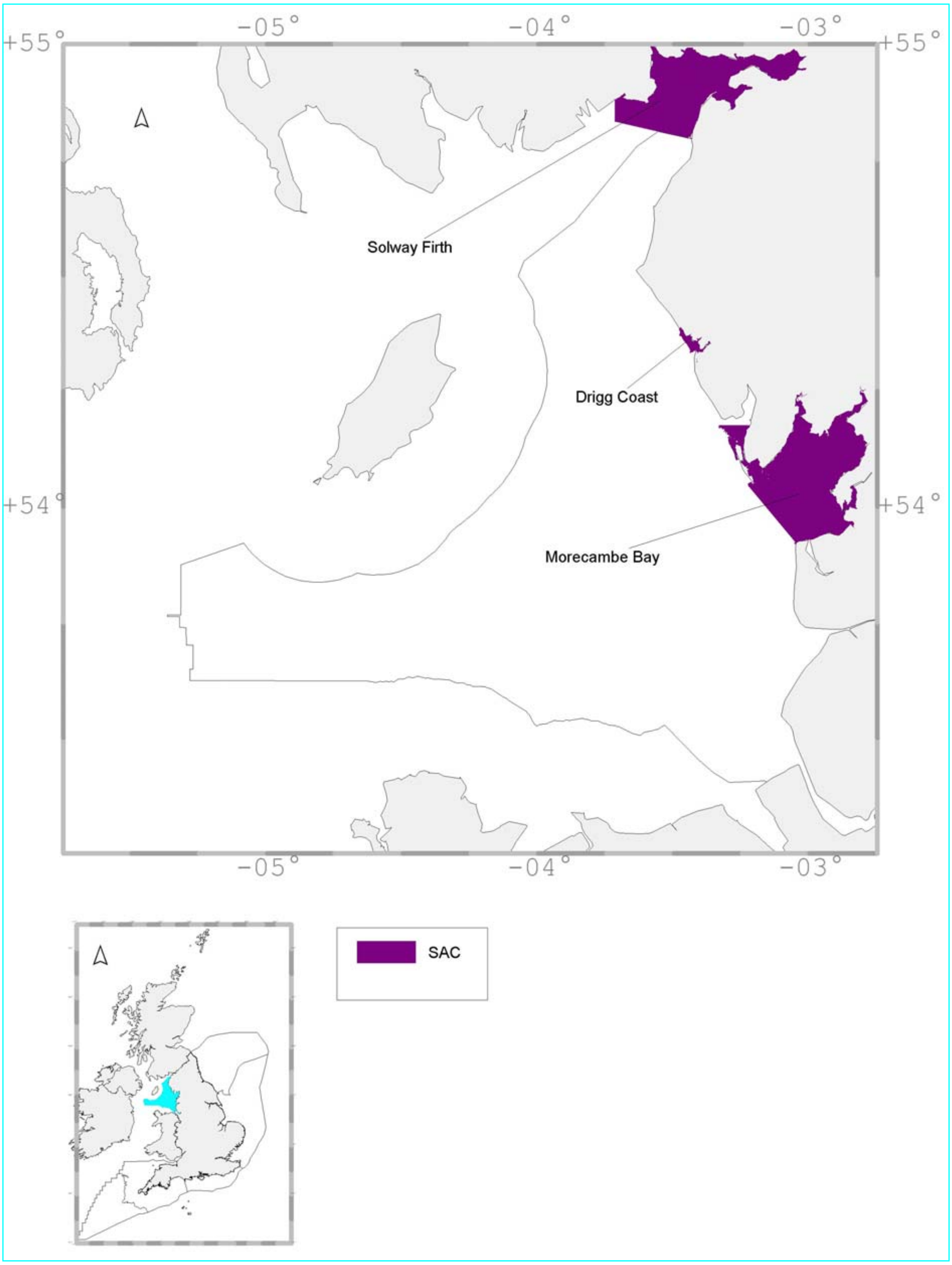


Figure 4.6 Candidate Special Areas of Conservation of relevance to the Irish Sea Marine Natural Area

Irish Sea

Internationally important populations of common scoter are found within this Natural Area. Mark Hamblin/ RSPB-images.com (right)

Herring shoals spawn and feed within this Natural Area. Bill Sanderson/Aquatic-us (below right)

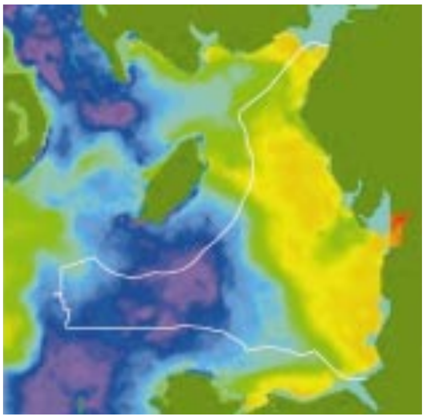
Norway Lobster *(Nephrops norvegicus)* on muddy sediment. There is a large *Nephrops* fishery within the Irish Sea Natural Area. JNCC (below)

Group of harbour porpoise, the most commonly sighted cetacean in the Irish Sea. Mick Baines (bottom right)

Loaded scallop dredge being hauled into trawler.
Bill Sanderson/Aquatic-us (above)

North Hoyle windfarm under construction.
Martin Bailey/English Nature (above)

Seawater surface temperature in the Irish Sea Natural Area in June 1997.
© Natural Environment Research Council (NERC) & Plymouth Marine Laboratory (PML) 2004 (below)



5 Key species

This section describes key species of nature conservation value in the Irish Sea. We have used the UK Biodiversity Action Plan (BAP) and the Habitats and Birds Directives as a focus and basis for structuring the text. Hence, for example, whilst a number of the fish species described are of commercial importance, they are included here because they are covered by Species Action Plans under the UK BAP. The main conservation measures currently in place are noted for each group of species, to indicate the effort being made towards their protection.

5.1 Marine birds

5.1.1 Background

The UK's coastal and offshore waters are of exceptional importance for several species of resident and migratory marine birds[9]. Of the twenty-four species of seabird which regularly breed in the UK, 17 are present in UK waters in numbers greater than 50% of the EU population (Lloyd *et al* 1991).

The distribution of marine birds is influenced by a wide variety of factors. Perhaps the most important of these is food availability (Hunt and Schneider 1987), though proximity to suitable nesting habitat is of crucial importance throughout the breeding season (Skov *et al* 1994).

Fish are the main prey for the majority of marine bird species. Among the most important are sandeel *Ammodytidae*, herring *Clupea harengus*, sprat *Sprattus sprattus* and mackerel *Scomber scombrus* (Skov *et al* 1995). The larvae of many of these species feed on plankton and occur at elevated densities where plankton is abundant. Such conditions occur at fronts, where deeper, nutrient-rich waters mix with warmer, sunlit surface waters (Lloyd *et al* 1991, Pingree *et al* 1975). The abundance of food at fronts attracts both fish and marine birds (see for example Stone *et al* 1995).

During the breeding season, the distance over which a nesting species will forage varies according to species. Northern fulmar *Fulmarus glacialis* may feed 400 kilometres or more from their breeding colony (Dunnet & Ollason 1982), whilst others, such as the black guillemot *Cepphus grylle*, rarely feed more than than a few kilometres offshore (Lloyd *et al* 1991). Outside the breeding season many species of seabirds disperse over a wider area.

Many species congregate at high densities to feed, nest and moult. In such situations a large proportion of the total population is susceptible to local incidents, such as oil spillages. The majority of marine birds are long-lived, do not reach breeding condition for several years and have low reproductive rates, hence even highly localised incidents can have a significant impact upon a population (Tasker *et al* 1990). Several species of marine bird, most notably

[9] Marine birds include all birds that are wholly or partly reliant upon the sea. For the purpose of this document marine birds have been divided into two categories (following Tasker & Leaper 1993):

- True Seabirds – birds reliant on the sea all year. These include terns, gulls, petrels, cormorants, auks, skuas and gannet *Morus bassanus*.
- Coastal Birds – birds reliant on the sea (open coasts as well as estuaries) for only part of the year. These include divers, grebes and seaduck.

the auks, divers, grebes and seaduck, moult their flight feathers simultaneously, becoming temporarily flightless. Such species are particularly vulnerable at this time.

Predation can significantly affect breeding marine bird populations. The threats from predation are most severe for seabirds nesting on islands due to limited space, restricted available habitat and lack of effective anti-predator behaviour (Burger & Gochfeld 1990).

5.1.2 Marine bird distribution

The Irish Sea Natural Area is important for marine birds in both a national and international context (Tasker *et al* 1990). The twenty-nine regularly occurring species are indicated in Table 5.1, together with a summary of their distribution and abundance in the Natural Area.

Sixteen of these species use the shoreline for nesting. All rely upon the marine waters of the Natural Area to a greater or lesser extent for feeding, preening, mating and resting. The majority, including fulmar *Fulmarus* glacialis and guillemot *Uria aalge*, are highly dependent on marine waters in the Natural Area throughout the year. Other species, notably the terns *Sterna spp.*, Manx shearwater *Puffinus puffinus* and storm petrel *Hydrobates pelagicus*, are seasonally dependent, migrating to more distant waters outside the breeding period.

In winter, the relatively mild climate and good feeding conditions present in the intertidal and coastal waters of the area attract large numbers of waterbirds from breeding areas as far apart as arctic Canada and Siberia. On the adjacent shoreline, the Duddon Estuary, Morecambe Bay, the Ribble and Alt Estuaries and the Dee Estuary have all been designated as Special Protection Areas (SPAs) (Figure 5.1) f their internationally important marine bird populations. Together, these sites hold internationally important numbers of four of the five species of tern *Sterna spp.* found in the UK.

During the breeding season Morecambe Bay SPA regularly supports over sixty thousand individual seabirds and includes the UK's largest herring gull *Larus argentatus* and lesser black-backed gull *L. fuscus* colonies. Lesser black-backed gull and herring gull are opportunistic feeders and have a scattered distribution throughout this natural area, often associating with fishing vessels to feed on by-catch and discards.

The sandy substrata and rapid water circulation of the eastern Irish Sea provide ideal spawning conditions for sole *Solea solea*, plaice *Pleuronectes platessa* and whiting *Merlangius merlangus*, major components of the diet of several marine bird species. Species including divers *Gavia spp.*, black-headed gGull *Larus ridibundus*, Common Gull *L. canus*, and little gull *L. minutus*, feed on shallow water fish such as blennies, gobies and butterfish and thus tend to be most frequent in the relatively shallow coastal waters. Diving ducks such as common scoter *Melanitta nigra* and eider *Somateria mollissima* feed in shallow waters with superabundant benthic invertebrates, primarily blue mussels *Mytilus edulis* and cockles *Cardium spp* (Durinck *et al* 1993). Recent aerial surveys have discovered internationally important numbers of Common Scoter (16,000 or more birds) in the Liverpool Bay area throughout the winter months (Oliver *et al* 2001). Evidence suggests that these birds move to deeper waters to feed when benthic invertebrate resources become depleted in shallower areas in late winter and also to moult in late summer-early autumn. (International Windfarm Conference 2001)

The Irish Sea Front runs between areas of weak and strong tides running from parallel to the Duddon Estuary in the north to the Dee Estaury in the south (Vincent *et al* 2004).
It attracts important numbers of guillemot and razorbill *Alca torda* from July until September. In the latter part of this period it provides an important feeding ground for fulmar, manx shearwater, kittiwake and to a lesser extent puffin *Fratercula arctica* and common terns *Sterna hirundo* (Rees and Jones 1982). It has a relatively constant position (Simpson and Bowers 1979), which almost certainly enhances its value as a food source for seabirds (Stone *et al* 1995).

5.1.3 Nature conservation measures

Six Special Protection Areas (SPAs) on the neighbouring coastline have been designated for the internationally important populations of marine birds that they support (see Figure 5.1). As well as supporting important populations of marine birds, these sites are also of international importance for a range of other species that rely upon the rich intertidal, brackish and freshwater habitats present. Both the Duddon Estuary and Morecambe Bay SPAs have internationally important populations of breeding terns.

All of these sites are protected by the Habitats and Species Directive, the Habitats Regulations and the Countryside and Right of Way Act 2000. Currently, the majority of SPAs extend no further seaward than mean low water, although work is underway to identify additional marine areas that should be considered for designation. These sites will include areas where birds aggregate, eg for feeding and over-wintering. However, in the period prior to identification of proposed Natura 2000 sites, locations supporting relevant features of interest should be treated with care to ensure that they are not damaged or altered in such a way that might affect their selection as Natura 2000 sites.

Table 5.1 Summary of regularly occurring marine birds in the Irish Sea Natural Area. This information has been compiled from a variety of sources including county avifaunas, county bird reports, Stone *et al* (1995), Lloyd *et al* (1991), Mavor *et al* (2001), Stroud *et al* (2001), Skov *et al* (1995) and Brown & Grice in press.

Species	Jan → Dec	Key areas	Status
Red-throated Diver		Main concentration in coastal areas.	PM, A1
Great Northern Diver		Rare.	M, A1
Great Crested Grebe		Typically inshore.	PM
Little Grebe		Inshore, sheltered areas.	PM
Fulmar		Predominantly along Irish Sea Front.	PM
Great Shearwater		Occasional along Irish Sea Front.	M
Manx Shearwater		Important numbers in area 1. Absent in winter during migration	M
Storm Petrel		Mainly along front.	M, A1
Leach's Petrel		Mainly in coastal areas.	M, A1
Gannet		Distributed throughout. Main concentration around Irish Sea Front. Numbers peak post-fledging	PM
Cormorant		Principally coastal distribution.	PM
Shag			PM
Eider		Coastal waters.	PM
Common Scoter		Highest densities in sheltered, coastal zones to the north of the Natural Area Non-breeding birds remain during the breeding season.	PM
Red-breasted Merganser		As above.	PM
Skua (Arctic and Great)		Highest densities Aug–Oct. during migration to wintering grounds.	M
Little Gull		Internationally important numbers in coastal waters during autumn.	M
Black-headed Gull		Mainly coastal, throughout year.	PM
Common gull		Mainly coastal, highest numbers Oct-Feb.	PM
Herring Gull		Predominantly coastal distribution. Highest densities Nov-Feb.	PM
Lesser Black-backed Gull		Scattered distribution throughout spring and summer.	PM
Great Black-backed Gull		As above	PM
Kittiwake		Widespread. Highest densities around Irish Sea Front.	PM
Sandwich Tern		Main concentrations in coastal waters. Migrate post breeding.	M, A1
Common Tern		Shallow areas adjacent to colonies, in coastal waters. Migrate post breeding.	M, A1
Guillemot		High densities areas in coastal waters. Disperse from colonies post breeding.	PM
Razorbill		Breeding season - concentrated around north and coastal areas.	PM
Puffin		Highest densities offshore.	PM

Table notes:

Graded Lines indicate relative seasonal abundance within a species.

———	Present in small numbers	▬	Common
▬	Uncommon	■	Abundant
----------	Scattered or irregular		

Key areas

Status A1 = Listed on Annex I of Birds Directive.
M = Migratory species.
PM = Partially migratory species.

5.2 Cetaceans

Cetaceans (whales, dolphins and porpoises) form a group of top predators in the marine environment. Those species which have been recorded for the Irish Sea include large and small cetaceans and are divided into two suborders:

- **Baleen whales** (Mysticeti), which use plates of baleen (keratin) to filter out food from the water column.
- **Toothed whales** (Odontoceti), which have teeth. These include dolphin and porpoise species.

This part of the Irish Sea is relatively unimportant for cetaceans. Cetaceans, with the exception of harbour porpoises, seem only to occur as visitors within the Irish Sea.

Figure 5.2 shows where particular species of cetaceans have been sighted within the Natural Area over the period 1992-2001. Although very large, the data set used to compile the map does reflect the degree of observer effort and the location of observers such as ferries, coasts and offshore platforms. Therefore, it should only be considered as illustrative and not as a definitive picture of cetacean distribution in this area. A more qualified account is given by Reid *et al* (2003) which also includes an analysis of species abundance within a defined area. This work can be viewed at www.jncc.gov.uk/publications/cetaceanatlas.

5.2.1 Baleen whales

No baleen whale species are resident or regularly occurring within the Irish Sea Natural Area. Occasional sightings of the minke whale *Balaenoptera acutorostrata* have been made.

5.2.2 Toothed whales

The harbour porpoise *Phocoena phocoena* is the most frequently sighted species cetacean in the Irish Sea, particularly in the summer months. Although species are occasionally sighted offshore, individuals are more common near the coast in this Natural Area where groups are often found hunting large shoals of fish such as herring.

The common dolphin *Delphinus delphis* has been recorded in this Natural Area. Sightings tend to be offshore with peak numbers and frequency of sightings occurring between June and October, particularly to the south-west of the Isle of Man. A peak number of calves are seen during the summer (Evans 1992).

Bottlenose dolphins *Tursiops truncatus* have been sighted within this Marine Natural Area though they tend to be found in the near shore waters of the UK.

A number of other species of toothed whale have been occasionally sighted within this Natural Area and include the sperm whale *Physeter macrocephalus*, white-beaked dolphin *Lagenorhynchus albirostris*, striped dolphin *Stenella coeruleoalba*, Risso's dolphin *Grampus griseus,* killer whale *Orcinus orca* and long-finned pilot whale *Globicephala melas.*

5.2.3 Nature conservation measures

A summary of protection measures can be seen in Table 5.2.

All cetacean species found in this Natural Area are listed on either Appendix I or II of Convention on International Trade in Endangered Species (CITES). The former lists species that are the most endangered and therefore prohibits commercial trade and the latter lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled.

All cetaceans are protected by the Bern Convention (1979) which conveys special protection to those species which are vulnerable or endangered. Although an international convention, in England it is implemented through the Wildlife and Countryside Act 1981.

The Bonn Convention (1979) protects migratory wild animals across all or part of their natural range through international co-operation, particularly those species that are in danger of extinction. One of the measures identified is the adoption of legally binding agreements of which ASCOBANS (described above), is one.

All toothed and baleen cetaceans are protected under Annex IV of the EC Habitats Directive because they are either endangered, vulnerable or rare. Harbour porpoise and bottlenose dolphin are also listed under Annex II of the Habitats Directive which requires Member States to designate SACs to ensure their conservation. However, no areas essential to life and reproduction have been identified for these species within this Natural Area.

In addition to those protection measures listed in Table 5.2, there is an Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) Formulated in 1992, this Agreement has been signed by eight European countries (including the UK) bordering the Baltic and North Seas (including the English Channel). Under the Agreement, provision is made for protection of specific areas, monitoring, research, information exchange, pollution control and increasing public awareness of small cetaceans.

Under schedule 5 of the Wildlife and Countryside Act 1981 (as amended), all cetaceans are given full protection within British territorial waters. This protects them from killing or injury, sale, destruction of a particular habitat (which they use for protection of shelter), and disturbance. Common and bottlenose dolphins and harbour porpoises are also listed under schedule 6 of the Act which prevents these species being used as a decoy to attract other animals. This schedule also prohibits the use of vehicles to take or drive them, prevents nets, traps or electrical devices from being set in such a way that would injury them and prevents the use of nets or sounds to trap or snare them. Under the Countryside and Rights of Way Act 2001 is it an offence to deliberately or recklessly damage or disturb any cetacean in English and Welsh protected waters. The nature conservation measures which are in place to protect cetacean species are summarised in Table 5.2.

Table 5.2 Summary of cetacean protection measures.

	Schedule 5 Wildlife & Countryside Act	**EC Habitats Directive (Annex)**	**CITES (Annex)**	**Bonn Convention (Appendix II)**	**IUNC Red Data List Species**	**Bern Convention (Appendix)**	**Biodiversity Action Plan**
Harbour porpoise *Phocoena phocoena*	•	II IV	II	•	• VU	II	Harbour Porpoise Species Plan
Common dolphin *Delphinus delphis*	•	IV	II	•			Small dolphins Grouped Plan
Bottlenose dolphin *Tursiops truncatus*	•	II IV	II	•		II	Small dolphins Grouped Plan
Sperm whale *Physeter macrocephalus*	•	IV	I	•			Toothed Whales Grouped Plan
Striped dolphin *Stenella coeruleoalba*	•	IV	II	•	• LR cd	II	Small dolphins Grouped Plan
Risso's dolphin *Grampus griseus*	•	IV	II	•			Small dolphins Grouped Plan
Long-finned pilot whale *Globicephala melas*	•	IV	II	•		II	Toothed Whales Grouped Plan
White-beaked dolphin *Lagenorynchus albirostris*	•	IV	II	•			Small dolphins Grouped Plan
Minke whale *Balenoptera acutorostrata*	•	IV	I		LR nt	III	Baleen whales grouped plan
Killer whale *Orchinus orca*	•	IV	II	•	LR	II	Toothed whales grouped plan

(See overleaf for notes)

Table notes:

Annex IV EC Habitats directive – This annex includes 'Animal and plant species of community interest in need of strict protection'. Under Annex IV the keeping, sale or exchange of such species is banned, as well as deliberate capture and killing.

CITES

Annex I - Prohibits the commercial trade of species included on this appendix.
Annex II - Imposes strict regulation on the trade of species that may not necessarily be currently threatened with extinction.

IUCN Red List of Threatened Species - **LR**=Lower risk
VU=Vulnerable
cd= Conservation dependent

Biodiversity Action Plan
This is the UK Government's response to Article 6 of the Convention on Biological Diversity (1994). The overall goal is to conserve and enhance biodiversity in the UK. A Species Action Plan provides detailed information on the threats facing species and the opportunities for maintaining and enhancing populations. A 'Grouped' Species Action Plan has been produced for Baleen whales as a range of common policies and actions are required for all species listed.

5.3 Seals

There are very few common seals *Phoca vitulina* within this Natural Area. Occasionally animals have been recorded at the mouth of the River Dee, at various sites in Morecambe Bay and at certain sites along the Cumbrian coast. The only significant haul-out sites are on certain sandbanks and mudflats within Morecambe Bay. The number of Grey seals *Halichoerus grypus* in the region increases during the summer months with haul out sites again being found within Morecambe Bay and West Hoyle Sands near Hilbre Island (Barnes *et al* 1996). There are no major grey seal breeding sites within the Natural Area.

5.3.1 Nature conservation measures

Both common and grey seals are listed on Annex II of the Habitats Directive which requires Member States to designate SACs for their conservation where sites can be identified as being essential to life and reproduction. However, as the populations of grey seals within this Natural Area are not considered to be nationally important, there are no sites designated for their specific protection Both Common and Grey seals are also listed on Annex V of the Habitats Directive which requires their exploitation or removal from the wild to be subject to management measures. Both the grey and common seals are listed under Appendix III of the Bern Convention. This Appendix requires appropriate and necessary legislative and administrative measures to be made so as to ensure the protection of the wild fauna. Any exploitation of wild fauna should also be regulated in order to keep the populations out of danger.

The Conservation of Seals Act 1970 provides for close seasons during which it is an offence to take or kill any seal except under licence or in certain particular circumstances. For grey seals, the closed season is from 1 September to 31 December and, for common seals, from 1 June to 31 August. Following the halving of the common seal population through disease in

1998, an Order was issued under the Act which provided year-round protection of both grey and common seals on the east coasts of England. The Order was last renewed in 1999.

5.4 Marine turtles

Individuals of the leatherback turtle *Dermochelys coriacea* have very rarely been reported from this Natural Area. In fact, since 1970 and 2000 only six live leatherback turtles have been recorded swimming off the Scottish Solway and Cumbrian coast (Weighell 2000). Outside the boundary of the Natural Area, two individuals were found dead – one entangled in fishing gear and the other stranded. Although all other species of turtle are believed to arrive in UK waters accidentally, the occurrence of the leatherback is almost certainly the result of a deliberate, migratory movement (UKBAP 1999).

5.4.1 Nature conservation measures

The two species of turtle which have been recorded in UK waters (the leatherback *Dermochelys coriacea* and loggerhead *Caretta caretta*) are listed on Appendix I of the Convention on the International Trade in Endangered Species of Flora and Fauna (CITES) 1975, which lists species that are the most endangered and therefore prohibits commercial trade.

They are also listed on Appendix II of the Bern Convention 1979 which conveys special protection to those species which are vulnerable or endangered. Although an international convention, in England it is implemented through the Wildlife and Countryside Act 1981.

These turtle species are also listed on Appendices I and II of the Bonn Convention 1979 which protects migratory wild animals across all or part of their natural range through international co-operation, particularly those species that are in danger of extinction. .

They are also listed on Annex IV of the EC Habitats Directive because they are endangered, vulnerable or rare.

The loggerhead is also listed as a priority species[10] on Annex II of the EC Habitats Directive, which allows for SACs to be designated in areas identified as essential for life and reproduction. It is unlikely that any SACs will be identified in UK waters for loggerhead turtle.

Both the leatherback and loggerhead turtles are protected under Schedule 5 of the Wildlife and Countryside Act 1981 and the Conservation (Natural Habitats etc.) Regulations 1994. Under Schedule 5 of the Wildlife and Countryside Act 1981 (as amended), all marine turtles are given full protection within British territorial waters. This protects them from killing or injury, sale, destruction of a particular habitat (which they use for protection of shelter), and disturbance. Under the Countryside and Rights of Way Act 2000 is it an offence to deliberately or recklessly damage or disturb any turtle in UK protected waters.

There is also a Grouped Biodiversity Species Action Plan for Marine Turtles.

[10] Priority species means a species for the conservation of which the Community has particular responsibility in view of the proportion of their natural range which falls within the territory. Priority species are indicated by an asterix in Annex II Habitats Directive.

5.5 Fish

The Irish Sea, in general, is an important area for populations of a number of commercial fish species, providing spawning and nursery grounds and feeding areas for a number of fish species.

Fish are referred to in terms of pelagic or demersal (ground fish) species. Pelagic species are generally found in shoals swimming in the mid-water whereas demersal species are found living on or near the seabed.

In the Irish Sea Natural Area important commercial species include cod, plaice, skates/rays, haddock and whiting. Those species which are covered by the Commercial marine fish grouped species action plan are featured below.

5.5.1 Pelagic

Herring *Clupea harengus* spawning and feeding grounds can be found within this Natural Area (see Figure 5.3a). This species typically lives in large shoals and the population can be divided into a number of distinct breeding stocks. Spawning grounds are found to the east of the Isle of Man during the autumn (September – October). Spawning tends to occur on the edge of sediment banks with egg-laying taking place where there is coarse shell, grit and gravel. The distribution of spawning grounds can be roughly equated with the distribution of known gravel deposits. Nursery grounds, however, tend to be further inshore with juvenile herring being found along the inshore boundary of this Natural Area.

Sprat *Spratus spratus* are widely distributed throughout this Natural Area and their main egg and larval area of distribution covers the whole area. Juvenile sprats are often found mixed with young herring along the inshore boundary of the area.

Individual records of the non-commercial species, the lampern *Lampetra fluviatilis* and Allis shad *Alosa alosa* have occurred in Morecambe Bay however their status is not well known, and areas where spawning is thought to occur needs to be studied to determine their value in both a national and international context.

One of the most notable (and certainly the largest) fish species that is seen on its migration path through the waters of this Natural Area during the spring and summer is the basking shark *Cetorhinus maximus*. Although this is the largest fish in British waters (growing up to 12 metres in length and weighing up to 7 tonnes), relatively little is known of its reproductive biology and population dynamics. The basking shark feeds on plankton which it filters from the water as it swims along with its mouth open. The shark's common name comes from its habit of 'basking' on the surface during the summer months as it feeds. In these situations, it is often seen in association with shoals of herring, which are also plankton feeders.

5.5.2 Demersal fish

Cod *Gadus morhua* are widely distributed in the region during the summer. Cod aggregate during February and March in a spawning area off Cumbria (see Figure 5.3b). Juvenile fish are found in nursery areas in the south west of the Natural Area.

Plaice *Pleuronectes platessa* is the most abundant flatfish occurring within the Natural Area, with much being known about its life history (see Figure 5.3c). The main spawning grounds run down the centre of the area and also in the south-west with spawning taking place between January and March. Tagging experiments on these spawning grounds show that plaice movement is very limited (Griffith 1971; Hill 1971; Mace, 1972). Plaice occurs on sandy areas of the seabed throughout the region, with juveniles living close to the inshore boundary of the Natural Area in nursery areas. Fish gradually move to deeper water as they grow.

Sole *Solea solea* have a similar lifestyle to plaice and spawn in the early summer (April-June) within this Natural Area (see Figure 5.3 d). Young sole may spend up to two years in the inshore nursery areas also used by plaice.

5.5.3 Conservation measures

The Common Fisheries Policy (CFP) is the European Union's instrument for the management of fisheries and aquaculture. The CFP was created to manage a common resource and to meet the obligations set out in the Treaty of Rome. It provides the legal framework for the exploitation of living marine resources in EU waters and for those vessels registered in the EU fishing in non-EU waters. The Common Fisheries Policy (CFP) not only sets the framework for the allocation of fisheries resources amongst Member States and their rights of access to community waters, but also allows the introduction of technical measures for the conservation of fisheries resources The Commission for the European Community has exclusive rights to administer up to the High Water Mark. However, in practice they devolve authority to the UK government (- Defra) to manage the fisheries within the twelve miles limit of the UK and to control the activities of UK-registered fishing vessels.

Under the Sea Fisheries Regulation Act 1966, the Sea Fisheries Committees (SFCs) of England and Wales are responsible for the management of fisheries within 6 nautical miles of Mean High Water. They also share responsibility for marine nature conservation. The SFCs have the power to introduce byelaws within this six nautical mile zone, and they enforce UK and EC fishery conservation legislation. Two SFCs operate within this Natural Area: North Western and North Wales SFC and Cumbria SFC.

5.5.3.1 Total Allowable Catch and Quotas

One of the four components of the CFP is the conservation and enforcement policy, which aims to set fishing activity at a sustainable level. An objective of the Conservation Policy is the sharing or allocation of resources to Member States. In order to regulate this, a fixing system of Total Allowable Catches (TAC) and quotas has been implemented. Total Allowable Catches are agreed annually by the Council of Ministers for each protected species in waters administered by the CFP and are divided so that each Member State receives a percentage or quota of TAC. It is difficult to break down the species quota by Natural Area as quotas are given for waters within the ICES fishing areas and there is often overlap between these and Natural Area boundaries. However the quotas for the whole of the Irish Sea (ICES fishing area VIIa) for 2004 can be seen in Table 5.3.

Table 5.3: A summary table of 2003 fishing quotas.for the zones in which the Irish Sea Natural Area is located. (As agreed by Council Regulation EC 2287/2003)

Species	TAC (tonnes)	UK TAC (tonnes)
Cod *Gadus morhua*	1,950	562
Herring *Clupea harengus*	4,800	3,550
Plaice *Pleuronectes platessa*	1,675	428
Sole *Solea solea*	1,010	224

5.5.3.2 Technical measures

Mesh size

This is the most basic form of technical measure, stipulating a minimum mesh size that may be used for nets in a particular area or fishery, thus permitting immature fish to pass through the net. This can be a very successful conservation measure, as it enables more fish to reach sexual maturity and become part of spawning stock. In addition it avoids catching unmarketable fish that would be discarded. However, demersal fisheries often consist of mixed species of varying sizes. This can lead to immature fish of larger species being caught, such as cod.

Minimum Landing Size (MS)

Another fisheries conservation measure is concerned with regulating the Minimum Size (MS) of fish. Fish not attaining the MS may not be landed for sale and must be returned to the sea. The approach aims to discourage fishermen from targeting concentrations of juvenile fish and from using small mesh nets.

Grids, separator panels, veil nets, etc.

These devices are essentially adaptations of or additions to fishing gear, mainly demersal or pelagic trawls, which aim to reduce bycatch of target and non-target species. Grids, panels, etc., essentially operate via exclusion of "undersized" or otherwise unwanted species in a fishery. This is achieved by making use of the biology (size, age, behaviour, biodynamics) of the fish and other species, which guides and informs the development of such fishing gear adaptation.

5.5.3.3 Sea Fisheries Committees' byelaws

Each Sea Fishery Committee is able to introduce byelaws within their districts for governing the management of sea fish and the marine environment. These cover regulations such as boat size, gear type as well as the dimensions and the size of fish and shellfish.

5.5.3.4 Other conservation measures

These can be total closures where no fishing is permitted, seasonal closures where fishing is suspended at particular times of the year, temporary closures where fishing may be suspended at short notice and selective closures where only specific fishing gears are permitted.

Closed areas

Closures of a fishery can be spatial or temporal. They can be total closures, where no fishing is permitted; seasonal closures, where fishing is suspended at particular times of the year; temporary closures, where fishing may be suspended at short notice; and selective closures, where only specific fishing gears are permitted. There are areas within this Natural Area where fishing for herring is prohibited either all year round or at various times of the year (see Figure 5.4) in order to protect the spawning stock. Management of the fishery within these areas is a result of the collapse of the herring stocks in 1980.

Closures for reasons other than fisheries conservation

Many areas around the UK are closed to fishing activity for a number of reasons not related to fisheries conservation. Reasons range from the need to protect high security Royal Navy ports to ensuring safety near oil and gas installations. For example, there are safety exclusion zones (extending to a radius of 500 metres) for all fishing activity around operational oil and gas well heads. There is also an area within the Irish Sea Natural Area where fishing activity is temporarily prohibited during dredging for marine aggregate (Figure 5.4). Interruption to fishing activity is sporadic and difficult to predict, but normally covers a small proportion of the licensed area at any one time.

Reduction in fishing effort

Many of the commercially exploited fish stocks are too heavily fished and a reduction in fishing pressure is needed from both a biological and an economical point of view. Following the reform of the Common Fisheries Policy, reductions in fishing effort to achieve a stable and enduring balance between fishing capacity and fishing opportunities have continued. These are detailed in Chapter III of the Council Regulation EC 2371/2002. Implementation of the reduction in the Community fleet capacity, in terms of tonnage and power, is provided in Council Regulation EC 1438/2003. In addition, a special incentive has been put in place (Council Regulation EC 2370/2002) for the period 2003 to 2006, to provide Member States with funds to co-finance the scrapping of fishing vessels to achieve the additional reductions in fishing effort resulting from recovery plans.

Fishing rights

Access rights to the waters around the UK also control the level of fishing activity. Access to fisheries in the 6 nautical mile belt of UK Territorial Seas is limited to UK vessels and access by non-UK fishing vessels to the 6-12 nautical mile belt of the UK Territorial Sea is limited to nations with 'historic' rights. Ireland has rights to fish for *Nephrops* and demersal species the whole area between 6-12 nm within the Natural Area. France has rights to fish all species between 6-12 nm from an area offshore between Morecambe and Port Lynas.

5.5.3.5 Nature Conservation measures

There is a grouped Species Action Plan for Commercial Marine Fish. This provides detailed information on the threats facing species and the opportunities for maintaining and enhancing populations. A 'Grouped' Species Action Plan was produced as a range of common policies and actions are required for a number of similar species. The Commercial Marine Fish action plan differs from others in that it is aimed at particular stocks rather than the individual species as a whole. Within this Natural Area, stocks of cod, herring, mackerel, plaice and sole are included in the Plan. The basking shark has its own Species Action Plan.

The lampern and Allis shad are considered threatened in the UK and European waters (Potts and Swaby 1993). As such they are protected under the Annex II of the EC Habitats Directive which includes species 'of community interest whose conservation requires the designation of special areas of conservation' where sites can be identified as being essential to life and reproduction. They are also listed on Annex V of the EC habitats Directive which lists animal and plant species 'of community interest whose taking in the wild and exploitation may be subject to management measures'.

These species are also listed on Appendix III of the Bern convention which include species for which appropriate and necessary legislative and administrative measures must be taken to ensure the protection of the wild fauna species. Any exploitation of wild fauna specified in Appendix III is regulated in order to keep the populations out of danger. Measures which should be taken include:

- closed seasons and/or other procedures regulating the exploitation;
- the temporary or local prohibition of exploitation, as appropriate, in order to restore satisfactory population levels;
- the regulation as appropriate of sale, keeping for sale, transport for sale or offering for sale of live and dead wild animals.

The basking shark is a protected species under Schedule 5 of the 1981 Wildlife & Countryside Act (1998 Amendment) which prohibits the intentional killing, capture or disturbance within 12 nautical miles of the coast. The species also has its own Species Action Plan. In early November 2002 it was added to Appendix II of the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES). This CITES Appendix II listing provides important data collection and reporting requirements on 160 countries that attend the Convention with regards their trade in basking shark products.

Figure 5.1 SPAs adjacent to the landward boundary of the Irish Sea Natural Area

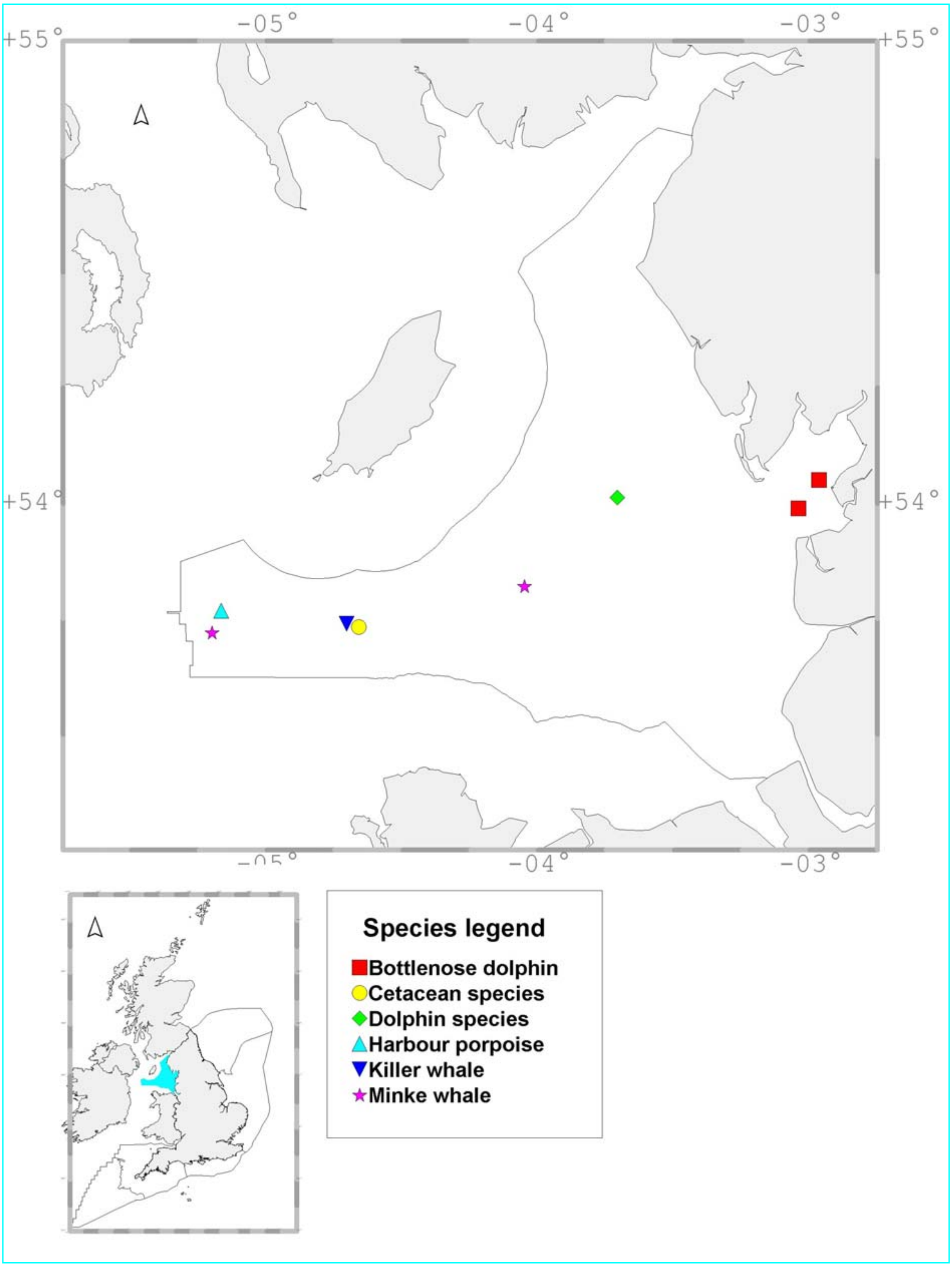
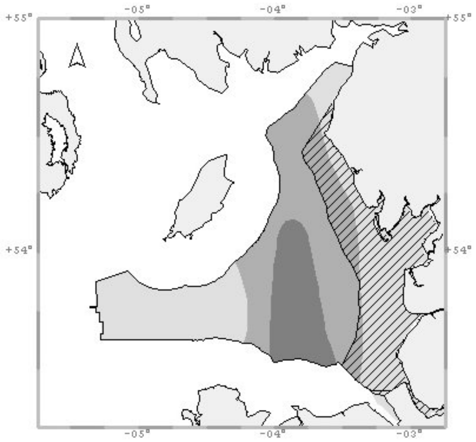


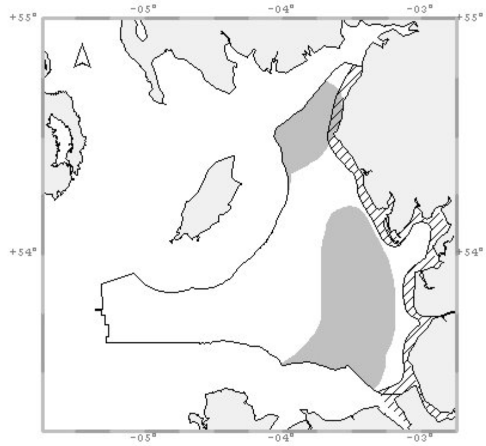
Figure 5.2 Records of Cetaceans seen in the Irish Sea Natural Area (after Evans *et al* 2003).

a) Distribution of **herring** spawning (Sept - Oct) and nursery areas in the Irish Sea Natural Area

b) Distribution of **cod** spawning (Feb – March) and nursery areas in the Irish Sea Natural Area



c) Distribution of **plaice** spawning (Jan - March) and nursery areas in the Irish Sea Natural Area (dark grey = intensive spawning → light grey = low intensity spawning)



c) Distribution of **sole** spawning areas (Apr – June) in the Irish Sea Natural Area

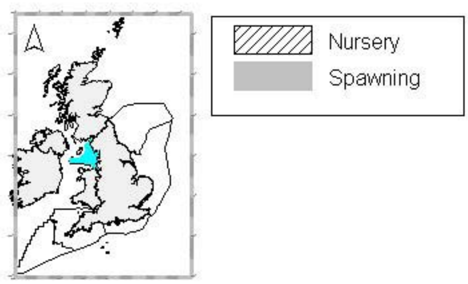


Figure 5.3 Maps showing the distribution of fish spawning and nursery areas within the Irish Sea Natural Area (taken from Coull *et al* and provided by CEFAS)

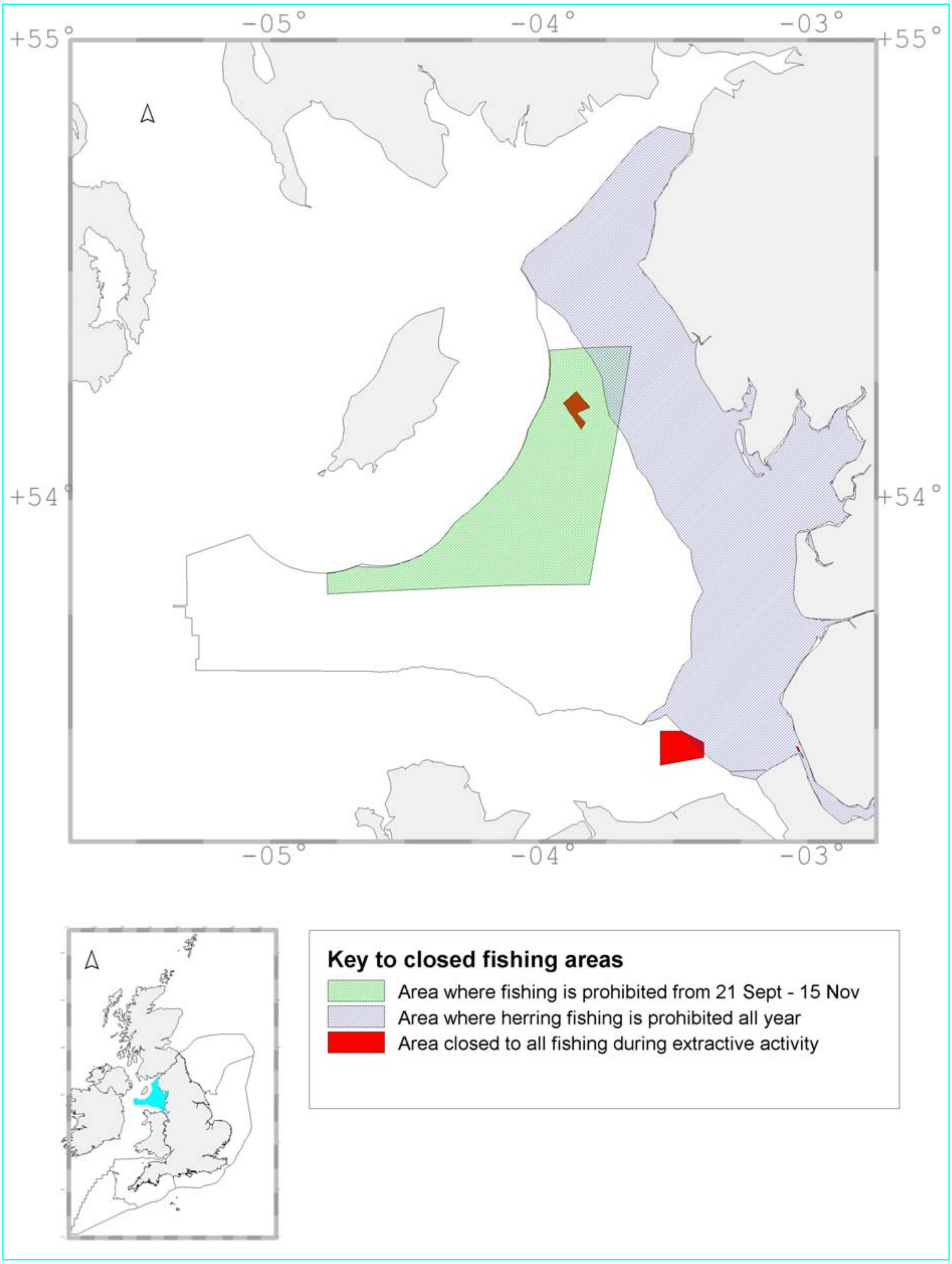


Figure 5.4 Map of areas closed to fishing activity in Irish Sea Natural area both permanently and at specific times of the year.

6 Human activity and use

This section outlines significant human activities in the Irish Sea which are relevant to the nature conservation values described in the previous sections. This section does not provide a comprehensive listing of all the social and economic activities of Irish Sea, and for those that are included, the descriptions are brief. Rather, the intention is to give an overview of the range of activities which do or could interact with the environment. We have emphasised the need to consider these together if we are to achieve sustainable use of the marine environment and its biodiversity.

6.1 Fisheries

The fishery in the Irish Sea has always been a mixed one with different species of demersal fish, pelagic fish and shellfish dominating from time to time and place to place. Fleetwood is the only major fishing port (as defined by Defra) within this Natural Area. The trawl fleet comprises around 45 vessel, 20-25 of which fish in grounds within the 12 nm limit. There are numerous other ports where fish are landed but nowhere near the amount as those landed at Fleetwood (Figure 6.1).

Fishing activity within this area has both direct and indirect effects on the environment. Although the most evident and direct impact of fishing is mortality and removal of fish from the marine ecosystem, other impacts are described in the following sections.

6.1.1 Physical impact of fishing gears

6.1.1.1 Towed or dragged gears

Trawling is the principal method of fishing for demersal species such as cod, plaice and sole within this Natural Area. The gears used in the demersal fisheries in the Irish Sea are beam trawls and otter trawls, though mid-water trawling for pelagic species such as herring is used within the Irish Sea. This method of fishing is being developed for the capture of cod within the Irish Sea.

Beam trawls - Beam trawlers are largely used to target flatfish such as sole and plaice that burrow in the sand, and pink and brown shrimps. The gear used by beam trawlers runs over the top of the seabed, often leaving behind a track or scour mark, depending on the type of ground being worked (Gubbay & Knapman 1999). In this type of trawl the mouth of the net is kept open by the beam that is mounted at each end on guides or skids that travel along the seabed. The trawls are adapted and made more effective by attaching tickler chains that drag along the seabed in front of the net, causing the fish to rise from the sand and into the oncoming trawl. The extent to which the seabed is affected depends on the type of fishing gear, the substrate and its physical characteristics (Jennings & Kaiser 1998; Lindeboom & De Groot 1998). The tracks will gradually fill in, the time taken for this to happen depending on the type of ground, the depth of water (usually less then 50 metres), the strength of the tide and overall weather conditions. Other types of towed gear can also alter the substrate. The impact appears to be greatest on densities of small fragile benthic species, possibly because larger animals live deeper in the sediment or are better able to escape (Bergman & Hup 1992). Changes in benthic community structure occur following beam trawling but the effects can be variable (De Groot 1984; Jennings & Kaiser 1998; Lindeboom & De Groot

1998). In intensively trawled areas it has been suggested that the community becomes more dominated by highly productive, opportunistic species such as polychaetes

Beam trawling is also used for the capture of the Queen Scallop *Aequipecten opercularis* in offshore gravelly areas within this Natural Area.

Otter trawls - The otter trawl is a large cone-shaped net, which is towed across the seabed. The mouth of the net is kept open by otterboards. These are in contact with the seabed. They may mound the sediment as well as creating a scour furrow (Gilkinson *et al* 1998). This may alter the surface roughness of an area as well as the sediment structure. Otter trawling, like beam trawling, can result in the capture of a considerable amount of by-catch species, though certain selectivity measures (such as incorporating square mesh 'windows' in the top of trawl nets which allow the release of non-target species) are now more readily used. Trawls can sometimes be fitted with rock-hopper gear to enable them to traverse reefs. Otter trawls are mainly used to target species such as cod, plaice, sole and *Nephrops.* The minimum mesh size of the nets used in *Nephrops* trawling is 70 mm, plus an obligatory 80 mm square mesh section incorporated into the cod-end in order to allow small whiting to escape. The fishery attracts a lot of effort from visiting boats from Scotland and Northern Ireland. *Nephrops* are targeted from late summer through to spring so fishermen alternate between trawling for demersal fish and *Nephrops*.

Scallop dredge – This method of capturing scallops involves dragging dredges along the seabed. The dredges are attached to beams and are towed either side of the boat. A dredge is composed of a bar, bearing metal teeth, which rake-up the molluscs which are then deposited in a reinforced net bag. This method of fishing results in physical disturbance of the seabed, which in turn affects the benthic communities and possibly also the transport of seabed materials and contaminants (OSPAR 2000).

6.1.2 Static gear

Gill nets can be set at or below the surface, on the seabed, or at any depth in-between. This type of gear can result in the incidental capture of marine life, most notably marine mammals and seabirds (See section 6.1.4). A programme to assess the marine mammal by-catch of the Irish and UK bottom-set gillnet fisheries has been established. . They also have the potential to continue fishing if lost or discarded, an effect which has been described as 'ghost fishing' (Kaiser *et al* 1996) (see section 6.1.3).

6.1.3 Stock depletion

One of the consequences of over-fishing is stock depletion to the point where there is a risk of stock collapse. Stocks of cod are considered outside safe biological limits in this part of the Irish Sea (ICES area VIIa) (ICES 2003). ICES recommend that given the very low stock size, the recent poor recruitments, and continued high fishing mortality, a closure of all fisheries for cod as a targeted species or by-catch. In fisheries where cod comprises solely an incidental catch there should be stringent restrictions on the catch and discard rates of cod, with effective monitoring of compliance with those restrictions. These and other measures that may be implemented to promote stock recovery should be kept in place until there is clear evidence of the recovery of the stock size associated with a reasonable probability of good recruitment and there is evidence that productivity has improved.

6.1.4 Fishing debris

Fishing activity has been identified as one of the four major sources contributing to litter found on UK beaches (Marine Conservation Spciety 1999). Items such as fishing nets, fish boxes and buoys are attributable to the fishing industry, accounting for 11.2% of the total amount of litter found. One of the consequences of fishing-related debris in the marine environment is 'ghost fishing'. This is the term given to the phenomenon whereby nets or pots, lost because of bad weather, snagging, when towed away by mobile fishing gears, or simply discarded remain either on the Seabed or in the water column and continue to fish. Often though, lost or discarded nets are rolled up on the seabed by the action of currents or wave action and cease fishing relatively quickly. However, floating debris may entangle marine life close to the surface, such as cetaceans, seabirds, seals and turtles.

6.1.5 By-catch

One of the problems associated with most types of fishing gear is that of incidental capture or by-catch of non-target species. This may include other commercial and non-commercial fish, seabirds and sea mammals. Concern has grown over the impact of a number of gill-net fisheries on cetaceans. This method of fishing accounts for the majority of marine mammal by-catch in British waters (Jefferson & Currey 1994). Cetaceans are also captured incidentally in certain trawl fisheries. For example, common dolphins are inadvertently killed in some pelagic trawl fisheries for mackerel. The impact of incidental capture on porpoise populations around the UK, as a whole is not known. However it has been suggested that incidental by-catch could be a significant contributory factor in the overall decline in abundance of harbour porpoise in European waters (Gislason 1994). The interaction between gill nets and harbour porpoises has been investigated in several areas particularly the Celtic Shelf, the North Sea and west of Scotland (Defra 2003).

Various methods and devices have been trialled to deter cetaceans from becoming entangled in nets, including the use of 'pingers'. These are acoustic deterrent devices (Reeves *et al* 2001) that can be run with a small battery pack for periods of months or years. Pingers have been shown to be effective in mitigating small cetacean by-catch in fixed gear, both in controlled experiments and in fishing operations. They have been recommended for use in large mesh nets and wreck nets in certain part of the North Sea (Defra 2003). However, they have only been tested on a few small cetacean species so far. The Government is developing a small cetacean by-catch response strategy that may include compulsory use of sonic devices and wider use of observers at sea.

Other mitigation measures include the use of 'escape hatches' in nets, making nets more 'reflective' (experiments have been tried by coating nets with a layer of iron oxide or barium impregnated nylon to make them stiffer (Larsen *et al* 2002)).

Whiting by-catch from *Nephrops* fisheries is also a problem within the Irish Sea as a *Nephrops* fishery operates on the main whiting nursery areas. Levels of discards in this *Nephrops* directed fishery during the late 1990s were around 43% by weight of the estimated catch of whiting, rising to approximately 73% in the most recent assessment year 2000. This means that the fishing mortality on whiting cannot be effectively controlled by restrictions on landings alone, but would also require measures to reduce discards. Square mesh panels have been mandatory of all UK trawlers (excluding beam trawlers) in the Irish Sea since 1993, and for Irish trawlers since 1994. While the effects of this technical measure have not been formally evaluated, the *Nephrops* fishery still generates substantial quantities of whiting discards, indicating that further measures are necessary. Management measures for the *Nephrops* fishery should also take into account the effect on whiting.

6.1.6 Ecosystem effects

The intense fishing activity in the North Sea has resulted in the 'fishing down' of the food web (Pauly and Maclean 2003). This is where the top predators have been removed, leading to modifications in predator-prey relationships and changes in marine food chains. The removal of the top predators has been linked to the growth of industrial fisheries (those fisheries targeting species for non-human consumption), in particular those focussed on sand eels. However, these industrial fisheries are also of concern. As species near the base of the food chain are removed in vast quantities this may impact the breeding success of bird species that rely on them as a food source.

6.2 Gas and oil extraction

There are a number of wellheads within this Natural Area (Fig 6.2). Offshore gas production within this Natural Area started in 1985 following construction of a 34 km pipeline between the Morecambe south field and Barrow-in-Furness. Peak production for this field is 9.82 billion cubic meters per year. Extraction from the Morecambe north field came on stream 1994 with peak production rate of 3.46 billion cubic meters per year.

Oil was found in 1990 in the Douglas Field and is transported ashore by tanker while gas is conveyed to north Wales by a 20km pipeline. This oil extraction activity is operated by BHP Billington Petroleum Limited as part of their Liverpool Bay Asset which came on stream in 1995. Today, the LBA accounts for around 2% of the total hydrocarbons produced in the UK. Further information on the locations of fields and installations can be viewed at http:///www.og.dti.gov.uk/information/index.htm.

The UK government has the right to grant licences to explore and exploit resources such as oil and gas. The UK Continental Shelf is divided into a series of blocks for which licences are granted. Each year a number of blocks are licensed during 'licensing rounds'. Further information can also be obtained from the DTIs Strategic Environmental Assessment reports which are available via the SEA website at http//www.offshore-sea.org.uk/sea/index.php.

Any activities for or in connection with the exploration for or production of petroleum which are situated wholly or partly in the UK Continental Shelf Designated Area are subject to the application of the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 which apply the Habitats and Birds Directive to the offshore waters in relation to oil and gas activity. In addition to provision for features covered by the Habitats and Birds Directives, all activities are required to submit a notification to the Consent Authority and an Appropriate Assessment may be required before consent is granted.

The major activities associated with oil and gas developments that have potential impacts on the marine and coastal environments can be summarised under the following categories:

6.2.1 Evaluation

During the initial surveys to locate reserves, seismic surveys are carried out using air guns, which can disturb fish and cetaceans. Underwater sounds from seismic activities are most likely to affect baleen whales, which communicate primarily at similar frequencies to those produced by air guns (Baines 1993). However, our understanding of cetacean communication and sensitivities is currently restricted due to data limitations. There are several characterisation and impact studies planned that will add substantially to our understanding of the issue in the near future.

Some seismic survey techniques have the potential to interfere with commercial fishing, with some species of fish being more resistant to these effects than others. Fish with cylindrical bodies and thick-walled swim bladders will be more resilient to the effects of air guns than fish with flat bodies and thin-walled swim bladders (Hailey 1995). Potential adverse effects of seismic surveys on fish are considered to be mitigated by seasonal exclusion zones. There is some evidence to show that the shoaling behaviour of some species is affected by seismic surveys, whilst others avoid areas in which surveys are being conducted.

Conditions on exploration and production licences, recommended by Fisheries Departments, prevented seismic surveys being carried out during specified periods of the year (during fish spawning) in specific areas (CEFAS 2001b). These have now been replaced by a survey permit system. Proposed seismic surveys are subject to the application of the Offshore Petroluem (Conservation of Habitats) Regulation 2001 and should follow the JNCC's *Guidelines for minimising disturbance to marine mammals from seismic surveys*.

6.2.2 Exploration

One of the most significant impacts of the exploration stage is the effect of drill cuttings on marine wildlife. Two types of adverse effects of discharges of cuttings can be distinguished:

- physical smothering, which creates anoxic conditions and may eliminate all benthic fauna, and
- chronic pollution of the benthos as a result of the use of oil-based muds (though these are rarely used now).

It has been suggested that contaminated cuttings quickly disperse, causing little impact on the seabed around the drilling area and so decreasing the impacts from exploration

6.2.3 Development and production

Seabed disturbance will occur as a result of the placement of the platform and its subsequent presence. Drilling will result in larger and more heavily concentrated discharges of drilling fluids and cuttings. There is also a small risk of blow-outs, though most of the reserves are so heavily extracted there is probably insufficient pressure to produce this. Accidental spillages can also result from refuelling of the rig and pipeline installation will result in some disturbance of the seabed.

6.2.4 Abandonment and decommissioning

The process of decommissioning can also have detrimental affects on the benthic and pelagic marine environment. The main source of concern is the level of toxic substances that are released. These substances may consist of hydrocarbons, heavy metals, naturally occurring radioactive material and possibly organo-chlorines such as polychlorinated biphenyls (PCBs) (Environment Agency, 1998). Another concern is that the dismantling of platforms may also disturb the piles of contaminated drill cuttings on the seabed, which could release substantial amounts of oil into the environment. However, decommissioning applications are considered on a case-by-case basis by the Department of Trade and Industry in full consultation with JNCC, English Nature and other consultees.

6.3 Aggregate extraction

Sand and gravel on the seabed are important sources of industrial aggregate for concrete production, road construction, building and, increasingly, for beach replenishment and soft coastal defence. As pressures on land-based sand and gravel sources increases, there is a need to consider alternative sources of supply. Whilst secondary and recycled aggregates play an increasing role there is likely to be an increased demand for marine dredged sand and gravel. The main market for marine-dredged aggregates is in the south east of England.

The Crown Estate license extraction within their areas of jurisdiction. However, Government controls the dredging of marine aggregates and this has historically been exercised through the Government View Procedure, currently administered by the Minerals and Waste Planning Division of the Office of the Deputy Prime Minister. It is anticipated that new Regulations will come into force in the near future. These new Statutory Regulations will apply to England, Wales and Northern Ireland. Scotland will introduce their own regulations to govern extraction of marine minerals.

Applications for the extraction of marine minerals are currently operating under the Interim Government View Procedures, pending introduction of the Statutory Procedures. Both the Interim and proposed Statutory Procedures are to be administered by Office of the Deputy Prime Minister in England, DoE(NI) in Northern Ireland, the Welsh Assembly Government and the Scottish Executive, as appropriate. Each application will require an Environmental Impact Assessment and extensive consultation with the fishing industry, relevant government bodies and the general public. Both the Interim and Statutory Procedures have provision to hold a public inquiry if necessary.

Within this Natural Area there are two licensed extraction areas - one 30km offshore from Barrow-in –Furness and the other, which straddles Natural Area boundary, some 25 km offshore from Liverpool. In addition to these, there are a number of areas, which are subject to application for extraction licences and which may support extraction in the future (see Figure 6.3).

The physical impacts of marine aggregate extraction arise from substrate removal and alteration of the bottom topography, creation of a turbidity plume in the water column, and sediment mobilisation. Dredging may disturb the benthic community and possibly reduce the number and diversity of benthic species (Rosenberg 1977). One fish species considered to be potentially at risk as a result of marine aggregate extraction within the Natural Area is the herring *Clupea harengus,* which lays demersal eggs that adhere to gravel (ICES 1992).

Sediment plumes arising from dredging introduce sediment into the water column in the vicinity of the dredged area. Plumes arise from both the action of the drag head (on the seabed) and also from hopper overflow and the screening process (from the vessel on the surface). Hitchcock *et al* (1999) found that the bulk of the plume settled out of the water column within 300 m (sands) to 500 m (silts) downstream. This corresponded to a time period of 10-15 minutes after release. Coarse sands and gravels were found to settle out virtually instantaneously. It is concluded, therefore, that providing the deposit being dredged does not have abnormally high levels of fine material, the spread of turbid water is likely to be limited to within the close proximity of the aggregate extraction site.

John *et al* (2000) identified the reduction of light penetration as a result of turbidity as one of the main water quality issues arising as a consequence of increasing suspended sediment concentrations in the water column. High levels of suspended sediments, along with the associated reduction in light penetration can adversely affect primary production within the water column (Iannuzzi *et al* 1996).

Mobilisation and redistribution of the sediment particles from the sediment plumes will also occur and once settled on the seabed, may be susceptible to re-suspension. A consequence of this may be the smothering of benthic species, resulting in the suffocation of many suspension-feeding invertebrates, and smothering of fish eggs on spawning grounds.

6.4 Shipping

6.4.1 Commercial

Many different types of vessel operate in this area, according to the nature of the cargo they are carrying. (Figure 6.4 and table 6.1).

Since the mid-nineteenth century the volume of goods transported by sea has grown enormously. The growth of the petroleum industry had a very significant effect on shipping with the advent of the oil tanker, which is the largest carrier of cargo. The carriage of goods by sea inevitably places marine and coastal environments at some risk. Almost any vessel anywhere has the potential to cause a degree of environmental damage, either through routine operations or accidents. Despite this, shipping is responsible for a relatively small proportion of all marine pollution in the UK compared to that from land-based sources which may be traced back to centres of population and to industrial and agricultural operations. Pollution from ships can be categorised in three ways:

- **Historical pollution** - for example, the application of TBT has now been banned on vessels of all sizes by the International Maritime Organisation, with a global ban due to come into force in 2008.
- **Operational pollution** – Consists of oil and oily wastes, noxious liquid substances, sewage, garbage and anti-fouling paints.
- **Accidental pollution** – As a result of collision or grounding, which can result in large quantities of pollutant being released into the marine environment. The types of pollutants are similar to those associated with operational discharge.
- **Physical damage** – Resulting from the grounding of vessels, anchors dragging along the seabed and disturbance from propellers.

The extent of environmental damage following any accident depends on a range of factors, in particular, the cargo of the vessel, where the accident occurs, the depth of water, the status of the tides and at what time of year. The most common vessels operating within the area are cargo vessels and oil tankers (see Figure 6.4 and table 6.1).

Within recent years a number of shipping incidents involving the release of oil has occurred within and around the boundary of this Natural Area (Figure 6.5). Of the six oil spills which occurred in and around the Irish Sea Natural Area during 1989-1998, a total of 43 tonnes of oil were released into the environment (Safetec 2000. It is likely that the oil would have been carried into the Natural Area. Attention tends to focus on accidents involving large oil tankers, although smaller vessels carrying other cargos and large quantities of fuel, together with illegal ship discharges can also threaten marine environments. Seabirds are most vulnerable to oil spills as many species congregate at high densities to feed, nest and moult. In such situations, a large proportion of the total population is susceptible to local incidents, such as oil spillages (RSPB 2000). Species of divers and grebes found within this Natural Area, moult their feathers simultaneously, becoming temporarily flightless (Webb *et al* 1990). This make them particularly vulnerable to oil spills at this time. In addition, the majority of marine birds are long-lived, do not reach breeding condition for many years and have low reproductive rates. As a result, even highly localised incidents can have a significant impact upon a population.

In an attempt to address some of the problems caused by shipping, the Donaldson Inquiry was initiated to 'identify what can reasonably be done to protect the UK coastline from pollution from merchant shipping' (Donaldson, 1994). The Inquiry, initiated after the Braer disaster, provided an overview of the use of routeing measures aimed at accident prevention and subsequently dangers of pollution and loss of life. Routeing measures ensure that ships are kept outside areas where pollution would cause particular damage to the environment. One of the major recommendations of the inquiry was the establishment of Marine Environmental High Risk Areas (MEHRAs). These are comparatively limited areas of high environmental sensitivity that are at risk from shipping. The idea was that identifying MEHRAs would give ship masters additional information relevant to passage planning, which would result in the usage of the recommended routeing and reduce pollution risk at these sites.

The process of identifying MEHRAs is well advanced though the timescale for their introduction has not been decided.

Table 6.1 Annual total number of vessels passing through the Irish Sea Marine Natural Area in 1999 (Data taken from COAST database)

Vessel type	Annual total for the Irish Sea Marine Natural Area
Bulk	768
Cargo	11,640
Ferry	4,126
Gas Carrier	448
Ro-Ro	1,068
Standby	130
Supply	416
Chemical Tanker	1,900
Oil Tanker	4,080
Shuttle Tanker	60

6.4.2 Ferries

A proportion (17%) of the marine traffic passing through this Natural Area are ferries that transport cars and passengers across the Irish Sea to Northern Ireland, the Republic of Ireland and the Isle of Man (Figure 6.6). Approximately 600 passenger ferries pass through the Natural Area on a weekly basis.

Passenger and/or car ferries pose very little threat to the marine environment when compared with tankers or cargo vessels as they tend not to carry hazardous chemicals. However, grounding incidents can have an impact on the marine environment and may result in large areas of the seabed being damaged. In shallow water, propellers can also cause disturbance. Information taken from Lloyd's Register Casualty Database (Safetec, 2000) shows that over in the period 1989-1998, only 3% of grounding incidents for the whole of the UK involved ferries.

6.5 Waste disposal

The disposal of waste or other matter into the sea is prohibited by the OSPAR Convention, with the exception of dredge material, waste from fish processing, inert material of natural origin and, until 2004, vessels and aircraft (OSPAR Commission 2000). In the past a range of material including sewage sludge and industrial waste had been disposed of at sea, although industrial waste disposal was phased out in 1992. The disposal of sewage sludge has been banned under the OSPAR Convention since 1 January 1999. Sewage sludge used to be disposed of in Liverpool Bay at a rate of 50000 tonnes dry weight, per year (Dickson, 1987: Dickson & Boelens, 1988).

There is currently little information on the continuing affects of sewage sludge disposal since it ceased in January 1999. However, data is being collected by CEFAS (Centre of Environment, Fisheries and Science) under the auspices of the National Marine Monitoring Program (NMMP), from a number of the old disposal sites that will hopefully provide some insight into the long-term impact of sewage sludge dumping.

As indicated earlier in this section, the disposal of dredged material is still permitted at a number of sites within this Natural Area (see Figure 6.7). Disposal of dredged material in UK territorial waters is controlled under the Food and Environment Protection Act 1985 (FEPA), which requires a licence for depositing substances or articles onto the seabed.

Dredged material consists primarily of material removed to keep navigation channels clear (maintenance dredging), or material removed in the course of coastal construction engineering projects, including the digging of new navigation channels (capital dredging). The sediments dredged from some of the UK's ports and harbours may be contaminated with heavy metals, nutrients, organic pollutants and other substances. However, stringent sediment quality guidelines are applied during the consents procedure to prevent heavily contaminated material being disposed of out to sea.

Open water disposal of uncontaminated dredged material, if properly handled, appears to cause few problems in the long term (GESAMP 1990). The short-term effects of disposing of dredged material at sea are summarised by Posford Duvivier (1992) as:

- Increased turbidity in the dumping area reducing light penetration and affecting filter-feeding organisms.
- Smothering benthos with the result of destroying the communities present
- Potential change in sediment size distribution that may affect spawning and recolonisation.
- Water quality deterioration if the sediment is contaminated
- Changes in bathymetry of the seabed that may affect benthic and demersal communities.

Defra's policy on disposal aims to minimise the disposal of clean dredged materials, especially sands and gravels, in favour of identifying beneficial uses such as beach nourishment, saltmarsh restoration or mudflat enhancement. This also helps to reduce the loss of material from coastal cells. The Marine Consents and Environment Unit within Defra tries, wherever possible, to work with licence applicants, nature conservation bodies, coast protection authorities, the Environment Agency and others, to identify potential schemes that use dredged material in a practical and appropriate manner.

6.6 Litter

Despite laws and regulations, litter is still a considerable problem for the marine environment and coastal communities (OSPAR 2000). Potential sources of litter are mainly related to waste generated by shipping and tourist/recreational activities. Litter may also be transported into the sea by winds, currents and rivers. Fishing debris such as nets and buoys also contribute to the litter found within this Natural Area. One of the consequences of fishing-related debris in the marine environment is ghost fishing, whereby the discarded gear continues to 'fish' (see section 6.1.3). The Marine Conservation Society's Beachwatch 2001 survey found that 9.2% of litter found on the NW coast of England was comprised of fishing related debris. Floating debris may also entangle marine life close to the surface, such as seals, cetaceans, turtles and seabirds. Surveys carried out by the Tidy Britain Group have identified the main types of litter washed up on the shores of the Irish Sea as being plastic, metal, and glass (Irish Sea Study Group 1990).

At a recent OSPAR commission ministerial meeting, the contracting parties agreed to "do their utmost to take measures to eliminate the problem of litter" including through OSPAR's Marine Litter Monitoring Work Programme (OSPAR 2003).

6.7 Submarine cables

A number of submarine communication cables traverse the Irish Sea Natural Area (Figure 6.8). Submarine cables have been laid on the seabed since before 1900. Cables installed since 1983 are buried beneath the seabed wherever possible, to a depth of 40-90 cm although they can often be scoured out by tide and current or can be dragged out by anchors and fishing gear. Even though attempts are made to bury new cables they can still interfere with fishing operations or cause damage if they become snagged in fishing gear. The environmental effects of cable laying, however, are limited (DoE, 1993).

6.8 Wind farms

As part of its strategy to reduce emissions of greenhouse gases (notably carbon dioxide) from burning fossil fuels, the Government has set a target to generate 10% of the UK's electricity from renewable sources of energy by 2010 and 5% by 2003 (English Nature *et al* 2001). Wind energy is the fastest growing energy technology in the world and Government recognises that offshore wind farms can contribute considerably to those targets.

In April 2001, following a pre-qualification process, companies were given an agreement of lease by the Crown Estate to pursue 15 developments in the first Round of offshore wind farms in the UK. At the time of going to press, four wind farms within the Irish Sea MNA from this first round (Figure 6.9) have received development consents. In July 2003, a second round of offshore wind developments was announced. In this round, leases have only been offered within three 'Strategic Areas' of the UK which have undergone a Strategic Environmental Assessment process. Most of the marine environment within this MNA lies within the Liverpool Bay Strategic Area where three further locations have been leased for windfarm development under 'Round 2'. If these proposals progress to seeking development consents, it is unlikely that applications will be submitted before 2005. Further information can be obtained from http://www.og.dti.gov.uk/offshore-wind-sea/process/envreport.htm. At North Hoyle off the north Wales coast adjacent to this Natural Area, the UK's first commercial offshore windfarm has been operational since November 2003.

Factors that have influenced the initial location of proposed sites include the available wind resources, connection to the national grid, depth and substrata (as many sites coincide with shallow sandbanks). Other interests which may have been taken into account include other human activities and environmental interests. Each of these will be addressed in the Environmental Impact Assessments that accompany applications for relevant sites.

Windfarms may have a number of potential impacts on the environment, including on birds (eg risk of collision, exclusion from feeding areas), on mobile species from noise and vibration, on sediment transport and coastal processes, and on marine and coastal habitats and benthos. There is presently much discussion regarding the limitation of current data on many of these issues. Indeed, these issues form core concerns with respect to mitigation measures. However, the lack of extensive data severely restricts the effectiveness of the mitigation options available. To investigate some of these issues, a group was established in 2002 to co-ordinate research into impacts of offshore wind energy development on the environment. Chaired by the Crown Estate, the Collaborative Offshore Wind Research Into the Environment consists of members representing industry, NGOs and statutory nature conservation bodies including English Nature. The Group operates a research fund from the interest accrued from seabed leases granted as a result of the 'Round One consultation phase.

Projects underway include the effects of electromagnetic fields; the effects of underwater noise and vibration; comparison of aerial and boat-based surveys for bird distribution and population studies; and investigation into potential displacement from feeding grounds of common scoter. Further information can be obtained from the Crown Estate website: http://www.crownestate.co.uk/estates/marine/index.shtml.

6.9 Recreational uses

This chapter has mainly considered the most important human activities within the Natural Area. There is, however, a range of recreational activities that occur within the Marine Natural Area which have a significant input into the local economy and are of interest to those engaged in coastal planning and management, as well as the users themselves. However, as most of these activities are confined to the coastal and inshore waters, we have not dealt with them in any great detail here. Further information can be found in the other publications such as the JNCC's Coastal Directories (eg Barne *et al* 1996) and English Nature's 'Regulation 33 Packages' (eg English Nature 2000).

The waters in and around the Irish Sea Natural Area are moderately important on a national scale for water-based leisure, despite strong tides and some pollution problems (Barne *et al* 1996). This probably reflects the high seasonal population on the north Wales and Lancashire coast, coupled with Merseyside's large resident population. There are seven marinas in the region surrounding the Natural Area, with more than 50 affiliated sailing or yacht clubs listed for the region by the Royal Yachting Association (1992).

Use of the Natural Area for water-based recreation poses little threat to marine habitats and wildlife. The most likely impacts are damage to the seabed through anchoring and there is also a possibility of noise impact.

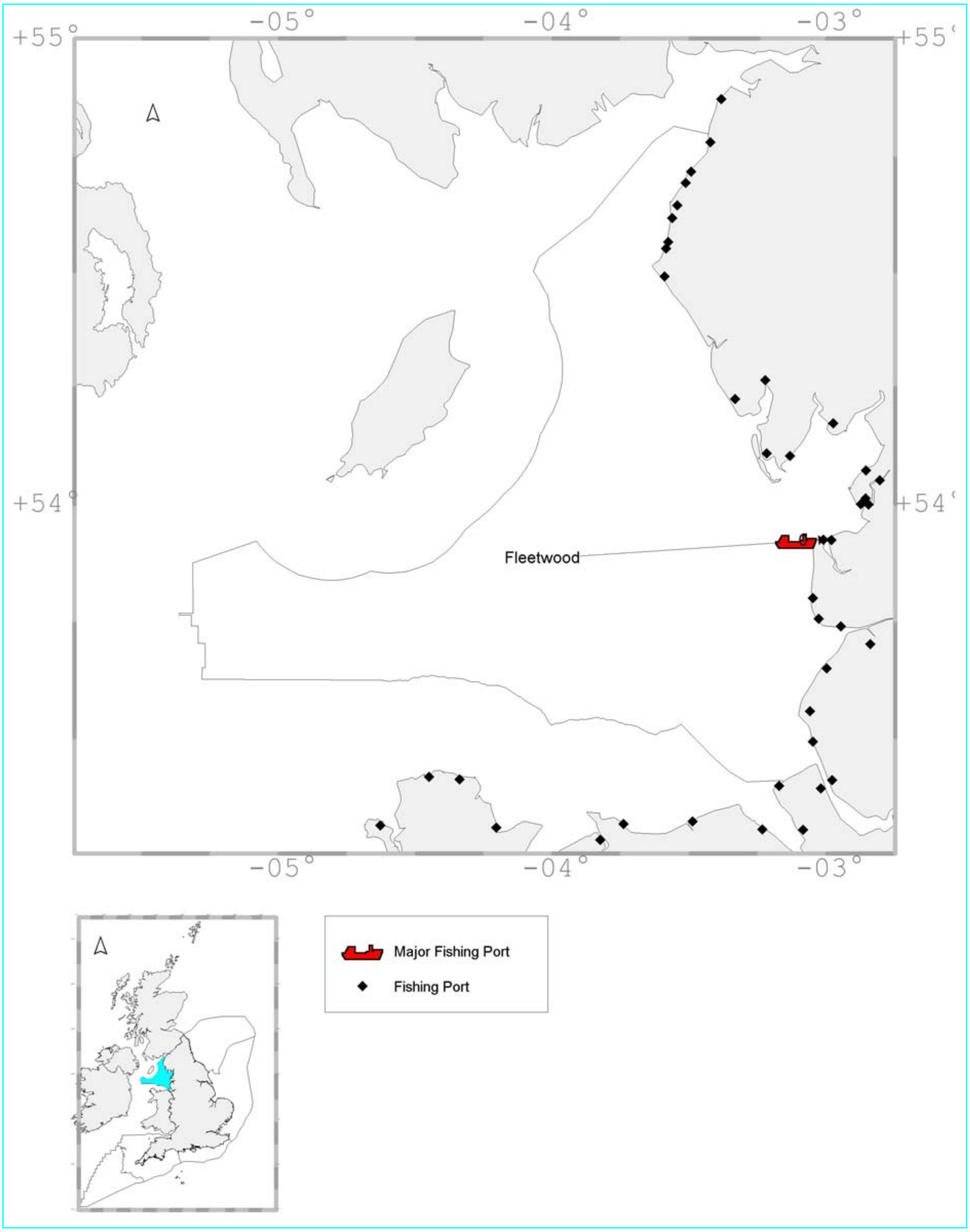


Figure 6.1 Distribution of fishing ports in the Irish Sea Natural Area (Data provided by CEFAS)

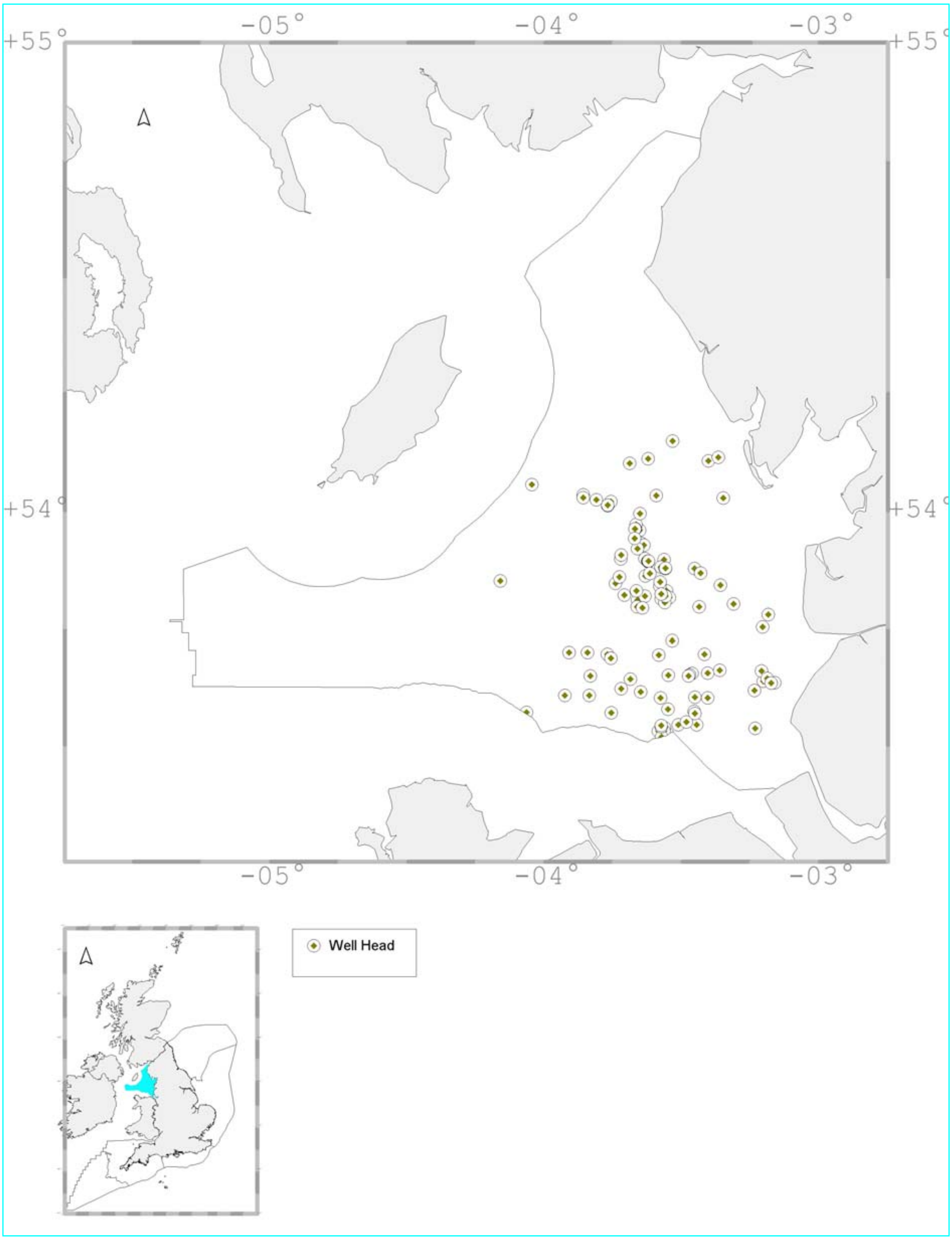


Figure 6.2 Map showing the distribution of oil and gas well heads in the Irish Sea Natural Area.

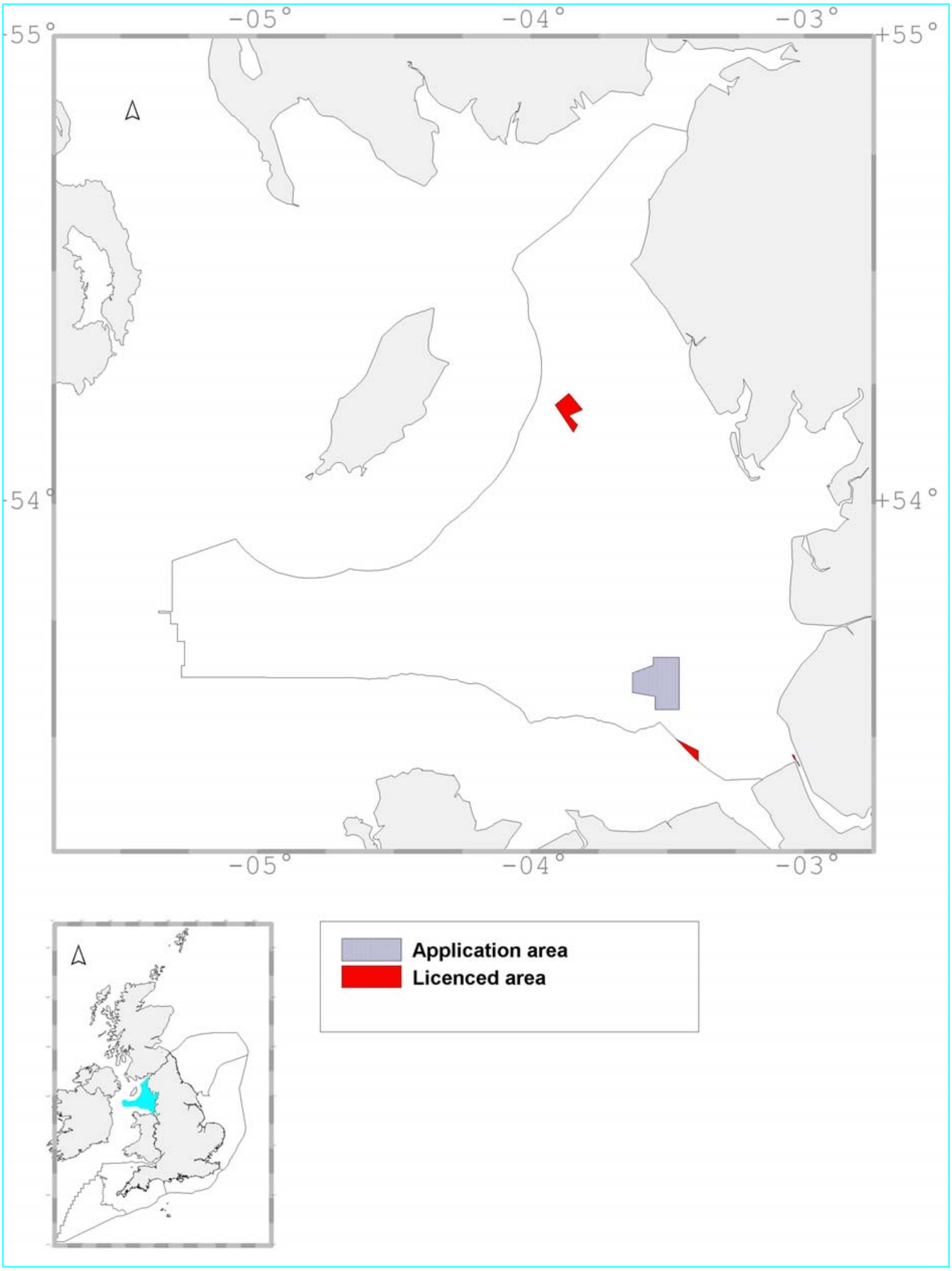


Figure 6.3 Map of dredging areas in the Irish Sea Natural Area (Data provided by Crown Estate in 2003)

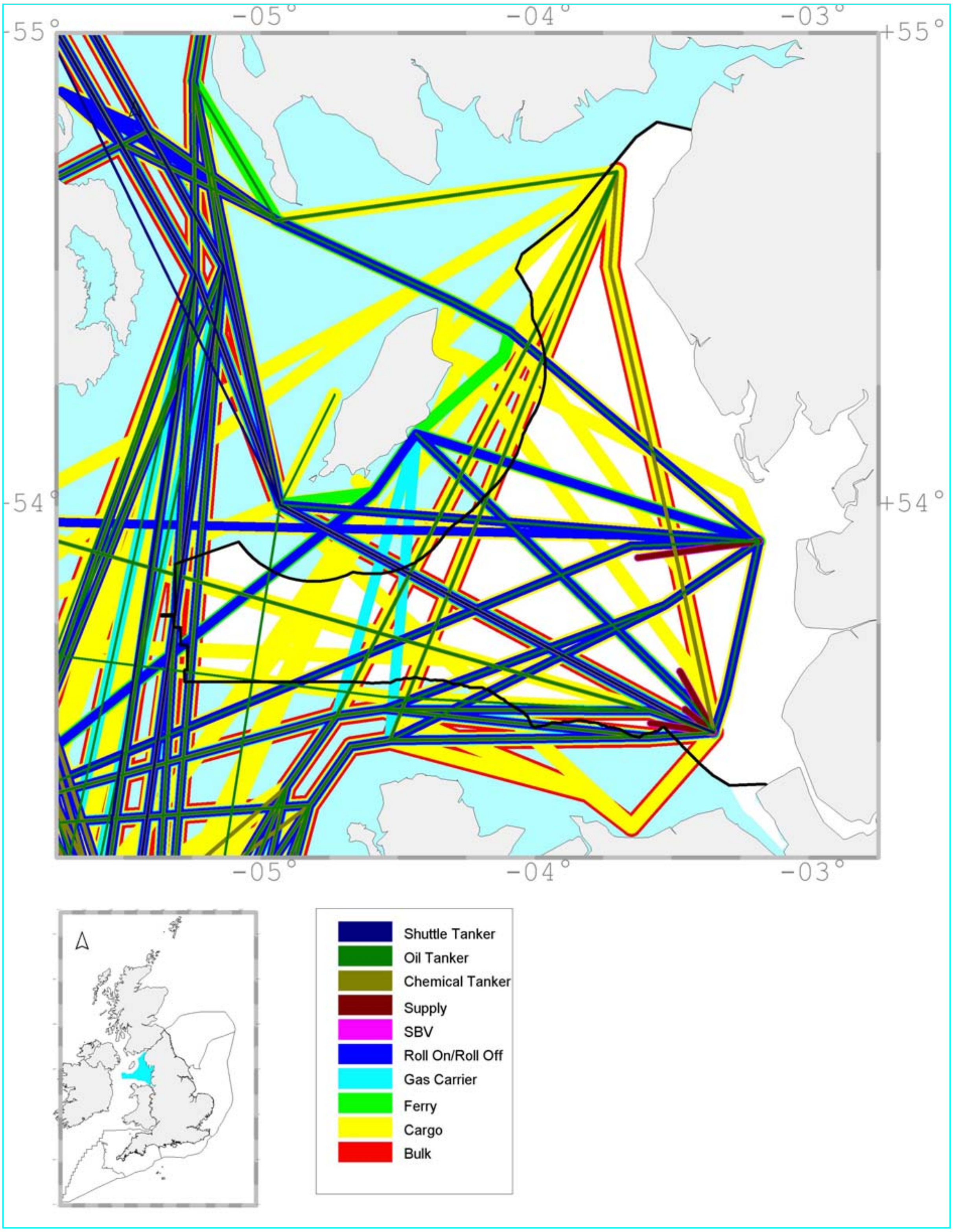


Figure 6.4 Map showing the various types of vessel operating with the Irish Sea Natural Area during 1999 (Data taken from COAST database) (SBV- Standby vessel)

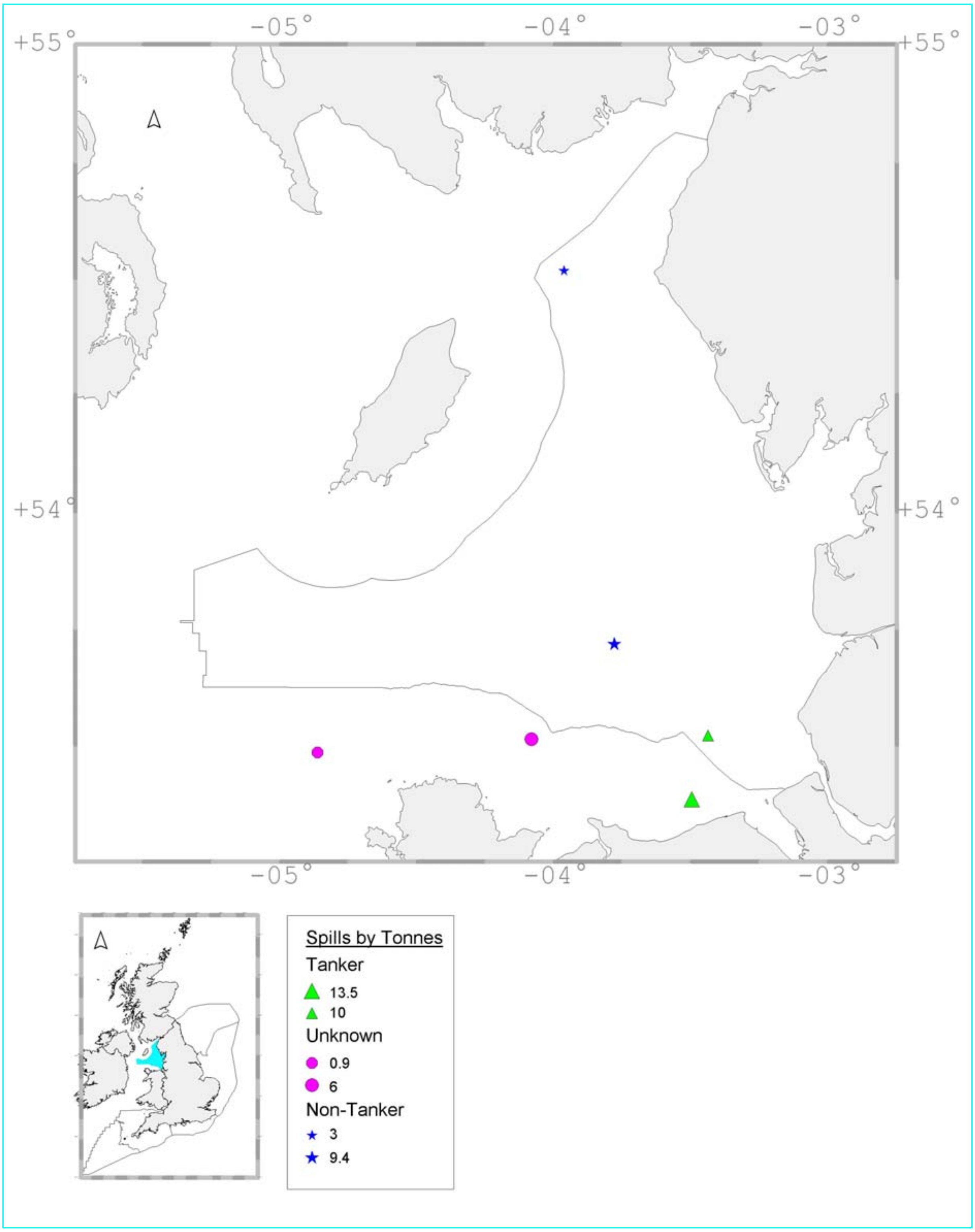


Figure 6.5 The distribution and size of oil spills in the South Western Peninsula Natural Area in the period 1989–1998 (ACOPS data from COAST database).

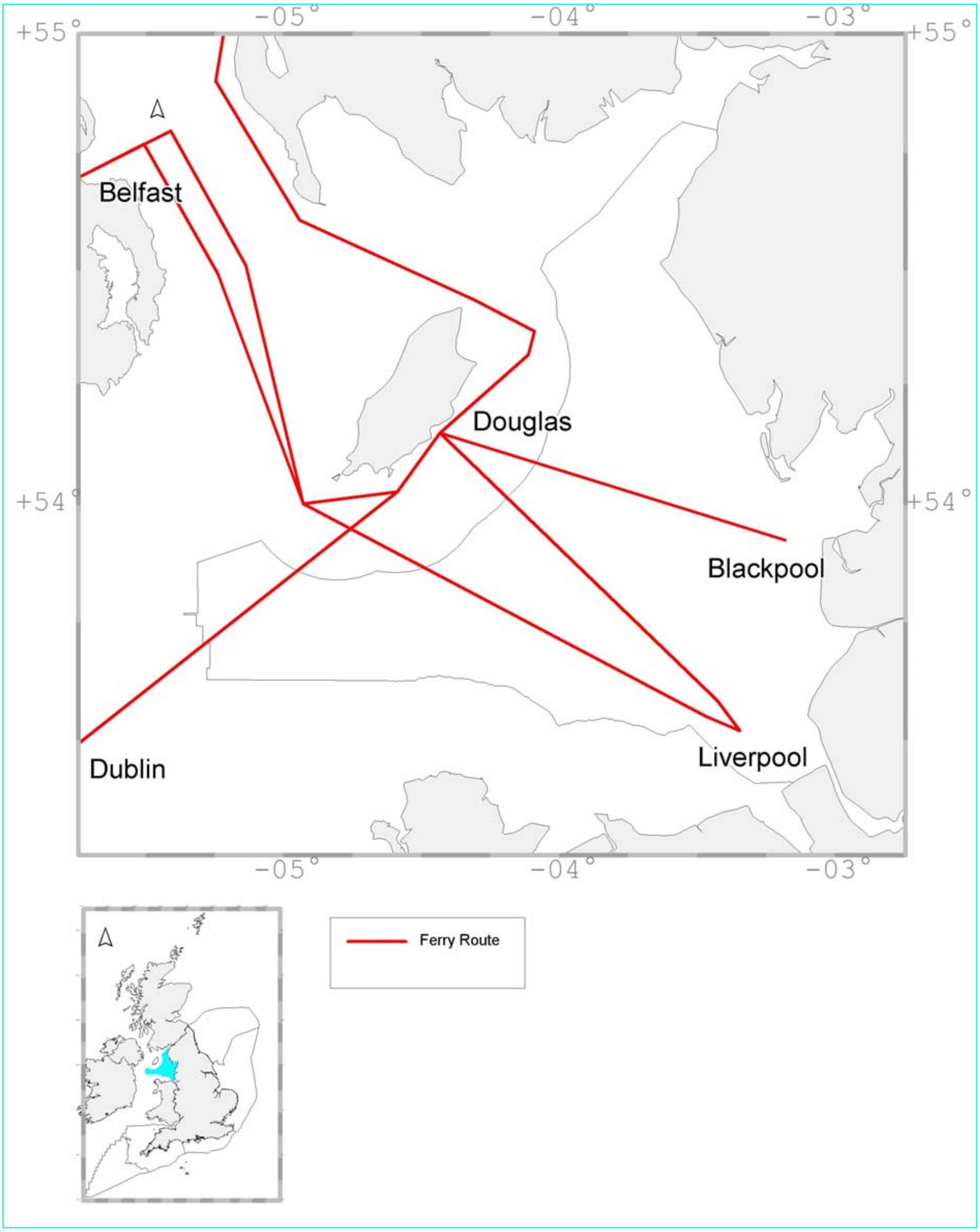


Figure 6.6 Map of ferry routes crossing the Irish Sea Natural Area

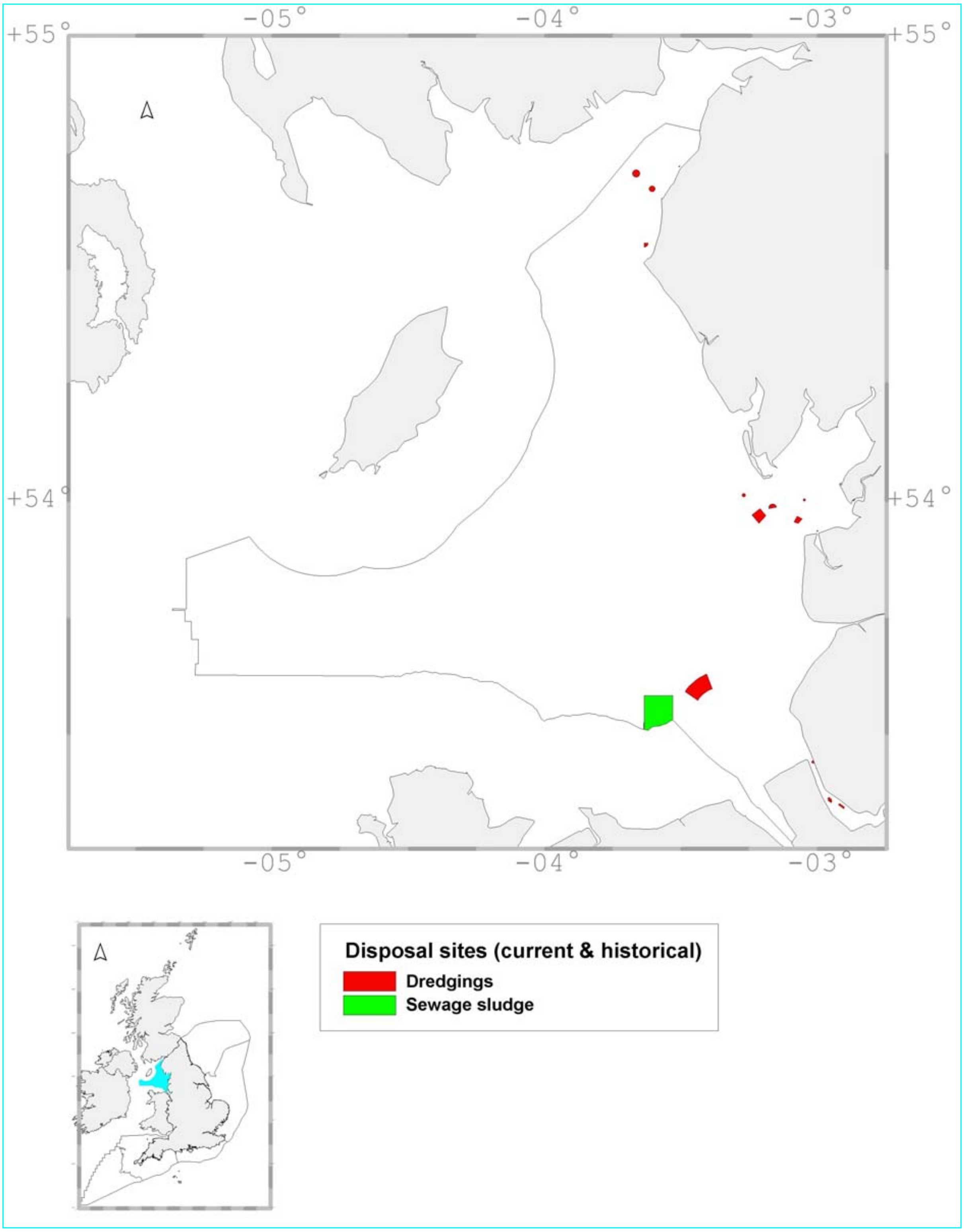


Figure 6.7 Distribution of disposal sites in the Irish Sea Natural Area (data provided by CEFAS)

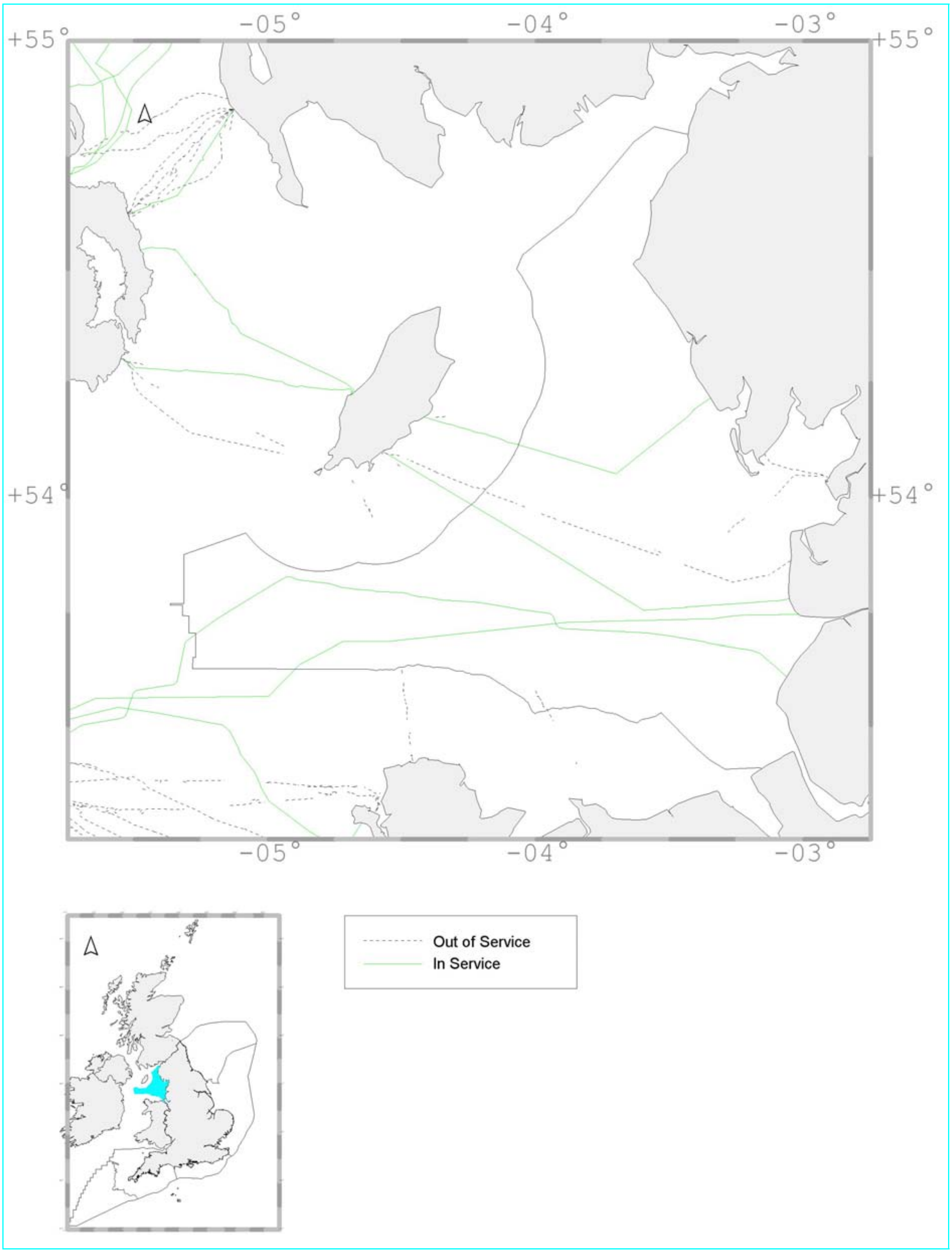


Figure 6.8 Map of submarine cables passing through the Irish Sea Natural Area

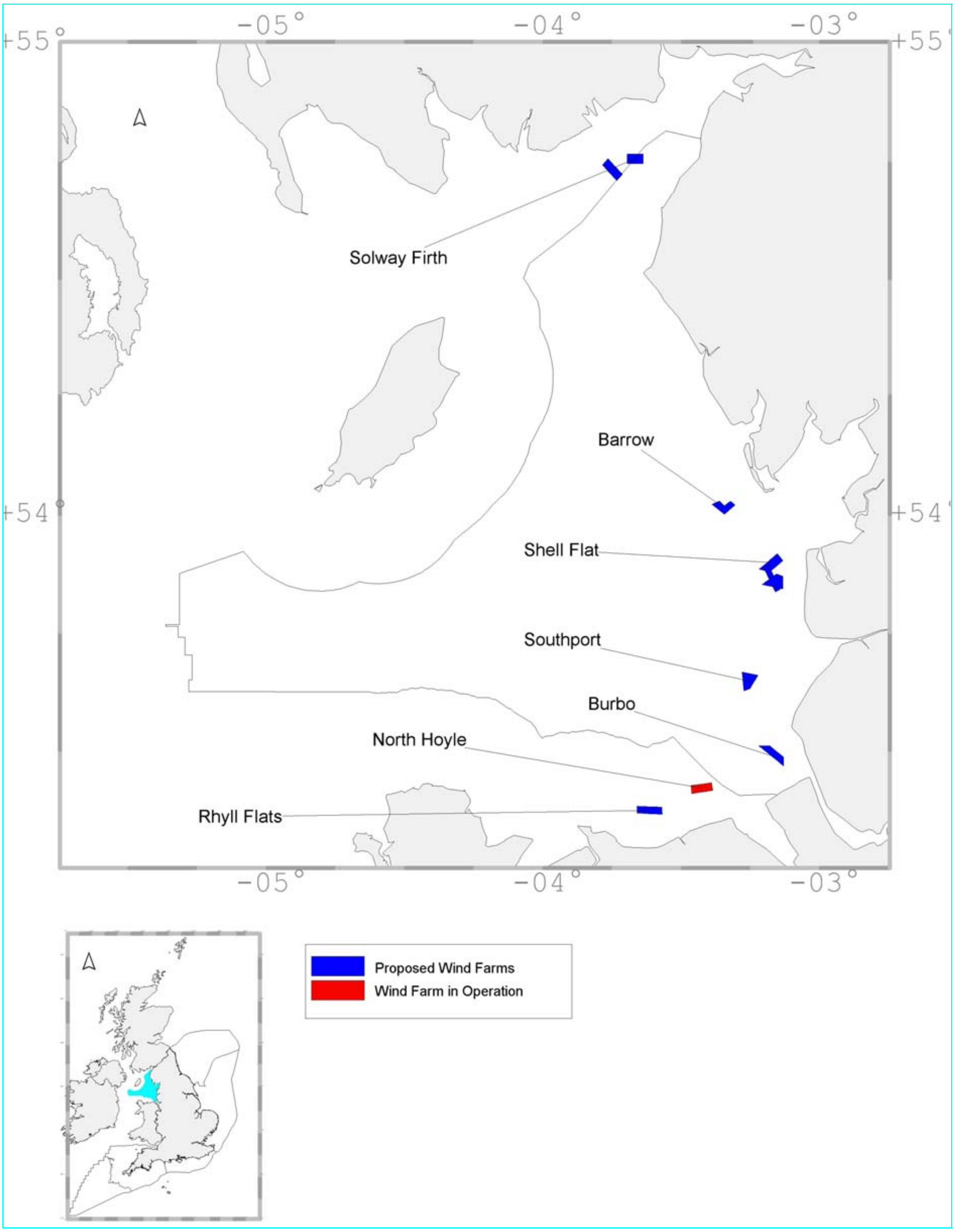


Figure 6.9 Map showing the distribution of proposed windfarms in the Irish Sea Natural Area.

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8 References

ALLABY, A. & ALLABY, M., eds, 1990. *Concise Oxford Dictionary of Earth Sciences*. Oxford: Oxford University Press.

ALLDREDGE, A.L. & HAMNER, W.M., 1980. Recurring aggregation of zooplankton by a tidal current. *Estuarine and Coastal Marine Science*. **10**, pp 31-37.

ALLEN, Y., MATTHIESSEN, P., SCOTT, A.P., HAWORTH, S., FEIST, S., & THAIN, J E., 1999. The extent of oestrogenic contamination in the UK marine environment – further surveys of flounder. *Science of the Total Environment,* **233**, pp.5-20.

ALLEN, Y., HURRELL, V., JONES, C., REED, J., & MATTHIESSEN, P., 2000. Endocrine disrupters and European Marine Sites in England. *English Nature Research Reports*, No. 531.

ALLEN, J. BILLINGS, I, CUTTS, N. & ELLIOTT, M., 2002. *Mapping, condition and conservation assessment of honeycomb worm* Sabellaria alveolata *reefs on the Eastern Irish Sea coast.*

BAINES, M.E., 1993. *Marine mammal monitoring during the seismic exploration of block 107/21 in Cardigan Bay, Autumn 1993*. Haverfordwest: Dyfed Wildlife Trust.

BARNE, J.H, ROBSON, C.F., KAZNOWSKA, S.S., DOODY, J.P., DAVIDSON, N.C., eds, 1996. *Coasts and seas of the United Kingdom. Region 13 Northern Irish Sea: Colwyn Bay to Stranraer, including the Isle of Man.* Peterborough: Joint Nature Conservation Committee.

BARETTA-BECKER J.G., DUURSMA, E.K. & KUIPERS, B.R., eds, 1992. *Encyclopedia of marine sciences.* Berlin: Springer-Verlag.

BERGMAN, M.J.N & HUP, M., 1992. Direct effects of beam trawling on macro-fauna in a sandy sediment in the southern North Sea. *ICES Journal of Marine Science*, **49**, pp 5-11.

BOURNE, W.R.P., 1982. Concentrations of Scottish seabirds vulnerable to oil pollution. *Marine Pollution Bulletin,* **13**: pp 270-273.

BRAMPTON, A.H. & EVANS, C.D.R., 1998. *Structured approach to regional seabed sediment studies.* London, CIRIA Founders' Report 2, CIRIA Research Paper 549.

BROWN, A.E., BURN, A.J., HOPKINS, J.J., & WAY, S.F., 1997. The habitats directive: selection of Special Areas of Conservation in the UK. *JNCC Report,* No 270.

BURGER, J., & GOCHFELD, M., 1990. Predation and effects of humans on island nesting seabirds. *In*: D.N. NETTLESHIP, J. BURGER, & M. GOCHFELD, 1990. *Seabirds on Islands: Threats, Case Studies and Action Plans*. Birdlife International.

CEFAS, 1998. Monitoring surveillance of non-radioactive contaminants in the aquatic environment and activities regulating the disposal of wastes at sea, 1995 and 1996. CEFAS, Lowestoft. *Science Series Aquatic Environment Monitoring Reports*, No. 51.

CEFAS, 2000. Monitoring and surveillance of non-radioactive contaminants in the aquatic environment and activities regulating the disposal of wastes at sea, 1997. CEFAS, Lowestoft. *Science Series, Aquatic Environment Monitoring Report,* No. 52.

CEFAS, 2001. Monitoring surveillance of non-radioactive contaminants in the aquatic environment and activities regulating the disposal of wastes at sea, 1998. CEFAS, Lowestoft. *Science Series Aquatic Environment Monitoring Reports*, No. 53.

COLE, S., CODLING, I.D., PARR, W., & ZABEL, T., 1999. *Guidelines for managing water quality impacts with European marine sites*. Report prepared for the UK Marine SACs Project, October 1999. Swindon: WRc.

CONNOR, D.W., DALKIN, M.J., HILL, T.O., HOLT, R.H.F., NORTHERN, K.O. & SANDERSON, W.G., 1997. *Marine Nature Conservation Review: marine biotope classification for Britain and Ireland. Volume 2. Sublittoral biotopes*. Version 97.06. Peterborough: JNCC Report, No. 230.

COVEY, R., & LAFFOLEY, D. d'A., 2002. *Maritime State of Nature Report for England: getting onto an even keel.* Peterborough: English Nature.

CRUMPTON, C.A, GOODWIN, M.J, & HOLT, T.J., 1996. Chapter 9 Water quality and effluent discharges. *In*: J.H. BARNE, C.F. ROBSON, S.S. KAZNOWSKA, J.P. DOODY, & N.C. DAVIDSON, eds. *Coasts and seas of the United Kingdom. Region 13 Northern Irish Sea: Colwyn Bay to Stranraer, including the Isle of Man*. Peterborough: Joint Nature Conservation Committee.

DEFRA, 2002a. *Safeguarding our seas: A strategy for the Conservation and Sustainable Development of our Marine Environment.* London: Defra.

DEFRA, 2002b. *Endocrine disruption in the marine environment (EDMAR).* London: Defra.

DEFRA, 2003. *UK small cetacean bycatch response strategy*. London: Defra.

DEPARTMENT OF THE ENVIRONMENT, 1993. Development below low water mark – a review of regulation in England and Wales. London: Department of the Environment (DOE) & Welsh Office.

DICKSON, R.R., 1987. Irish Sea status report of the Marine Pollution Monitoring Group. pp.83. *Aquatic Environment Monitoring Report*, No. 17., Lowestoft: MAFF Directorate of Fisheries Research. .

DICKSON, R.R. & BOELENS, R.G.V., 1988. The status of current knowledge on anthropogenic influences in the Irish Sea. Copenhagen: *ICES Cooperative Research Report*, No. 155, pp 88.

DINTER, P.D., 2001. *Biography of the OSPAR maritime area - A synopsis and synthesis of biogeographical distribution patterns described for the North East Atlantic*. Bonn: Federal Agency for Nature Conservation.

DOODY, J.P., JOHNSON C. & SMITH B., eds., 1993. *Directory of the North Sea coastal margin.* Peterborough, Joint Nature Conservation Committee.

DONALDSON, 1994. *Safer ships, cleaner seas*. Report of Lord Donaldson's Inquiry into marine safety. London: HMSO.

DUNCAN, K., 1992. *An introduction to England's marine wildlife*. Peterborough: English Nature.

DUNNET, G.M., & OLLASON, J.C., 1982. The feeding dispersal of fulmars *Fulmarus glacialis* in the breeding season. *Ibis*, **124**, pp. 359-361.

DURINCK, J., CHRISTENSEN, K.D., SKOV, H. & DANIELSEN, F., 1993. Diet of the common scoter *Melanitta nigra* and velvet scoter *Melanitta fusca* wintering in the North Sea. *Ornis Fennica* **70, (4)**, pp. 215-218.

EKMAN, S., 1953. *Zoogeography of the sea*. 1st ed. London: Sidgwick & Jackson.

ELLIS, N.V., (ed) BOWEN, D.Q., CAMPBELL, S., KNILL, J.L., McKIRDY, A.P., PROSSER, C.D., VINCENT, M.A., & WILSON, R.C.L., 1996. *An introduction to the Geological Conservation Review.* GCR Series No. 1. Peterborough: Joint Nature Conservation Committee.

EMERY, K.O. & AUBERY, D.G., 1985. Glacial rebound and relative sea levels in Europe from tide gauge records. *Tectonohysics*, **120**, pp. 239-255.

ENGLISH NATURE, 1994. *Strategy for the 1990s. Natural Areas. Responses to English Nature's consultation document*. Peterborough: English Nature.

ENGLISH NATURE, 2000. *Morecambe Bay European marine site. English Nature's advice given under Regulation 33(2) of the Conservation (Natural Habitats etc.) Regulations 1994*. Peterborough: English Nature.

ENGLISH NATURE, RSPB, WWF-UK & BWEA, 2001. *Wind farm development and nature conservation - A guidance document for nature conservation organisations and developers when consulting over wind farm proposals in England.* Peterborough: English Nature.

ENVIRONMENT AGENCY, 1998. Oil and Gas in the Environment. *Environmental Issues Series.*

EUROPEAN COMMISSION, 1999. *Interpretation manual of European Union habitats. Version EUR 15/2*. Brussels, European Commission (DG Environment).

EVANS, P.G.H., 1992. Status Review of Cetaceans in British and Irish Waters. Report to UK Department of Environment. Oxford: Sea Watch Foundation. 98pp.

EVANS, P.G. H., ANDERWALD, P., & BAINES, M.E., 2003. UK cetacean status review. Report by Sea Watch Foundation to English Nature & Countryside Council for Wales.

FOLK, R.L., 1954. The distinction between grain-size and mineral composition in sedimentary rock nomenclature. *Journal of Geology*, **62**, pp. 344-359.

FRASER, W.R. & AINLEY, D.G., 1986. Ice edges and seabird occurrence in Antarctica. *Bioscience* 3

GESAMP, 1990. The state of the marine environment. Nairobi: *UNEP Regional Seas Reports and Studies* No.115.

GILKINSON, K., PAULIN, M., HURLEY, S. & SCHWINGHAMER, P., 1998. Impacts of trawl door scouring on infaunal bivalves: results of a physical trawl door model/dense sand interaction. *Journal of Experimental Marine Biology and Ecology*, **224,** pp. 291-312.

GISLASON, H., 1994. Ecosystem effects of fishing activities in the North Sea. *Marine Pollution Bulletin*, **29**, pp. 520-527.

GRIFFITH, D. 1971. *Notes on the biology of Plaice*. MSc thesis, University of Dublin.

De GROOT, S.J., 1984. The impact of bottom trawling on benthic fauna of the North Sea. *Ocean Management*, **9,** pp. 177-190.

GUBBAY, S. & KNAPMAN, P.A., 1999. *A review of the effects of fishing within UK European marine sites*. English Nature (UK Marine SACs Project). Peterborough: English Nature.

HAILEY, N., 1995. Likely impacts of oil and gas activities on the marine environment and integration of environmental considerations in licensing policy. Peterborough: *English Nature Research Reports*, No.145.

HAYWARD P.J. & RYLAND J.S. *eds*., 1995. *Handbook of the Marine Fauna of North-West Europe.* Oxford: Oxford University Press.

HILL, H.W., 1971. The seasonal movement of young plaice in the north east Irish Sea. *Fishery Investigation, London* Series 2 (26).

HILL, S., BURROWS, M.T., & HAWKINS, S.J., 1998. Intertidal reef biotopes (Volume VI). *An overview of dynamics and sensitivity characteristics for conservation management of marine SACs.* Oban: Scottish Association of Marine Science. (UK Marine SACs Project).

HILLIS, J.P., 1971. The whiting fisheries off Counties Dublin and Louth on the east coast of Ireland. 2. Research Vessel investigations. *Irish Fishery Investigation Series B (March)* No. 7.

HISCOCK, K., 1990. Marine Nature Conservation Review: methods. *Nature Conservancy Council CSD Report,* No 1072. (Marine Nature Conservation Review Report No. MNCR/OR/14.)

HISCOCK, K., 1991. Benthic marine ecosystems in Great Britain: a review of current knowledge. Introduction and Atlantic-European perspective. *Nature Conservancy Council CSD Report* No. 1170.

HISCOCK, K., ed., 1996. *Marine Nature Conservation Review: rationale and methods.* Peterborough, Joint Nature Conservation Committee. (Coasts and seas of the United Kingdom. MNCR Series)

HISCOCK, K., SOUTHWARD, A., TITTLEY I., & HAWKINS, S. In prep. Warmer waters and seabed marine life in Britain and Ireland. *Aquatic conservation.*

HITCHCOCK, D.R., NEWELL, R.C., & SEIDERER, L.J., 1999. *Investigation of benthic and surface plumes associated with marine aggregate mining in the United Kingdom – Final Report*. Contract Report for the US Department of the Interior, Mineral Management Service. Coastline Surveys Ltd. Ref. 98-555-03 (Final). United States MMS.

HOLME, N.A., 1996. The bottom fauna of the English Channel. *Journal of the Marine Biological Association of the United Kingdom,.* **41**, pp. 397-461.

HOLT, T.J, REES, E.I, HAWKINS, S.J. & SEED, R., 1998. Biogenic reefs (volume IX). *An overview of dynamic and sensitivity characteristics for conservation management of marine SACs*. Scottish Association for Marine Science (UK Marine SACs project)

HUNT, G.L., & SCHNEIDER, D.C., 1987. Scale-dependent processes in the physical and biological environment of marine birds. *In*: J.P. CROXALL, ed. *Seabirds - feeding ecology and the role in marine ecosystems*, pp.7-41. Cambridge: Cambridge University Press.

IANNUZZI, T.J., WEINSTEIN, M.P., SELLNER, K.G., & BARRETT, J.C., 1996. Habitat disturbance and marina development: An assessment of ecological effects. Changes in primary production due to dredging and marine construction. *Estuaries,* **19,** pp. 257-271.

ICES, 1992. Effects of extraction of marine sediments on fisheries. *ICES Cooperative Research Report* No.182.

ICES, 2001. Report of the ICES advisory committee of fishery management. *ICES Cooperative Research Report* No.246.

ICES 2003. Report of the ICES advisory committee of fishery management. *ICES Cooperative Research Report* No.261.

IPCC, 2001. *Climate change 2001: The Scientific Basis*. *Contribution of working group I to the third assessment report of the intergovernmental panel on climate change*. Cambridge: Cambridge University Press.

IRISH SEA STUDY GROUP., 1990. *The Irish Sea; an environmental review. Part 2: waste inputs and pollution*. Liverpool: Liverpool University Press.

JEFFERSON, F.A. & CURREY, B.E., 1994. Global review of porpoise Cetacea: Phocoenidae mortality in gill nets. *Biological Conservation*, **76,** pp 167-183.

JENNINGS, S. & KAISER, M.J., 1998. The effects of fishing on marine ecosystems. *Advances in Marine Biology*, **34,** pp 201-352.

JOHN, S.A, CALLINOR, S.L., SIMPSON, M., BURT, T.N. & SPEARMAN, J., 2000. *Scoping the assessment of sediment plumes from dredging.* London: Construction Industry Research and Information System (CIRIA).

JOHNSTON, C.M., TURNBULL, C.G., & TASKER, M.L., 2002. Natura 2000 in UK offshore Waters: advice to support the implementation of the EC Habitats and Birds Directives in UK offshore waters. *JNCC Report,* No. 325.

JONES, N.S., 1950. Marine bottom communities. *Biological Reviews,* **25,** pp 283-313.

KAISER, M.J., BULLIMORE, B., NEWMAN, P. & GILBERT, S., 1996. Catches in 'ghost fishing' set nets. *Marine Ecology Progress Series*, **136**, pp 1-11.

LARSEN, F., EIGAARD, O.R., & TOUGAARD, J., 2002. *Reduction of harbour porpoise by-catch in the North Sea by high-density gillnets*. Paper presented to the Scientific Committee of the International Whaling Commission, Shimonoseki, May 2002, SC/54/SM30.

LEE, A.J., & RAMSTER, W.J., 1981. *Atlas of the seas around the British Isles. Ministry of Agriculture, Fisheries and Food (MAFF*). Directorate of Fisheries Research. Fisheries Research Technical Report, No. 20. Lowestoft: MAFF.

LINCOLN, R.J. & BOXHALL, G.A., 1987. *The Cambridge illustrated dictionary of natural history.* Cambridge: Cambridge University Press.

LINCOLN, R.J., BOXHALL, G.A. & CLARK, P.F., 1982. *Dictionary of ecology, evolution & systematics*. Cambridge: Cambridge University Press.

LINDEBOOM, H.J. & DE GROOT, S.J., eds 1998. *The effects of different types of fisheries on the North Sea and Irish Sea benthic ecosystems*. IJmuiden, The Netherlands. RIVO-DLO Report C003/98.

LLOYD, C., TASKER, M.L., & PARTRIDGE, K., 1991. *The status of seabirds in Britain and Ireland.* London: T. & A.D. Poyser.

LUMB, C.M., FOWLER, S.L., ATKINS, S.M., & GILLILAND, P.M. & VINCENT, M.A. 2004. The Irish Sea Pilot: *Developing marine nature conservation objectives for the Irish Sea.* Report to Defra by the Joint Nature Conservation Committee, Peterborough.

LUMB, C.M., WEBSTER, M., GOLDING, N. ATKINS, S.M., & VINCENT, M.A., 2004b. The Irish Sea Pilot: Report on collation and mapping of data. Peterborough: Joint Nature Conservation Committee.

McLAREN, P., 1989. *The sediment transport regime in Morecambe Bay and the Ribble Estuary.*

MACER, C.T., 1972. The movements of tagged adult plaice in the Irish Sea. *Fishery Invest., Lond.* (Ser. 2). 27(6).

MACKIE, A.S.Y., 1990. Offshore benthic communities of the Irish Sea. In: *The Irish Sea: An environmental review. Part One: Nature Conservation*. Liverpool: Irish Sea Study group, Liverpool Universities Press.

MESSENGER, D., 1988. *Seaforth Bird Report* 1986/87. Preston: Lancashire Trust for Nature Conservation.

MARINE CONSERVATION SOCIETY, 1999. *Beachwatch 1999 nationwide beach-clean & survey report*. Ross-on-Wye: Marine Conservation Society.

MARINE CONSERVATION SOCIETY, 2000. Exploitation & Impacts. In: *Fisheries Information Pack.* Ross-on-Wye: Marine Conservation Society.

MAFF, 1992. Monitoring and surveillance of non-radioactive contaminants in the aquatic environment and activities regulating the disposal of wastes at sea, 1990. Lowestoft: CEFAS*: Science Series, Aquatic Environment Monitoring Report,* No. 53.

MARINE POLLUTION MONITORING MANAGEMENT GROUP, 1998. *Survey of the Quality of UK coastal waters*. Aberdeen: National Monitoring Programme.

MATTHIESSEN, P., THAIN, J.E., LAW, R.J. & FILEMAN, T.W., 1993. Attempts to assess the environmental hazard posed by complex mixtures of organic chemicals in UK estuaries. *Marine Pollution Bulletin*, **26 (2)**: pp. 90-95.

MAVOR, R.A., PICKEREL, G., HEUBECK, M., & MITCHELL, P.I., 2001. *Seabird numbers and breeding success in Britain and Ireland, 2000*. Peterborough: Joint Nature Conservation Committee.

MINISTRY OF DEFENCE, 1987. *Admiralty manual of navigation. Volume 1: general navigation, coastal navigation and pilotage*. 3rd ed. London: HMSO, for Ministry of Defence, Directorate of Naval Welfare.

NRA, 1995. *The Mersey Estuary: A report on environmental quality*. National Rivers Authority, Water Quality Series No. 23. Bristol: National Rivers Authority (now Environment Agency).

NORTH SEA TASK FORCE, 1993. *North Sea Sub-region 9 assessment report 1993*. London: Oslo and Paris Commissions (OSPARCOM) for North Sea Task Force.

OLIVER, F, ROBINSON, P. & HARROD, C., 2001. *Common Scoter* Melanitta nigra *survey in Liverpool Bay*. Countryside Council for Wales Contract Science 470.

OSPAR COMMISSION, 1998. *Assessment of PCB fluxes and inventories relevant to the OSPAR Convention Area*. OSPAR Commission, meeting document No. INPUT(1) 98/7/1

OSPAR COMMISSION, 2000. *Quality Status Report 2000, Region III – Celtic Seas.* London: OSPAR Commission.

OSPAR COMMISSION, 2003. *Bremen Statement.* Ministerial meeting of the OSPAR Commission 25th June 2003, Bremen.

PANTIN, H.M., 1977. Quaternary sediments of the northern Irish Sea. *In*: C. KIDSON AND M.J. TOOLEY, eds. *The quaternary history of the Irish Sea*, pp. 27-54. Geological Journal Special Issue. Liverpool: Seel House Press.

PANTIN, H.M., 1978. Quaternary sediments from the north-east Irish Sea: Isle of Man to Cumbria. Bulletin of the Geological Survey of Great Britain: 64.

PAULY, & McLEAN, 2003. *In a perfect ocean. The state of fisheries and ecosystems in the North Atlantic*. Island Press.

PINGREE, R.D., HOLLIGAN, P.M. & MARDELL, G.T., 1978. The effects of vertical stability on phytoplankton distributions in the summer on the northwest European shelf. *Deep-Sea Research,* **25**: pp 1011-1028.

POSFORD DUVIVIER ENVIRONMENT, 1992. Capital and maintenance dredging – A pilot case study to review the potential benefits for Nature Conservation. Peterborough: *English Nature Research Reports,* No. 7.

POTTS, G.W., & SWABY, S.E., 1993. *Marine fishes on the EC Habitats and Species Directive*. Peterborough: Joint Nature Conservation Committee. (Confidential report to the Joint Nature Conservation Committee).

POULTON, C.V.L., PHILPOTT, E.J., JAMES, J.W.C., TASONG, W.A., GRAHAM, C., & LAWLEY, R.S., 2002. *Framework for the identification of seabed habitats and features within offshore English Waters to 12 nautical miles.* British Geological Survey Commissioned Report CR/02/134.

REES, E.I.S., & JONES, P.H., 1982. Seabirds associated with frontal systems in the Irish Sea. *In:* P.H. JONES, ed. *Proceedings of the first Seabird Group conference,* pp22-23. Sandy: Seabird Group.

REEVES, R.R., READ, A.J., & NOTARBARTOLA-DI-SCIARA, G., 2001. *Report of the workshop on interactions between dolphins and fisheries in the Mediterranean: evaluation of mitigation alternatives, Rome, 4–5 May 2001.* Rome, ICRAM. (Presented also to International Whaling Commission Scientific Committee, as paper SC/53/SM3.)

REID, J.B., EVANS, G.H., & NORTHRIDGE, S.P., 2003. *Atlas of cetacean distribution in north west European waters.* Peterborough: Joint Nature Conservation Committee.

ROSENBERG, R., 1977. Effects of dredging operations on estuarine benthic macrofauna. *Marine Pollution Bulletin*, **8(5),** pp. 102-104.

ROYAL YACHTING ASSOCIATION (RYA), 1992. *RYA affiliated organisations.* Romsey: Royal Yachting Association. (G25/92).

RSPB, 2000. *The development of boundary selection criteria for the extension of breeding seabird Special Protection Areas into the marine environment.* Sandy: Royal Society for the Protection of Birds.

SAFETEC, 2000. *Marine Traffic Data.* London: Department of the Environment Transport and Regions (DETR). Vol.1. (Consultation Draft).

SCOTT, C.R., HEMINGWAY, K.L., ELLIOT., M., DE JONGE, V.N., PETWICK, J.S., MALCOLM, S. & WILKINSON, M., 1999. *Impact of nutrients in estuaries. Phase 2*. Report to English Nature and the Environment Agency.

SIMPSON, J.H. & BOWERS, D., 1979. Shelf sea fronts' adjustments revealed by satellite IR imagery. *Nature,* **280,** pp. 648-651.

SKOV, H., DURINCK, J., DANIELSEN, F. & BLOTCH, D., 1994. The summer distribution of Procellariiformes in the central North Atlantic Ocean. *Die Vogelwarte* **37,** pp 270-289.

SKOV, H., DURINCK, J., LEOPOLD, M.F., TASKER, M.L., 1995. *Important bird areas for seabirds in the North Sea, including the Channel and the Kattegat.* Birdlife International.

STONE, C.J., WEBB, A., BARTON, C., RATCLIFFE, T.C., REED , T.C., TASKER, M.L., CAMPHUYSEN, C.J. & PIENKOWSKI, M.W., 1995. *An atlas of seabird distribution in north-west European waters.* Peterborough: JNCC.

STROUD, D.A., CHAMBERS, D, COOK, S., BUXTON, N., FRASER, B., CLEMENT, P., LEWIS, P., MCLEAN, I., BAKER, H., & WHITEHEAD, S., 2001. *The UK SPA network: its scope and content*. Peterborough: JNCC.

TASKER, M.L., 1996. Chapter 5.10. Seabirds. *In*: J.H. BARNE, C.F. ROBSON, S.S. KAZNOWSKA, J.P. DOODY, & N.C. DAVIDSON, N.C., eds.. *Coasts and seas of the United Kingdom. Region 9 Southern England: Hayling Island to Lyme Regis*. Peterborough: Joint Nature Conservation Committee.

TASKER, M.L., WEBB, A., HARRISON, N.M., & PIENKOWSKI, M.W., 1990. *Vulnerable concentrations of marine birds west of Britain.* Peterborough: Joint Nature Conservation Committee.

TASKER, M.L., & LEAPER, G.M., 1993. *Protecting marine birds in the United Kingdom: A review of the UK's international commitments, and recommendations for action*. Peterborough: Joint Nature Conservation Committee.

TASKER, M.L., WEBB, A., GREENSTREET, S.P.R., UTTLEY, J.D. & GRIFFITHS A., 1985. *Concentrations of auks of the north-east coast of Britain, August 1984*. Nature Conservancy Council, CSD Report No. 589.

THOMAS, K.V., BLAKE, S.J., & WALDOCK, M.J., 2000. Antifouling paint booster biocide contamination in UK marine sediments. *Marine Pollution Bulletin*, **40**, pp.739-745.

UK BIODIVERSITY GROUP, 1999. *UK Biodiversity Group Tranche 2 Action Plans. Volume V – maritime species and habitats*. Peterborough: English Nature.

VILES, H.A., 2001. *Impacts on marine environments. In*: P.A. HARRISON, P.M. BERRY, & T.E. DAWSON, eds. *Climate change and nature conservation in Britain and Ireland: Modelling natural resource responses to climate change (the MONARCH project).* pp. 229-239. UKCIP Technical Report: Oxford.

VINCENT, M.A. ATKINS, S.M, LUMB, GOLDING, N., LIEBERKNECHT, L.M., & WEBSTER, M., 2004. *Marine nature conservation and sustainable development – the Irish Sea Pilot.* Report to Defra by the Joint Nature Conservation Committee.

WATSON, L., 1985. *Whales of the world*. London: Christopher Helm.

WEBB, A., HARRISON, N.M., LEAPER, G.M., STEELE, R.D., TASKER, M.L. & PIENKOWSKI, M.W., 1990. *Seabird distribution west of Britain*. Peterborough: Nature Conservancy Council.

WEIGHELL, T., 2000 . Directory of the Celtic Coasts and Seas. Joint Nature Conservation Committee.

WENTWORTH, C.K., 1922. A scale of grade and class terms for clastic sediments. *Journal of Geology,* **30**, pp. 377-392.

Appendix 1 Marine Natural Areas and the ecosystem approach

An ecosystem consists of a community of plants, animals and micro-organisms and their physical environment. They are inter-dependent and may be best described as a network or web. In 2000 the Conference of the Parties to the Convention on Biological Diversity (CBD 2000) stated, amongst other things, that:

"The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. Thus, the application of the ecosystem approach will help to reach a balance of the three objectives of the Convention: conservation; sustainable use; and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources."

"An ecosystem approach is based on the application of appropriate scientific methodologies focused on levels of biological organization, which encompass the essential structure, processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of many ecosystems."

The following table provides a brief outline of the relevance of Marine Natural Areas to taking forward the ecosystem approach.

12 principles recommended by the Conference of Parties of the Convention on Biological Diversity in 2000 to guide signatory countries in the practical application of the ecosystem approach	**Relevance of Marine Natural Areas**
The objectives of management of land, water and living resources are a matter of societal choice.	English Nature believes that all key stakeholders should be involved in the management of the marine environment. The degree to which the ideas and information presented in these Marine Natural Area profiles are taken forward should be decided through dialogue amongst those stakeholders.
Management should be decentralised to the lowest appropriate level.	The better management of many marine activities around England, such as fisheries, aggregates and energy generation, requires a regional rather than simply a national approach. We feel that the Marine Natural Areas framework is at a scale that is appropriate for managing and governing the seas around England.
The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.	Marine Natural Areas are a broad scale, ecologically meaningful framework. Although some boundaries of individual Marine Natural Areas may need further refinement, we feel that this initial framework provides a good basis for testing and applying the ecosystem approach at an appropriate, ie regional, scale.
Recognising the varying temporal scales and lag-effects that characterise ecosystem process, objectives for ecosystem management should be set for the long-term.	Marine Natural Areas reflect broad scale factors and processes, some of which change only in the long-term, eg current patterns. Consequently objectives to guide management of human activities in Marine Natural Areas should consider a long-term as well as short-term perspective.

12 principles recommended by the Conference of Parties of the Convention on Biological Diversity in 2000 to guide signatory countries in the practical application of the ecosystem approach	**Relevance of Marine Natural Areas**
Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.	The emphasis on the key processes that help to define the Marine Natural Areas highlights the need to consider the interconnections both within the sea and also between Natural Areas. Consequently there is a need for a more integrated, holistic view of the effects of individual activities, including the cumulative effects over broad areas and adjacent waters.
Recognising potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management programme should: reduce those market distortions that adversely affect biological diversity; align incentives to promote biodiversity conservation and sustainable use; and internalise costs and benefits in the given ecosystem to the extent feasible.	Although Marine Natural Areas focus on defining ecological units and describing their biodiversity and nature conservation values, the descriptions also recognise key economic activities. Marine Natural Areas provide an ecologically relevant framework for management, including sustainable use, and offer a potentially common framework for aligning economic with environmental concerns. We appreciate the challenges this brings. We also recognise that the basis of 'regional seas' is likely to evolve and boundaries may be refined as interest in a potential regional approach to the marine environment gathers momentum.
Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.	Marine Natural Areas are based on both functional processes and structure and the link between them. Both should be reflected in conservation objectives for Marine Natural Areas.
Ecosystems must be managed within the limits of their functioning.	We must manage human use of the coasts and seas so that they do not damage the way the ecosystem works. For example, we should seek to ensure that particular activities do not affect the productivity of the marine environment. The development and application of conservation objectives for Marine Natural Areas will help towards identifying such limits.
Management must recognise that change is inevitable.	The marine environment is dynamic and responds to both man-made and natural changes. The profiles do not describe changes that have occurred within each Marine Natural Area in detail but change is implicit in an approach which emphasises functional processes and the link between these and structure.The development of conservation objectives and management for Marine Natural Areas should reflect the fact that change is often inevitable.
The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.	Marine Natural Areas provide an ecologically relevant framework at a scale appropriate for managing the use of biological diversity (such as fisheries) in a way that maintains wildlife. This will be addressed further through the development of conservation objectives and management for Marine Natural Areas, in conjunction with key stakeholders and government.
The ecosystem approach should consider all forms of relevant information including scientific and indigenous and local knowledge, innovations and practices.	The definition and description of Marine Natural Areas has drawn on a wide range of information but this has been largely technical in nature. Other relevant information is likely to be drawn on in the process of developing management for regional seas in partnership with other stakeholders, building on Marine Natural Areas as appropriate.

12 principles recommended by the Conference of Parties of the Convention on Biological Diversity in 2000 to guide signatory countries in the practical application of the ecosystem approach	Relevance of Marine Natural Areas
The ecosystem approach should involve all relevant sectors of society and scientific disciplines	A number of organisations have been consulted in defining and describing Marine Natural Areas including relevant regulatory authorities, industry, agencies and scientific institutes. However, this has been limited to those with relevant technical information. It is hoped that Marine Natural Areas will help to inform and structure a wider debate involving all relevant stakeholders in developing management for regional seas.

Appendix 2 Biodiversity Action Plan and Habitats Directive Classifications

Broad habitat types	**Priority habitats**
Inshore sublittoral rock	Sublittoral chalk *Sabellaria spinulosa* reef *Modiolus modiolus* beds
Inshore sublittoral sediment	Seagrass beds (*Zostera marina*) *Maerl* beds Mud in deep water Sublittoral sands and gravels
Offshore shelf sediment	Sublittoral sands and gravels

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EC Habitats Directive – Annex I Habitats (relevant to Marine Natural Areas)

Physiographic features	**Habitats**
Large shallow inlets and bays	Sandbanks which are slightly covered by seawater at all times
	Mudflats and sandflats not covered by seawater at low tide
	Reefs
	Submerged or partially submerged seacaves

Appendix 3 Wentworth and Folk sediment classifications

SEDIMENT SIZE				
phi value	milli-metres	SIZE CLASS		
		WENTWORTH		FOLK
-8	256	Boulder		Gravel
-6	64	Cobble		
-2	4	Pebble		
-1	2	Granule		
-0.5	1.41	Very Coarse	Sand	Sand
0	1			
0.5	0.71			
1	05	Coarse		
1.5	0.35			
2	0.25	Medium		
2.5	0.17			
3	0.125	Fine		
3.5	0.088			
4	0.0625	Very fine		
8	0.0039			
		Silt		Mud
		Clay		

Appendix 4 Glossary and abbreviations

Definitions based largely on:
Covey & Laffoley (2002), Ellis *et al* (1996) and Hiscock (1996).

ASCOBANS
Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas.

Anadromous (of fish)
Upward-running: spending part of their life in the sea and migrating up rivers in order to breed (eg salmon) (cf. "catadromous").

Bathymetry
Measurement of ocean or lake depth and the study of floor topography (Lincoln & Boxhall 1987).

Benthos
Those organisms attached to, or living on, in or near, the seabed, including that part which is exposed by tides as the littoral zone.

Bioaccumulation
The accumulation of a harmful substance such as a radioactive element, a heavy metal, or an organochlorine in a biological organism, especially one that forms part of the food chain.

Biodiversity (biological diversity)
"The variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems." (UN Convention on Biological Diversity 1992).

Biogeographic region
A region which is separated from adjacent regions by barriers or a change in environmental conditions which limits the movement of species or prevents their establishment outside their natural geographical range.

Biota
Any living organisms, both animals and plants.

Biotope
The physical "habitat" with its biological "community"; a term which refers to the combination of physical environment (habitat) and its distinctive assemblage of conspicuous species. MNCR uses the biotope concept to enable description and comparison.
The smallest geographical unit of the biosphere or of a habitat that can be delimited by convenient boundaries and is characterised by its biota (Lincoln, Boxhall & Clerk 1982).

Boreal
(Biogeographical) Pertaining to cool or cold temperate regions of the northern hemisphere. In marine zoogeographical terms, Ekman (1953) states that the centre of the Boreal region lies in the North Sea. It is bounded by the subarctic transitional zone to the north between Shetland, the Faroe Islands and Iceland, and in the south west of Britain by a transitional zone with the Mediterranean-Atlantic Lusitanean region.

Catadromous (of fish)
Downward-running: spending most of their life in rivers and migrating downstream to the sea in order to breed (eg eels) (cf. "anadromous").

Coastal zone
The space in which terrestrial environments influence marine (or lacustrine) environments and vice versa. The coastal zone is of variable width and may also change in time. Delimitation of zonal boundaries is not normally possible; more often such limits are marked by an environmental gradient or transition. At any one locality, the coastal zone may be characterised according to physical, biological or cultural criteria, which need not, and rarely do, coincide.

Cobble
A rock particle defined in two categories based on Wentworth (1922): large (128-256 mm); small (64-128 mm) (from Hiscock 1990).

Common Fisheries Policy (CFP)
A 20-year programme agreed in 1983 by EC Member States for the management and conservation of fish stocks, the maintenance and improvement of the market structure associated with the fishing industry, and international fisheries agreements.

Continental shelf
The seabed adjacent to a continent to depths of around 200 metres, or where the continental slope drops steeply to the ocean floor. Defined in law as "the seabed and subsoil of the submarine areas adjacent to the coast… to a depth of 200 metres"; the legal landward limit is set at the outer limit of territorial waters (q.v.) (Geneva Conference on the Law of the Sea, Convention on the Continental Shelf, 1958).

Controlled waters
In the UK, for the purposes of pollution control and other regulations, all rivers, streams, lakes, groundwaters, estuaries and coastal waters to a distance of three nautical miles (5.5 km) offshore (12 nautical miles (22 km) for migratory fish). The term is also used to refer to the area extending to 200 km from baselines (or to the midline between countries where less than 200 km) where a country has rights in relation to utilisation of resources and control of pollution but where the area is not described as an "Exclusive Economic Zone" (q.v.).

Current
Horizontal movement of water in response to meteorological, oceanographical and topographical factors (see also "tidal stream") (from Ministry of Defence 1987); a steady flow in a particular direction. "Current" refers to residual flow after any tidal element (ie tidal streams) has been removed.

Demersal
Living at or near the bottom of a sea or lake, but having the capacity for active swimming.

Diadromous
Fish that spend part of their life in freshwater and part in saltwater; eg anadromous salmon and catadromous eels.

Ebb tide
Outgoing or falling tide.

Ecosystem
A community of organisms and their physical environment interacting as an ecological unit (from Lincoln, Boxhall & Clerk 1982). Usage can include reference to large units such as the North Sea down to smaller units such as kelp holdfasts as "an ecosystem".

Ecosystem approach
The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way (Convention on Biological Diversity). There have been various elaborations on the definition, eg in a marine context as "the comprehensive integrated management of human activities based on best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of the marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity" (definition being discussed under the developing EU Marine Strategy).

Eddy
Motion of a fluid in directions differing from, and at some points contrary to, the direction of the larger-scale current (from Allaby & Allaby 1990); a circular movement of water, the diameter of which may be anything from several cm to several km, caused by topographical features or sudden changes in tidal or tidal stream characteristics. (Based on Ministry of Defence 1987). Cf. "gyre".

Endocrine disruptor
An endocrine disruptor is an exogenous substance or mixture that alters the function(s) of the endocrine system and consequently causes adverse health effects in an intact organism, or its progeny, or (sub) populations.

Eustatic
Local sea-level changes deriving from global changes in sea level, which have been estimated as rising at between 1.5 and 2 mm per year.

Eutrophication
The enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, causing an accelerated growth of algae and higher forms of plant life to produce an undesirable disturbance to the balance of organisms present in the water and to the quality of the water concerned (UWWTD, 1991).

Exclusive Economic Zone (EEZ)
A legal concept introduced by the United Nations Conference on the Law of the Sea III (UNCLOS III) (1967-82), giving coastal states certain sovereign rights and jurisdictions for economic purposes over an area of sea and seabed extending up to 200 nautical miles (370 km) from a baseline (normally low-water line) (based on Baretta-Becker, Duursma, & Kuipers 1992). Cf. "controlled waters".

Flood-tide
Incoming or rising tide.

Front, frontal system
An interface between two fluid bodies with different properties (based on Baretta-Becker, Duursma, & Kuipers 1992).

Graben
A fault-bounded crustal block, generally elongate, that has been depressed relative to the blocks on either side.

Gravel
Sediment particles 4-16 mm in diameter, based broadly on Wentworth (1922), which may be formed from rock, shell fragments or maerl (based on Hiscock 1990).

Gyre
A circular or spiral motion of fluid.

Gulf Stream
A relatively warm ocean current flowing north-eastwards off the Atlantic coast of North America from the Gulf of Mexico. It reaches north eastern Atlantic waters off Europe as the North Atlantic Drift.

Igneous [rocks]
Rocks formed from molten rock (magma). They usually consist of interlocking crystals, the size of which is dependent on the rate of cooling (slow cooling gives larger crystals; rapid cooling produces smaller crystals).

Irish Sea
The area of sea between Great Britain and Ireland north of a line across St George's Channel from St Annes Head to Carnsore Point in the south, and south of a line across the North Channel from Mull of Kintyre to Fair Head in the north, including all estuaries except the Firth of Clyde (Irish Sea Study Group definition, based on Shaw (1990)).

Isostatic
Changes in sea level deriving from the effect of local crustal movements which result in Scotland rising and southern England sinking, due to the removal of the weight of ice since the last glacial period.

Lusitanean
(Biogeographical) Referring to a biogeographical region centred to the south of the British Isles and influencing the extreme south west of the British Isles.

Maerl
Twig-like unattached (free-living) calcareous red algae, often a mixture of species and including species which form a spiky cover on loose small stones - 'hedgehog stones'.

Marine
Pertaining to the sea.

Marine Nature Conservation Review (MNCR)
A project initiated by the Nature Conservancy Council (NCC) in 1987 to consolidate the information already collected on British marine ecosystems, particularly the extensive data collected from marine survey projects commissioned by the NCC since 1974, and to complete survey work and the interpretation of the data. Since 1991, the MNCR has been undertaken within the UK's Joint Nature Conservation Committee. The area included in the MNCR is the coastline of England, Scotland and Wales (excluding the Isle of Man and the Channel Isles) extending from the lower limit of terrestrial flowering plants out to the limit of British territorial seas, and into estuaries and other saline habitats to the limits of saltwater influence. The MNCR concentrates on the benthos, and is based on descriptions of habitats and the recorded abundance of conspicuous species.

Maritime
Situated, living or found close to, and having a special affinity with, the sea.

Mean Low Water Springs (MLWS)
The average of the heights of two successive low waters during those periods of 24 hours when the range of the tide is greatest (from Ministry of Defence 1980).

Mud
Fine particles of silt and/or clay, <0.0625 mm diameter (from Hiscock 1990, after Wentworth 1922). Sediment consisting of inorganic and/or organic debris with particles in this category.

Natura 2000 site(s)
The European Community-wide network of protected sites established under the Birds Directive and the Habitats Directive.

Natural Areas
A concept, introduced by English Nature, for defining areas based on their landscape features, geology and biota and resulting in the definition of 92 terrestrial and 24 coastal/maritime Natural Areas in England (English Nature 1994). Maritime Natural Areas are based on coastal cell boundaries.

Nautical Mile
A unit of distance used in navigation, equivalent to 1° of latitude. The standard, or international, nautical mile is 1852 metres; the true nautical mile changes with latitude, from 1861.7 metres at the equator to 1842.9 metres at the poles.

North Atlantic Drift
A north easterly continuation of the warm Gulf Stream current into the eastern North Atlantic.

North Sea
As defined for the purposes of the North Sea Conferences it is southwards of 62°N, eastwards of 5°W and northwards of 48° 30'N and includes the Kattegat defined by lines between coastal features (Oslo and Paris Commissions 1994 where it is described as the "Greater North Sea"). For the British coast, these are the seas to the east of Cape Wrath, and of Falmouth. This is the definition used by the JNCC for the *Directory of the North Sea Coastal Margin* (Doody, Johnson & Smith 1993) and elsewhere.

OSPAR
OSPAR (or Oslo and Paris) Commission for the Protection of the Marine Environment of the North East Atlantic. The UK is one of the sixteen contracting parties to the OSPAR convention.

Pebble
Rock particle 16-64 mm in diameter (from Hiscock 1990, after Wentworth 1922).

Pelagic zone
The open sea and ocean, excluding the sea bottom. Pelagic organisms inhabit such open waters.

Phytoplankton
Planktonic plant life: typically comprising suspended or motile microscopic algal cells such as diatoms, dinoflagellates and desmids.

Precautionary principle
A principle underlying the concept of sustainable use of resources, which implies that:
prudent action be taken in the absence of scientific certainty; the balance of the burden of proof should be to show that no irreversible harm will occur rather than to prove that significant damage will occur; environmental well-being will be given legitimate status and best-practice techniques will be developed. (From *WWF Marine Update* No. 14, April 1994.)

SAC (Special Area of Conservation)
A site of [European] Community importance designated by the [EU] Member States through a statutory, administrative and/or contractual act where the necessary conservation measures are applied for the maintenance or restoration, at a favourable conservation status, of the natural habitats and/or the populations of the species for which the site is designated (Commission of the European Communities 1992). This status is achieved by sites adopted by the European Commission.

Sand
Particles defined in three size categories based on Wentworth (1922): very coarse sand and granules (1-4 mm); medium and coarse sand (0.25-1 mm); very fine and fine sand (0.062-0.25 mm) (from Hiscock 1990).

Seagrasses
Higher plants (angiosperms) that are adapted to living submerged in seawater. They are not true grasses, but belong to the order Helobiae, and are related to pondweeds. Two genera are present in British coastal waters: *Zostera* (eelgrass) and *Ruppia*, a brackish-water genus.

SPA (Special Protection Area)
A site of European Community importance designated under the Wild Birds Directive (Commission of the European Communities Council Directive 79/409/EEC of 2 April 1979 on the Conservation of Wild Birds).

Sublittoral
The zone exposed to air only at its upper limit by the lowest spring tides. The sublittoral extends from the upper limit of the large kelps and includes, for practical purposes in nearshore area, all depths below the littoral.

Territorial waters
The seas over which a nation exercises jurisdiction and control, but within which other states have certain rights, notably for innocent passage of vessels. In UK law, the landward limit of UK territorial seas is defined as "the low water line around the coast" (Territorial Waters Order in Council 1964); the seaward limit is 12 nautical miles offshore from the landward limit.

Wentworth Scale
A scale of sediment particle size categories described by Wentworth (1922), based on a doubling above or halving below, a fixed reference diameter of 1 mm, and with descriptive class terms ranging from boulder (> 256 mm) to clay and colloid (<0.004 mm). This scale is used as the basis of the MNCR and most other sediment classifications. The Wentworth Scale is transformed to the phi (Φ) scale for statistical analysis of sediments.

Zooplankton
The animal constituent of plankton consisting mainly of small crustacea and fish larvae.

Abbreviations and acronyms

ACOPS	Advisory Committee on Protection of the Sea
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
BAP	Biodiversity Action Plan
BGS	British Geological Survey
BMAPA	British Marine Aggregate Producers Association
BOD	Biological Oxygen Demand
c	(as prefix, eg cSAC) candidate
CCW	Countryside Council for Wales
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CFP	Common Fisheries Policy
CITES	Convention on the International Trade in Endangered Species of Wild Fauna and Flora
CROW	Countryside Rights of Way Act 2001
cSAC	Candidate Special Area of Conservation
Defra	Department of Environment, Food and Rural Affairs
DoE	Department of the Environment (now subsumed by Defra)
DTI	Department of Trade and Industry
EEC	European Economic Community (later the European Community, now the European Union)
EEZ	Exclusive Economic Zone
EQS	Environmental quality standards
EU	European Union
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine environmental Protection (until about 1991, the Joint Group of Experts on the Scientific Aspects of Marine Pollution) (an advisory body to the Heads of eight organisations of the United Nations System).
GIS	Geographic Information System(s)
IBA	Important Bird Area (South Cornwall Coast: MNA4)
ICES	International Council for the Exploration of the Sea
IUCN	International Union for the Conservation of Nature and Natural Resources (now IUCN – The Conservation Union)
JNCC	Joint Nature Conservation Committee
MAFF	Ministry of Agriculture, Food and Fisheries (now subsumed by Defra)
MAGP	Multi-annual Guidance Programme

MARPOL	International Convention for the Prevention of Pollution of the Sea from Ships
MCS	Marine Conservation Society
MEHRA	Marine Environmental High Risk Area
MS	Minimum Size
MLW	Mean Low Water
MNA	Marine Natural Area
MNCR	Marine Nature Conservation Review
MSC	Marine Stewardship Council
mSPA	Marine Special Protection Area
m/g	Milligrams per litre
m/s	Metres per second
n/l	Nanograms per litre
µg/l	Micrograms per litre
NMMP	National Marine Monitoring Programme
NVZ	Nitrate Vulnerable Zone
OSPAR	Oslo and Paris Convention (short title for the 1992 International Convention for the Protection of the Marine Environment of the North-East Atlantic).
PAHs	Poly-cyclic Aromatic Hydrocarbons
PCBs	Poly-chlorinated biphenyls
Ro-Ro	Roll on - Roll off ferry
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SFC	Sea Fisheries Committee
SMRU	Sea Mammal Research Unit
SNH	Scottish Natural Heritage
SPA	Special Protection Area
STW	Sewage treatment Works
TAC	Total Allowable Catch
TBT	Tri-butyl tin
UWWTD	Urban Waste Water Treatment Directive
W& C Act	Wildlife and Countryside Act 1981

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Top left: North Hoyle windfarm under construction. Martin Bailey/English Nature
Bottom left: Seawater surface temperature for all Natural Areas in June 1997. © Natural Environment Research Council (NERC) & Plymouth Marine Laboratory (PML) 2004
Main: Basking shark, the largest fish found in British waters is frequently sighted in the Irish Sea Natural Area. Bill Sanderson

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