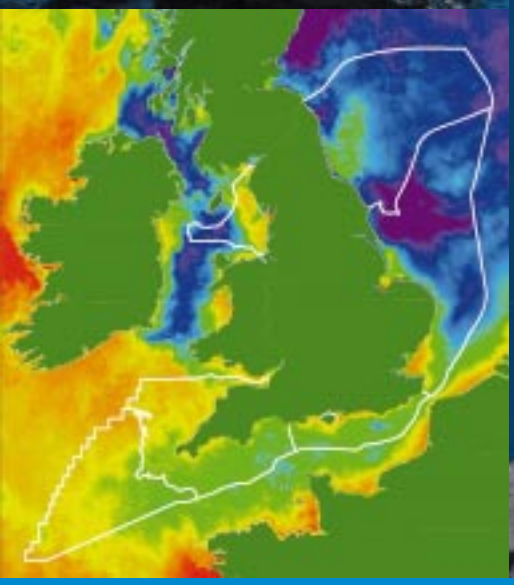
ENGLISH NATURE

The Southern North 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 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 we need to take a more integrated approach to managing human activities 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 and the information set out in this document is a positive step forward in meeting this challenge.

English Nature initially conceived the idea of 'Natural Areas' on land and in the nearshore 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 help us to manage specific sites better. They also help us to understand the nature conservation value of the wider countryside. Natural Areas provide a strategic framework for English Nature, in consultation with stakeholders, 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. 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.

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 a healthy, resilient marine environment supporting biodiversity and a variety of sustainable economic uses. That requires new ideas and initiatives and as such we commend this report as a contribution to the debate about how best to achieve this.

Sue Collins
Director Policy
English nature

Malcolm Vincent
Science Director
Joint Nature Conservation Committee

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1. Introduction

1.1 Definition and role of Marine Natural Areas

Marine Natural Areas (MNAs) 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. MNAs 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 near shore environment[1], Marine Natural Areas emphasise the importance of natural processes, the interaction between these, geology, and wildlife. We have identified 6 MNAs, 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];
- presents information in a structured and easily accessible manner which can be adapted for use by others as required.

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 (JNCC), Government and others. We will use them to:

[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.

- 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 distribution of seabird breeding colonies may indicate not only suitable nesting conditions, but also the distribution of important marine feeding grounds, for example 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 Convention.

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

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).

[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-nmile administrative boundary. For convenience, the term "seas adjacent to England" is used when referring to waters within and beyond 12 nautical miles.

These were based on the coastal process cells and sub-cells in which sediment movement is largely contained within discreet 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.

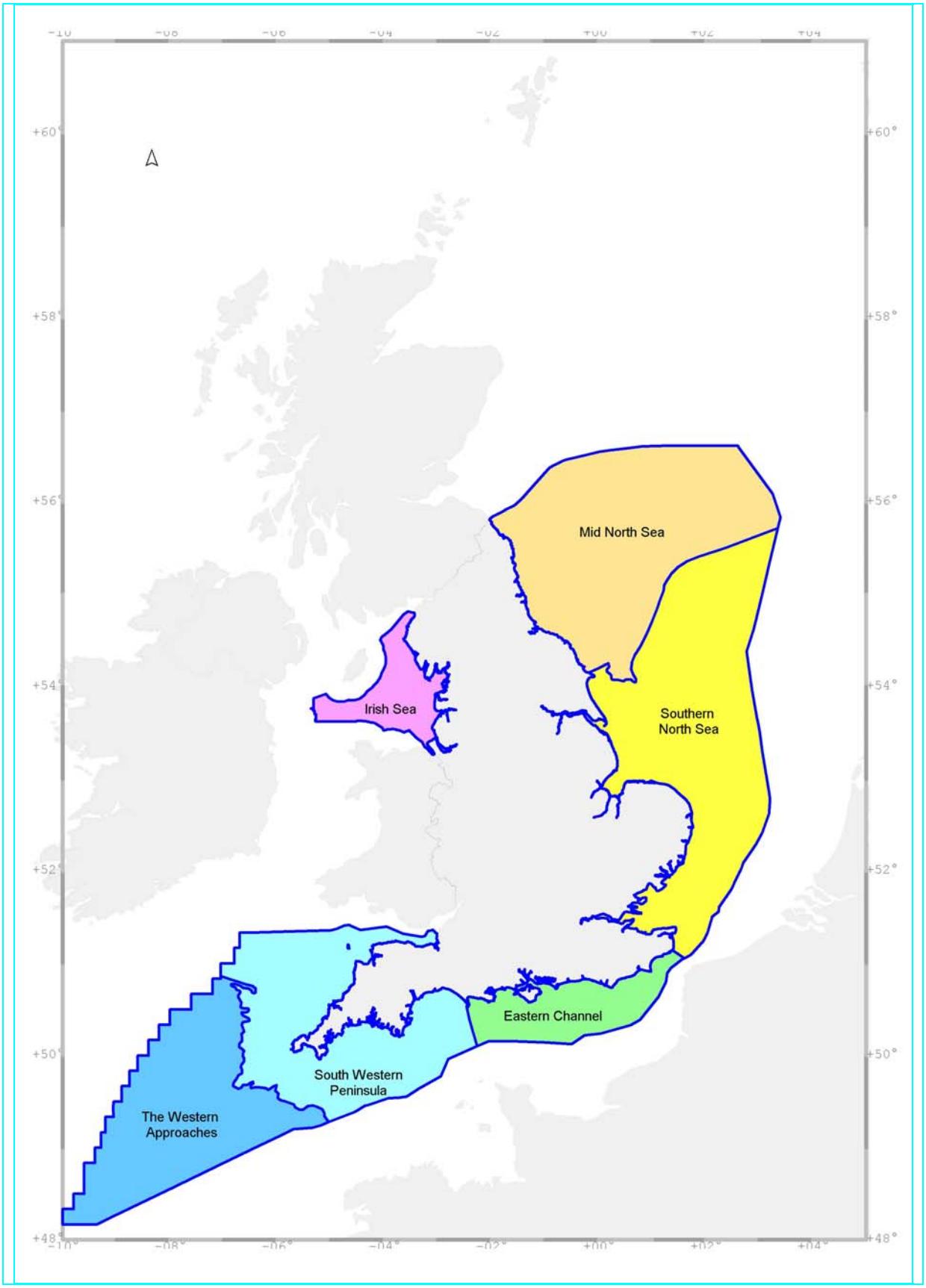


Figure 1.1 The six Marine Natural Areas around England.

2. General summary

The Southern North Sea Marine Natural Area extends from the 50 metre isobath at Flamborough Head southwards to the Dover Strait (Figure 2.1). The northern boundary follows the offshore frontal system (the 'Flamborough Front'), which results in a distinct temperature gradient between the waters to the north and south of Flamborough Head. The southern boundary of the Southern North Sea lies at the narrowest section of the Strait that divides the southern North Sea from the English Channel. The inshore boundary is the Mean Low Water (MLW) and the offshore boundary is at the limit of UK jurisdiction. The area above MLW is within English Nature's coastal series of Natural Areas, the boundaries of which are shown in Figure 2.1.

This Natural Area occurs within the Boreal biogeographic region (Dinter 2001). The biogeographical conditions of the Southern North Sea reflect the movement of water through the Dover Strait, with water from the English Channel providing some of the highest temperatures found throughout England's seas.

The seabed here is largely composed of mixed sand and gravel sediments. In some areas these habitats are nationally and internationally important and are protected under the EC Habitats Directive. There is also a UK Biodiversity Action Plan for sublittoral sands and gravels. Areas of chalk substrata present within the Natural Area meet the definition of a reef listed in the EC's Habitats Directive. A Biodiversity Action Plan has also been prepared for Littoral and sublittoral chalk reefs.

Many important species occur within the Natural Area and these include a number of species covered by the UK Biodiversity Action Plan. There is a grouped Action Plan for commercial marine fish, baleen whales and small dolphins. There is also a plan for harbour porpoise and *Sabellaria spinulosa* reefs.

The main commercial activities in the Southern North Sea are fisheries, gas exploration and aggregate extraction. The main species targeted by fisheries are cod, sole, herring, plaice and sprat (Barne *et al* 1995, 1998). Shipping is also widespread, with several major ports in the Area. There is significant interest in offshore wind development in this area.

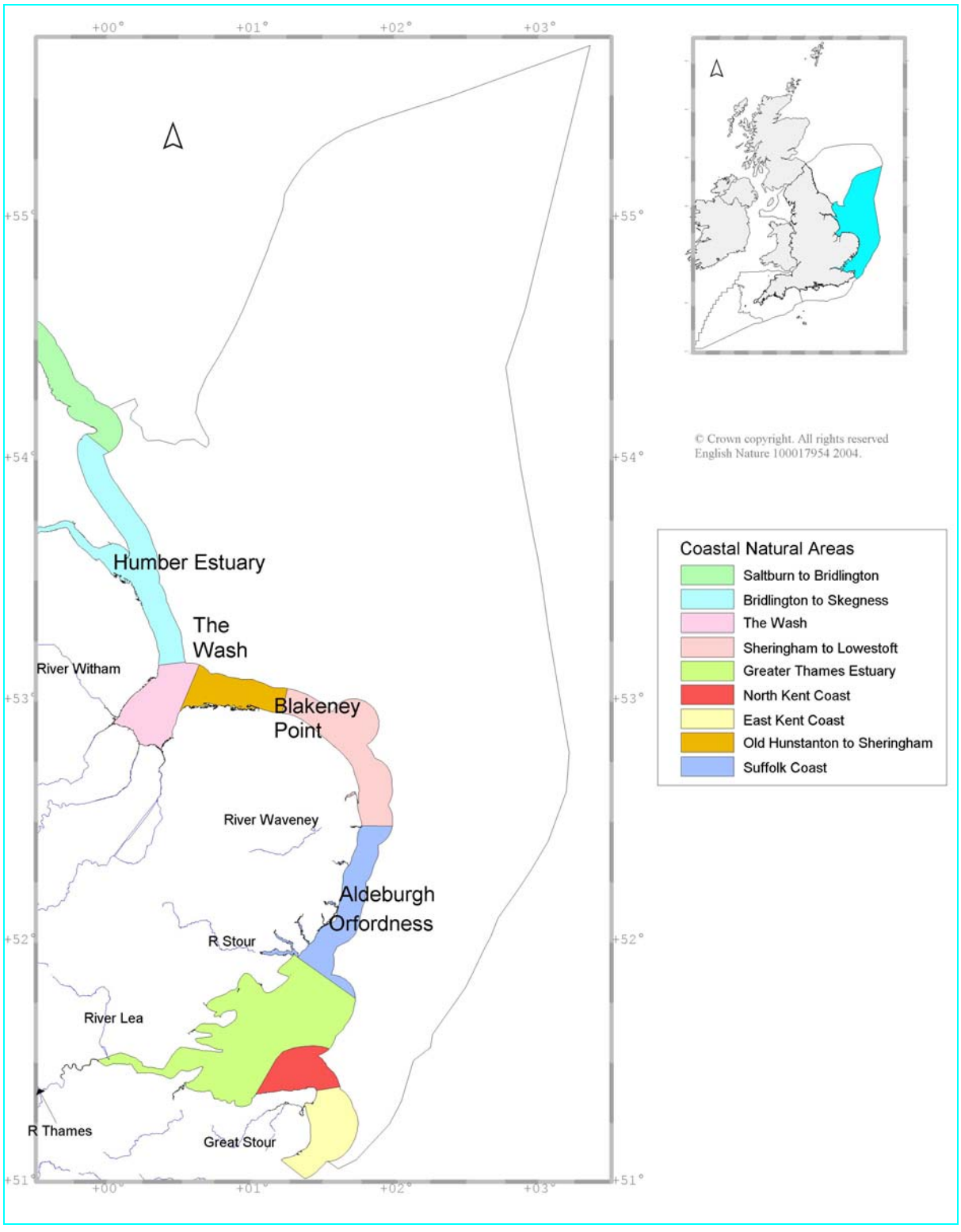


Figure 2.1 Southern North Sea Marine Natural Area, adjacent coastal Natural Areas and places mentioned in the text.

3. Physical environment and character of the 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 influences the morphology of the seafloor, the distribution of seafloor sediments, and the distribution of many of the associated habitats. Together, 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 seafloor topography and sediments. Given the complex geology of the Natural Area, the description given below is necessarily brief.

The bedrock underlying the Quaternary sediments in the Southern North Sea Natural Area ranges from the Permian (286 to 248 million years ago) to the Pliocene (5.1 million years ago to 1.6 million years ago). Rocks of Carboniferous age, including Coal Measures, are present at depth to the north of the North Norfolk coast, where they form the main source of natural gas in the southern North Sea. In the south of the Natural Area, rocks of Cretaceous age rest directly upon Lower Palaeozoic layers, forming the Anglo-Brabant Massif. Generally, the oldest rocks are at or near the seafloor in the west, whilst younger, Palaeogene and Neogene rocks are found across the eastern part of the area. These outcrop onshore in East Anglia. Offshore, they are largely buried underneath Pleistocene (1.6 million years to 10 thousand years ago) sediments that reach a depth of 0.5 kilometres in the north east of the area. The nature of the sediments and the fossils found in these rocks is evidence of a complex history. The Natural Area has at various times been a tropical sea, a tropical forest, an enclosed evaporating sea, a desert and a river delta.

Structurally, the Natural Area consists of three main units: the Anglo-Brabant Massif in the south; the East Midlands Shelf; and an area of structural highs in the west and north west. These units are separated by arrays of faults (eg the Dowsing Fault zone) that are associated with such structures as the Sole Pit Trough and the Anglo Dutch Basin. At times these structures have formed the focus for the accumulation of a great thickness of sediment. But at other times, they have been uplifted and acted as sediment sources. Permian and Triassic evaporite (salt) deposits have been mobilised to form salt domes or diapirs that have pierced rocks layers as young as the Pleistocene.

Bedrock is rarely exposed on the seafloor as it is largely buried under Pleistocene and Holocene sediments. Where bedrock is exposed it is often chalk. Submerged chalk platforms are present off part of the north Norfolk and north and east Kent coasts.

Most of the seafloor in the Natural Area consists of clays, silts, sands and gravels (Figure 3.1) that are Pleistocene or younger in age. The oldest of these rocks are marine and estuarine sediments from rivers that once extended further north into the North Sea. Resting upon these are marine, estuarine and glacial sediments. These underlie much of the modern floor of the North Sea at least as far south as southern East Anglia. With the exception of the area now forming the Dogger Bank, glaciers extended as far south as the Wash during the last major ice advance. The area to the south (as far as the straits of Dover) formed dry land and at that time the Rhine flowed into the English Channel. Thus, the raised area forming the Dogger Bank consists largely of glacial outwash deposits that have resisted erosion during the Holocene. Stiff boulder clays underlie the glaciated areas. Depressions in the sea floor (eg Silver Pit and Sole Pit) were probably scoured out by glacial meltwater.

The sediments reworked from these deposits form much of the modern seafloor and their distribution is largely influenced by the present shape and topography of the floor of the North Sea. Although the pattern of the reworked sediments is a key factor controlling the distribution of benthic habitats, they have masked the influence of the deeper geology on habitat distribution. However, Pleistocene and Holocene events have influenced the distribution of habitats - as the two examples below illustrate.

As mentioned above, The Dogger Bank is formed of glacial outwash deposits as opposed to the boulder clays that are found in this part of the North Sea. These well-bedded deposits have resisted erosion, so the bank forms a raised feature that influences the convergence and mixing of Atlantic water and residual flows from the English Channel. Sand waves are a conspicuous feature over much of the southern North Sea. Those in deeper water are relict, and formed as sea-level rose after the last glaciation. They are no longer mobile and may host habitats different to those on the mobile, more inshore sand waves.

3.2 Bathymetry

Water depth varies considerably within this Natural Area. Much of the inshore part of the area has shallow water, rarely exceeding 10 metres in depth. Off the north east Kent coast, the 20 metre isobath marks the limit of the Outer Thames Estuary banks that run parallel with the shore (see Figure 3.3). The elongate depression of the Silver Pit, north-east of the Wash, extends seaward into the broad area of relatively flat seafloor. In the north-east of the region water depths exceed 80 metres from Skate Hole to the Outer Silver Pit. Water depths around the Dogger Bank (falling within UK waters) do not exceed 20 metres. In the Dover Strait, water depths increase from the coats of England and France to more than 40 metres in the centre of the Strait.

3.3 Tidal currents and range

The tidal currents in the Southern North Sea flood southwards and ebb northwards. To the north of the Natural Area, the maximum tidal current increases southwards, from approximately 1 knot in the north to 3 knots in the south. The tidal range follows a similar pattern, increasing from 2 metres in the north to 5 metres in the south. For a variety of reasons (see Pugh 1987) there are higher high tides and lower low tides than might otherwise be expected, resulting in tidal ranges being greater than those elsewhere in the North Sea.

In the south, tidal current speeds in the eastern English Channel increase in the Straits of Dover, owing to the restriction of the channel and the presence of tidal sand ridges aligned

with the direction of flow. The maximum speed of tidal streams at Dover is about 1.75 metres per second. As greatest tidal ranges tend to occur in narrow channels, it is not unusual for the range to reach 7.0 metres in the Dover Straits and the English Channel.

Low atmospheric pressure may raise the water level in this Natural Area, with dramatic effects. This especially occurs when low pressure is associated with northerly winds that force water into the narrowing funnel of the southern North Sea. Tidal ranges may be up to 30% greater during gales. The resulting extremely high tide levels, which increase in height from north to south, are known as surges. During surges, high water levels may be sustained for periods of up to several hours.

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 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.

The whole of the North Sea coastal margin contains widespread evidence of sea-level changes, reflecting the combined effects of both isostatic and eustatic controls. The most detailed information is available for changes during and since the retreat of the last ice sheet (about 18,000 - 10,000 years before present). However, older interglacial changes have been recorded from a few sites, notably on the east coast of England.

Geological evidence for sea-level change in the past may be found in fossil coastlines (raised beaches, etc) on or inland from the present shorelines, or in peat and alluvial gravels on or below the sea floor. Multiple or individual raised beaches, ie former beaches which are now higher than the present shoreline or platforms, may form a stepped or staircase profile to the coast. These features are higher than their modern equivalents, implying a higher sea level during their formation. On the coast of East Anglia Holocene sea-level changes are widely recorded in the sediments buried along the coast, most notably in the Essex chenier plane, the Fens, along the north Norfolk coast, in the Broads area, and at Orfordness.

There is also evidence for shoreline change in deposits below present sea-level. This indicates where coasts have been submerged since the sediments were laid down. Intertidal peat beds exposed on the coast of eastern England, for example at Chapel Point, indicate that there was a lower sea level at about the mid-Holocene time.

It has been suggested by Cannell *et al* (1999) that at Lowestoft, mean sea level increased by 1.55 (± 0.53) millimetres per year over the period 1960-1996. This is a significant upward trend.

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 IPPC have predicted that mean sea level would rise by 48 centremeters 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. Several areas along the coastline of this Natural Area, in particular around the Wash, Norfolk and Suffolk,could be at risk of flooding due to a combination of sea level rise and increased storminess.. The gradual rise in sea level could have serious implications for a number of important coastal wildlife habitats. 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 (Lee 1998). A good source of further information is the Proudman Oceanographic Laboratory website (**www.pol.ac.uk/ntslf/reports**).

3.5 Water temperature

In winter, the waters in the north of the Natural Area are some of the coldest areas of the UK, however sea-surface temperatures increase southwards (from 5 to 7 ^{o}C) in February. This is a result of a wedge of relatively warm water extending up from the English Channel which prevents water temperatures dropping below 5 ^{o}C. In August, temperatures increase progressively to the south (from 14 to 16.5 ^{o}C), reflecting increased proximity to the warm European landmass. The waters here are also well mixed at that time of year and show no stratification, whereas in the north of the Natural Area, bottom temperatures are 2-3^{o}C lower than the surface temperatures.

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 seawater this Natural Area is relatively uniform except in the coastal zone between the Humber Estuary and the Wash. Here the salinity is on average lower (34). Where the tide flows into and out of the Wash and the Humber mixing of saline water with

freshwater occurs. In both summer and winter, salinity increases southwards down the coast of East Anglia from less than 34.2 to 34.75.

3.7 Water quality

About 80% of marine pollution comes from a variety of land-based activities (Defra 2002a). Most pollutants enter the Southern North 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 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 mostly influenced by the presence of Suspended Particulate Matter (SPM), 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.

Plankton species found in the waters of this Natural Area are mostly neritic (in coastal waters), resulting in high concentrations being found inshore (Adams 1987). Diatoms, which 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.

3.7.2 Non-toxic contaminants

3.7.2.1 Organic matter

Organic matter can enter the Southern North Sea through externally and internally derived sources. External inputs of organic matter include point discharges of sewage and industrial effluents, and from diffuse sources such as agricultural run-off. However, in common with most land-based sources of pollution, the effects from these inputs are more noticeable in estuaries and near-shore areas and are unlikely to be detected in offshore locations within this Natural Area. Organic matter can enter the marine environment in both dissolved and particulate form. 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 the 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 the basis for primary productivity. Nitrogen and phosphorus enter the Southern North 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. For example 98% of the nitrate load and 90% of the orthophosphate load

into the Humber estuary is derived from riverine sources (Environment Agency 1993). In nutrient-poor waters, atmospheric deposition of nitrogen can be a significant source of this nutrient. Silicon, essential for the growth of diatoms but of less importance for other marine organisms, enters the North Sea predominantly via rivers.

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. These effects are more likely to be observed in estuaries and nearshore areas.

Work has been conducted on modelling dissolved nitrogen budgets in the Southern North Sea (Hydes *et al* 1997). These studies have indicated that that algal production is mostly influenced by internal nutrient cycling rather than external inputs; the area is an overall sink for nitrogen; and that the light climate is more important in limiting production than supply of nitrogen.

Improvements to sewage treatment under the Urban Waste Water Treatment Directive is likely to reduce some point sources of nitrate, but there will still be a considerable input from diffuse sources. The Nitrates Directive (91/676/EC) was implemented to provide some controls on nitrate from diffuse agricultural sources. The Directive requires Member States to designate Nitrate Vulnerable Zones (NVZs), and to produce action programmes for reducing 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 substances

3.7.3.1 Oil

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

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 these substances have been banned. Now, alternative oil-based drilling fluids can only be used if the oil on the cutting is less than 1%. Waste is shipped ashore for disposal or re-injected, which reduces discharges to the marine environment. There may also be contaminated water discharges emanating from oil and gas producing installations.

3.7.3.2 Trace metals

Trace metals reach the Southern North Sea predominantly via rivers, direct discharges and from some sea-based activities, such as exploitation of offshore resources and dumping of dredged materials. Highest concentrations of trace metals are found near freshwater outlets, with much lower levels in the open sea.

Factors controlling the distribution of trace metals in this Natural Area are likely to include water circulation patterns and levels of SPM. CEFAS (1998) reported that trace metals in general (with the exception of lead) are higher in this Natural Area than in the northern North Sea. This is due to the river inputs from eastern Britain being carried south, hence dissolved metals are more concentrated in this area. CEFAS noted that lead concentrations are more influenced b SPM levels due to its particle reactivity, and high levels of SPM can remove lead from the water column. Therefore in turbid estuaries, lead can be removed from the water column and not transported by circulatory patterns. In the North Sea overall, mean concentrations of cadmium and lead have decreased compared with 1982-1985 and 1986-1990 levels (OSPAR Commission 2000). This reflects a significant reduction in the input of heavy metals from trade and domestic effluents. The North Sea overall has higher concentrations than the English Channel, as a result of land based inputs (CEFAS 1998).

Like lead, some metals show a strong affinity for particulates and will accumulate in sediments that may subsequently accumulate up the food chain. Monitoring for the National Monitoring Programme (NMP) between 1992 and 1995 found higher concentrations of metals in sediments at estuarine sites than at offshore sites (Marine Pollution Monitoring Management Group 1998).

CEFAS have monitored mercury in commercial fish species since the 1970s and detected high concentrations in the outer Thames estuary, where there had been significant inputs from sewage sludge disposal. Monitoring ceased here in 1985 when concentrations were lower than a newly derived an Environmental Quality Standard (CEFAS 2001a).

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 harmful effect on molluscs such as dogwhelks and oysters. But, it is still commonly used on ships longer than 25 metres. These vessels still act as a major input source of TBT to the marine environment. TBT concentrations in offshore waters are generally less than 1 µg/l when compared with values recorded up to 100 µg/l in frequently used waterways. The current Environmental Quality Standard for tributyltin in seawater is 2 µg/l (Cole *et al* 1999). Thomas *et al* (2000) could not detect TBT in sediments off Dogger Bank (<0.002 µg/g), and concluded that there would be little accumulation of TBT in offshore sediments. However, TBT has been detected in the tissue of pelagic cetaceans For example, CEFAS (2001a)

reported a concentration of 38 µg/kg in the liver of a white-beaked dolphin found in Sizewell, Suffolk in 1995.

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. A study assessing the flux of PCBs into the North Sea around The Wash and the Humber Estuary highlighted that the dominant source of PCBs into this area was from the Humber Plume, with little contribution from The Wash (Klamer and Fomsgaard 1993). This illustrates the industrial history of the Humber. 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.

Concentrations in sediment and biota are markedly higher in near-shore areas than the open sea. For example, CEFAS (1998) found concentrations of PCBs in offshore sediment within this Natural Area ranging from <0.04 to 2.79 µg/kg. According to concentration guidelines defined by Wells *et al* (1989), these sediments are classified as "contamination not detected" and "slightly contaminated". These concentrations are lower than that of dredged sediment taken from UK estuaries, which typically contain 10s of µg/kg (CEFAS 2001a). CEFAS (1998) reported the bioaccumulation of PCBs in dab (*Limanda limanda*) liver with levels of between 0.07 and 0.28 mg/kg in fish collected from offshore stations within this Natural Area.

Polycyclic aromatic hydrocarbons (PAHs)

PAHs are formed during the incomplete combustion of fossil fuel, and are also components of petroleum products. They can enter the Southern North Sea via industrial and sewage discharges, surface run-off, atmospheric deposition and oil spills. The MPMMG (1998) found that highest concentrations of PAHs in the water column were in estuaries including the Humber, Great Ouse, and Thames (with total PAH concentrations >1µg/l). At sites further offshore, PAHs were undetectable. Like PCBs, most PAHs can accumulate in sediments and may accumulate up the food chain. CEFAS (1998) reported concentrations in

[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 organotin compounds as biocides.

sediments collected within the Natural Area ranged from PAH of 38 to 753 µg/kg, compared with concentrations over 5,000 µg/kg in sediments from the Thames and Humber estuaries.

3.7.3.4 Endocrine disrupters

Some contaminants can act as endocrine (hormone) 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 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.

Although the effects of endocrine disrupters tend to be greater in estuaries, less severe oestrogenic effects have been observed in offshore flounder *Platichthys flesus* in the Southern Bight of the North Sea (off Holland) (Allen *et al* 1997). The effects on the offshore spawning populations of flounder are likely to be due to exposure to oestrogenic compounds in estuaries. However, the possibility of contamination in the open sea cannot be excluded.

A recent report on Endocrine Disruption in the Marine Environment (Defra 2002b) details the findings of a £1.5 million three-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

Radioactivity has both natural and man-made sources. Inputs natural radionuclides to the Southern North Sea are mainly from phosphate fertiliser production but mining, ore processing, burning coal, oil and natural gas also contribute (OSPAR Commission 2000). Artificial radionuclides in the Southern North Sea originate from the nuclear fuel reprocessing plants at Sellafield and Cap de la Hague. Although no data is available specifically for this Natural Area, overall the levels observed for the North Sea as a whole have decreased in recent years (OSPAR Commission 2000).

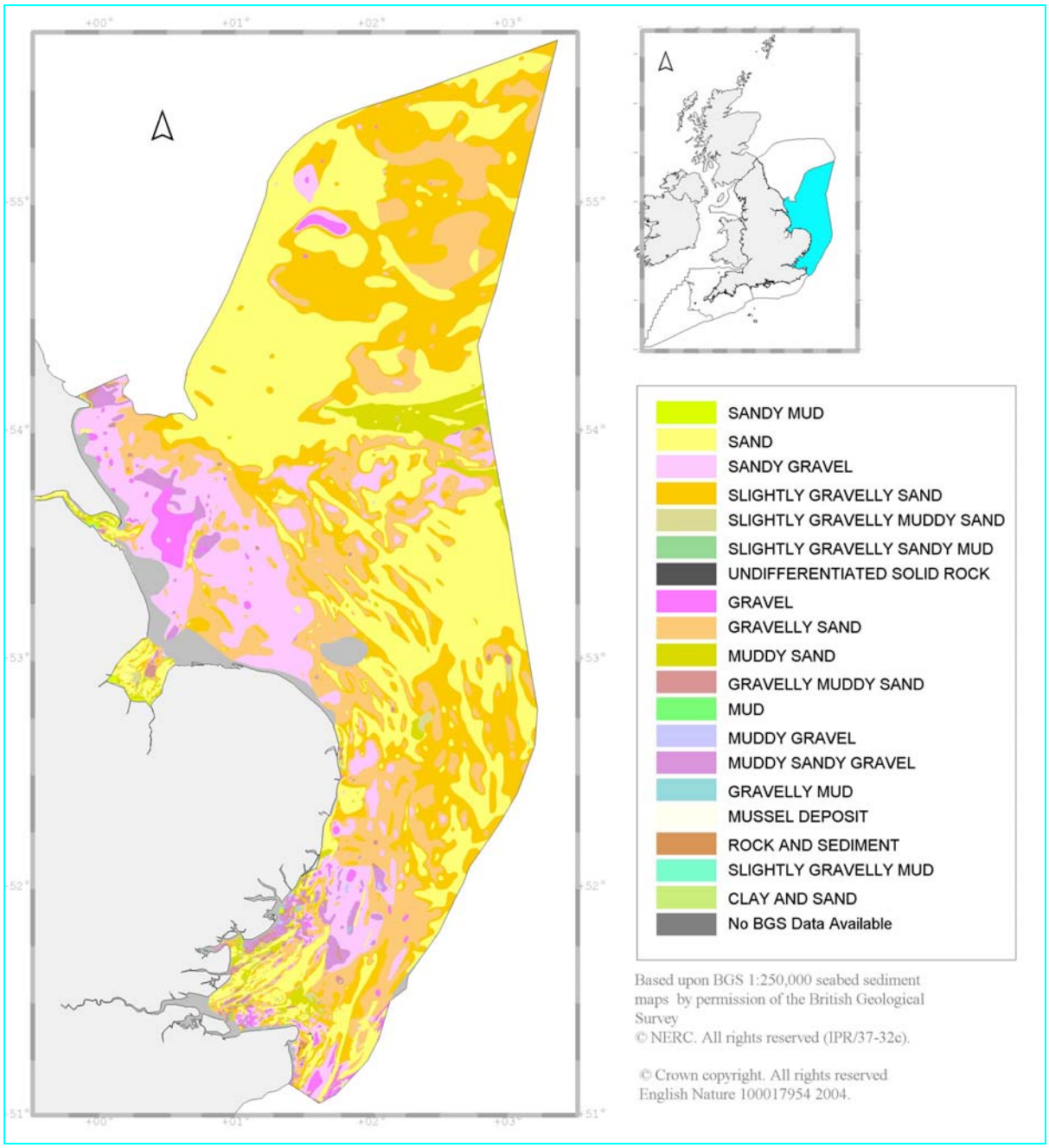


Figure 3.1 Seabed sediments of Southern North Sea Natural Area (taken from Poulton *et al* 2002). See Figure 3.2 for definitions of sediments.

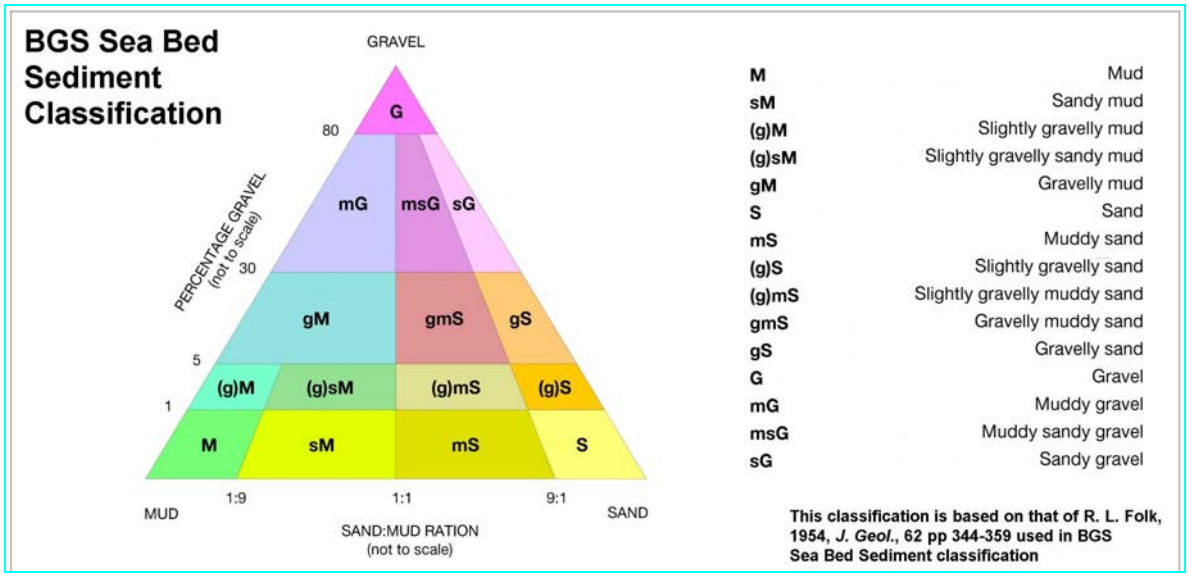


Figure 3.2 British Geological Survey seabed sediment classification taken from Poulton *et al* (2002)

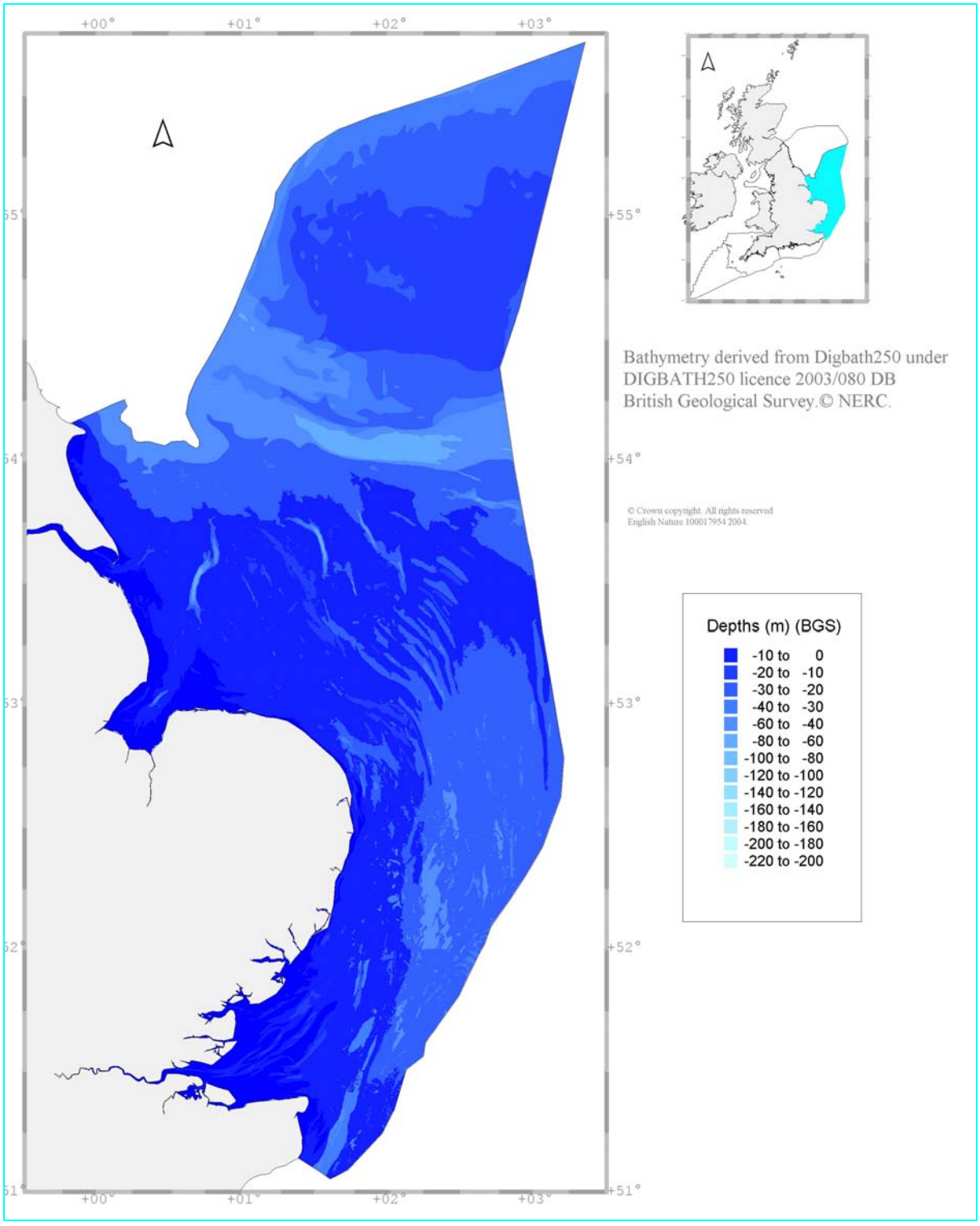


Figure 3.3 Bathymetry of the Southern North Sea Natural Area.

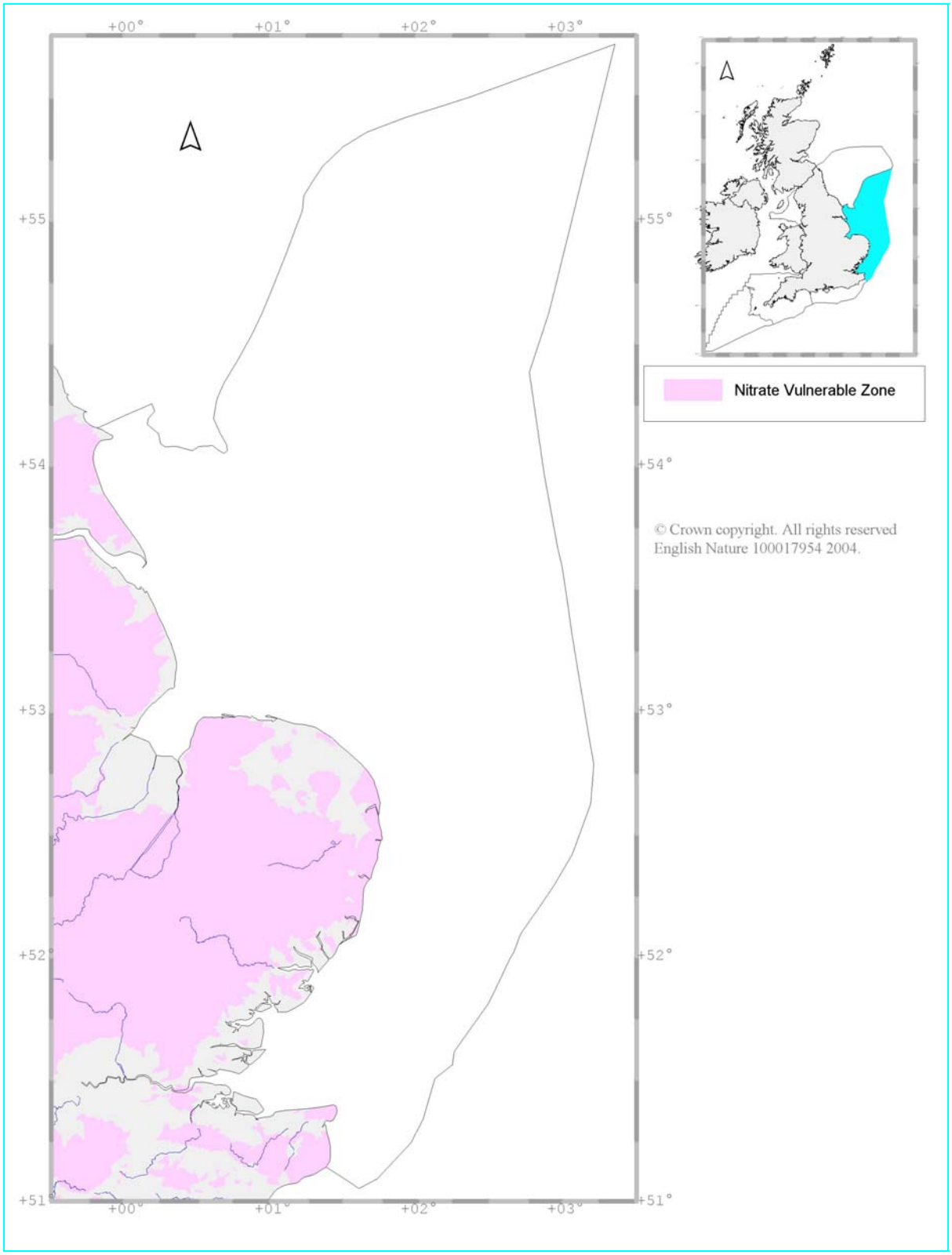


Figure 3.4 The distribution of Nitrate Vulnerable Zones (NVZ) adjacent to this Natural Area (map provided by Defra).

4. Key habitats

This section describes the main habitats in the Southern North 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 4.2 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 waters of this Natural Area are largely influenced by the North East Atlantic. Surface currents (moving at approximately 2½ kilometres per day, Lee and Ramster 1981), sweep relatively warm water northwards around the west coast of Scotland, through the Pentland Firth (between Orkney and the mainland), and then southwards along the east coast of Scotland. By the time it reaches this Natural Area, it has become mixed with North Sea water (the movement of which is variable and wind-driven) and south-flowing, colder water from Shetland.

Plankton (both phytoplankton and zoo plankton) provide a fundamental role in the food chain of pelagic (oceanic) wildlife. 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 (Edwards and John 1995). The abundance of plankton is strongly influenced by factors such as depth, tidal mixing and temperature stratification, all of which determine the vertical stability of the water column. The distribution of planktonic species is influenced directly by salinity and temperature, by water flows in the area and by the presence of local seabed communities.

Plankton blooms begin well offshore in March, when nutrient levels are high, the amount of daylight increases and the seawater gradually warms. Within this Natural Area blooms are dominated by diatoms, which spread westwards throughout the Natural Area by April. After the diatom peak , dinoflagellates (*Ceratium lineatum* and *Dinophysis norvegica*) become predominant during summer in near-shore areas (Edwards and John 1995). Diatoms tend to predominate in inshore mixed waters, while dinoflagellates are more often found in stratified offshore waters during the summer and autumn.

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 common feature of the North 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 10–30 metres, typically getting progressively deeper from May to September as surface water temperatures increase.

One of the most distinct fronts in the North Sea, 'the Flamborough Front', forms the northern boundary to this Natural Area. This front occurs between the deeper waters to the north and the vertically mixed waters to the south of Flamborough Head which are permanently mixed. 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.

4.1.2 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 Southern North Sea Natural Area are defined by the substrata of the seabed. Within the Natural Area the seabed is composed predominantly of sandy gravel closer to the shore, whereas further offshore the sediment is mainly sand with patches of gravel, sandy mud and sandy gravel (see Figure 3.1).

As a result of this mosaic of different sediment types, there is 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 scale divides the Folk classes into smaller fractions) (see Appendix 3). The habitats below are described using a modified version of the Folk classification, since more detailed information of the seabed sediments is currently unavailable for the whole of this 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.

The JNCC have developed the Marine Nature Conservation Review (MNCR) biotope classification system[5] (Connor *et al* 1997) 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.

4.2.1 Gravel habitats

The particle structure of these habitats ranges from various combinations of sand and gravel to pure gravel (Figure 4.1). 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 low water mark around the coast of the UK (UK Biodiversity Group, 1999). North Sea sands and gravels tend to be formed from rock material, although shell fragments and whole shells may form 30% or more of the gravel sediment off the coast of Suffolk.

Towards the southern end of this Natural Area a discontinuous belt of gravel and sandy gravel extends offshore from Aldeburgh in Suffolk to the vicinity of Clacton-on-Sea in Essex. To the north of the area many of these sediments generally form a surface layer less than 1 metre thick, with the underlying glacial deposits or bedrock often exposed locally.

The gravel habitats found in deeper offshore areas (>30 metres) generally tend to be less perturbed by natural disturbance than those found closer inshore. These areas also tend to support a diverse marine fauna which may include a wide range of anemones, polychaetes, bivalves and amphipods, and both mobile and sessile epifauna. Kingston and Rachor (1982), in defining the major macrofaunal communities of the North Sea, identified the mixed sand and gravel areas as being characterised by *Venus* bivalve communities. Of the biotopes identified in the MNCR biotope classification scheme (Connor *et al* 1997), several may be found in the gravel substrata in this Natural Area (see table 4.1).

4.2.1.1 Nature conservation measures

Gravel habitats are covered by a priority Habitat Action Plan[6] for sublittoral sands and gravels (UK Biodiversity Group 1999).

However, gravel habitats are not protected 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). Some gravel habitat may meet the definition of 'Reefs' under the

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

[6] A Habitat Action Plan is a document which describes the current status of a particular habitat, gives costs and targets for its restoration, management or creation, and is endorsed by the UK Biodiversity Group

Directive, where they are predominantly composed of boulders and cobbles, since these are stable and 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 UK coast. Work is underway to identify offshore sites both in offshore waters, ie beyond 12 nautical miles (see Johnston *et al* 2002), and potentially in English territorial waters. Preliminary work has been undertaken to derive areas of seabed which contain qualifying habitat. Within this Natural Area such areas could include 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 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 4.2 for a summary of the conservation measures.

4.2.2 Sand habitats

Sand habitats are widespread throughout this Natural Area and are the dominant habitat type found in the North Sea (Figure 4.2). They tend to be mobile but accumulate in areas of moderate to strong tidal currents. In such situations the sands are coarse and clean with little silt/mud.

More mobile sand habitats tend to be characterised by robust and sometimes impoverished faunas, dominated by organisms which are capable of rapid burrowing, such as certain mobile polychaete worms and thick-shelled bivalves.

Within the areas of sand that dominate the region in the middle section of the Natural Area are a series of sandbanks and tidal sand ridges (see Figure 4.4). Many tidal sandbanks are more or less of straight linear form but some are strongly V- or S ~ shaped in plan view. The complex sandbanks are thought to be related to systems of ebb or flood dominant channels. The straighter banks are approximately parallel to the peak tidal flow, but can lie at an angle of as much as 20^{o} to this direction (Lee & Ramster 1981). One side of the bank may be steeper than the other, and this steeper side faces the direction of transport. Tidal sandbanks can be active or moribund forms. The latter are found in areas where the present-day tidal currents are weak (less than 1 knot near the sea surface) and are thought to be relict features. These older banks were probably formed largely after the end of the last glacial period, but before sea level reached its present height.

Sandbanks are also found inshore in this Natural Area, generally in shallow water. The communities they support are determined by the sediment type and a variety of other physical factors, including geographical location, the relative exposure of the coast and differences in the depth, turbidity and salinity of the surrounding water. .

Sandy sediments occupy most of the subtidal area of The Wash and North Norfolk coast, resulting in one of the largest expanses of this habitat type in the UK (English Nature 2000b). The subtidal sandbanks vary in composition and include coarse sand through to mixed sediments at the mouth of the embayment. Subtidal communities include large areas of dense

brittle star *Ophiothrix fragilis* beds. Species include polychaete worms such as the sand mason worm *Lanice conchilega,* and the bivalve tellin *Angulus tenuis*. Seabed communities on sandflats in the deeper, central part of The Wash are particularly diverse. The sublittoral sandbanks also provide important nursery grounds for young commercial fish species, including plaice *Pleuronectes platessa*, cod *Gadus morhua* and sole *Solea solea* (Brown *et al* 1997). Within The Wash and North Norfolk candidate Special Area of Conservation (SAC), muddy sand habitats are characterised by very dense aggregations of the brittlestars *Ophiura ophiura* and *Ophiura albida.* This site is unique in that these two species are not found together in a brittlestar bed in any other SAC (English Nature 2000b). In areas of silty fine sands, such as those found in the Boston Deeps, the sand community is characteristically rich and includes the bivalve mollusc *Abra alba*, bristleworms *Scoloplos armiger* and *Spiophanes bombyx*, brittlestars *O. ophiura* and *O. albida*, and sometimes dense populations of the peacock worm *Sabella pavonia*.

In tide-swept areas mobile, rippled sand with occasional cobbles and pebbles are characterised by colonies of the hydroid *Hydrallmania falcate.* These grow on the stones and are tolerant of periodic burial in the shifting sands. The infaunal component usually consists of spionid worms and deposit-feeders. Such tide-swept shallow areas have dense beds of the sand mason worm *Lanice conchilega* (which further stabilises the sediment) with other polychaetes such as *Scoloplos armiger* and *Chaetozone setosa*.

The largest offshore sandbank within this Natural Area is the Dogger Bank, which is an extensive, flat sandbank with an average breadth of 64 kilometres and is approximately 257 kilometres long. The Bank straddles the Natural Area boundary and, although the water is generally about 37 metres deep across the bank, within the Natural Area the water depth is little more than 15 metres. The Dogger Bank has been a commercial fishing ground for centuries, with cod, plaice and herring being especially abundant. To the south of the Natural Area the Norfolk Banks, composed of sand-rich sediments, attain a maximum thickness of about 40 metres.

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 which are 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. The Wash and North Norfolk SAC (Figure 4.3) includes 'sandbanks which are slightly covered by seawater all the time' as an interest feature. The Habitats Directive also includes the habitat 'Large shallow inlets and bays' which can encompass areas of sand habitat. This is again an interest feature of the Wash and North Norfolk SAC. See table 4.2 for a summary of the conservation measures.

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.

4.2.3 Mud habitats (including muddy gravel)

The presence of mud mixed in with other sediment types usually indicates an area of relative shelter from wave exposure or from tidal currents. It is under such conditions that silt can settle onto the seafloor and become incorporated into the sediments. Because of the exposed nature of much of this Natural Area, few areas of mud-dominated sediment can be found except in deeper water such as in 'troughs' or 'deeps'(Figure 4.4). Polychaete worms, bivalve molluscs and brittlestars often dominate the fauna of muddy sediments.

The JNCC Marine Nature Conservation Review (MNCR) biotope classification scheme (Connor *et al* 1997) identifies a number of biotopes which may be found in association with the small area of mud habitat in this Natural Area (see Table 4.1).

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', an interest feature of the Wash and North Norfolk SAC. See also Table 4.2.

4.2.4 Rock habitats

Rock habitats include exposed areas of bedrock, which have a flat profile or rise from 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 chalk, limestone or sandstone also have an effect on biotope type.

4.2.4.1 Reefs

The term reef is generally used to refer to an area of rock habitat that arises from the surrounding seabed, although it has a specific definition under the Habitats Directive. The communities that are found on reefs and reef-like habitats depend on a number of factors including the rock type, depth, exposure to wave action and tidal streams, and turbidity. In shallow water, light intensity is sufficient to allow for the growth of dense forests of kelp. In deeper water, where light intensity is lower, communities become animal- dominated, often with turfs of bryozoans and hydroids, sponges and sea squirts. The only rocky reefs of note in this Natural Area comprise of chalk.

Chalk reefs occur at two locations within the Southern North Sea Natural Area, in the south within the Thanet coast Special Area of Conservation (SAC), and in the north within the Flamborough Head SAC (see Figure 4.3). Only 1 % of the British coastline is composed of chalk, yet this represents 75 % of the chalk reefs in Europe (Brown *et al* 1997). Of the 75%, Thanet comprises 12% and Flamborough Head 9 %. The chalk found at Thanet is typically quite soft and easily bored by animals, whereas the chalk at Flamborough Head is notably different in being particularly hard, due to compression by overlying rocks and by glaciation.

Chalk reef habitats characteristically support a wide range of species, some of which are unique to this type of substrata. Subtidal chalk at Thanet is bored by piddocks *Barnea* spp., *Pholas dactylus*, *Hiatella artica* and *Petricola pholadiformis* (English Nature 2000c). This piddock-dominated habitat is the most widespread biotope on the subtidal reef and is considered to be scarce in Britain. The chalk reefs at Flamborough support kelp *Laminaria hyperborea* forests with an associated fauna that typically colonises the holdfasts. These kelp communities are considered to be a key structural and functional component of the chalk reefs at Flamborough Head (English Nature 2000a). The chalk reefs at Flamborough also support a variety of faunal 'turf' communities. They range from low encrusting forms, such as sea mats and sponges, to tall erect forms, such as soft corals and sea fans, plus mobile organisms such as crustaceans, echinoderms, molluscs and fish.

The JNCC Marine Nature Conservation Review (MNCR) biotope classification scheme (Connor *et al* 1997) has identified a number of biotopes which are associated with rocky habitats in this Natural Area (See Table 4.1.)

4.2.4.2 Sea caves

The UK has the most varied and extensive sea caves on the Atlantic coast of Europe (Brown *et al* 1997). Caves can vary in extent, from only a few metres to more extensive systems that extend several tens of metres into the rock. There may be tunnels or caverns with one or more entrance, in which the vertical and overhanging rock faces provide the principal habitat. Sea cave communities vary considerably depending on the structure and extent of the cave system, their degree of submergence and of exposure to scour and surge, and the nature of the geology. Caves are typically colonised by encrusting animal species but may also support shade-tolerant algae near their entrances.

There are larger numbers and a wider range of cave habitats at Flamborough Head candidate Special Area of Conservation (cSAC) than at any other chalk site in Britain (Brown *et al* 1997). Over 200 caves (Howson 2000) have been recorded at Flamborough Head, though not all are within the boundary of this Natural Area as they occur above Mean Low Water. In this situation the caves have formed from weaknesses in the rock in the chalk which has been exposed to wave action. Specialist plant and animal communities become attached to the chalk, some of which are unique to this substrata. Because this rock type is rare on the coast these specialists species are also rarely found, making them of high conservation value. Flamborough Head cSAC is particularly important for its specialised encrusting and filamentous algal communities which include *Hildenbrandia rubra*, *Pseudendoclonium submarinum*, *Sphacelaria nana* and *Waerniellina lucifuga* (George *et al* 1988). The bedrock floors of the caves in this Area are characterised by abundant *Sabellaria alveolata* and sponges such as *Leucosolenia* spp. or the chalk-boring yellow sponge *Cliona celata* and *Polydora* spp. worms, characteristic of the chalk habitats.

There are a significant number of caves of nature conservation importance in Thanet, although the majority of caves are above the mean low water mark and are therefore outside the boundaries of this Natural Area.

4.2.4.3 Nature conservation measures

There is a priority Habitat Action Plan for Littoral and sublittoral chalk habitats. The Habitats Directive includes two rock habitat types for which SACs can be designated: 'Reef' and or 'Submerged or partially submerged seacaves'. Within the Southern North Sea there are two sites where sea caves are a feature of interest under the Habitats Directive, namely the Thanet Coast and Flamborough Head candidate SACs.

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 could include scattered areas of bedrock shown in Figure 3.1. Further work is being undertaken to verify and refine these areas, eg to identify reef or reef-like habitat within rocky 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.

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 to bare flat bedrock. In this section, a small number of biogenic habitats are highlighted. 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 their classification 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 animals such as the ross worm *Sabellaria* spp can be associated with a range of habitats such as gravel, pebbles and cobbles, and bedrock. The most notable biogenic habitats in this Natural Area are reefs.

Biogenic reefs are where species aggregate to form a hard substratum and allow a community of other species to develop. Biogenic reef-forming species include *Serpula vermicularis*, *Sabellaria alveolata*, *Sabellaria spinulosa*, *Lophelia pertusa*, *Mytilus edulis* and *Modiolus modiolus*. In this Natural Area, the main biogenic reef-forming species are *Sabellaria* spp. Another species that modifies the surrounding sediments when it occurs in large aggregations is *Limaria hyans*, although whether it forms 'reefs' is still under discussion.

4.3.1 *Sabellaria spinulosa* reefs

Sabellaria spinulosa reefs comprise dense, subtidal aggregations of a small, tube-building polychaete worm. *Sabellaria spinulosa* can stabilise cobble, pebble and gravel habitats, providing a consolidated habitat for other species. *Sabellaria spinulosa* reefs are solid

structures, at least several centimetres thick, raised above the surrounding seabed, which persist for many years. As such, they provide a biogenic habitat that allows many other associated species to become established. Reefs found in mixed sediment areas are important, as they allow fauna and crevice infauna to become established in areas where they would normally be absent. The MNCR biotope classification scheme (Connor *et al* 1997) defines two *Sabellaria* biotopes (see Table 4.1)

Within much of its geographical range, *S. spinulosa* does not form reefs but is solitary or occurs in small groups encrusting pebbles, shell, kelp holdfasts and bedrock. Where conditions are favourable, much more extensive thin crusts can be formed, sometimes covering extensive areas of the seabed. However, these crusts are ephemeral in nature, being broken up during winter storms. As a result, these crusts do not constitute true *S. spinulosa* reef habitats. *Sabellaria spinulosa* requires only a few key environmental factors for survival in UK waters. Most important seems to be a good supply of sand grains, which are put into suspension by strong water movement and are used for tube building.

Sabellaria reefs are present within this Natural Area, in particular offshore from The Wash (see Figure 4.6). Here the species occurs on sandy gravel substratum. Foster-Smith and White (2001) found that *Sabellaria spinulosa* occurred in only very small densities on mobile sediment when compared with more stable sediments, indicating that some degree of sediment stability is a requirement. *Sabellaria spinulosa* reef has been also been found in an aggregate licence area (401/2) which is approximately 13 nautical miles east of Great Yarmouth (Newell *et al* 2000) (see Figure 6.3). The area surrounding the *Sabellaria* reef is characterised by stable coarse, gravelly sand and it is likely that this habitat is present in the surrounding offshore waters.

There is also an area of *Sabellaria spinulosa* reef discovered as part of a survey in 2003 by Subsea 7 under contract to ConocoPhillips, located in the southern North Sea sandbank area between Swarte and Broken banks (see Figure 4.6). Samples from the reef indicate an associated community dominated by polychaetes (most abundant species are *Pholoe synophthalmica* and *Mediomastus fragilis*) and epifaunal species other wise associated with crevice habitats (eg *Galathea intermedia*). The gastropod mollusc, *Noemiamea dolioliformis*, believed to an ectoparasite of *Sabellaria spinulosa* was also recorded (Subsea 7 2003)

4.3.1.1 Nature conservation measures

Sabellaria spinulosa reefs are covered by their own Habitat Action Plan but are also indirectly covered by the HAP for sublittoral sands and gravels. Within the Southern North Sea *Sabellaria* reefs are an interest feature of the Wash and North Norfolk Coast SAC (Figure 4.3).

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. 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 MNCR biotopes (Connor *et al* 1997) associated with the key habitats in the Southern North Sea Natural Area.

Key habitat	Biotopes description (and code)
Gravel habitats	Venerid bivalves in circalittoral coarse sand or gravel (CGS.Ven) *Sabellaria spinulosa* and *Polydora* spp. on stable circalittoral mixed sediment (CMX.SspiMx)
Sand habitats	Shallow sand faunal communities (IGS.FaS)
Mud habitats	*Amphiura filiformis* and *Echinocardium cordatum* in circalittoral clean or slightly muddy sand (CMS.AfilEcor)
Notable biogenic habitats	Circalittoral *Sabellaria* reefs (MCR.Csab) *Sabellaria spinulosa* and *Polydora* spp. on stable circalittoral mixed sediment (CMX.SspiMx) Kelp with cushion fauna, foliose red seaweeds or coralline crusts (exposed rock) (EIR.KfaR) Kelp with red seaweeds (moderately exposed rock) (MIR.KR) Fauna and seaweed (shallow vertical rock) (IR.FaSwV) Soft rock communities (MCR.SfR)
Sea caves	Caves and overhangs (deep) (CR.Cv)

Table 4.2 Summary of nature conservation measures.

Habitat type	EU Habitats Directive [1]				UK Biodiversity Action Plan[2]				
	Sandbanks which are slightly covered by seawater all the time [a]	Seacaves[a]	Large shallow inlets and bays	Reefs [a]	Sublittoral sands and gravels	Sheltered muddy gravel	Mud habitats in deep water	*Sabellaria spinulosa* reefs [b]	Littoral and sublittoral chalk
Gravel habitats			•	• Boulders and cobbles	•				
Sand habitats	•		•		•				
Mud habitats			•			•	•		
Chalk reefs				•					•
Sea caves		•							•
Sabelleria 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.

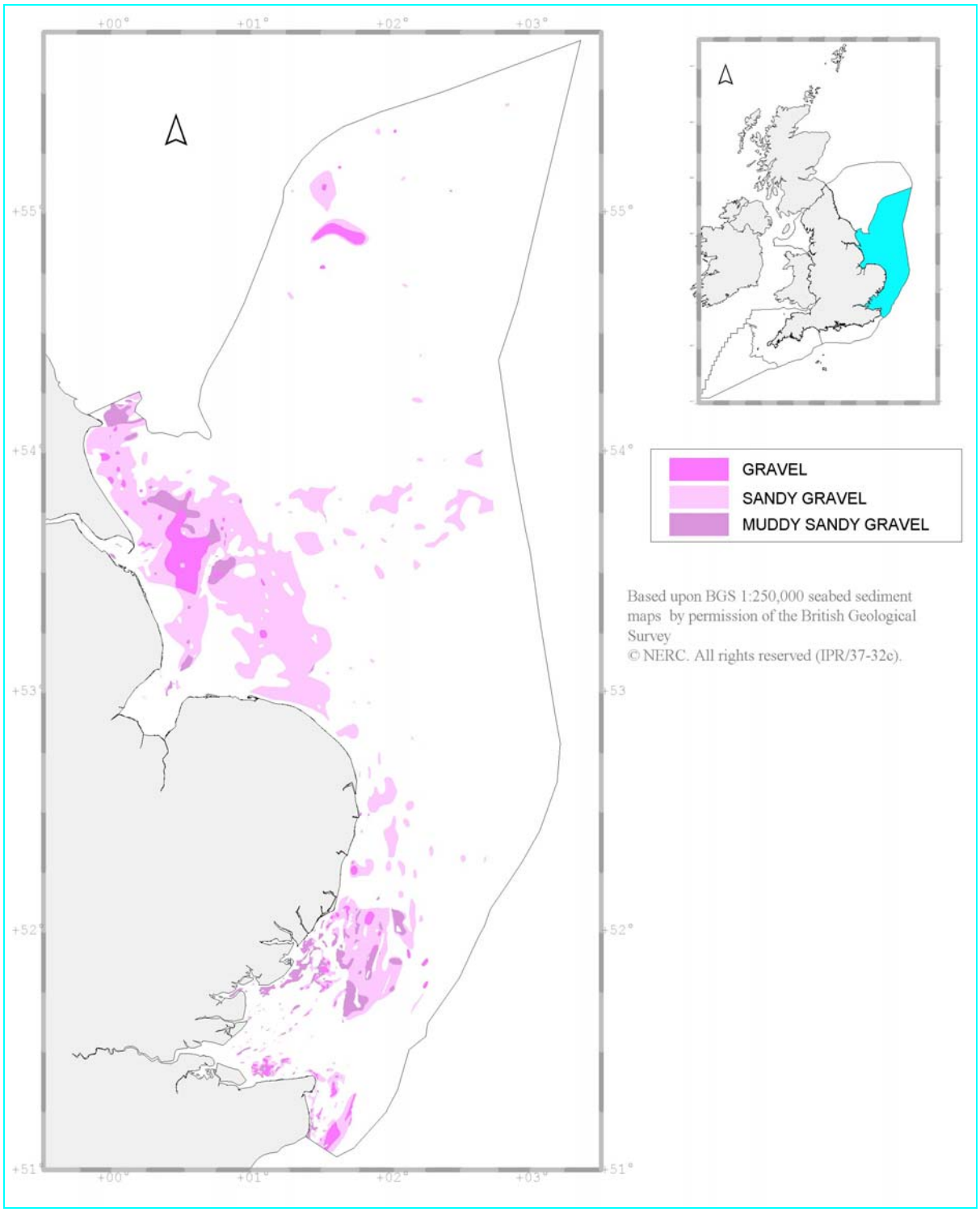


Figure 4.1 Gravel habitats in the Southern North Sea Natural Area.

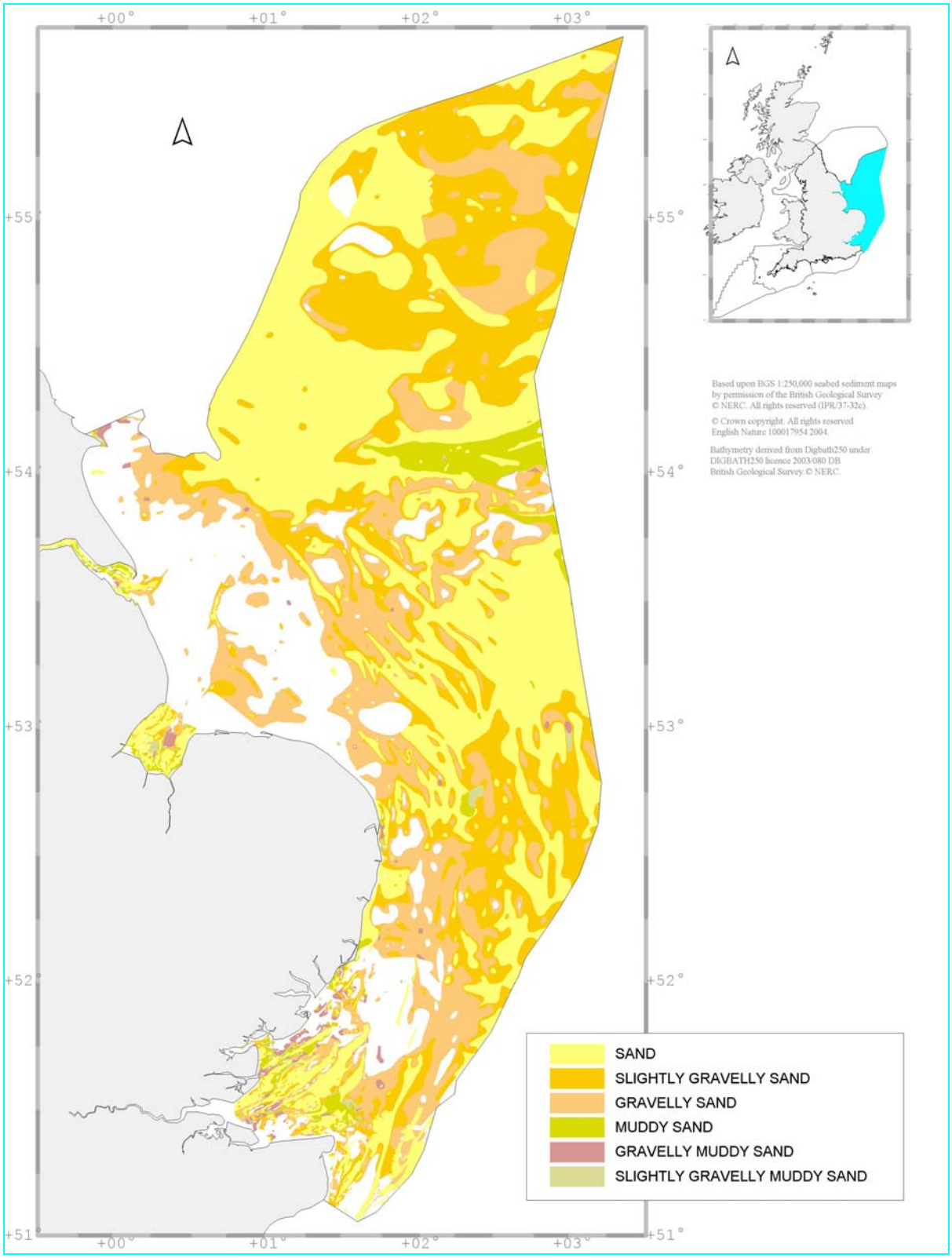


Figure 4.2. Sand habitats in the Southern North Sea Marine Natural Area.

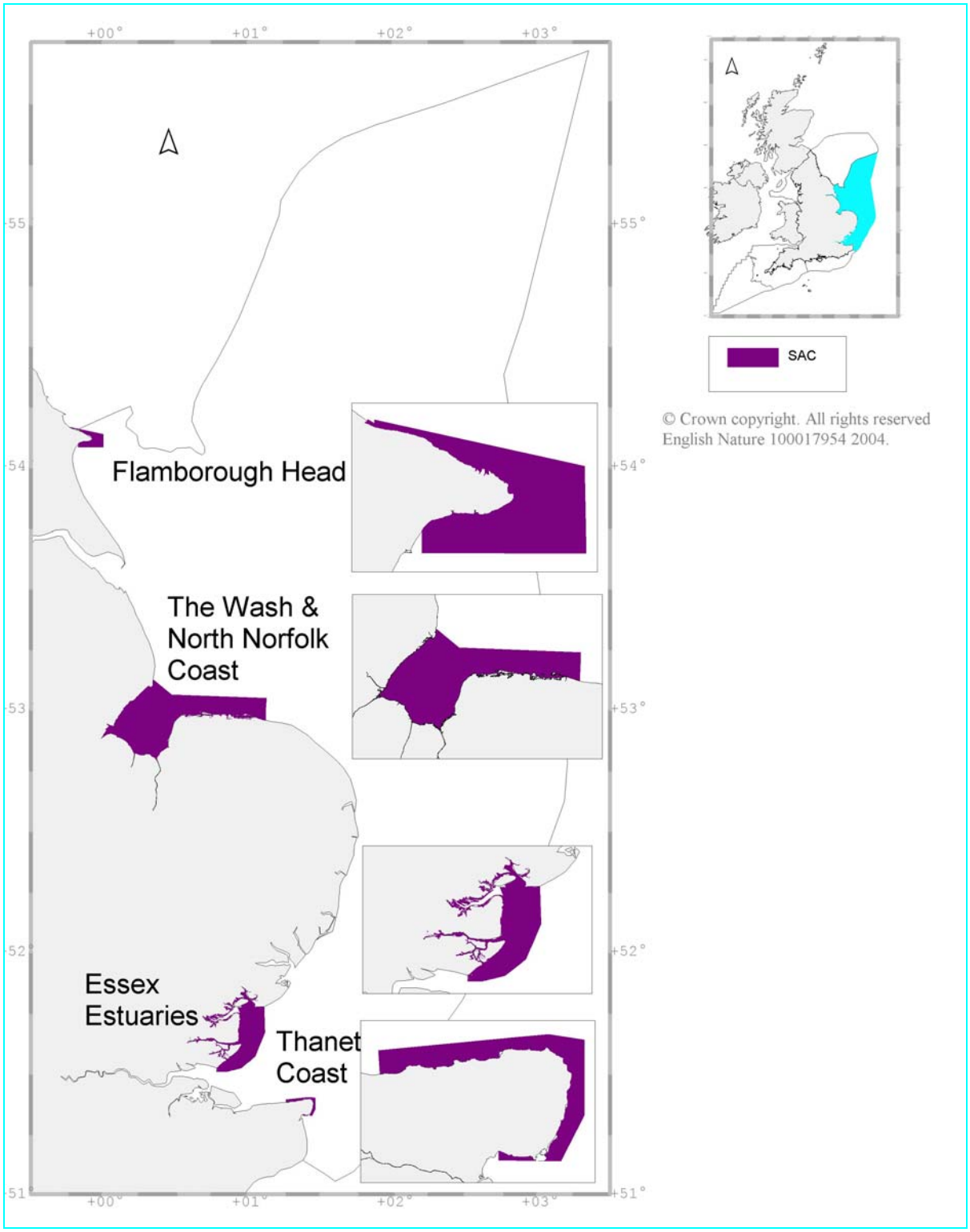


Figure 4.3 Candidate Special Areas of Conservation in the Southern North Sea Marine Natural Area.

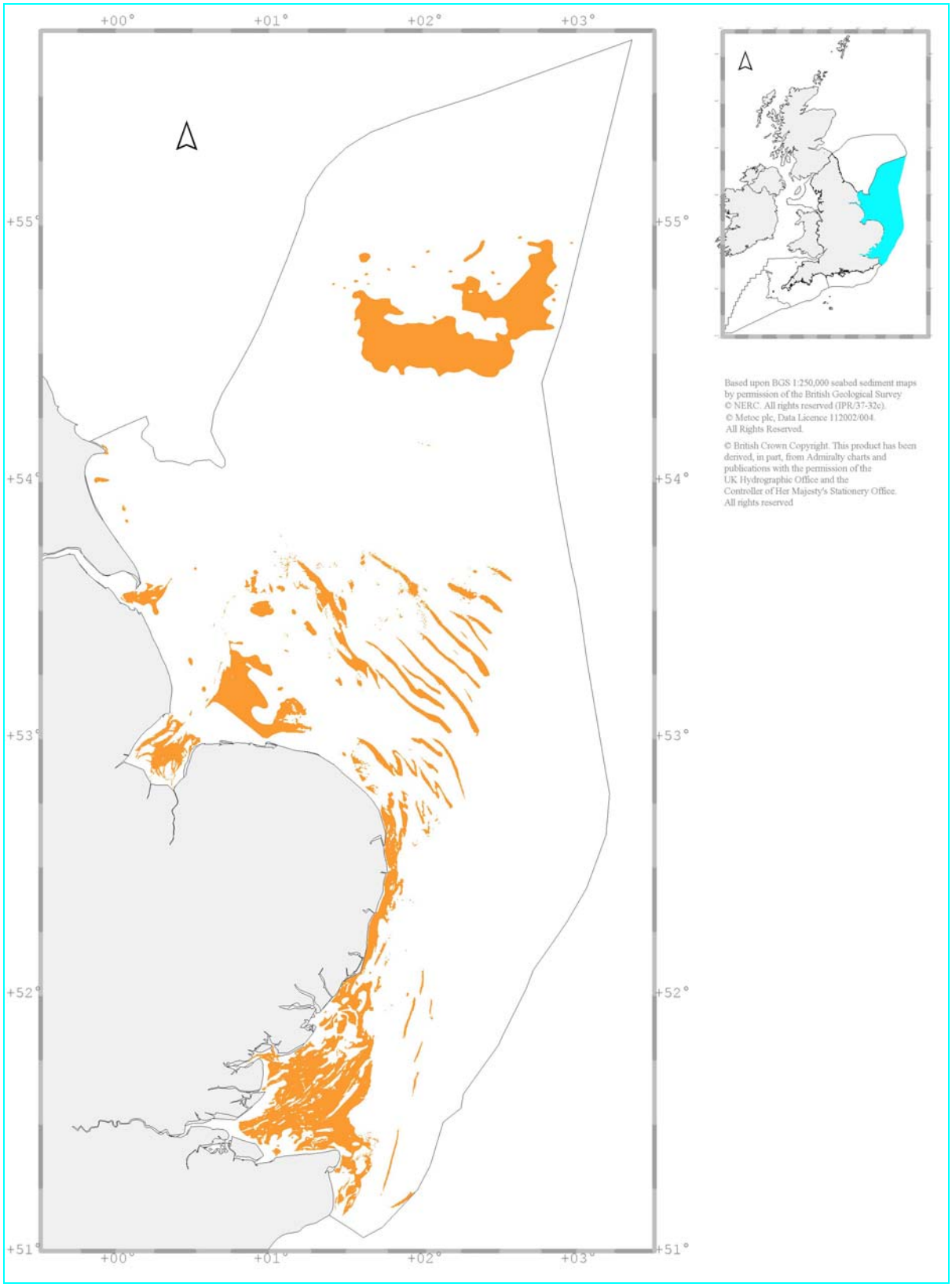


Figure 4.4 The distribution of shallow (<20 metres) sandy seabed areas, which indicates the potential location of 'Sandbanks which are slightly covered by sea water all the time' (*sensu* Habitats Directive) in the Southern North Sea Marine Natural Area. Further refining of these areas will define seabed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

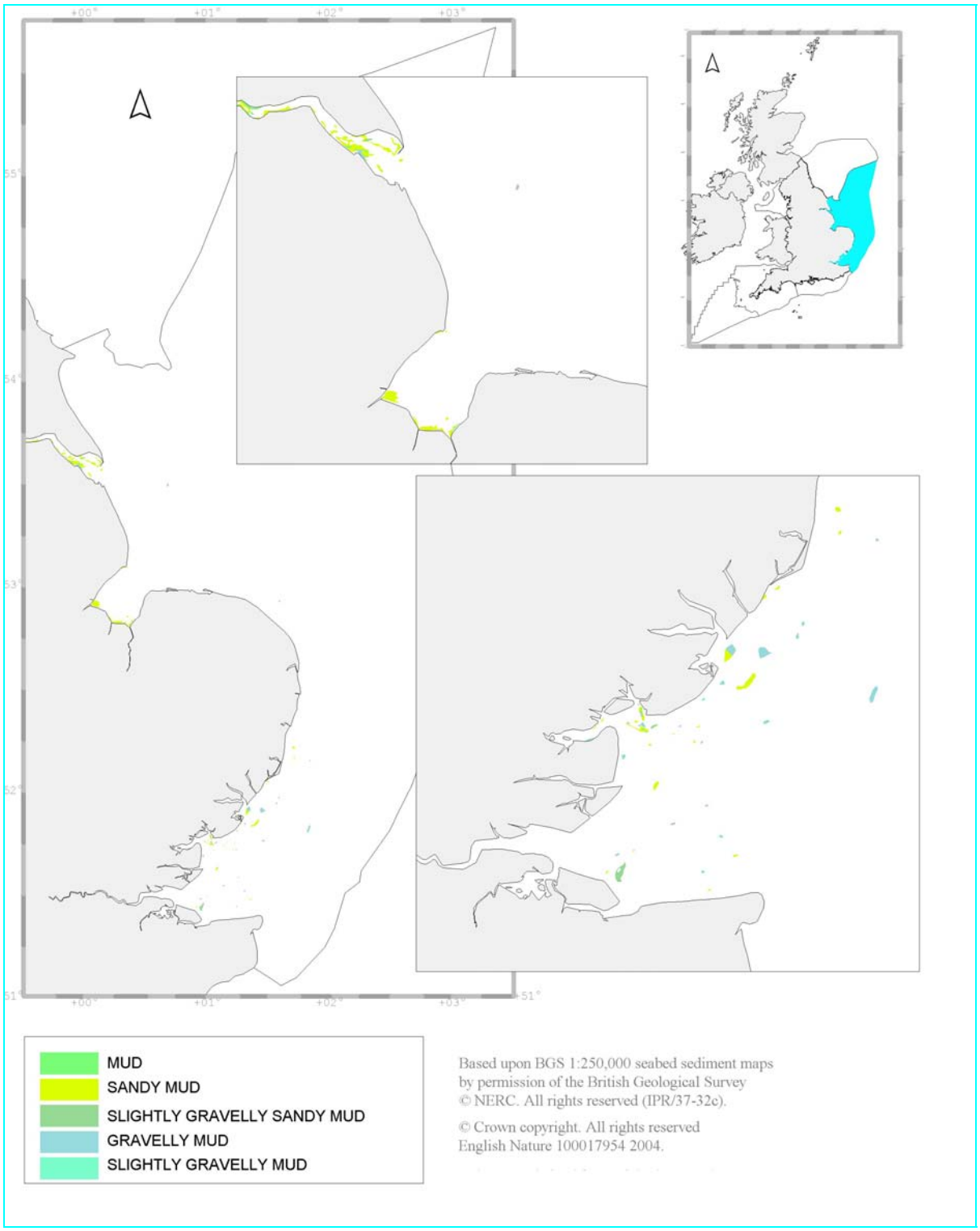


Figure 4.5 Mud habitats in the Southern North Sea Natural Area.

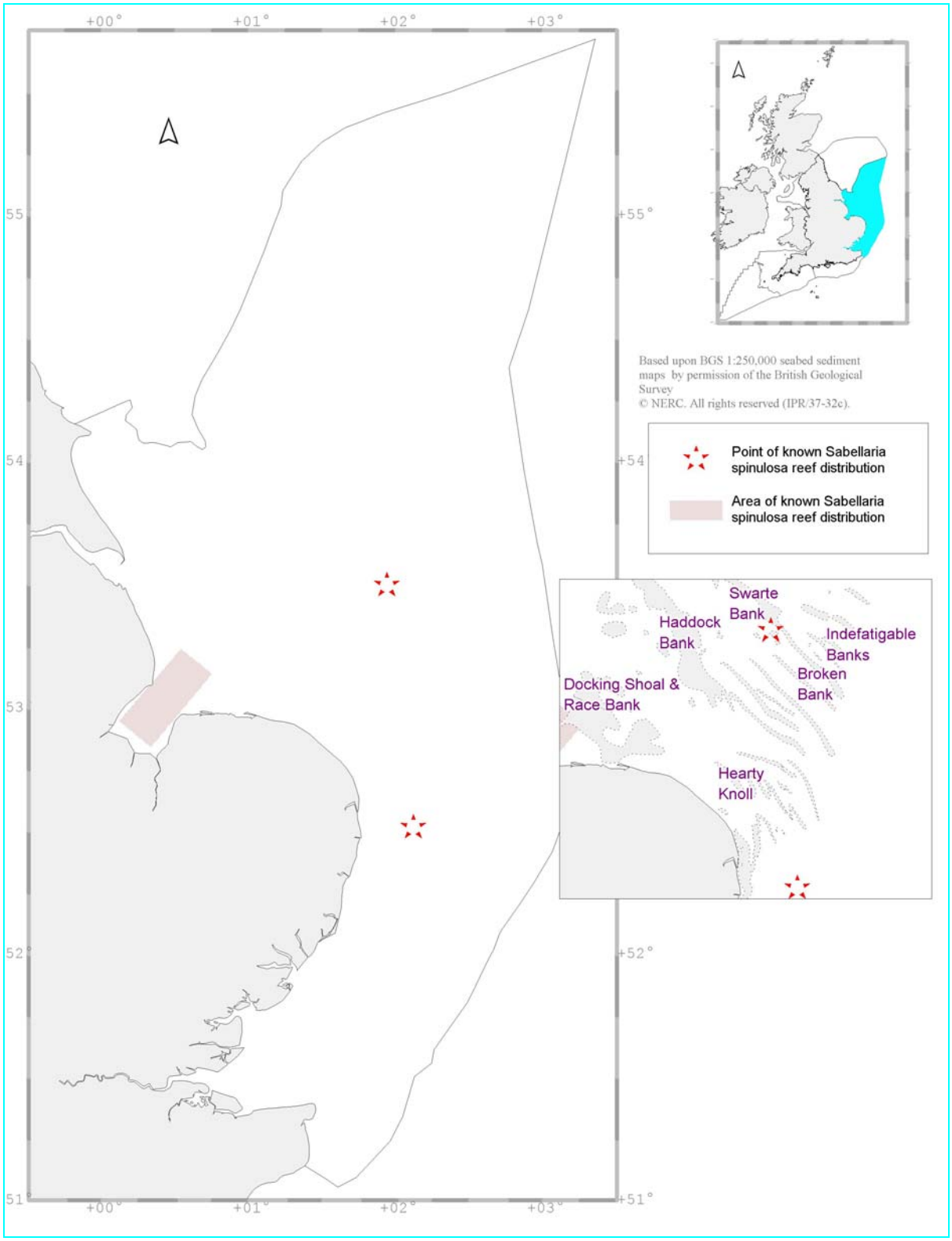


Figure 4.6 Areas of known *Sabellaria spinulosa* reefs in the Southern North Sea Natural Area.

Southern North Sea

Common seals on sands at North Norfolk which holds 9% of UK population of this species.
Peter Wakely/English Nature (above)

Piddocks boring into upward-facing circalittoral clay at Thanet. This habitat is considered to be scarce in Great Britain.
Roger Covey/JNCC (right)

Recently located *Sabellaria spinulosa* reefs between Swarte & Broken Banks in Southern North Sea.
Conoco Philips (bottom left)

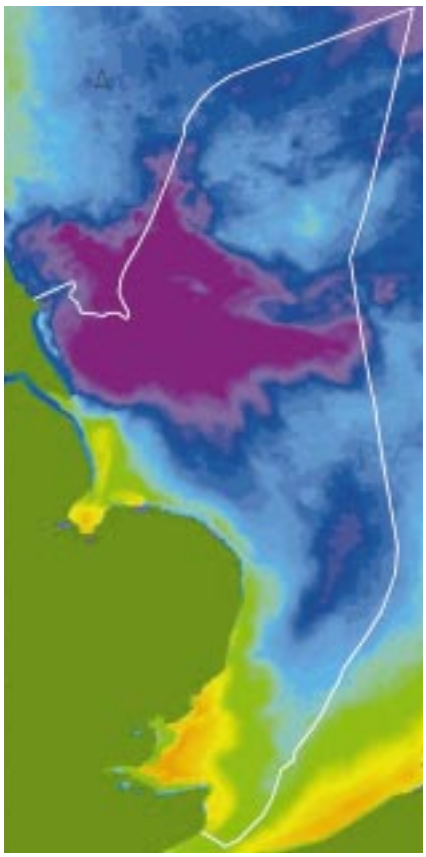
High speed ferry crossing between Harwich to the Hook of Holland.
Chris Gibson/English Nature (bottom right)

Internationally important Sandwich tern which uses this Natural Area for feeding and nesting on adjacent cliffs.
MIke Lane/RSPB-images.com (left)

Inshore shrimping boat in the Wash, North Norfolk.
Robert Irving/Seascope (below)

Wind turbines. There are 17 proposed windfarm sites within the Southern North Sea Natural Area.
Paul Gilliland/English Nature (bottom left)

Seawater surface temperature for Southern North Sea 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 Southern North Sea. We have used the UK Biodiversity Action Plan (BAP)and the Habitats and Birds Directives as a focus for structuring the text. 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. For each feature we note the main specific conservation measures currently in place, 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[7]. For example of the 25 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 (Fraser & Ainley 1986; Skov *et al* 1994).

Fish are the main prey for the majority of marine bird species. Among the most important are sandeel, 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 high 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* 1978). The abundance of food at fronts attracts both fish and marine birds (see for an 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 can be vulnerable to local incidents such as oil spillages. The majority of marine birds are long-lived and do not reach breeding condition for several years. For example, on average, fulmar do not breed until their ninth year and may live for at least another 35 years (Dunnet & Ollason 1978). Many marine birds also have low

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

1. True Seabirds – birds reliant on the sea all year. These include terns, gulls, petrels, cormorants, auks, skuas and gannet.
2. Coastal Birds – birds reliant on the sea for only part of the year. These include divers, grebes and seaduck.

reproductive rates. Hence, even highly localised incidents can have a significant impact upon a population, particularly where adults are affected (Webb *et al* 1990). Several species of marine bird, most notably the auks, divers, grebes and seaducks, moult their flight feathers simultaneously, becoming temporarily flightless. Such species are also 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 Distribution of marine birds

The Southern North Sea Natural Area is important for marine birds. Thirty-three species regularly occur here and these are indicated in Table 5.1, together with a summary of their distribution and abundance in the Natural Area.

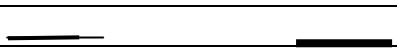
Marine birds are unevenly distribution throughout the Southern North Sea Natural Area, both geographically and in time (Stone *et al* 1995). The varied coastline adjacent to this Natural Area provides suitable nesting habitat for a wide range of marine bird species: cliff grasslands are home to species including puffin *Fratercula arctica* and several species of gull and tern; rugged cliffs and islands present ideal nesting conditions for fulmar, guillemot *Uria aalge* and razorbill *Alca torda*. Shag *Phalacrocorax aristotelis* tend to prefer the more gentle boulder-strewn slopes, whilst terns and gulls nest also on sparsely vegetated upper foreshore.

All of these birds 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, gannet *Morus bassanus* and guillemot *Uria aalge*, occur within the Natural Area throughout the year. Other species, notably the terns, *Sterna spp.*, are seasonally dependent on the area, migrating to more distant waters outside the breeding period.

Several species, including shearwaters, petrels and skuas, pass through the Natural Area on migration. Large numbers of seaducks, divers and grebes migrate from their northern breeding grounds to over-winter in the shallow, productive waters of this Natural Area.

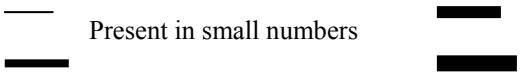
Away from inshore waters, marine birds may feed, roost or fly over most areas of open sea in low numbers. Larger concentrations tend to occur only where food resources are both available and abundant, including areas of temporary abundance, eg in the vicinity of fishing vessels. During the breeding season nesting birds are also limited by distance from nesting grounds. Possibly the most influential feature away from the coast within the Natural Area is the ‘Flamborough Front’. This forms the boundary between the Southern North Sea and Mid North Sea Natural Areas and provides a rich food source for a large number and diversity of seabirds. Relatively little is currently known of the spatial and temporal distribution of seabirds across the Flamborough Front. In addition to the Flamborough Front, several temporary fronts of seasonal importance occur throughout the Natural Area.

Table 5.1 Summary of regularly occurring marine birds in the Southern North 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		Flamborough Front	PM, A1
Black-throated diver		Flamborough Front	PM, A1
Great northern diver		Flamborough Front	M, A1
Red-necked grebe		Mainly inshore.	M
Great crested grebe		Mainly inshore.	PM
Fulmar		High concentrations all year area in the coastal shallows, moderate around the Flamborough Front.	PM
Manx shearwater		Generally dispersed, highest densities in the coastal shallows	M
Sooty shearwater		Generally dispersed, highest densities in the coastal shallows	M
Storm petrel		Scattered distribution.	M, A1
Leach's petrel		Scattered distribution.	M, A1
Gannet		Important concentrations in the coastal shallows. Numbers peak post-fledging.	PM, A2
Cormorant		Principally coastal distribution.	PM
Eider		Highest densities around the Flamborough Front.	PM
Long-tailed duck		Low numbers throughout winter around the Flamborough Front.	M
Common scoter		Highest densities in sheltered, coastal zones around the Flamborough Front.	PM
Velvet scoter		Highest densities in sheltered, coastal zones around the Flamborough Front.	M
Red-breasted merganser		Highest densities in sheltered, coastal zones around the Flamborough Front.	PM
Skua (Arctic and great)		Highest densities Aug. –Oct. during migration to wintering grounds.	M
Little gull		Internationally important numbers in the north west coastal shallows, during autumn.	M
Black-headed gull		Mainly coastal, throughout year.	PM
Common gull		Mainly coastal, highest numbers Oct-Feb.	PM
Lesser black-backed gull		Scattered distribution throughout spring and summer.	PM
Herring gull		Highest densities Nov-Feb due to influx from northern colonies.	PM
Great black-backed gull		Highest densities Nov-Feb due to influx from northern colonies.	PM
Kittiwake		Highest densities areas in the coastal shallows and the Flamborough Front, dispersing post-breeding.	PM
Sandwich tern		Shallow areas adjacent to colonies. Migrate after breeding.	M, A1

Species	Jan → Dec	Key areas	Status
Common tern		Shallow areas adjacent to colonies. Migrate after breeding.	M, A1
Little tern		Shallow areas adjacent to colonies. Migrate after breeding.	M, A1
Guillemot		High densities areas in the coastal shallows. Disperse from colonies after breeding.	PM, A2
Razorbill		Breeding season - concentrated around north west in the coastal shallows.	PM, A2
Little auk		Highest densities Nov-Feb.	M
Puffin			PM, A2

Table notes:
Graded lines indicate relative seasonal abundance of a species.



Status A1 = Listed on Annex 1 of Birds Directive.
M = Migratory species (as cited in Stroud *et al* 2001).
PM = Partially migratory species (as cited in Stroud *et al* 2001).

Many species of fish taken as prey by marine birds require a sandy substrata with rapid water circulation in which to spawn. The Southern North Sea Natural Area has two major sandbank systems which provide such conditions; the Dogger Bank in the north and the Brown Ridge located off the Norfolk coastline. Both are probably of great importance to feeding birds. These sandbanks also cause tidal upwellings, which concentrate zooplankton and hence the fish that prey upon them (Alldredge & Hamner 1980).

Diving ducks feed on benthic invertebrates, primarily edible mussels *Mytilus edulis*, cockles *Cardium spp.*, clams and other bivalves. These organisms live in shallow waters and occur in important concentrations in the Southern North Sea Natural Area, particularly off the North Norfolk Coast Special Protection Area in an area called 'the Brown Ridge' (Figure 5.1).

5.1.3 Nature conservation measures

There are ten Special Protection Areas designated for internationally important tern populations on the coastline adjacent to the Natural Area (Figure 5.1). Breeding terns, in particular Sandwich tern *Sterna sandvicensis* use the Natural Area for feeding.

The cliffs adjacent to the Flamborough Front support a colony of seabirds of national and international importance, including the Flamborough Head and Bempton Cliffs SPA which has one of the largest kittiwake *Rissa tridactyla* colonies in the world - 25,000 pairs in 2000- Mitchell *et al* (in press). The SPA also supports the only mainland gannetry in England and substantial populations of puffin *Fratecula artica*, razorbill *Alca torda*, guillemot and fulmar. During the breeding season this site regularly supports over 300,000 individual seabirds (Stroud *et al* 2001).

All of these sites are protected by the Birds and Habitats Directive, the Habitats Regulations and the Countryside and Right of Way Act 2001. 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.

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 North 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.

The cetacean fauna of the southernmost North Sea is relatively poor, both in numbers of animals and diversity of species (Barne *et al* 1998). Nine species of cetacean occur regularly within the Southern North Sea Natural Area. Their distribution and current status is discussed below.

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

Only one species of Baleen whale, the minke whale *Balaenoptera acutorostrata*, occurs occasionally in the northern part of this Natural Area, especially offshore from Flamborough Head, in the late summer/early autumn. This may be related to the plankton frontal system that occurs in this area. This species is usually absent from the southern part of the Natural Area, however casual sightings have been made. Minke whales are rarely seen in the North Sea before May and most sightings are made within 100 kilometres of the coast. Individuals usually occur singularly or in pairs (Evans 1995).

5.2.2 Toothed whales

The white-beaked dolphin *Lagenorynchus albirostris* is the most common dolphin species in the North Sea (Barne *et al* 1995). Although greatest numbers are found to the north and west of this Marine Natural Area, individuals are regularly recorded in the Southern North Sea

Natural Area, particularly towards the coast of Norfolk. This species does occur throughout the year, but is most often observed in the late summer/early autumn.

The long finned pilot whale *Globicephala melas* occurs occasionally in the north of this Natural Area, particularly during the autumn months. This species is scarce in the southern part of the Natural Area. However, pilot whales have been sighted in the English Channel.

The harbour porpoise *Phocoena phocoena* is the most frequently sighted cetacean species in the North Sea, particularly in late summer/autumn. It is most common to the north of the Southern North Sea Natural Area, with sightings decreasing in abundance towards the southerly sector. Although species are occasionally sighted offshore, individuals are more common near the coast to the north of this Natural Area and may be associated with large numbers of feeding seabirds. Numbers of harbour porpoises in the North Sea may have declined over the last 50 years, particularly in the southern North Sea and English Channel (Doody *et al* 1993).

The common dolphin *Delphinus delphis* occurs irregularly in the North Sea. It has been sighted occasionally within the Southern North Sea Natural Area, often in relatively large groups. Sightings have usually been at distances greater than 100 kilometres from the coast. There is some indication of an offshore movement, with animals seen further from the coast in late summer and during the winter months.

Bottlenose dolphins *Tursiops truncatus*, like the harbour porpoise, were once a regular visitor to the southern part of the North Sea during the summer months, but is now a rare sight in this area.

The Atlantic white sided dolphin *Lagenorynchus acutus* is sighted only occasionally in the north of this Natural Area. This species favours the cool temperate and sub-arctic waters of the North Atlantic, and is rarely found south of the English Channel. The Atlantic white-sided dolphin has a similar distribution to the white-beaked dolphin, but white-sided dolphins tend to occur more offshore, particularly along the continental slope. Like many of the other smaller species of dolphin in these waters, they appear to move nearer the shore in summer.

The orca *Orcinus orca* is generally uncommon throughout the whole of the North Sea. Occasional sightings have been made throughout the year within the Southern North Sea and English Channel. In UK waters generally, orcas occur in all months of the year, but are recorded near the shore mainly between May and October when they may feed on seals.

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.

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.

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 the UK 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.

Under schedule 5 of the Wildlife and Countryside Act 1981 (as amended), all cetaceans are fully protected 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.

All toothed (and baleen) cetaceans are protected under Annex IV of the 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 areas essential to their life and reproduction (SACs) to ensure their conservation. However, no areas essential to life and reproduction have been identified for these species within this Natural Area.

Table 5.2 Summary of cetacean protection measures (see notes below table for explanation of designations and abbreviations)

	Schedule 5 Wildlife & Countryside Act	EC Habitats Directive (annex)	CITES (Appendix)	Bonn Convention (Appendix)	IUCN Red Data List Species	Bern Convention (Appendix)	UK Biodiversity Action Plan
Minke whale *Balaenoptera acutorostrata*	•	IV	I		LR nt	III	Baleen whales grouped plan
Harbour porpoise *Phocoena phocoena*	•	II IV	II	II	VU	II	Harbour porpoise species plan
White-beaked dolphin *Lagenorynchus albirostris*	•	IV	II	II		II	Small dolphins grouped plan
Atlantic white-sided dolphin *Lagenorynchus acutus*	•	IV	II	II		II	Small dolphins grouped plan
Killer whale *Orcinus orca*	•	IV	II	II	LR	II	Toothed whales grouped plan
Common dolphin *Delphinus delphis*	•	IV	II	II			Small dolphins grouped plan
Bottlenose dolphin *Tursiops truncatus*	•	II IV	II	II		II	Small dolphins grouped plan
Long finned pilot whale *Globicephala melas*	•	III IV	II	II		II	Toothed whales grouped plan

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.

Annex A Council Regulation (EC) No. 338/97 deals with the protection of species of wild fauna and flora by regulating the trade in these species.

CITES (Convention on International Trade in Endangered Species)
Appendix I - Prohibits the commercial trade of species included on this appendix.
Appendix 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
nt = near threatened

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

In the period between 1996 and 2001 about 33, 800 common seals *Phoca vitulina*, were counted in Britain of which 12% were found in England (Natural Environment and Research Council 2003). Britain holds 40% of the world population of common seals. A large colony of seals (9% of the UK population) is found within this Natural Area on and around The Wash and North Norfolk Coast (English Nature 2000b). This census of the common seal population is based on numbers hauling-out in coastal locations during the moulting period in August. The extensive intertidal mud and sandflats of The Wash and North Norfolk Coast provide ideal breeding and haul-out sites. Females haul out onto the intertidal sand and mudflats to give birth and suckle cubs between June and July. Such areas are thought to be very important for the conservation of the species, as they tend to be the most important breeding colonies (Brown *et al* 1997).

In addition to pupping and suckling, these sites are also important for skin maintenance and moult, rest and sleep, energy saving and predator evasion (Brasseur *et al* 1996). Common seals typically show some seasonal and year to year movements between haul-out sites, but remain resident in the same geographical area throughout the year. During the winter, individuals may leave inshore waters to feed, returning to haul out and rest between feeding trips. During the summer breeding and moulting season, the seals tend to forage within a few kilometres of the haul-out sites (Thompson 1993).

Grey seals *Halichoerus grypus* are less numerous than common seals within this Natural Area. There is only one main breeding site, at Donna Nook in Lincolnshire, although pups are born along the Suffolk and Norfolk coasts (Barne *et al* 1995). Grey seals use a number of haul out sites at Blakeney Point and Scroby Sands.

5.3.1 Nature conservation measures

Grey seal and common seal are protected under Annex II of the Habitats and Species Directive which requires Members States to designate Special Areas of Conservation (SACs) for their conservation. Sites such as The Wash and on the North Norfolk Coast, which support concentrations of common seals and contain areas considered to be essential to their life and reproduction, lists this species as an interest feature.

Grey and common 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. These measures are provided for within national legislation.

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 ensure the protection of the listed species. Any exploitation of wild fauna must also be regulated in order to keep the populations out of danger.

The Conservation of Seals Act 1970 provides for closed 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 it is from 1 June to 31 August. Following the halving of the common seal population as a result of the phocine distemper virus in 1998, an Order was issued under the Act which

provided year-round protection of both grey and common seals on the east coast of England. The Order was last renewed in 1999. A re-occurrence of the disease, albeit at a much smaller scale, occurred in 2002.

5.4 Fish

The North Sea in general is an important area for populations of a number of commercial fish species, providing spawning grounds and nursery and feeding areas. Consequently it is an area of considerable importance to the fishing fleets of all countries bordering the North Sea. Fish are referred to here 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 Southern North Sea Natural Area important commercial species include cod, haddock, saithe, whiting, pollack, lemon sole, plaice, monkfish/angler fish, dogfish, dabs, flounders, sole, turbot, brill, witches, skates/rays and sprats. Only those species which are covered by the 'Commercial marine fish grouped species action plan' are featured below.

5.4.1 Pelagic

Mackerel *Scomber scombrus* used to be one of the most commercially important pelagic species within this Natural Area. Individuals reach up to 60 centimetres in length and they feed on small fish as well as on plankton. Feeding intensity is usually greatest in summer, after spawning. Two stocks of mackerel are found in north-west European waters, the western stock which spawns along the shelf edge west of Britain, and the North Sea stock which spawns in the central North Sea (Figure 5.3a). Seasonal immigrants from the western stock also occur in the North Sea. Spawning occurs within this Natural Area between May and August and the area is also important as a feeding ground from July to September.

Herring *Clupea harengus* reach a maximum size of 40 centimetres and are widely distributed in the seas of the north eastern Atlantic shelf. This species typically lives in large shoals and the population can be divided into a number of distinct breeding stocks. Spawning and feeding grounds are present within this Natural Area. Spawning tends to occur nearer the coast, usually on the edge of sediment banks, during the autumn and winter months with the exact timing depending on the locality (Figure 5.3b). Egg-laying takes place where there is coarse shell, grit and gravel, and the distribution of spawning grounds can be roughly equated with the distribution of known gravel deposits. Feeding grounds are found towards the northern part of this area, particularly offshore from Flamborough Head and the Humber Estuary.

The twaite shad *Alosa fallax* is anadromous. This means that individuals spawn in freshwater, where they also feed and grow for approximately five months before heading downstream to the sea. This species is declining throughout the UK although it has been recorded within this Natural Area (Potts & Swaby 1993). The Atlantic salmon *Salmo salar* is also anadromous and may also be found in the coastal waters in the north of this Natural Area.

5.4.2 Demersal fish

Cod *Gadus morhua* is one of the most important commercial fish species in the North Atlantic and is widely distributed around Britain. The North Sea population is self-contained and largely independent of the other populations of the North Atlantic. In general fish migrate to the northern part of this Natural Area for spawning in winter, and in the summer they are spread out over a wider area. Spawning takes place between February and April during which eggs and larvae drift in with the plankton (Figure 5.3c). After about two months the young fish become demersal (live on or near the seabed) and inhabit the nursery areas shown in Figure 5.4c. Cod have been traditionally caught by trawling, mainly from autumn to spring. They are also targeted by small beach boats using set lines. At present the cod stock is at an all-time low (and has been for some time) and a fish stock recovery plan has been put in place.

Plaice *Pleuronectes platessa* are most often found on sandy substratas down to depths of 120 metres, but this species also occurs on muddy bottoms and gravel. Plaice are long-lived fish, reaching maturity after three years. Spawning takes place on well defined spawning grounds in early spring (Figure 5.3d). Parts of these grounds are found within the northern and central parts of the Natural Area.

Dover sole *Solea solea* (also known simply as 'sole') is an important commercial species in the southern North Sea. In the North Sea it is at the northern limit of its north east Atlantic distribution. This species is particularly abundant in areas of muddy sand and fine sand where the polychaetes that it feed on are also abundant (Figure 5.3e). Dover sole spawn in the early summer and are mostly caught from early summer through to autumn.

The common skate *Dipturus batis* is widely distributed, but very scarce, throughout European waters. It is extremely rare within the North Sea and is only occasionally caught within this Natural Area.

5.4.3 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 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. EU Regulation 850/98 (as last amended by 973/2001) (dealing with technical measures) and corresponding UK legislation under the Sea Fish (Conservation) Act 1967, contain much of the prohibitions and restrictions that affect UK fishing vessels. (Note that EU Regulation 850/98 is currently under review and is likely to be replaced in 2003.) 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 12 mile 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 six nautical miles of mean High Water Mark. 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. Three SFCs operate within this Natural Area: North Eastern SFC, Eastern Joint SFC, and Kent and Essex SFC.

5.4.3.1 Total Allowable Catch and Quotas

One of the four components of the Common Fisheries Policy is the conservation and enforcement policy, which aims to ensure the sustainable exploitation of resources. 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 (TACs) 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 2003 quotas for the **whole** of the zone in which the North Sea (ICES fishing area IV) quotas are allocated to can be seen in Table 5.3.

Table 5.3 Summary table of 2004 fishing quotas for the zone in which the North Sea is located in. (As agreed by Council Regulation EC 2287/2003 (i = EC waters)

Species	Zone	TAC (tonnes)	UK TAC (tonnes)
Mackerel *Scomber scombrus*	IIa[(i)], IIIa, IIIbcd[(i)], IV	545, 500	1, 331
Herring *Clupea harrengus*	North Sea (North of 53° 30")	460, 000	62, 100
Sprat *Spratus spratus*	IIa[(i)], IV	257, 000	9, 035
Cod *Gadus morhua*	IIa[(i)], IV	27 ,300	10, 631
Plaice *Pleuronectes platessa*	IIa[(i)], IV	61, 000	16, 486
Sole *Solea solea*	II, IV	17, 000	729
Skates and rays *Dipturus batis*	IIa[(i)], IV	3, 503	2, 266

5.4.3.2 Technical measures

Mesh size

This is the most basic form of technical measure. This sets a minimum mesh size that may be used for nets in a particular area or fishery, allowing small and immature fish to pass through the net. This can be a very successful conservation measure as it allows more fish to reach sexual maturity and become part of the 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 Size (MS)

Another fisheries conservation measure is concerned with regulating the Minimum Landing Size (MS) of fish. Fish not attaining the MS may not be retained on board or 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.

5.4.3.3 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.

5.4.3.4 Other conservation measures

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.

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 are several areas within the Southern North Sea Natural Area where fishing activity may be briefly suspended when aggregate dredging takes place. These areas are adjacent to the Humber Estuary and Great Yarmouth (see Figure 6.3).

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 six nautical mile belt of UK Territorial Seas is limited to UK vessels. 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'. Within the Natural Area, France has rights to fish within the 6-12 nautical mile belt from Flamborough Head to Spurn Head, and between Lowestoft and North Foreland. Belgium has rights to fish within the 6–12 nautical mile belt from Cromer to North Foreland.

5.4.4 Nature conservation measures

A summary of the conservation measures can be seen in Table 5.4. Only two species found within this Natural Area are protected by the Habitats Directive - the twaite shad *Alosa fallax* and Atlantic salmon *Salmo salar*. The species are listed on Annex II (species 'of community interest whose conservation requires the designation of special areas of conservation) and also Annex V (species of community interest whose taking in the wild and exploitation may be subject to management measures). However there are no SACs designated for the protection of these species within this Natural Area (Atlantic salmon only qualifies as an interest feature of an SAC in freshwater).

Twaite shad is also listed on Appendix III of the Bern Convention which includes 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.

There is a grouped species 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 all species. Within this Natural Area, stocks of cod, herring, mackerel, plaice and sole are included in the plan. There is also a Species Action Plan for the common skate *Raja batis* and twaite shad.

Table 5.4 Summary of conservation measures in place to protect Southern North Sea fish species.

Species	EC Habitats Directive (Annex no.)	Wildlife & Countryside Act (schedule 5)	IUCN Red Data List Species	Bern Convention (Appendix III)	Biodiversity Action Plan
Common skate *Raja batis*			Endangered (Provisional)		Common skate Species Action Plan
Twaite shad *Alosa fallax*	II & V	•		•	Twaite shad Species Action Plan
Atlantic salmon *Salmo salar*	II & V				
Cod *Gadus morhua*					Commercial marine fish grouped Species Action Plan
Herring *Clupea harengus*					Commercial marine fish grouped Species Action Plan
Mackerel *Scomber scrombus*					Commercial marine fish grouped Species Action Plan
Plaice *Pleuronectes platessa*					Commercial marine fish grouped Species Action Plan
Dover Sole *Solea solea*					Commercial marine fish grouped Species Action Plan

Table notes:

Annex II EC Habitats Directive – This annex includes 'Animal and plant species of community interest whose conservation requires the designation of special areas of conservation.

Annex V EC Habitats Directive – This annex includes 'Animal and plant species of community interest whose taking in the wild and exploitation may be subject to management measures.

Bern Convention -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.

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 Commercial Marine Fish as a range of common policies and actions are required for all species listed.

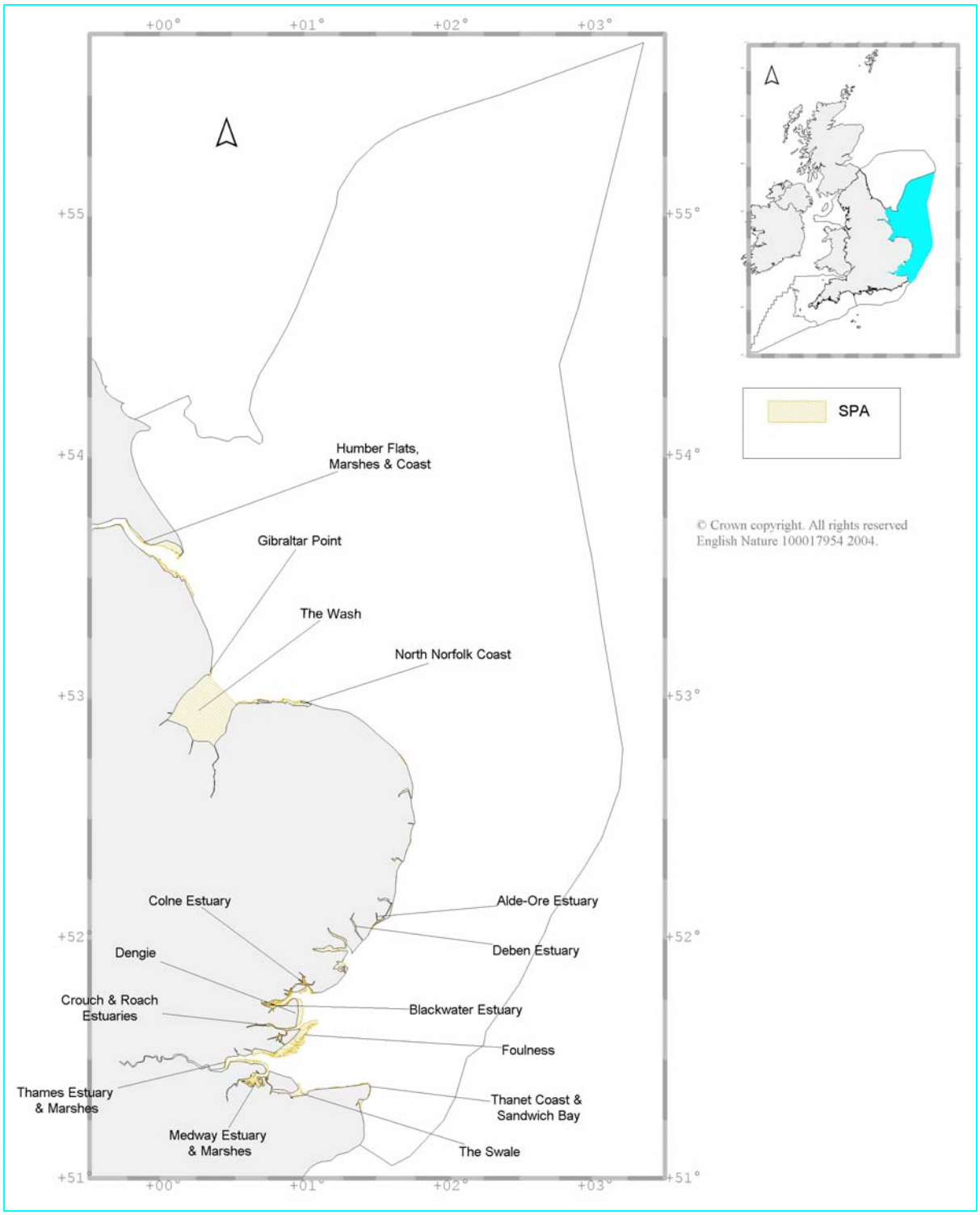


Figure 5.1 Special Protection Areas (SPAs) adjacent to the landward boundary of the Southern North Sea natural Areas

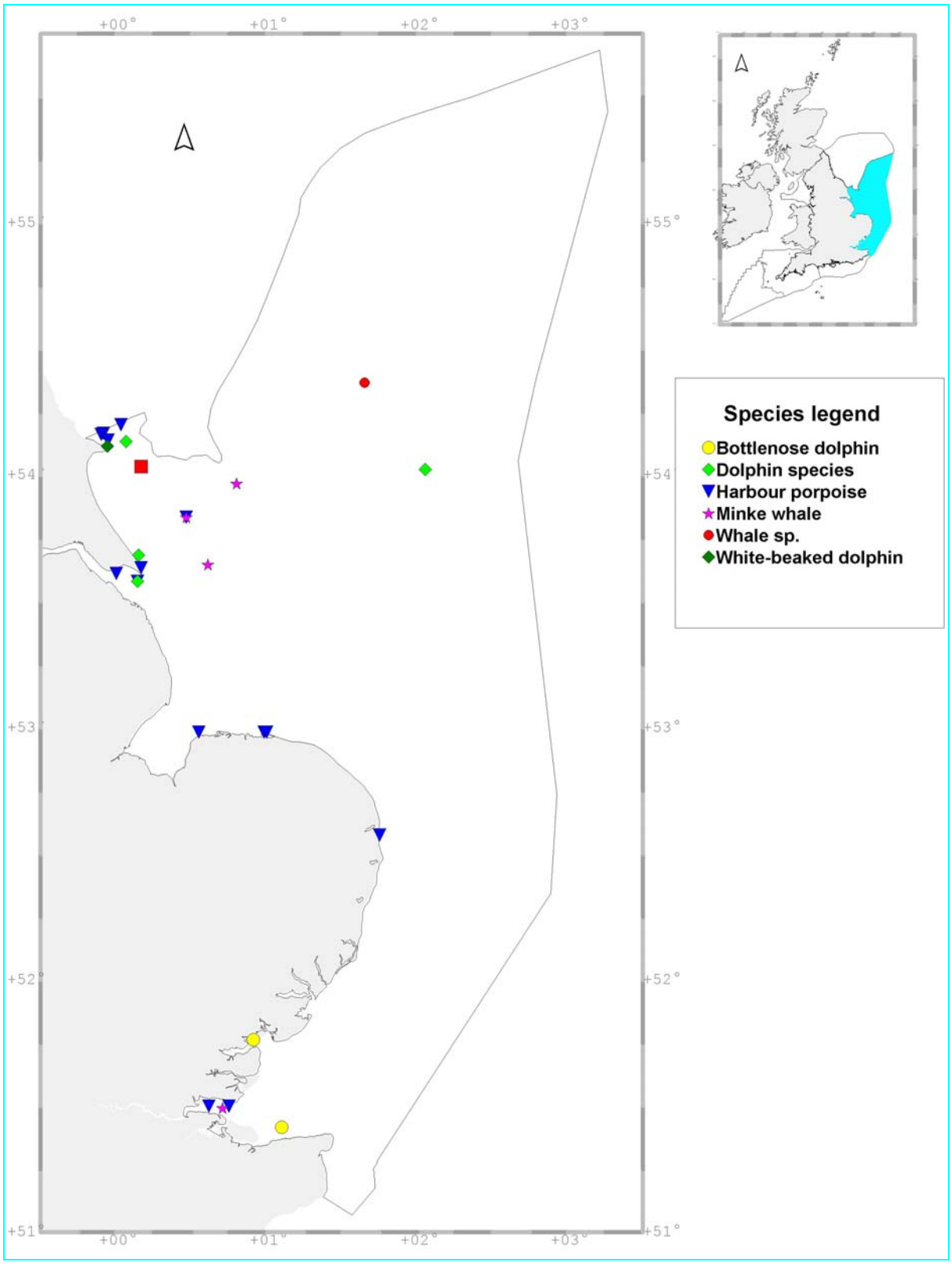
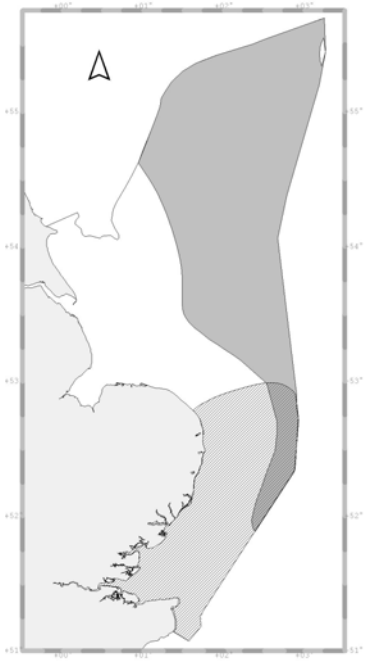
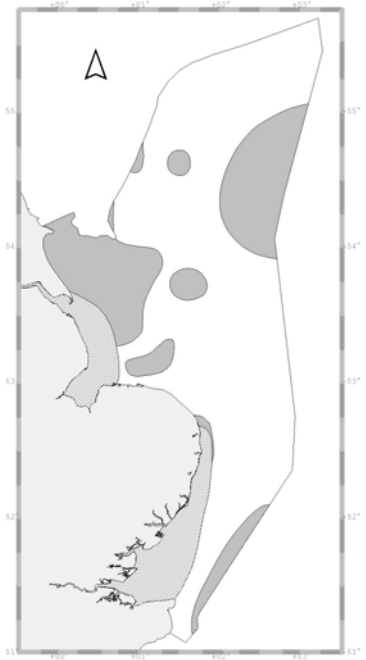


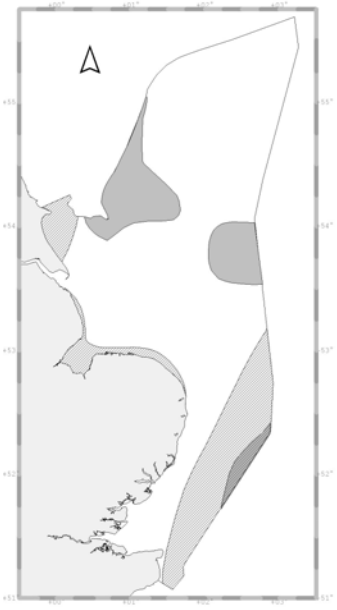
Figure 5.2 Records of Cetaceans seen in the Southern North Sea Natural Area. (after Evans *et al* 2003).



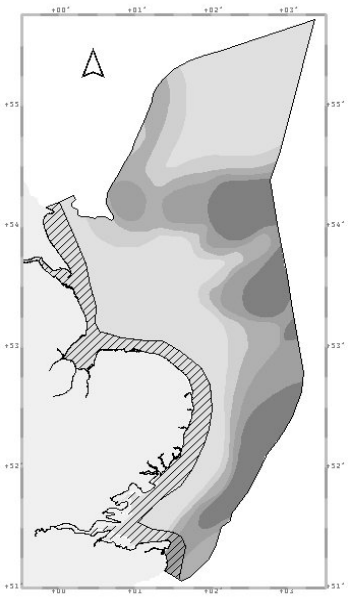
a) Distribution of mackerel spawning (May–Aug) and nursery areas within the southern North Sea Natural Area.



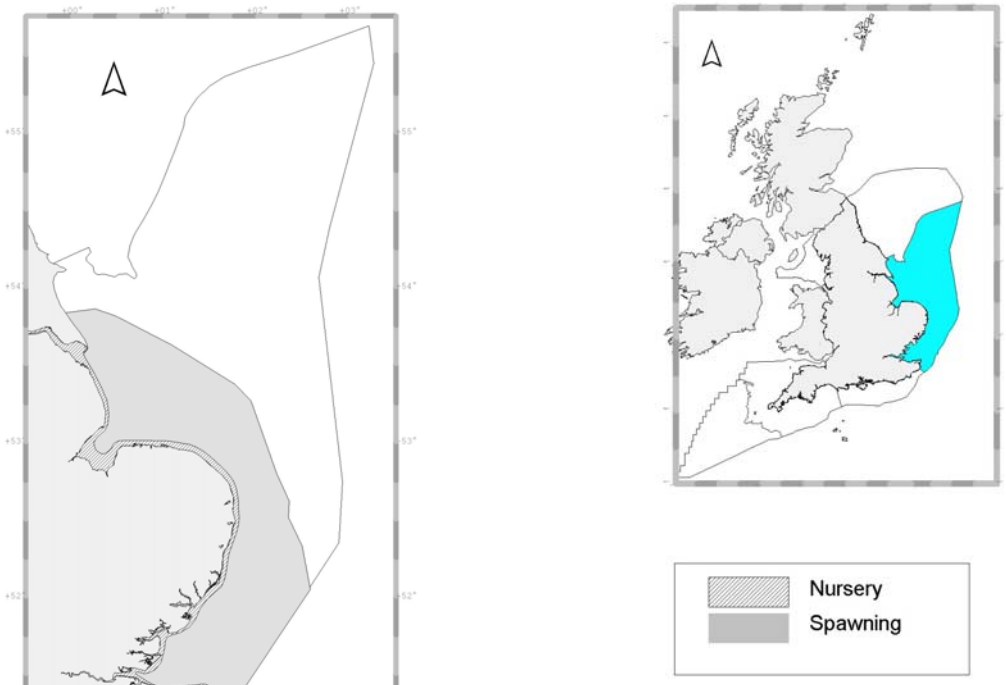
b) Distribution of herring spawning (autumn–winter) and areas within the southern North Sea Natural Area.



c) Distribution of cod spawning (Feb–April) and nursery areas within the Southern North Sea Natural Area.



d) Distribution of plaice spawning (Dec–March) and nursery areas within the Southern North Sea Natural Area (dark grey = intensive spawning → light grey = low intensity spawning)



e) Distribution of sole spawning (March–May) and nursery areas within the Southern North Sea Natural Area.

Figure 5.3 Maps showing the distribution of spawning areas within the Southern North Sea Natural Area (data provided by CEFAS and based on Coull *et al* 1998).

6. Human activity and use

This section outlines significant human activities in the Mid North 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 activites of the Mid North 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

This area of the southern North Sea forms an important focus for fishing activity. The region is an important area for populations of a number of commercial fish species, providing spawning grounds and nursery and feeding areas (see section 5.4). Consequently, it is an area of considerable importance for fishing activity. There are four major fishing ports (as defined by Defra) within this Natural Area - Bridlington, Kingston upon Hull, Grimsby and Lowestoft, as well as numerous other smaller ports that land fish (see Figure 6.1).

Apart from the finfish fishery, trawling occurs for shrimp along the Lincolnshire, Norfolk coast and in the Wash. Dredging for mussels and suction dredging for cockles takes place within the intertidal area of the Wash.

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. Examples of towed gears include beam trawls, dredges and trawl nets. These may be further considered in terms of mid-water and bottom trawl nets, depending on the depth of water and the species being caught.

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 digs into the seabed leaving tracks and disturbs the surface sediments (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 substrata and its physical characteristics (Jennings & Kaiser 1998; Lindeboom & De Groot 1998). The tracks will gradually fill and the time taken for this to happen depends on the type of ground, the depth of water (usually less than 50 metres), the strength of the tide and overall weather conditions. Other types of towed gear can also alter the substrata.

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).

Beam trawling is practiced throughout this Natural Area in low intensities. In the southern part of the Natural Area the main target species is sole, whereas brown and pink shrimp are targeted off the Lincolnshire coast and in The Wash.

Otter trawls - Otter trawls are mainly used to catch species such as cod, plaice, sole and lobster. 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 also results in the capture of a considerable amount of by-catch species. Otter trawling is carried out throughout the Natural Area, but in particular offshore from Bridlington within 50–100 nautical miles and within 12 nautical miles of Flamborough Head.

6.1.1.2 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. This gear also has the potential to continue fishing if lost or discarded, an effect which has been described as 'ghost fishing' (Kaiser *et al* 1996) (see section 6.6). Within this Natural Area the intensity of static gear fishing decreases away the coast. Most intensive activity occurs between The Wash and Dover. The main target of static gear is cod, whiting, pollack, ling, sole, plaice, skates and rays. Potting for crabs and lobsters takes place throughout this Natural Area, with some whelk potting. Long-line fishing takes place in this Natural Area for cod, skate, bass and whiting.

6.1.2 Stock depletion

One of the consequences of over-fishing is stock depletion to the point where there is a risk of stock collapse. The North Sea as a whole is one of the most productive fishing grounds in the world, with an annual harvest of approximately 2-3 million tonnes, equivalent to 3% of the world catch (Marine Conservation Society 2000). In the 1960s the North Sea herring fishery collapsed as a result of over-exploitation. This fishery was closed in 1977 and re-opened in 1981. More recently, record low levels in spawning stock have been recorded for North Sea plaice, haddock, sole, mackerel, skate and cod. A long-term cod recovery plan is in the process of being developed for the North Sea.

6.1.3 Fishing debris

Fishing activity has been identified as one of the four major sources contributing to litter found on UK beaches (Marine Conservation Society 1999). Items such as fishing nets, fish boxes and buoys from the fishing industry account 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 where nets or pots, lost either because of bad weather, snagging, being 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.

6.1.4 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)).

6.1.5 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 extraction

Gas production dominates the central and northern region of this Natural Area. The gas fields are located in an area between 25-30 kilometres offshore and extend eastwards out to the median line; their location is determined by the structural 'highs' of the continental shelf

(see Figure.6.2). 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. Of the 249 blocks within the Southern North Sea Natural Area, 20 were licensed in the 2001/02 20th licensing round. Further details of the 21st round are available at http://www.og.dti.gov/upstream/licensing/21_11_rnds/index.htm. Further information can also be obtained from the DTIs Strategic Environmental Assessment reports SEA2 and SEA3 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 by 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 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. 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. In addition to this sesmic surveys should follow the JNCC's *Guidelines for minimising disturbance to marine mammals from seismic survey*s (www.jncc.gov.uk/ marine/seismic_survey/default.htm#minimising).

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 (lack of oxygen) 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 now rarely used).

It has been suggested that contaminated cuttings quickly disperse in the North Sea with little impact on the seabed around the drilling area, and so decreasing the effects of exploration.

6.2.3 Development and production

Seabed disturbance occurs as a result of the construction/placement of the platform and its subsequent presence and use. 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 can disturb 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 comprise hydrocarbons, heavy metals, naturally occurring radioactive material and possibly organochlorines such as polychlorinated biphenyls (PCBs) (Environment Agency 1998). Another concern is that the dismantling of platforms may disturb the piles of contaminated drill cuttings on the seabed, which will 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 and English Nature (within 12 nautical miles) as well as with 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 anticipated Statutory Procedures are to be administered by the 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 anticipated Interim and Statutory Procedures have provision to hold a public inquiry if necessary.

A large proportion of Great Britain's licensed areas occur within this Natural Area, in particular offshore from the Thames and Humber Estuaries, as well as the Norfolk and Suffolk coasts (see Figure 6.3). In a report published by the British Marine Aggregate Producers Association (BMAPA 2002) the total area licensed for aggregate extraction within this Natural Area was reported to be 1052.69 square kilometres, of which 124.6 square kilometres (11.8%) was actually dredged in 2001.

The physical impacts of marine aggregate extraction arise from removing the substrata and altering the seabed topography; creation of a turbidity plume within the water column in the area of activity, and sediment redeposition. Dredging disturbs the benthic community and can 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 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. John *et al* (2000) identified reduced light penetration as a result of turbidity as one of the main water quality issues arising from increased suspended sediments in the water column. High levels of suspended sediments, along with the associated reduced light penetration, can adversely affect primary production within the water column (Iannuzzi *et al* 1996).

Redeposition of the particles from these sediment plumes will also occur and, once settled on the seabed, will be liable to resuspension or transport over the substrata. A consequence of this is the smothering of benthic species, which may suffocate many suspension-feeding invertebrates. This may also smother fish eggs on spawning grounds.

6.4 Shipping

6.4.1 Commercial

Some of the world's busiest shipping lanes are within the Southern North Sea Natural Area. At any one time there are around 5,000 ships operating throughout the whole of the North Sea (Safetec 2000). Many different types of vessel operate in this area (see 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 and the advent of the oil tanker, which is the largest carrier of cargo, had a significant effect on shipping. 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. Much of the marine pollution may be traced back to centres of population and to industrial and agricultural operations. There are four potential areas of concern with commercial shipping:

- **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** - these consist 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, and at what time of year. Within this Natural Area the predominant types of shipping vessels are cargo carriers (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 (see Figure 6.5). Of the 30 oil spills that occurred in and around the Southern North Sea Natural Area during 1989-1998, a total of 137 tonnes of oil were released into the environment (Safetec 2000).

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 such as seaduck, divers and grebes that are found within this Natural Area, moult their feathers simultaneously, becoming temporarily flightless (Tasker *et al* 1993). This makes 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 localised incidents can have a significant impact on 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 is that 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 of number of vessels passing through the Southern North Sea Marine Natural Area in 1999. (Data taken from COAST database).

Vessel type	Annual total for Southern North Sea Marine Natural Area
Bulk	11,548
Cargo	90,530
Ferry	28,870
Gas Carrier	6,204
Ro-Ro	32,680
Standby	438
Supply	1,689
Chemical tanker	11,822
Oil tanker	16,172
Shuttle tanker	532

6.4.2 Ferries

A proportion of the marine traffic within this Natural Area is composed of ferries that transport cars and passengers across the North Sea. On average 82 ferries pass through this Natural Area per week (see Figure 6.6). Passenger 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). Disposal of dredged material in UK territorial waters is controlled under the Food and Environment Protection Act 1985 which requires a licence for deposit of substances or articles on to the seabed.

A range of materials, including sewage sludge and industrial waste, were disposed of at sea in the past. However, industrial waste disposal was phased out in 1992 and incineration of liquid industrial waste on special incinerator vessels in the North Sea was terminated in 1989. The disposal of sewage sludge has been banned under the OSPAR convention since 1 January 1999. The largest site (historically) for the disposal of sewage sludge within the Natural Area was near the mouth of the Thames estuary at Barrow Deep. Other disposal sites included Spurn Head and Harwich. Licensed industrial waste disposal sites were also present at Spurn Head. There is currently little information on the continuing effects of sewage sludge disposal since it ceased in January 1999. However, data is being collected by CEFAS under the auspices of the National Marine Monitoring Programme from a number of the ex-

disposal sites. This will hopefully provide some insight into the long-term impact of sewage sludge disposal.

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 and localised effects of disposal 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 Commission 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). In 1991 the North Sea (along with the Baltic Sea) were designated as MARPOL Special Areas (Annex V), where the disposal of garbage and litter from ships is prohibited.

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 Southern North Sea Natural Area (see 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 centimetres, although they can often be scoured out by tide and currents 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. However, the environmental effects of cable laying are limited (Department of the Environment 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. Six windfarms within the Southern North Sea MNA from this first round have received development consents and construction is underway at one of these, at Scroby Sands near Great Yarmouth. 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. Much of the marine environment within this MNA lies within the Greater Wash Strategic Area where eleven further locations have been leased for windfarm development under Round 2 (including four areas beyond 12nm). 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.

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.

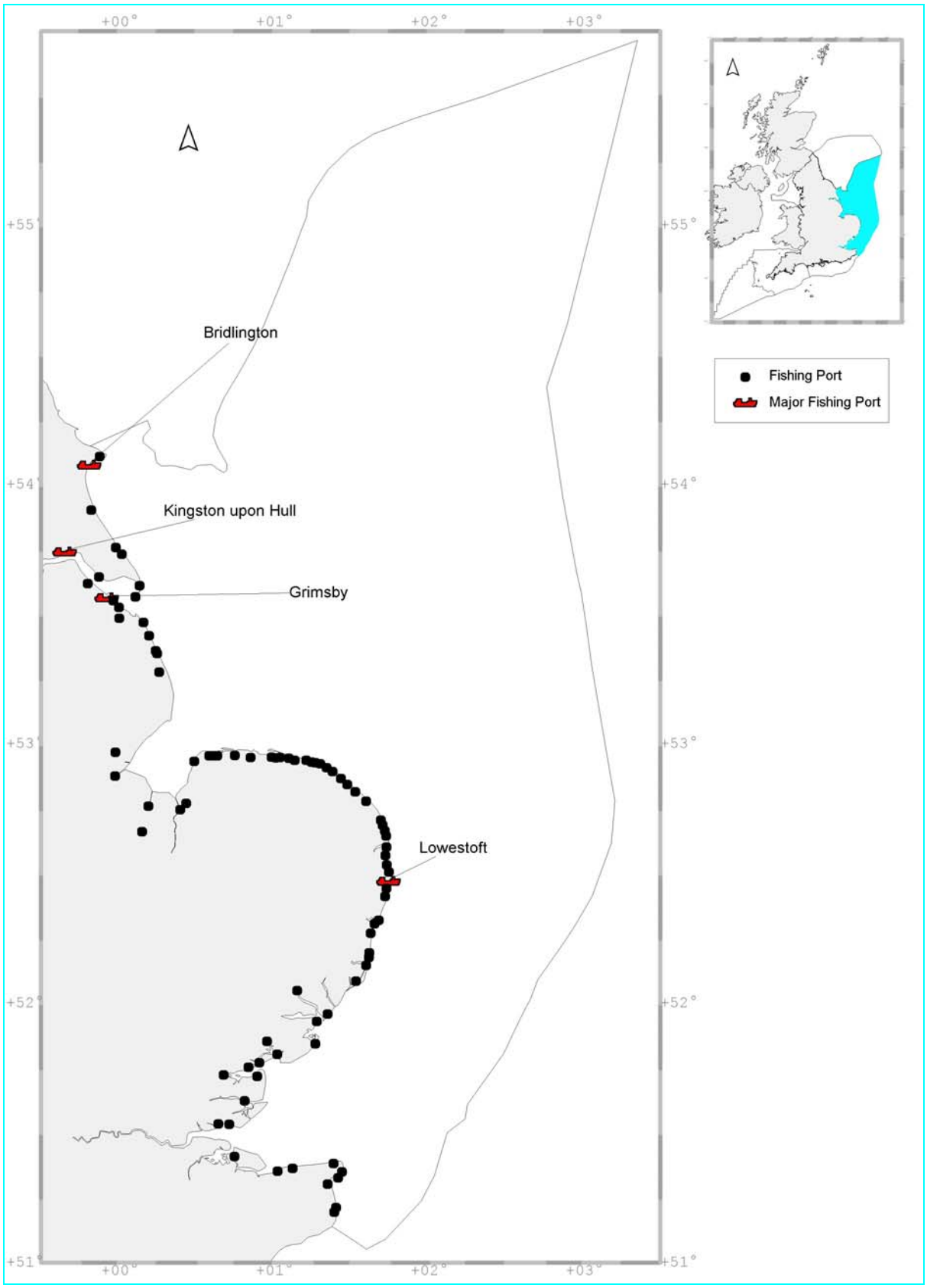
Chaired by the Crown Estate, the Collaborative Offshore Wind Research Into the Environment consists of members representing industry, NGOs and statutory nature conservation bodies including English Nature. The Group operates a research fund from the interest accrued from seabed leases granted as a result 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* 1995) and English Nature's 'Regulation 33 Packages' (eg English Nature 2000).

Within the past 30 years there have been many infrastructure developments along the coast of this Natural Area, including marinas, yacht moorings, dinghy parks and launching slips. These developments have often been concentrated in or near large conurbations, where new and proposed water sports centres are sometimes a part of schemes to regenerate waterfronts. Limited facilities, primarily recreational craft moorings, are also found in most of the small harbours along the coast, and there are facilities for watersports around the main estuaries (Dunbar & Fowler 1995).

Sailing is very popular within the Southern North Sea and this Natural Area provides numerous harbours, marinas and sheltered areas for the ever increasing number of boat owners. Sidaway (1991) recorded six marinas in Suffolk, 11 in Essex, 12 in Kent and one in Norfolk, indicating that much of the sailing activity in this Natural Area is located in the south. Whilst sailing has limited impact on the marine environment, motorboating often has an effect. Within this Natural Area the biggest threat motorboating poses is through noise and visual disturbance to seals at their haul-out sites. This has been recognised as a major threat to seal populations within The Wash and North Norfolk Special Area of Conservation, with populations being highly vulnerable to this kind of non-physical disturbance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Fishing Port
Major Fishing Port

Figure 6.1 Distribution of fishing ports in the Southern North Sea Natural Area (data provided by CEFAS).

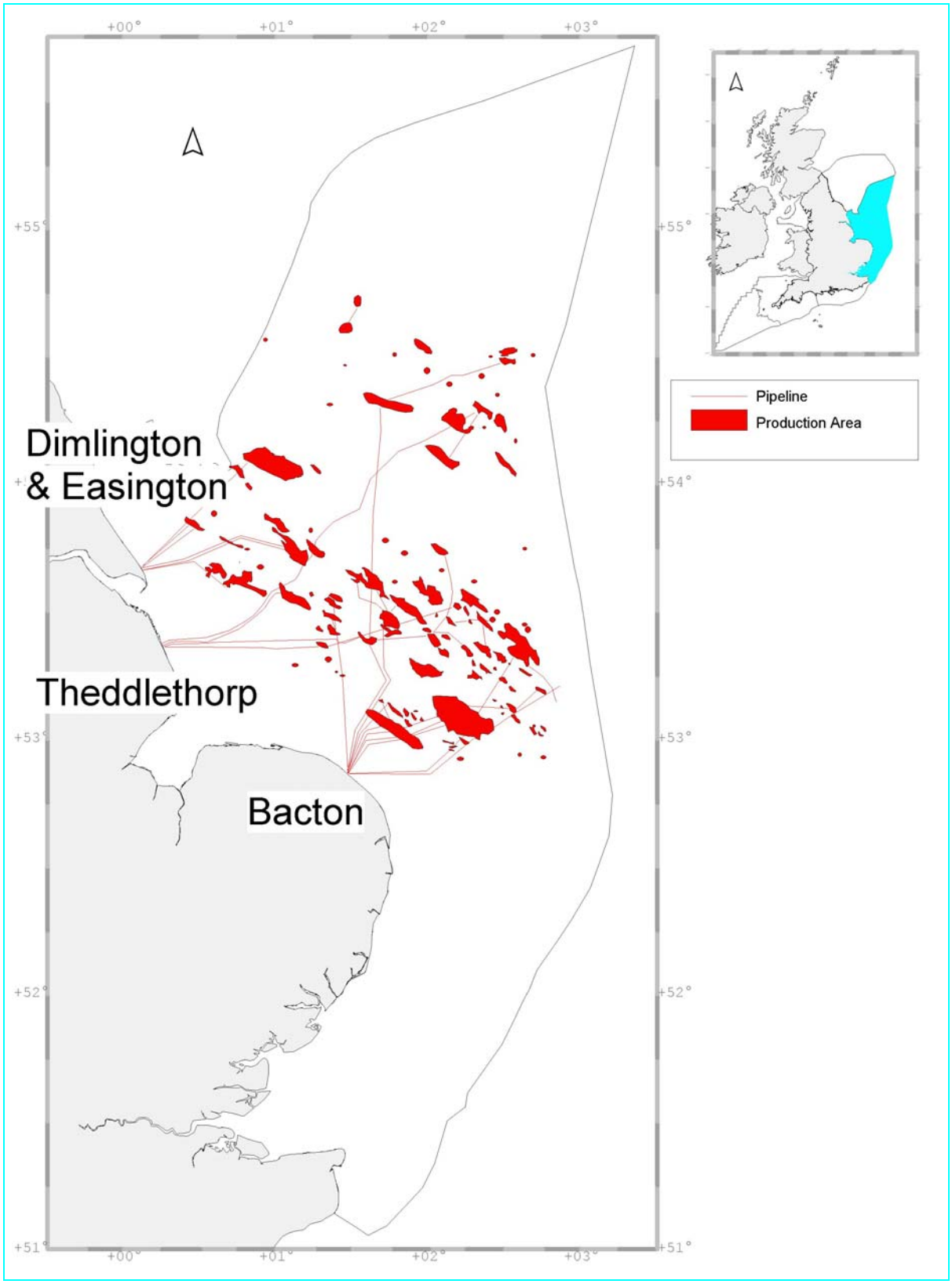

Figure 6.2 Map showing the distribution of gas fields and pipelines in the Southern North Sea Natural Area.

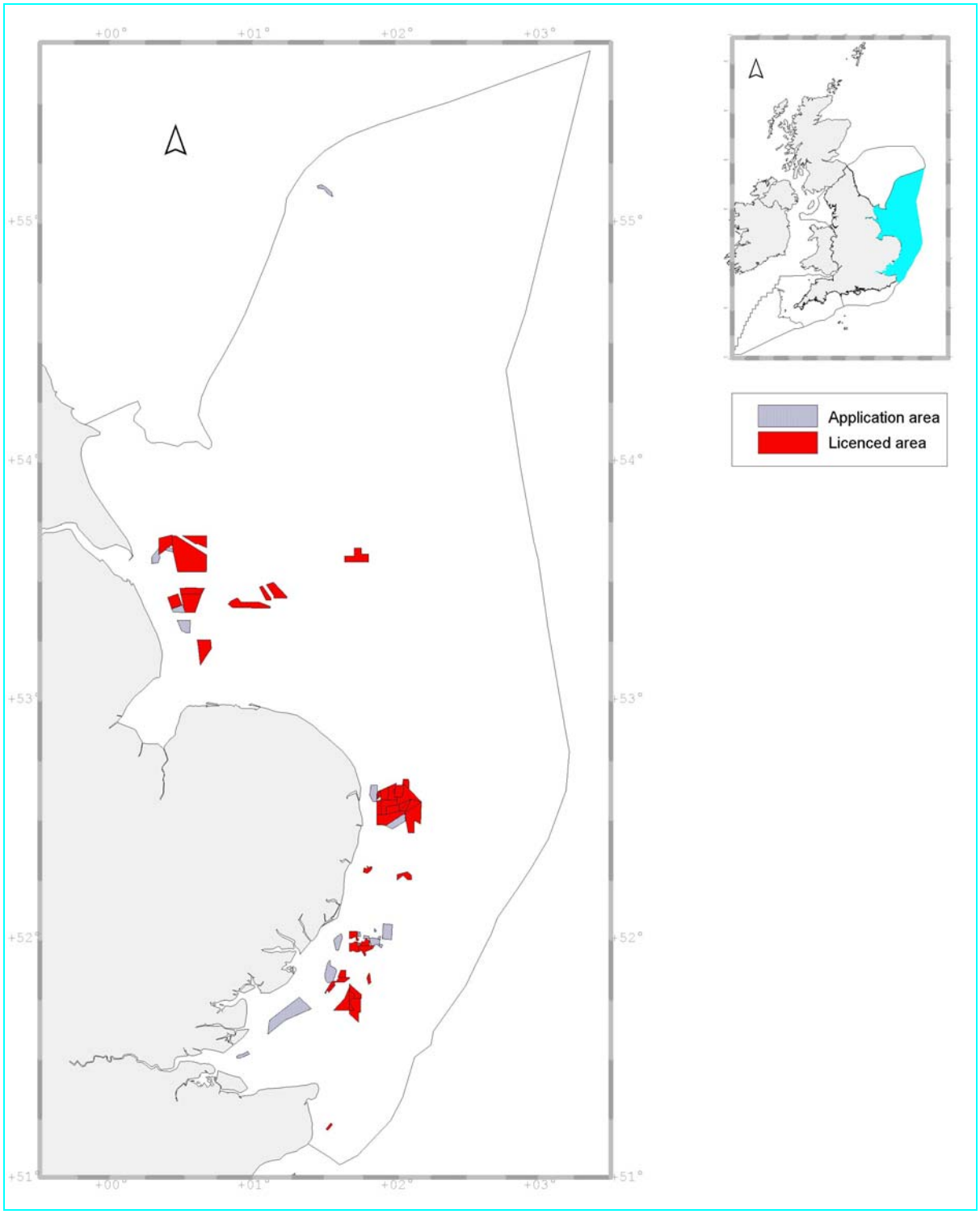

Figure 6.3 Map of areas under license and application for aggregate extraction in the Southern North Sea Natural Area (data provided by Crown Estates in 2003).

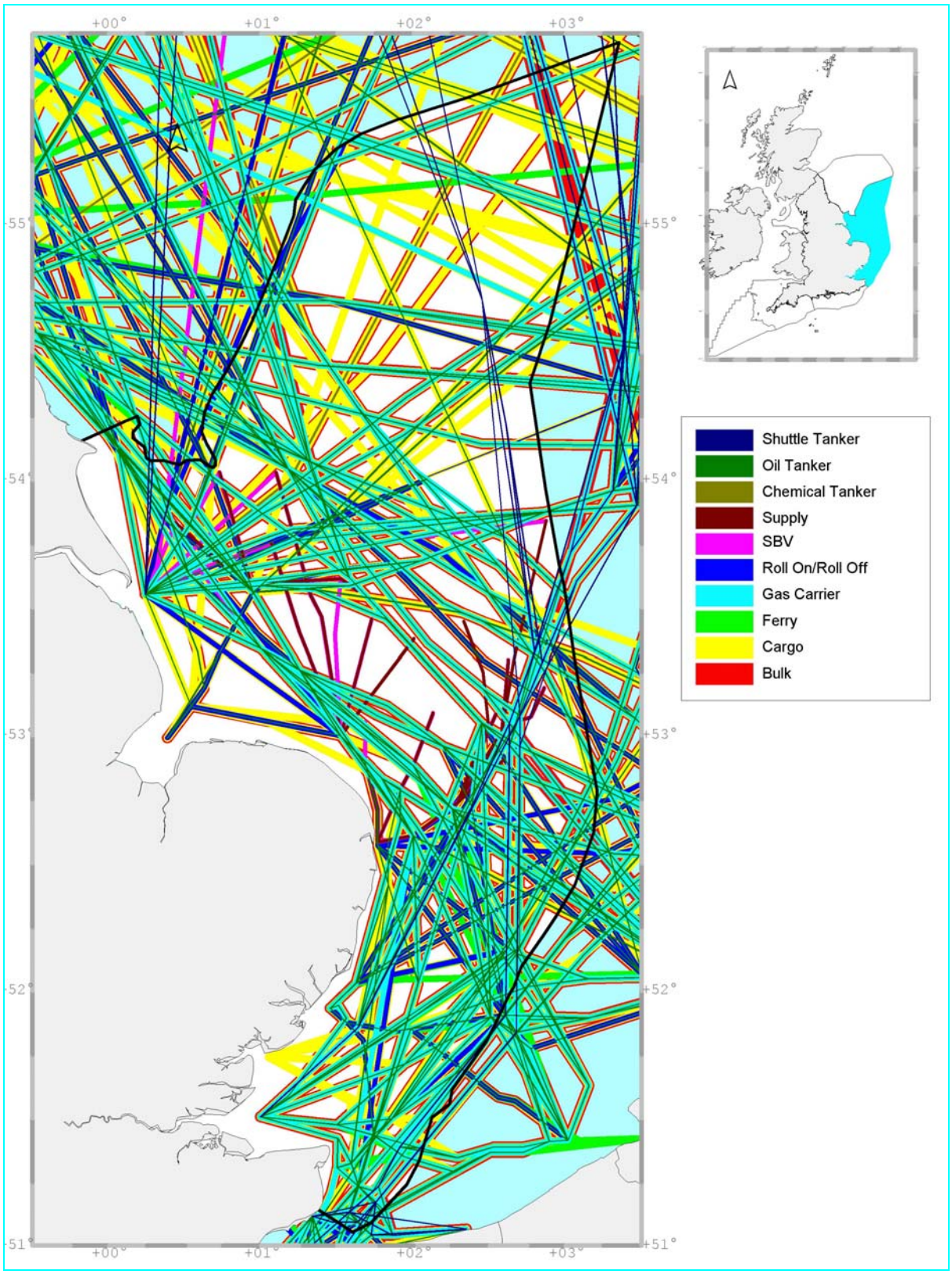

Figure 6.4 Map showing the various types of vessel operating with the Southern North Sea Natural Area during 1999. (SBV = Standby vessel) (Data taken from COAST database)

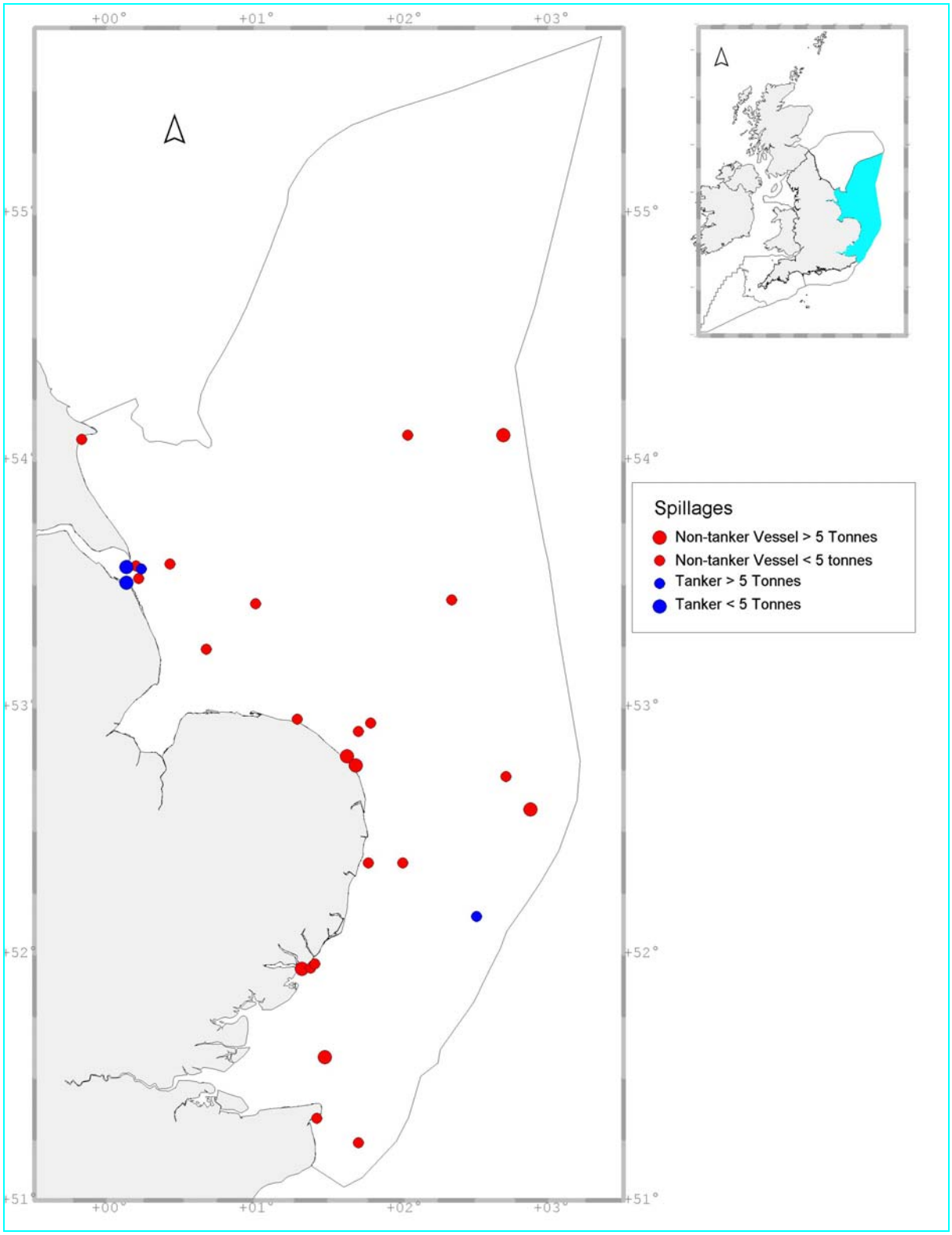

Figure 6.5 The distribution and size of oil spills in the Southern North Sea Natural Area in the period 1989–1998 (ACOPS data from COAST database).

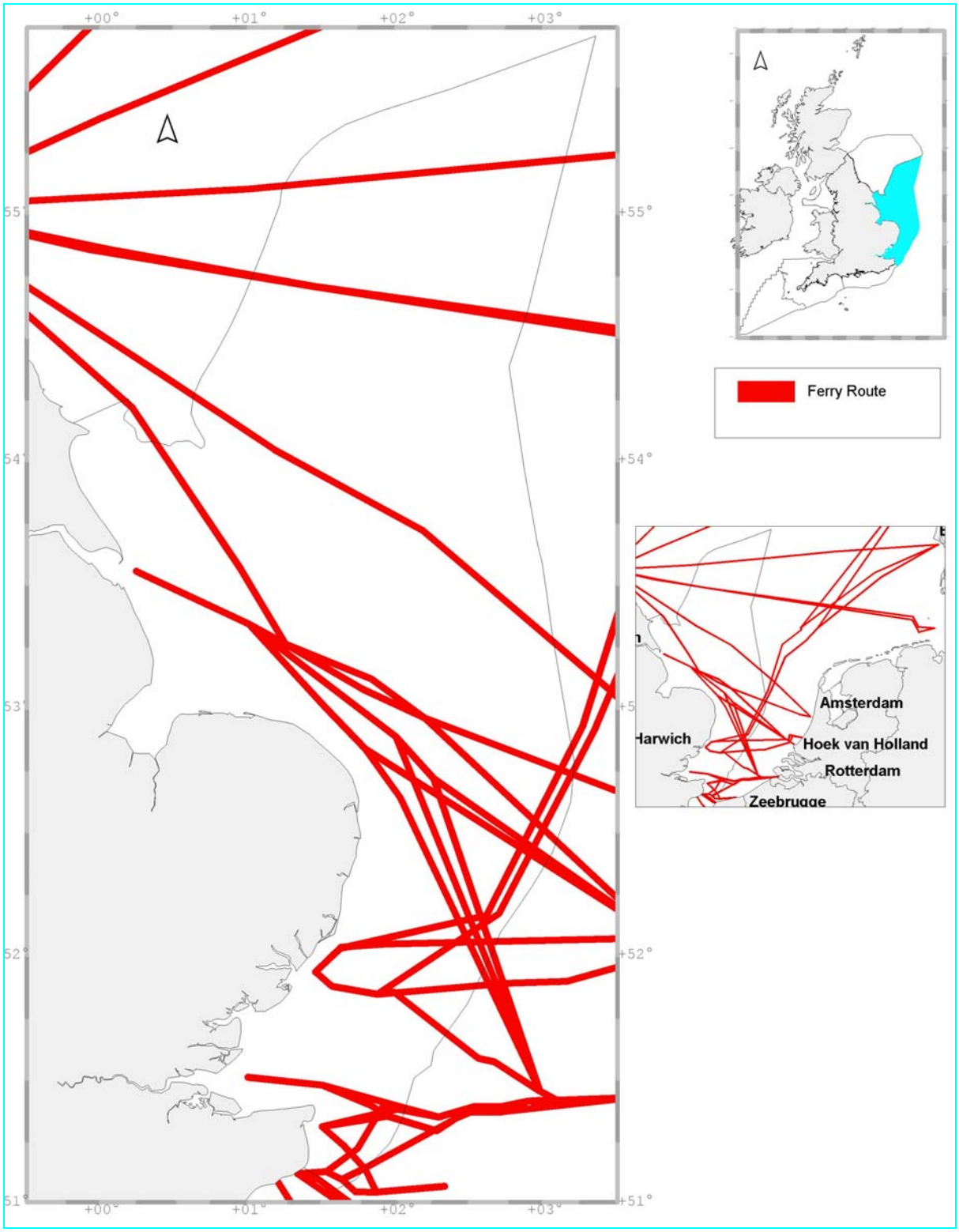

Figure 6.6 Map of ferry routes crossing the Southern North Sea Natural Area.

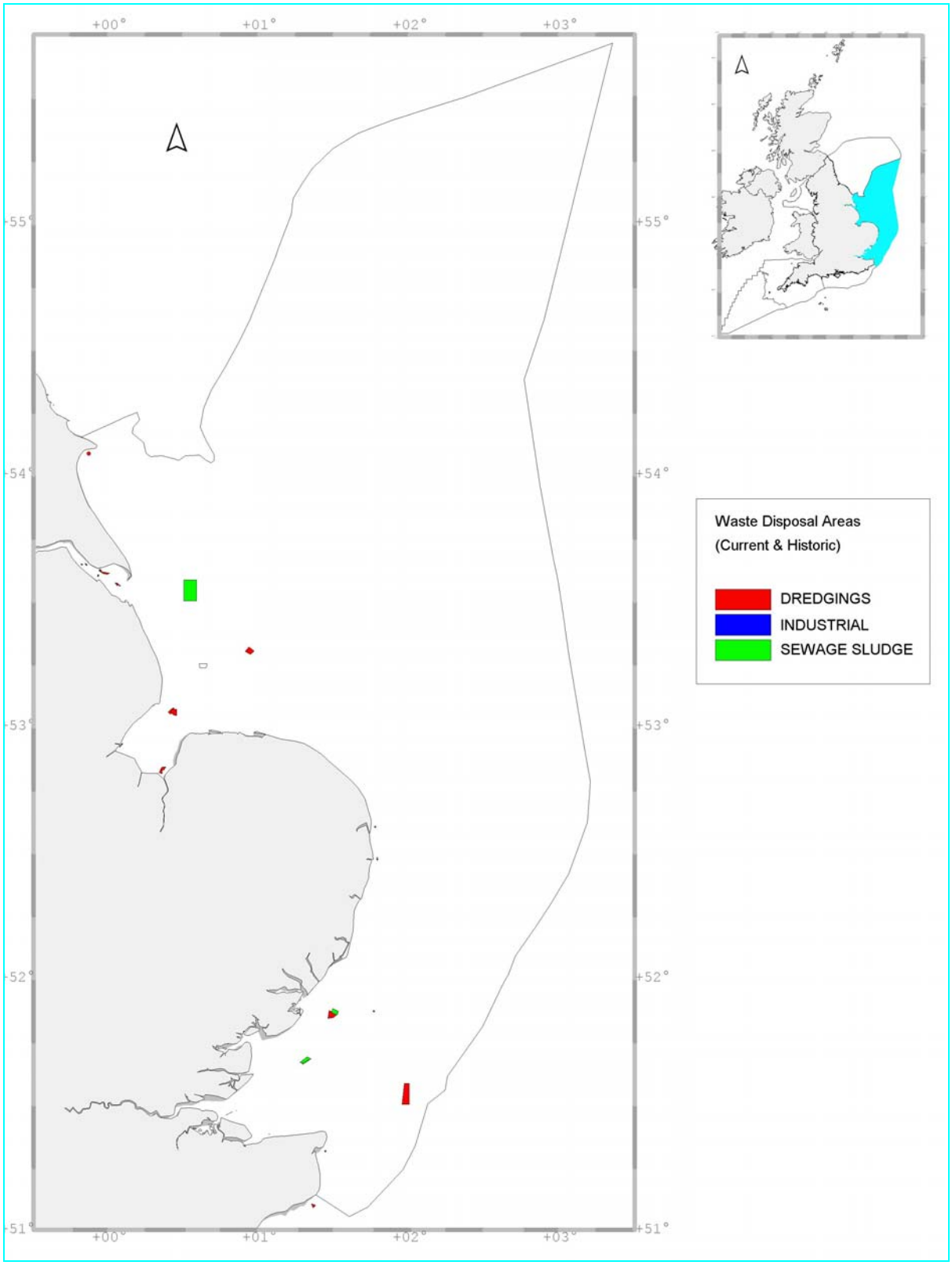

Figure 6.7 Distribution of disposal sites (current and historical) in the Southern North Sea Natural Area (data provided by CEFAS).

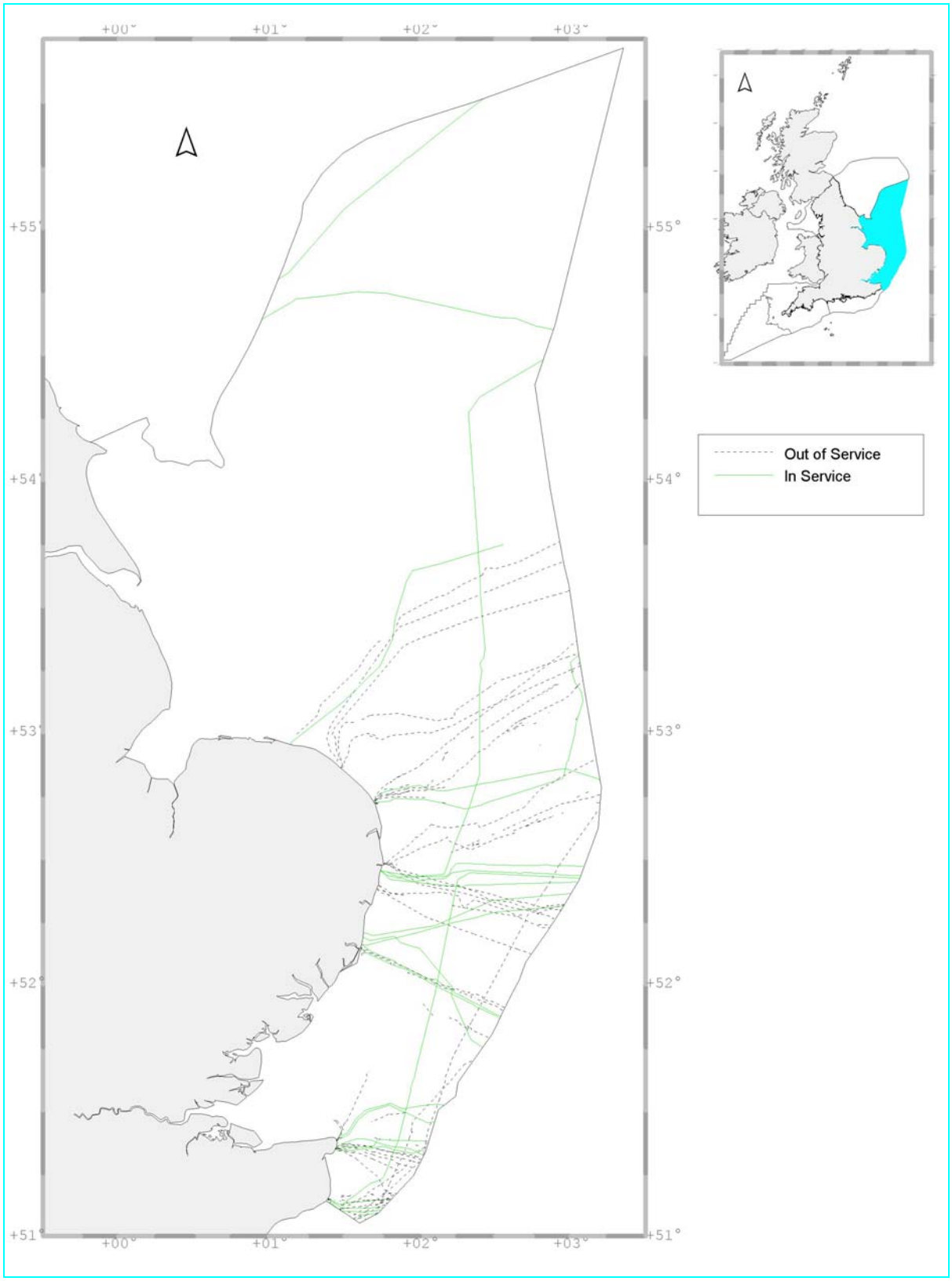

Figure 6.8 Map of submarine cables passing through the Southern North Sea Natural Area (data provided by Global Marine Systems).

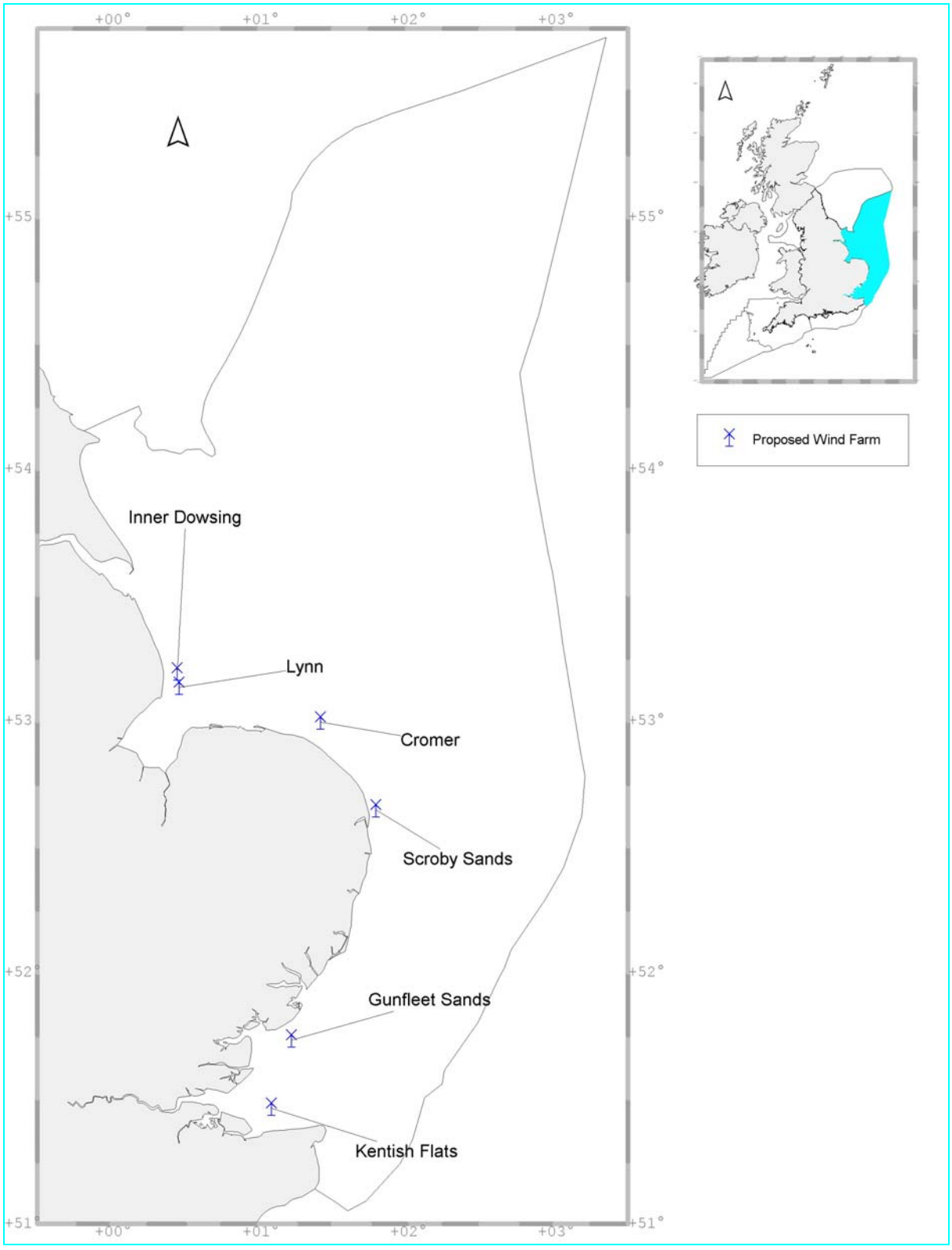

Figure 6.9 The approximate distribution of proposed wind farms in the Southern North Sea Natural Area (data provided by Crown Estates).

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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 though 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

After Volume 5 of the *UK Biodiversity Group Tranche 2 action plans*

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 sea water all the time
	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
		Cobble		
-6	64	Pebble		
-2	4			
-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).

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
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)
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
MLS	Minimum Landing 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
ng/l	Nanograms per litre
µg/l	Micrograms per litre
NMMP	National Marine Monitoring Programme
NVZ	Nitrate Vulnerable Zone
N2K	Natura 2000
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

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Bottom left: Seawater surface temperatre for all Natural Areas 1997. © Natural Environment Research Council (NERC) & Plymouth Marine Laboratory (PML) 2004
Main: Gannets taking flight. The Flamborough Head & Bempton Cliffs SPA adjacent to this Natural Area support the only mainland gannetry in England. Andy Hay/RSPB

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