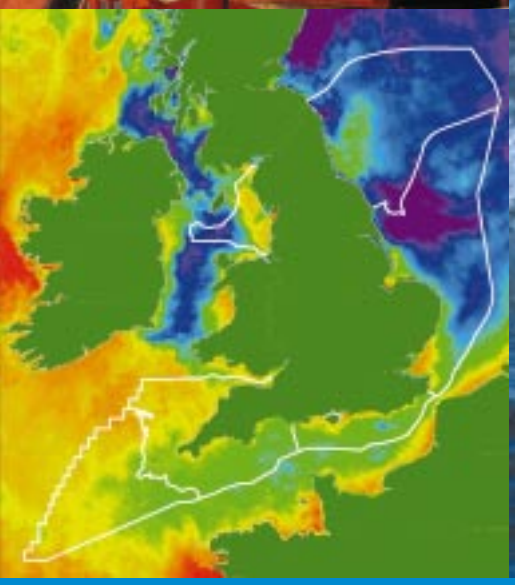
ENGLISH NATURE

The Eastern Channel 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.

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Contents

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1 Introduction

1.1 Definition and role of Marine Natural Areas

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

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

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 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

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

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

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

1.3 The audience for this document

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

1.4 The aim and structure of this document

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

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

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

Whilst the document contains some technical information it does not attempt to go into any great level of detail on any particular topic. Therefore, the reader may wish to follow up on a particular topic by referring to other technical reports such as the JNCC's *Coastal Directories,* the Marine Nature Conservation Review (eg Hiscock 1998), 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 Society (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 2002).

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* 2003, 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.

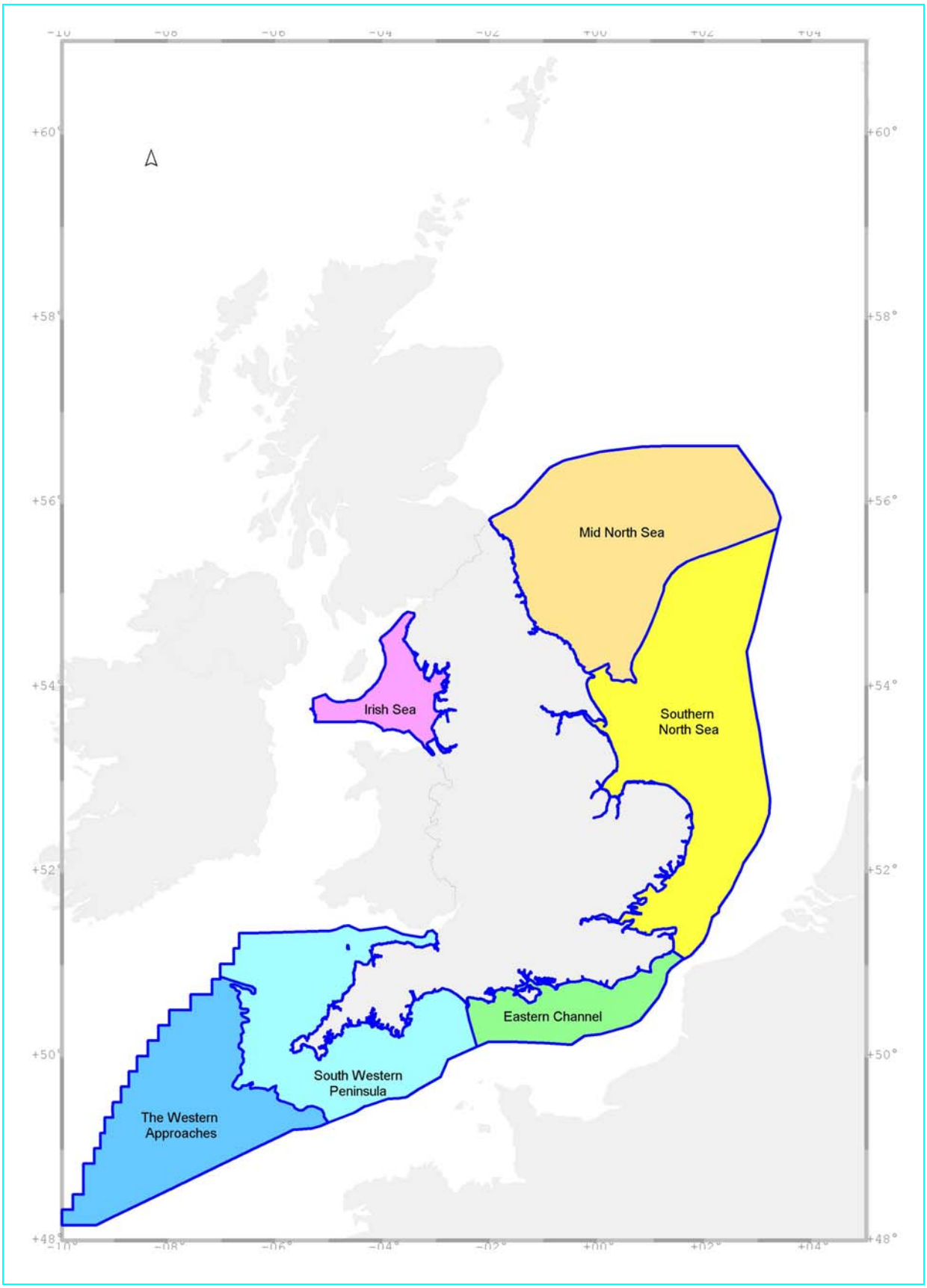


Figure 1.1 The six Marine Natural Areas around England.

2 General summary

The Eastern Channel Marine Natural Area extends west from Dover to Portland Bill. The inshore boundary is Mean Low Water (MLW) and the offshore boundary is the limit of UK jurisdiction. The area above MLW is within English Nature's coastal series of Natural Areas, whose boundaries are set out in Figure 2.1. The western boundary follows the well documented transition between the relatively colder and warmer waters of the Boreal and Boreal-Lusitanean biogeographic provinces (Dinter 2001) which intercepts the coast at Portland Bill (Figure 2.1).

Within this Natural Area there is a transition occurs between Atlantic and North Sea influences. This occurs in conjunction with a transition from hard substrates to soft substrates and limits the distribution of more southerly species within the English Channel from west to east (Doody *et al* 1993).

Much of the seabed of the Eastern Channel Natural Area is composed of mixed sand and gravel sediments, particularly to the south and west of the Isle of Wight. There is a UK Biodiversity Action Plan for sublittoral sands and gravels. Certain areas of chalk substrate present within the Natural Area (particularly south of the Isle of Wight) are nationally and internationally important and are protected under the EC Habitats Directive as reef habitat. There is also a Biodiversity Action Plan for 'Littoral and sublittoral chalk reefs'.

Many important species occur within the Natural Area, including bottlenose dolphin and harbour porpoise, in the western part in particular. Several of these species are covered by UK Biodiversity Action Plans (BAPs). There are grouped BAPs for commercial marine fish, baleen whales (which are seen only rarely in this Natural Area) and small dolphins. There is also a Species Action Plan for harbour porpoise. Other BAP species which occur within the Natural Area include basking shark and native oyster.

The main commercial activities within the Eastern Channel Natural Area are aggregate extraction, shipping (including ferry traffic) and fishing. The main commercial fish species targeted in this area (in order of decreasing tonnage of landings) are plaice, Dover sole, whiting, cod, pollack, horse mackerel, lemon sole, skates & rays, dab, flounder and sprat, with important nursery areas for cod, Dover sole and plaice. There are also important fisheries for crabs, mussels, scallops, lobsters and whelks (Barne *et al* 1996, 1998a, 1998b).

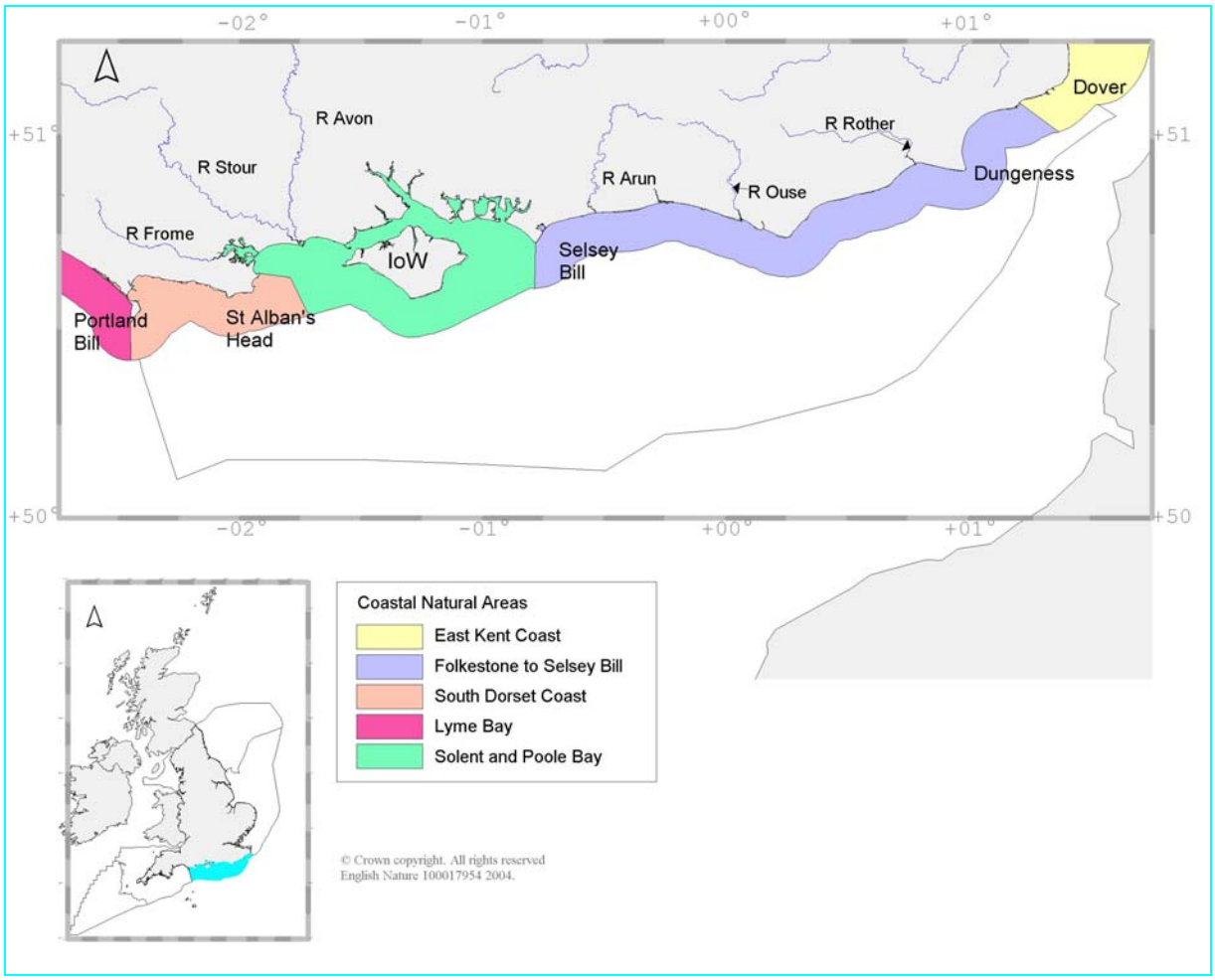


Figure 2.1 Eastern Channel Marine Natural Area, adjacent Coastal Natural Areas and places mentioned in the text.

3 Physical environment and character of the Natural Area

This section outlines the geology, physical processes and chemical conditions 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, human influences on physical and chemical characteristics, such as water quality, are described in the same section.

3.1 Geology

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

The geology of the Eastern English Channel floor can be divided into two parts: firstly, the Quaternary deposits of sand and gravel which dominate the sea floor (see Figure 3.1), and secondly the older bedrock that lies beneath them. The youngest bedrock here is the Tertiary rock found in the centre of the Natural Area. The majority of the remainder of the offshore geology is Cretaceous in age. There is also an area of Jurassic rocks in the west of the Natural Area between Portland and St Albans Head.

The recent history of this area is controlled not by global tectonic influences but mainly by changing sea levels caused by various glacial periods. Although glaciers never reached the Channel, it was affected by the changing global climate. As the ice caps increased in size there was less seawater available and so sea levels dropped. During these periods of lower sea levels many large rivers developed and cut valleys in those areas that had previously been covered by the sea. The sands and gravels which filled-in these palaeo-valleys are now covered by seawater and are an important economic resource as marine aggregates.

Seabed sediment varies in thickness from virtually none where the bedrock outcrops (such as south of Weymouth and Fairlight) to 40 metres in the sand deposits on the meridian line south of Dungeness. Apart from those areas mentioned above, where the older bedrock is exposed, a lag deposit (a deposit formed through the removal of finer sediments by currents to leave a relatively coarse deposit) covers the seafloor of the Marine Natural Area. This lag deposit is thickest where it overlies the palaeo-valleys but elsewhere is usually less than 50 centimetres thick. On the whole, deposits of gravel and sandy gravel cover the area, although the deposit becomes more varied closer to shore and further east.

Unlike other Marine Natural Areas there are no extensive offshore rock outcrops here, which can be an important habitat. This is because the relatively young rocks which make up this area are easily eroded.

3.2 Bathymetry

The English Channel is relatively shallow, deepening from about 30 metres in the east to over 100 metres at its western end (see Figure 3.3). The seabed topography shows evidence of river valleys that were carved into the seabed during glacial periods when the sea level was lower. The most conspicuous features are two linear, east-west trending troughs. St Catherine's Deep, just south of the Isle of Wight, reaches depths of over 60 metres in places and was probably formed by tidal scour when sea levels were lower than present; the larger Hurd Deep in mid-channel exceeds 160 metres in depth (Doody *et al* 1993). In the Dover Strait, water depths increase from the coasts of England and France to more than 40 metres in the centre of the Strait.

Dramatic seabed features which occur within this Natural Area include the 67-metre-deep 'hole' at the Shoal of the Lead of the Outer Owers reef, some 8 kilometres east-south-east of Selsey Bill. (The incline of the northern side drops from 0 metres to 67 metres within a horizontal distance of about 40 metres.) There is also the Mixon Hole, a 20 metre near-vertical cliff of clay capped by limestone, which is found 2 kilometres south-east of Selsey Bill.

3.3 Tidal currents and range

The tidal currents in the English Channel flood eastwards and ebb westwards. Overall, there is a residual flow of water entering the North Sea from the eastern end of the English Channel, though this accounts for just 10% of the inflow into the North Sea. The maximum tidal current speed at the eastern end of the Natural Area is at Dover (about 1.75 metres per second) owing to the restriction of the Channel. As a result of this, tidal sand ridges aligned with the direction of flow have formed. The strongest tidal currents, however, are present off Portland Bill at the western end of the Natural Area, where they may reach over 3.5 metres per second (British Geological Survey 1996a). Strong tidal currents, often with associated overfalls, occur off pronounced headlands such as Selsey Bill, St Catherine's Point and St Alban's Head. Overfalls occur where the seabed falls away sharply, and where surface water travels faster than that close to the seabed, leading to down-flows of water (similar to eddies). Within the main embayments, such as Rye Bay on the Kent/East Sussex border, Christchurch Bay, Poole Bay and Weymouth Bay, currents are relatively weak, especially in shallow water. For much of the central part of the English Channel the maximum speed of tidal currents is between 0.75 metres per second and 1.25 metres per second.

Within the Solent, strong currents flow through the Hurst Narrows (1.8 metres per second on spring tides) at the western entrance to the Solent (Velegrakis 1994). However, at the entrances to Portsmouth, Langstone and Chichester Harbours, surface currents may reach in excess of 3 metres per second on a full spring ebb (Admiralty Chart 3418).

The tidal range for this Natural Area is greatest in the east, being 7.0 metres near Dungeness. The smallest tidal ranges in the whole of the UK, less than 2.0 metres at spring tides, are found in the Poole/Christchurch Bay areas. West of Swanage the range increases, but even at Portland at the western boundary to the Natural Area it is only 2.5 metres. Tidal range increases progressively offshore into the English Channel.

One peculiar feature of the tides in the western part of this Natural Area is the distortion of tidal curves due to the effect of shallow water. A consequence of this is that tides have a

marked ‘double low water’ between Portland Harbour and Kimmeridge Bay. From Swanage to Southampton ‘double high waters’ occur. In Poole and Christchurch Bays, this distortion results in a long stand of the tide at, or very close to, the high water level (British Geological Survey 1996a).

3.4 Sea-level change

3.4.1 The past and present

Apparent changes in sea-level arise 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 (IPCC 2001). This is known as eustatic or sea-level change.

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

Estimates for relative sea-level rise in this Natural Area vary considerably. Emery & Aubrey (1985, 1991) and Wallace (1990) suggest that the strongest crustal subsidence in Britain is focused upon West Sussex and south east Hampshire. Emery & Aubrey (1985, 1991) indicate a relative sea-level rise of 6-8 millimetres per year centred on Sussex, reducing to 2-4 millimetres per year in Dorset and Kent. Shennan (1989), however, suggests a relative rise in sea-level within the region of only 2-3 millimetres per year.

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 Intergovernmental Panel on Climate Change have predicted that mean sea level would rise by 48 centimetres by 2100 and the range will vary between 9-80 centimetres, as a result of the thermal expansion of ocean water and melting ice from the poles. It should be noted that the rise in sea level relative to the land will be greater than the global average in the southern and eastern England Natural Areas, as the land here is sinking. Extensive sections of the coast within this Natural Area are at risk from flooding. Several stretches could be affected by a combination of sea level rise and increased storminess.

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

on climate change is the Proudman Oceanographic Laboratory website (**www.pol.ac.uk/ntslf/reports**).

3.5 Water temperature

Sea surface temperatures in this Natural Area are strongly influenced by the movement of water along the English Channel which modifies the influence of continental Europe. In winter, relatively warm waters move up the English Channel, and average February temperatures range between 6.5º C and 8º C. In August, surface water temperatures in the central English Channel are on average 16-16.5 ºC (Lee & Ramster 1981). During the summer months, temperatures increase northwards from the middle of the English Channel towards the coast.

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 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

Although slightly lower than in winter (when averages are 35.0-35.2), salinity values remain relatively high in summer along the centre of the English Channel (between 34.75-35.0), owing to the eastward movement of Atlantic water. Salinity values decrease towards the coast in both summer and winter but normally remain above 34.5, except locally at river mouths where there is dilution from freshwater discharge.

3.7 Water quality

About 80% of marine pollution comes from a variety of land-based activities (Defra 2002a). Most pollutants enter the Eastern Channel 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, disposal 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 water quality in the Natural Area, including consideration of sediment and biota quality.

3.7.1 Turbidity

Turbidity is a measure of the decrease of light down through the water column and is primarily due to Suspended Particulate Matter (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.

Within this Natural Area, the regions with the greatest concentration of SPM (up to 5 milligrams per litre) occur nearer the coast, particularly in the vicinity of estuaries (OSPAR Commission 2000). In addition, a major factor contributing to the higher levels of turbidity in the Eastern English Channel is the presence of intertidal and subtidal chalk bedrock. Softer parts of the chalk rock are easily eroded and form very fine material ('fines') that is held in suspension for long periods of time (except in very calm conditions). It is only further offshore where the effects of wave action are lessened that areas with lower turbidity (ie clearer water) tend to occur.

3.7.2 Non-toxic contamination

3.7.2.1 Organic matter

Organic matter can enter the Eastern Channel through externally and internally derived sources. External inputs of organic matter include point source discharges of sewage and industrial effluents, and diffuse sources such as agricultural run-off. Organic matter can enter the marine environment in both dissolved and particulate form. However, in common with most land-based sources of pollution, the effects from these inputs are more noticeable in estuaries and nearshore areas and are unlikely to be detected in offshore locations within this Natural Area. Inputs of organic matter exert an increased Biochemical Oxygen Demand (BOD) in receiving waters, which can lead to oxygen depletion in water and sediments. Reductions in point sources of organic matter are being addressed through 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 form the basis for primary productivity. Nitrogen and phosphorus enter Eastern Channel predominantly from point sources, such as sewage treatment works, and from diffuse sources, such as agricultural run-off. Rivers often transport nutrients from both sources. In nutrient-poor waters, atmospheric deposition of nitrogen can be a significant source of this nutrient.

The Southern Nutrients Study (SONUS) was initiated in 1994 to determine the nutrient budget of Southampton Water and to establish fluxes to the English Channel. The amounts of nutrients entering this Natural Area since the mid-1980s have been considerably reduced (Crumpton & Goodwin 1996).

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.

There are areas adjacent to, but not included within, the boundary of this Natural Area that have symptoms of eutrophication, in particular Langstone, Chichester and Portsmouth Harbours (Hydes 2000) and Pagham Harbour, which contain excessive macroalgal growth on mudflats. These sites have been designated as Sensitive Areas under the Urban Waste Water Treatment Directive, and which require nutrient-stripping from significant wastewater discharges where they serve populations in excess of 10,000.

Improvements to sewage treatment under the Urban Waste Water Treatment Directive is likely to reduce some point sources of nitrates. The implementation of the Nitrates Directive (91/676/EC) will also provide some controls on nitrate from diffuse agricultural sources. This Directive requires Member States to designate Nitrate Vulnerable Zones (NVZs) and to produce action programmes to reduce nitrate run-off from agricultural areas. Those areas already identified are shown in the Figure 3.4 below. 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). A Nitrate Vulnerable Zone has been designated in the catchment of Poole Harbour as this has been found to be eutrophic. This area was designated in October 2002.

3.7.3 Toxic contamination

3.7.3.1 Oil

The input of any petroleum hydrocarbons within this Natural Area is most likely be the result of sea-based activities (shipping and oil/gas extraction) or of coastal discharges of sewage and industrial effluents. Oil spills may occur from both ships and offshore installations, and can be the result of both legal and illegal discharges or accidents. The majority of these spills consist of ships' 'bilge oil', but crude oil and lubricating oils also occur along with non-mineral oils (OSPAR Commission 2000). There is currently no oil exploration activity within this Natural Area

3.7.3.2 Trace metals

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

Concentrations of dissolved metals in water vary considerably depending on a number of factors, including the mixing of river and seawater, interactions with particles and the inputs from industrial and sedimentary sources (Millward & Turner 1995). Levels of trace metals in the waters of the English Channel are close to those found in surface waters of the oceans

(Crumpton & Goodwin 1996). Concentrations of dissolved metals in the Solent and adjacent coastal areas are low (see Table 3.1), being typical of other values reported for coastal and shelf sea systems (Statham 2000).

Table 3.1 Concentrations of dissolved trace metals (nmol/L) in the waters of the Solent and the Central English Channel (after Statham 2000).

	Solent	Central English Channel
Salinity range	34.52-34.74	34.86–34.93
Cd	0.20–0.26	0.18–0.31
Co	0.64–1.70	<0.06
Cu	6.0–11.4	2.7–4.0
Mn	6.4–17.4	1.0–1.5
Ni	7.2–10.2	3.3–4.0
Pb	0.14–0.21	0.16–0.20
Zn	11.8–21.7	6.5–10.5

CEFAS (1998) reported that concentrations of metals in the English Channel were generally lower than those found in the North Sea and Irish Sea, because it is less influenced by freshwater inputs.

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. To some extent, this is a consequence of the presence of fine-grained sediments (more suitable for binding metals) and slower water movement, particularly at the fringes of estuaries where the deposition of fine particles is highest.

CEFAS (1998) have reported relatively low concentrations of mercury and arsenic (0.07 and 4.4 milligrams per kilogram) and cadmium and lead (0.06 and 0.03 milligrams per kilogram) in the muscle tissue and liver from dab *Limanda limanda*, caught within the Natural Area.

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 1987). 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, after it was shown to be having a harmful effect on molluscs such as dogwhelks and oysters. However, it is still commonly used on vessels greater than 25 metres. These larger vessels still act as a major input to the marine environment. Southampton Water and Poole Harbour have been particularly susceptible to the impact of TBT paints because of the high density of small boats, larger vessels and relatively poor flushing of the waters (Statham 2000). Indeed, sediments in the Solent adjacent to commercial shipping areas are showing a continuing increase in TBT in spite of the ban on its use on small craft.

TBT concentrations in offshore waters are generally less than 1ng/l when compared with values recorded up to 100ng/l in frequently used waterways. The current Environmental Quality Standard for tributyltin in seawater is 2 ng/l (Cole *et al* 1999). CEFAS (2001a) reported TBT in waters in the Solent which exceeded this standard, but could not detect TBT at other stations within this Natural Area.

Thomas *et al* (2000) could not detect TBT in sediments collected within this Natural Area (<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 77 µg/kg in the liver of a striped dolphin found in the English Channel off Kent in 1996.

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

Polychlorinated biphenyls (PCBs)

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

Concentrations in sediment and biota are markedly higher in nearshore areas than the open sea. For example, CEFAS (1998) found concentrations of PCBs in sediment offshore of Selsey Bill and at South Varne of between <0.04–0.1 µg/kg. According to concentration guidelines defined by Wells *et al* (1989), these sediments fall within the category of 'contamination not detected'. These concentrations are lower than that of dredged sediment taken from UK estuaries, which typically contain 10s of µg/kg (CEFAS 2001).

CEFAS (1998) reported PCBs in dab (*Limanda limanda*) liver of 0.12 to 0.14 mg/kg collected from waters offshore South Varne and Selsey Bill in the English Channel.

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 Eastern Channel Natural Area via industrial and

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

1. 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.
2. Council Regulation (EC) 782/2003 addressing vessels already treated with organotin compounds as biocides.

sewage discharges, surface run-off, atmospheric deposition and oil spills. Woodhead, Law & Matthiessen (1999) found concentrations in sediments in the Eastern Solent and Southampton Water contained PAHs of 398 and 705 µg/kg respectively, although much higher concentrations have been recorded in the sediments further upstream of Southampton Water. Like PCBs, most PAHs show a strong affinity for particulates and will accumulate in sediments and biota.

3.7.3.4 Endocrine disrupters

Some contaminants can act as endocrine disrupters and 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 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.

There is evidence of the presence of endocrine disrupters adjacent to this Natural Area as Allen *et al* (1999) found moderate feminisation of male flounder in Southampton Water. This is probably related to the high level of discharges received from heavy industry (Allen *et al* 2000).

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 to the sea from natural sources, which are often enhanced by human activity, originate mainly from mining and ore processing, oil and gas extraction, burning coal, oil or natural gas in thermal power plants and the production of phosphate fertiliser (OSPAR Commission 2000). The majority of artificial radionuclides present within the water column of the mid- and eastern English Channel originate from the nuclear fuel reprocessing plant at Cap de La Hague. Although no data is available specifically for this Natural Area, overall the levels observed for the North Sea and the English Channel as a whole have decreased in recent years (OSPAR Commission 2000).

The discharges from the Cap de La Hague reprocessing plant are transported by Atlantic water passing up the Channel along the continental coast.

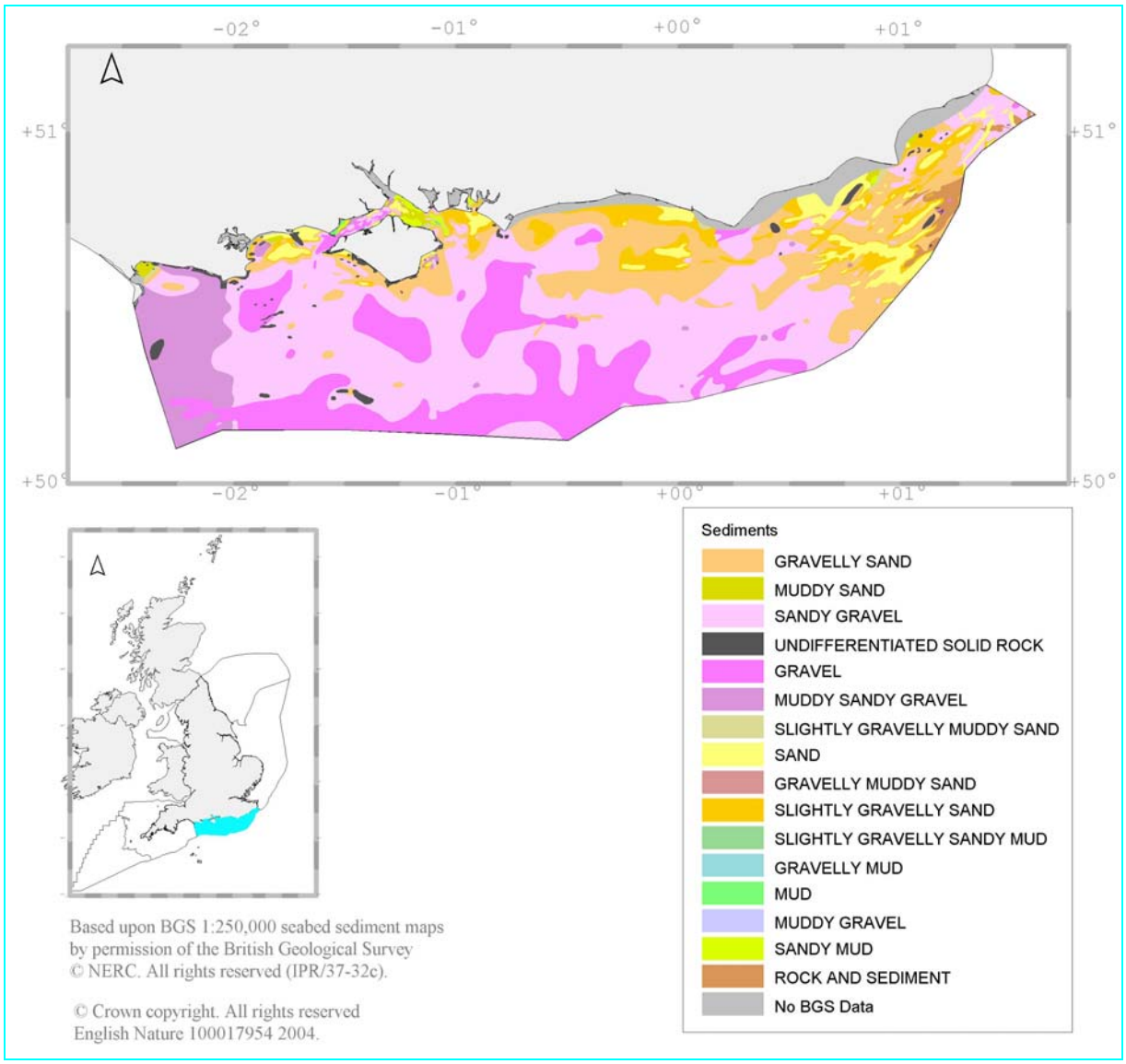


Figure 3.1 Seabed sediments of the Eastern Channel Natural Area. (taken from Poulton *et al* 2002). See Figure 3.2 for definitions of sediments.

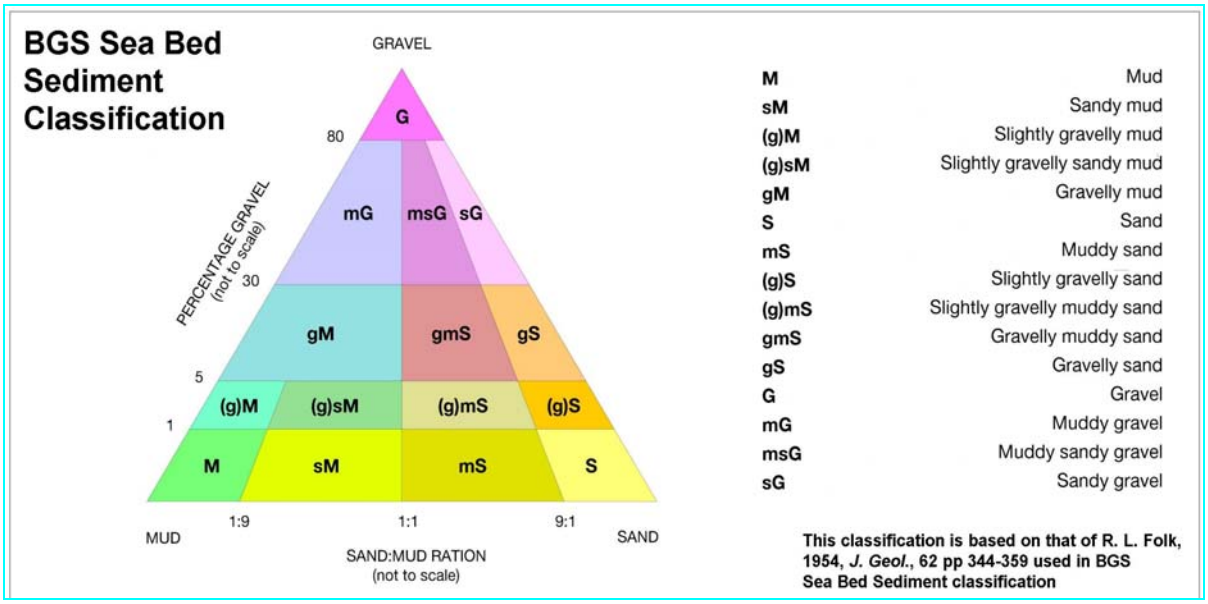


Figure 3.2 Seabed sediments of the Eastern Channel Natural Area (taken from Poulton *et al* 2002).

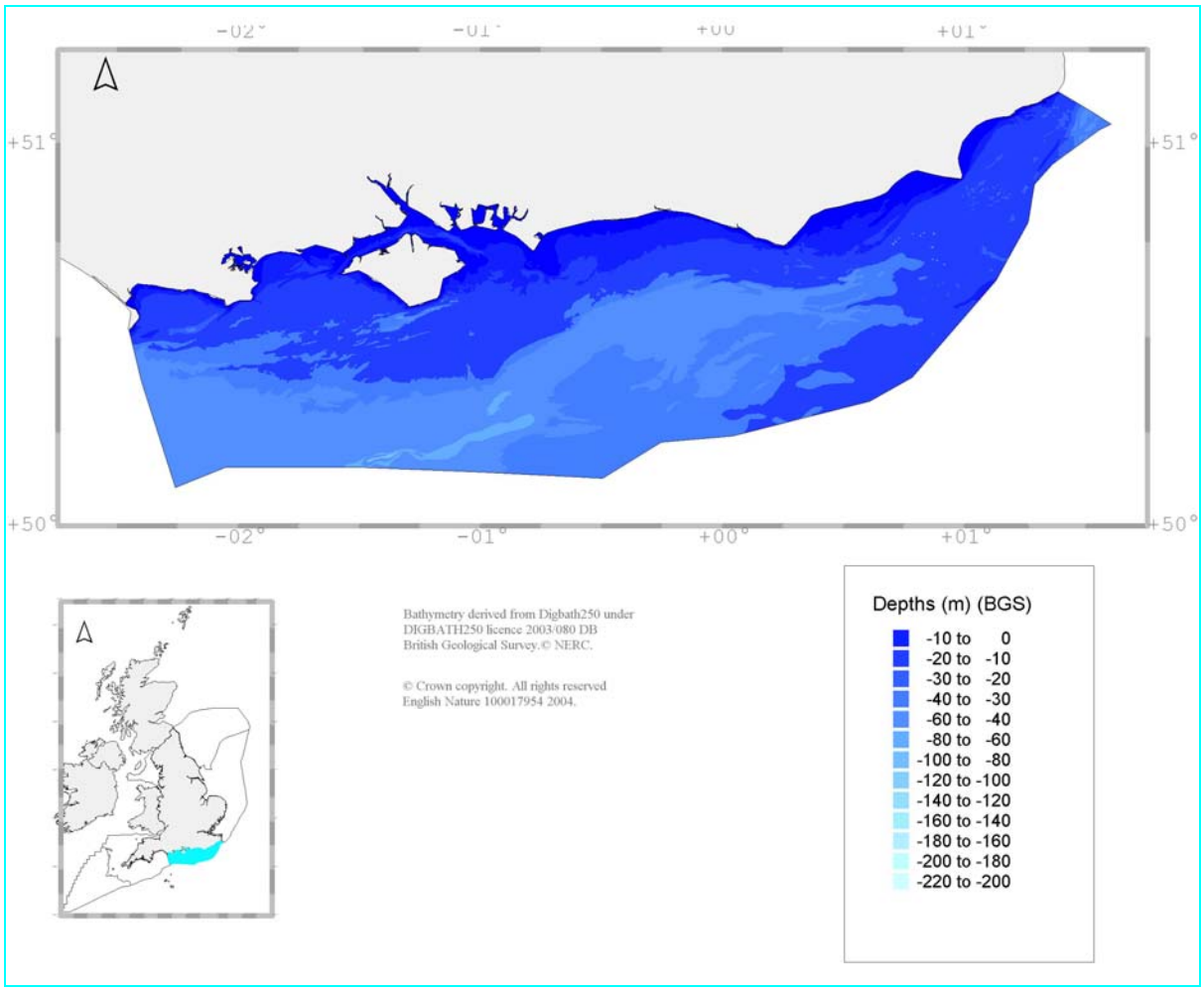


Figure 3.3 Bathymetry of the Eastern Channel Natural Area.

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 Eastern Channel Marine Natural Area. Different initiatives have used different ways of classifying seabed habitats (compare for example 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 which is 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 within the Eastern Channel are influenced both from the west (Atlantic/oceanic water) and from the east (North Sea/coastal waters). This results in a great variety of wildlife at the water surface and within the water column, of both plankton (ie organisms drifting with the currents) and nekton forms (organisms able to swim against the currents).

The abundance of plankton is strongly influenced by factors such as depth, tidal mixing and temperature stratification (layering), which determine the vertical stability of the water column. Plankton found in the waters of this Natural Area are mostly neritic (ie of coastal waters) resulting in high concentrations being found inshore. The distribution of species is influenced directly by salinity, temperature and water flows, and the presence of local benthic (bottom-dwelling) communities (Edwards & John 1996). Blooms of phytoplankton occur through late spring to early summer as daylight increases and the sea water gradually warms. Zooplankton blooms follow soon after, often dominated (up to 75%) by species of copepods. Copepods are also the group with the highest diversity in the zooplankton, with overall zooplankton biodiversity increasing away from the coast and towards the open sea. Diatoms, which largely account for the spring phytoplankton bloom, tend to predominate in inshore mixed waters, while dinoflagellates are more often found in stratified offshore waters during the summer and autumn.

Seasonal shoals of fish such as mackerel, sandeels and herring also occur, particularly to the west of the Isle of Wight. These in turn are exploited by a variety of other animals and provide a vital food resource for marine birds (see section 5).

4.1.1 Fronts

Fronts mark the boundaries between water masses. They are transition zones between 'layered' and 'well mixed' waters, and give rise to a marked horizontal temperature gradient in the surface layers, with changes of 1 ºC per kilometre being common (Lee and Ramster 1981). The temperature change may be as much as 6 ºC over a vertical distance of as many metres. The strength of this thermocline depends on the heat input and the turbulence

generated by tides and the wind. The depth of the thermocline also varies, ranging from 10 to 30 metres, typically getting progressively deeper from May to September as surface water temperatures increase.

Within this Natural Area there is only one weak front which lies to the south-east of the Isle of Wight, curling to the west, lying parallel to the coast (see Figure 4.1).

Generally speaking, the whole of this Natural Area comprises mixed water – ie non-stratified. This is due to the relatively shallow depth of water throughout the mid- and eastern English Channel, combined with the effects of tidal and wind-generated water movements. However, this Natural Area does mark a transition between two marine biogeographical provinces, centred on the Solent. The Eastern Channel is largely influenced by 'cooler' Boreal water (which dominates the North Sea system), whereas the western part of the Area is influenced by relatively warmer Lusitanean water, which comes in part from the Gulf Stream and in part from the water leaving the Mediterranean.

4.1.1.1 Nature conservation measures

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

4.2 The seabed substrate

The benthic habitats of the Eastern Channel Natural Area are defined primarily by the seabed substrate. Within the Natural Area a wide variety of seabed types are present, ranging from the fine muds of low-energy areas to bedrock exposures of sandstone, limestone, chalk and mudstone. In general, the nearshore seabed is an assortment of mixed sediments (especially gravel and shells) with sand and, in sheltered locations, mud. There are also occasional and sometimes extensive exposures of bedrock and boulder reefs, often occurring off headlands such as Beachy Head, Selsey Bill and the Purbeck coast. In deeper water further offshore, the seabed is dominated by sediments, mainly of sand, sandy gravel and gravel (see Figure 3.1).

Fine silts and muds are the sediments that characterise the near shore and sheltered harbours of the Solent, grading into sands, gravel, pebbles and cobbles. The tide-swept western Solent has deposits of gravel and pebbles. The entrance to the eastern Solent and Bracklesham Bay have extensive areas of sand and gravel. Large areas of sand and gravel are also present further offshore. Where mixed sediments are consolidated and stable, an associated rich fauna more characteristic of rocky areas can develop.

Along the Sussex coast, the predominant nearshore seabed is of mixed sediments and sand, though sandstone and limestone bedrock and boulder reefs also occur, together with chalk and clay exposures. In the mid-Channel area, there are three types of sublittoral rock. Limestone outcrops at Bembridge on the east of the Isle of Wight; and chalk outcrops at Culver Cliff and the Needles on the Isle of Wight, at Ballard Ledges north of Swanage and at White Nothe north east of Weymouth. Also, iron-stone boulders of the Christchurch Ledges occur off Hengistbury Head in Dorset. The most varied chalk topography is found around the Needles and in Alum Bay on the west side of the Isle of Wight, where there are sublittoral

cliffs, caves, gullies and boulder slopes. This area supports the greatest range of subtidal fauna in the Natural Area.

As a result of this mosaic of different sediment types, there are a wide variety of habitats found on the seabed of this region. Sediments are generally classified by either the Folk (1954) or Wentworth (1922) systems (the Wentworth scale divides the Folk classes into smaller fractions). 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 the Marine Natural Area. An exception to this is the 'muddy gravel' which, in terms of ecology, is closer to mud rather than gravel habitats and is therefore included with the former. As different types of sediment grade into one another separating gravel, sand and mud habitats (as we have done here) is simply a means of dividing up what is a continuum. One outcome of using the Folk classification is that areas defined as gravel by the British Geological Society may include cobbles, boulders, pebbles, and granules (see Appendix 3). 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 (Connor *et al* 1997)[5] 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 substrate, 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 4.2). The diversity and types of community associated with this habitat type are determined primarily by the sediment type, and also a variety of other physical factors such as the relative exposure of the coast and differences in the depth, turbidity and salinity of the surrounding water.

Sublittoral sand and gravel sediments are the most common habitats found below Low Water Mark around the coast of the UK (UK Biodiversity Group 1999). In offshore areas of the Eastern Channel there are extensive deposits of gravel to the south and east of Selsey Bill. Further west there are also significant banks known as the Dolphin and Shingles Banks (within the western approaches to the Solent), the Solent, Brambles and Ryde Middle Banks (Solent), the Horse and Dean and Medmerry Banks (eastern approaches to the Solent) (Velegrakis 2000), and Poole Bay (Figure 4.2). In addition to these banks there are several large gravel areas present, some of which exceed 2 metres in height and 0.25 metres in length. Several banks of sandy gravel occur offshore (Figure 4.2), though many of these are of 'veneer' thickness, ie <0.5 metres thick.

There are areas of nearshore 'mixed sediments' present in patches throughout the Natural Area. These areas tend to be formed of variable amounts of sand, gravel and cobble, often

[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

mixed with dead shells and shell gravel. In areas where these mixed sediments are stable, particularly during the summer months, settlement and subsequent growth of a rich variety of plant and animal species occurs. The anemones *Anemonia viridis* and *Urticina felina* are typical of gravel areas, with *Cerianthus lloydii* also frequently encountered. The slipper limpet *Crepidula fornicata* is a characteristic species of the Solent region (Collins & Mallinson 2000a). This species is commonly associated with gravel and its shells can form the main hard substrate in areas of soft sediments. Within the Solent system itself, a mix of subtidal gravel and sand can be found along the north coast of the Isle of Wight between Yarmouth and Gurnard Ledge, and on the South Hampshire coast to the west of Needs Ore in the mouth of the Beaulieu River.

The gravel habitats found in deeper offshore areas (>30 metres), in general, tend to be less affected by natural disturbance than those closer inshore. As a result, these areas tend to support diverse marine fauna which may include a wide range of anemones, polychaete worms, bivalves and amphipods and both mobile and sessile epifauna. The JNCC Marine Nature Conservation Review biotope classification has identified a number of biotopes found within this Natural Area and these are listed in Table 4.1.

4.2.1.1 Nature conservation measures

Gravel habitats are covered by a priority Habitat Action Plan 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 all the time' given under the Directive, since this habitat is restricted to sediments which predominantly comprise sand (0.0625-2 millimetres). However, some gravel habitat may meet the definition of 'Reefs' under the Directive, where they are predominantly composed of stable boulders and cobbles as these are stable and can form a reef-like structure. This type of reef habitat occurs off the coast at Ventnor and is therefore an interest feature of the South Wight Maritime Special Area of Conservation (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 potentially 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 to identify reef and reef-like habitat within areas of rocky or gravelly habitat. Prior to the identification of proposed Natura 2000 sites, locations supporting relevant features of interest should be treated with care to ensure that they are not damaged or altered in such a way that might affect their selection as Natura 2000 sites. 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.

Sussex is the only county in England to have extended its system of Sites of Nature Conservation Importance (SNCIs) (as designated by the County Councils) beyond Low Water Mark. To date, 24 marine SNCIs have been identified in nearshore areas off the Sussex coast (Irving 2001), of which only one (Shelley Rocks) features mixed sediments (cobbles, gravel, sand and shell) as the primary seabed type. The marine SNCI designation is non-statutory, but aims to highlight the importance of these areas for their nature conservation importance. It also aims to encourage those who carry out activities at or near

the sites to act in a responsible manner, thereby helping to maintain the interest of the site (Irving 1996).

4.2.2 Sand habitats

Sandy sediments are widespread throughout this Natural Area (Figure 4.5). Sand sediments are found in regions of moderate to strong tidal currents where they are able to settle but finer particles cannot. In such situations, the sand is often coarse and clean with little silt/mud, but with occasional shell fragments present. Mobile sands tend to be characterised by robust and sometimes impoverished faunas, typically venerid bivalves, amphipods (shrimps), polychaete worms and heart urchins (see Table 4.1 for MNCR biotope types).

Sandbanks within the Natural Area tend to be in shallow water (Fig 4.6). The communities they support are determined by the sediment type and 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. These sandbanks 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 Solent region, areas of clean sand extend throughout Bracklesham Bay to the east of the Isle of Wight. This sand is very mobile with ripples inshore and deep waves in the tidal mainstream. In the more stable areas, the tubes of the sand mason worm *Lanice conchilega* may form dense stands, such as at the mouth of Chichester Harbour (Irving 1999). Off the east Sussex coast, clean sand is favoured by the burrowing heart urchin *Echinocardium cordatum*, the masked crab *Corystes cassivelaunus* and the sea mouse *Aprodite aculeata*. A number of species, such as the anemones *Urticina felina* and *Cereus pedunculatus*, are sand-tolerant but require an underlying stone or hard substrate for attachment (Collins & Mallinson 2000a). Mobile species typically found in such areas include hermit crabs *Pagurus* spp. and gastropod molluscs such as *Hinia reticulata* and *Buccinum undatum*. Flatfish include brill *Scophthalmus rhombus*, plaice *Pleuronectes platessa*, dab *Limanda limanda* and Dover sole *Solea solea*.

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 Special Areas of Conservation (SACs) but large, flat areas of sand habitat may not be selected. Of the areas of sand habitat in less than 20 metres of water within the Eastern Channel Natural Area (Figure 4.5), only the Solent Maritime SAC has been designated for this habitat type (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 potentially within English territorial waters. Preliminary work has been undertaken to derive areas of seabed which contain qualifying habitat and this is shown in Figure 4.6. 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)

Estuarine areas and harbours, both of which tend to be dominated by muddy habitats, are described in the relevant Coastal Natural Area Profiles.

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 are present except in deeper water such as in 'troughs' or 'deeps' (see Figure 4.7). The fauna of muddy sediments is often dominated by polychaete worms, bivalve molluscs such as cockles, and brittlestars.

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

Generally, the muds and silts of the Solent region contain chains of slipper limpets *Crepidula fornicata*, which provide attachment for other organisms such as hydroids (eg *Kirchenpaueria pinnata* and *Hydrallmania falcata*) and sponges (eg *Halichondria* spp. and *Suberites* spp.). A number of small crab species, such as *Pisidia longicornis*, *Macropodia rostrata* and *Pagurus bernhardus*, are found in cover provided by the slipper limpet shell epifauna. North of Bembridge in St Helen's Road there is an unusual area of fine, deep, soft mud without any hard substrate. This sediment type supports a large population of the echiurid worm *Maxmuelleria lankesteri* (more often associated with sheltered Scottish sea lochs), in densities of several per square metre, with the amphipod *Ampelisca diadema* and the bivalve mollusc *Nucula nitidosa* (Collins & Mallinson 2000a).

Muddy sand is also present within Poole Bay, together with mud, sand, muddy gravel and gravel – the only site in the English Channel to contain all five sediment types (Holme 1966).

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'. The former primarily covers muddy gravels in estuaries, rias and sea lochs and is widespread within the many sheltered 'estuaries' of the Solent such as Portsmouth Chichester and Langstone Harbours (outside the boundary of this Natural Area). The Action Plan for "mud habitats in deep water" applies to mud habitats below 20 to 30 metres. Subtidal mud habitat is not listed on the Habitats Directive.

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 limestone, sandstone or chalk, also have an effect on biotope type. The distribution of rock habitat is shown in Figure 4.8.

4.2.4.1 Reefs

The term reef is generally used to refer to an area of rock habitat which arises from the surrounding seabed, although it has a specific definition under the Habitats Directive. The communities which are found on reefs and reef-like habitats are dependant 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 the growth of dense forests of kelp. In deeper water, where light intensity is lower, communities become animal-dominated, particularly with turfs of bryozoans and hydroids, sponges and sea squirts.

A number of subtidal reef types occur within the Natural Area including chalk, sandstone, limestone, clay/mudstone, greensand bedrock and boulder reefs, and 'stony' reefs of boulder and cobble (see also section 4.2).

4.2.4.2 Stony reefs

As discussed previously, some gravel and cobble areas meet the Habitats Directive definition of reef. Within the Marine Natural Area, exposed gravel is often colonised by keelworms *Pomatoceros triqueter* and by barnacles *Balanus* spp. On deeper areas of stable gravel and cobbles, the hydroids *Halecium halecinum*, *Kirchenpaueria pinnata*, *Hydrallmania falcata* and *Nemertesia antennina* are found. The foliose bryozoan *Flustra foliacea* occupies a similar niche. In areas of strong tidal flow, algae are seldom found on growing on gravel; this is presumably because of current dragging. By contrast, in more sheltered areas, a substantial proportion of the algae occurs on gravel and cobble substrates. The most striking area of algal growth is to the north of St Helens Fort (on the east side of the Isle of Wight), where there is total cover by fronds of *Laminaria saccharina*, reaching several metres in length, during the summer (Collins & Mallinson 2000a).

Mobile species commonly found on gravel are the whelk *Buccinum undatum*, topshell *Gibbula cineraria* and the netted dogwhelk *Hinia reticulata*, together with hermit crabs *Pagurus* spp. and the swimming crabs *Liocarcinus* spp. Where there is foliose algal cover there is an greater range of mobile fauna, including the spider crabs *Macropodia rostrata* and *Pisa tetraodon*. At one site to the south of Culver Spit (on the east side of the Isle of Wight), the gravel contains live maerl (*Phymatolithon* and *Lithothamnion* spp.). On gravel beds, the bryozoan *Alcyonidium diaphanum* grows extensively, blanketing the seabed in late summer.

Extensive brittlestar beds are frequently encountered in deep water (30-50 metres) in the eastern English Channel (Ellis & Rogers 2000), although they are also occasionally found closer to the coast. Collins (2002) recently found a brittlestar bed approximately 2 kilometres off Kimmeridge Bay, to the west of Swanage, Dorset. The species forming these beds is *Ophiothrix fragilis* and the number of individual brittlestars involved is likely to be in the

thousands. It would appear that these beds occur in areas with suitable tidal currents (~20-25 centimetres per second) and low sedimentation (Aronson 1989). Brittlestar beds are not true biogenic reefs as they have no solidity to them.

Offshore, the region of the eastern English Channel basin is dominated by a large expanse of potential reef habitat (Figure 4.4), which stretches 142 kilometres in length and 32 kilometres wide (Johnston *et al* 2002). The water depths in the vicinity are generally between 50-75 metres, with the exception of a linear deep that reaches 100 metres deep. The region has been surveyed by side-scan sonar and is extremely heterogeneous in nature (Graham *et al* 2001a), with gravel and bedrock outcrops present. This is due to the complex geology of the region, where folded bedrock is overlain patchily by coarse sediments (gravel, pebbles, cobbles and boulders), and both may be covered in more mobile sandy sediments. The current strengths are sufficient to mobilise fine gravel, which results in a highly disturbed environment. Epibenthic fauna, such as barnacles and bryozoans, have been found encrusting sampled cobbles from here (Graham *et al* 2001b).

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).

4.2.4.3 Chalk reefs

The coastline of the south east of England is well known for its chalk cliffs. Only 1% of the British coastline is composed of chalk, yet this represents 75% of the chalk reefs (both intertidal and subtidal) in Europe (Brown *et al* 1997). Chalk is also present in the shallow subtidal within this Natural Area, occurring as three main forms which may all be referred to as reefs. These are (1) gently shelving platforms which extend from the shore beyond Low Water Mark; (2) low-lying nearshore outcrops; and (3) sections of low-lying subtidal cliffs. These nearshore chalk exposures occur at Shakespeare Cliff, between Dover and Folkestone (outcrops); between Beachy Head and Seaford Head (platforms); between Newhaven and Brighton (platforms); off Hove and Worthing (cliffs); off Culver Cliff on the east side of the Isle of Wight (outcrops), at the Needles on the west side (outcrops); and at White Nothe on the east side of Ringstead Bay in Dorset (outcrops).

Chalk reef habitats support a wide range of characteristic species, some of which are predominantly found on or in this type of substrate. Chalk is a relatively soft rock and a number of species that are capable of boring into the rock tend to dominate the associated subtidal communities. These species include bivalve piddocks (in particular *Pholas dactylus*, *Hiatella artica*, *Barnea* spp. and *Petricola pholadiformis*), polychaete worms (especially spionids) and sponges. The biotope dominated by piddocks is often the most widespread of the biotopes which occur on these reefs but is scarce in Britain as a whole. The growth of the kelp *Laminaria hyperborea*, which typically grows as 'forests' on shallow parts of reefs elsewhere, is considerably restricted in the Eastern Channel due to the high turbidity and the consequent restricted light penetration. However, there are often lush growths of various red seaweeds such as *Calliblepharis ciliata*, *Delesseria sanguinea* and *Halurus flosculosus* and, slightly deeper, a variety of faunal turf communities. These latter are likely to feature low encrusting forms such as sea mats and sponges, to tall erect forms such as soft corals and hydroids, plus mobile organisms such as crustaceans, echinoderms, molluscs and fish.

4.2.4.4 Sandstone and limestone reefs

Sandstone reefs tend to occur more in the east of the Marine Natural Area (from Beachy Head to Selsey Bill), whilst limestone reefs are more commonly encountered in the west – ie at Bembridge on the Isle of Wight at Bembridge, and off Durlston, Kimmeridge, Lulworth and Portland in Dorset. The narrow limestone boulder reef of Bembridge is considered to support the widest diversity of sublittoral species within the Solent area (Collins & Mallinson 2000a).

In shallow water, sandstone and limestone bedrock and boulder surfaces are covered (often up to 80% covered) by foliose algae, with occasional kelp plants *Laminaria* spp. also present. Encrusting coralline algae are common, forming a thin, pink hard crust over the surface (see Jones (1999) for an algal species inventory for these areas). In slightly deeper water, several species of sponge are likely to be conspicuous, including *Esperiopsis fucorum* and *Dysidea fragilis*. Ross *Pentapora foliacea*, a coral-like bryozoan which may grow in clumps up to 40 centimetres tall, is often conspicuous on bedrock outcrops. Overhangs may be dominated by a variety of sea squirts, bryozoans, hydroids, anemones and the soft coral *Alcyonium digitatum*. Crustacea include edible crabs, spider crabs, lobsters and squat lobsters. Common fish include goldsinny, corkwing and ballan wrasse, two-spotted gobies, butterfish and long-spined sea scorpions.

4.2.4.5 Mudstone/clay reefs

Mudstone is a form of consolidated mud with a hard, clay-like consistency. It may be present as smooth, horizontal exposures in a number of nearshore areas, and is often partially covered by mixed sediments (which scour the surface of the mudstone smooth). Mudstone is likely to be composed of the same particulate matter as clay, though as a result of greater compaction it appears harder. In the eastern Solent it is often found below a layer of limestone cap rock. However, because of its soft nature it is eroded much more readily than the limestone, resulting in large chunks of the limestone breaking off and forming boulder slabs. Soft clay is commonly encountered in nearshore areas off Selsey Bill, most dramatically as the near-vertical cliff forming the Mixon Hole. Although little life is obvious on the cliff itself, the clay face is riddled with piddock *Pholas dactylus* holes, with various species of crustacea present on the horizontal ledges (Irving 1999).

Within Sandown Bay and elsewhere on the eastern side of the Isle of Wight, occasional, discrete area of soft mud reef-like 'beds' are present. The 'beds' are formed by thousands of mud tubes inhabited by the amphipod crustacean *Ampelisca* sp. Each animal builds a 10-centimetre long, vertical tube, approximately 5 millimetres wide, using silt particles. The tubes are packed tightly together to completely cover the underlying substratum, which may be smooth bedrock or consolidated mixed sediments. Each individual 'bed' rarely covers more than about 25 square metres of the seabed. Few other organisms are specifically associated with these *Ampelisca* 'beds'.

4.2.4.6 Sea caves

The UK has the most varied and extensive sea caves on the Atlantic coast of Europe (Brown *et al* 1997). Whilst the eastern part of England's south coast is not renowned for sea caves, there are some present, particularly in areas where softer rocks, such as chalk, occur.

Within the Eastern Channel Natural Area, the most notable sea cave systems lie within the South Wight Maritime Special Area of Conservation, between Freshwater Bay and Alum Bay at the western end of the Isle of Wight. Although predominantly in the littoral zone, some caves are also present below Low Water Mark too. These subtidal caves have formed at the base of 3-5 metre high cliffs as a result of erosion from continual scour by sand and flint pebbles. The caves are mostly between 0.5-2 metres high and 1-3 metres deep. They provide a variety of shaded and open rock surfaces and the full range of sloping, overhanging and cave-roof surfaces (Wood 1992). Communities present within these caves include the soft coral *Alcyonium digitatum*, encrusting sponges, hydroids, bryozoans and sea squirts.

4.2.4.7 Nature conservation measures

There is a priority Habitat Action Plan for Littoral and sublittoral chalk habitats (see Table 5.2). Within the Eastern Channel Natural Area there is one site where reef habitat is included as a feature of interest under the Habitats Directive, namely the South Wight Maritime Special Area of Conservation (Figure 4.3). This is also the only site for which seacaves are listed as an interest feature.

In addition, Sussex is the only county in England to have extended its terrestrial system of Sites of Nature Conservation Importance (SNCIs) (as designated by the County Councils) beyond Low Water Mark. To date, 24 marine SNCIs have been identified in nearshore areas off the Sussex coast, of which 15 are reefs (Irving 2001). These are (from east to west): Royal Sovereign Shoals (sandstone), Horse of Willingdon (sandstone), Beachy Head (greensand), Seaford Head to Beachy Head (subtidal chalk), Seaford Head Gullies (chalk), Brighton-Newhaven (subtidal chalk), Marina Reef (chalk), Ship Rock (chalk), Worthing Lumps (chalk), South-West Rocks (chalk), Looe Gate (chalk), the Waldrons (sandstone), the Outer Owers (limestone), the Mixon Hole (limestone and clay) and the Hounds (limestone and mudstone). The marine SNCI designation is non-statutory, and highlights the importance of these areas for their nature conservation. It also aims to encourage those who carry out activities at or near the sites to act in a responsible manner, thereby helping to maintain the interest of the site (Irving 1996).

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 substrate.

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.

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. These 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.

Within much of its geographical range, *S. spinulosa* does not form reefs but is solitary or occurs in small groups encrusting pebbles, shells, 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 typically ephemeral in nature, being broken up during winter storms. As a result, these crusts do not constitute true *S. spinulosa* reef habitats.

Sabellaria spinulosa biogenic reefs have recently been recorded 4 kilometres east of Swanage Pier in Dorset (pers. comm., Dorset Environmental Records Centre) (see Figure 4.9). The percentage coverage of *Sabellaria* on the seabed has been estimated at between 5–80%. The reef was reported to be free of silt and many mollusc shells had been incorporated into the structure of the reef, particularly single valves of *Nucula* spp. and fragments of cockles and venerids. This would imply that currents capable of moving such items must affect the site from time to time.

4.3.1.1 Nature conservation measures

Sabellaria spinulosa reefs have their own Habitat Action Plans and are also indirectly covered by the Habitats Action Plan for sublittoral sands and gravels.

Under the Habitats Directive the habitat "reef" includes biogenic reefs such as those formed by *Sabellaria* spp. However, currently there are no sites selected for this habitat in this Natural Area.

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

See Table 4.2 for a summary of the conservation measures.

4.3.2 Seagrass beds

Seagrasses grow in shallow coastal areas, often forming dense underwater meadows and creating a productive and diverse habitat that provides shelter and food for a variety of other species. They also provide food for wildfowl and shelter the juvenile stages of a number of commercially important fish. Being in the coastal zone, they are increasingly threatened by human pressures.

There are two (possibly three[6]) species of the seagrass *Zostera* which occur in the UK, although only one, *Z. marina*, is predominantly subtidal. Commonly referred to as eelgrass, *Z. marina* is the largest of the seagrass species and occurs just below Low Water Mark, on fine to coarse sand which may also have flint gravel mixed with it.

Eelgrass beds occur patchily in the Solent area (for precise locations see Tubbs 1999). For example, they occur within the extensive rockpools of Bembridge Ledges on the east side of the Isle of Wight (Collins & Mallinson 2000a); on the Christchurch Ledges east of Bournemouth (English Nature 1998); at Studland Bay to the north of Swanage; Ringstead Bay to the east of Weymouth; in Weymouth Bay itself; and in Portland Harbour (Collins 2002).

4.3.2.1 Nature conservation measures

Seagrass beds are covered by their own Habitat Action Plan (HAP) but are also indirectly covered by the HAPs for other 'host' habitats, such as sublittoral sands and gravels, mudflats and saline lagoons.

In relation to the Habitats Directive, sandbanks which are vegetated by seagrass *Zostera* spp. are included as a sub-type of the habitat 'Sandbanks which are slightly covered by sea water all the time' which is a feature of the Solent Maritime SAC (as well as a number of habitats more relevant to the Coastal Natural Areas such as 'Estuaries' and 'Mudflats and sandflats not covered by seawater at low tide').

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

See Table 4.2 for a summary of the conservation measures

4.3.3 Maerl beds

Maerl is the name for certain coralline algae that grow unattached on clean, tidal-swept areas of seabed. The most common species are *Phymatolithon calcareum* and *Lithothamnion coralloides*. In the UK, live maerl (which may be pink, red or purple in colour, as opposed to dead maerl which is bleached white) is generally found in areas exposed to currents in depths shallower than 20 metres below chart datum (Collins & Mallinson 2000b). Deposits of maerl are discrete and do not cover large areas of seabed. Whilst it is relatively widely distributed in northern Britain, in southern Britain its distribution is restricted to just a handful of sites, the largest being in the Helford River/Fal Estuary in Cornwall (Rostron 1987) (in the adjacent Marine Natural Area).

[6] The other two species are *Zostera noltii* and *Zostera angustifolia*. However, current thinking is that *Z. angustifolia* is just a different growth form of *Z. marina*, which is found intertidally (see Davison & Hughes 1998).

Although several areas of dead maerl (such as off Kimmeridge in Dorset) and maerl fragments are found west of the Isle of Wight, the largest area of live maerl off the Dorset coast is in the south west corner of Poole Bay. This is an extensive bed (>10km^2), though the density of the live maerl, of the single species *Phymatolithon calcareum*, is low (0-100g/m^2), existing as a thin layer over a sandy gravel seabed. Even at its densest, the live maerl coverage is rarely greater than 10% of the seabed, though white, dead maerl fragments cover at least 50% of the seabed, along with shells and stones. The biodiversity of the habitat has been confirmed to be high, with over 100 infaunal species, and 150 macrofloral and macrofaunal species present (Collins & Mallinson 2001).

4.3.3.1 Nature conservation measures

There is a priority Habitat Action Plan for maerl beds.

Maerl is considered to be of high conservation value in a European context (Birkett *et al* 1998). Maerl beds are included in four different habitat types of the EC Habitats Directive: 'Sandbanks which are slightly covered by seawater all the time'; 'Large shallow inlets and bays'; 'Estuaries'; and the priority habitat 'Lagoons'. The EC interpretation manual (European Commission 1999) specifically identifies maerl beds as being part of 'Sandbanks which are slightly covered by seawater all the time' within Special Areas of Conservation. The maerl fragments identified to the west of the Isle of Wight are located within the boundaries of the South Wight Maritime SAC. In addition, Annex V of the Habitats Directive lists two maerl species, *Lithothamnium coralloides* and *Phymatolithon calcareum*, as species of community interest, whose taking in the wild and exploitation may be subject to management measures.

Table 4.1 MNCR biotopes associated with the habitats in the Eastern Channel Natural Area.

Key habitat	Biotope description (& Higher/Biotope code)
Gravel	Venerid bivalves in circalittoral coarse sand or gravel (CGS.Ven)
	Sabellaria spinulosa and *Polydora* spp. on stable circalittoral mixed sediment (CMX.SspiMx)
	Phymatolithon calcareum maerl beds in infralittoral clean gravel or coarse sand (IGS.MrlPhy)
	Laminaria saccharina and filamentous seaweeds on infralittoral mixed sediments (IMX.KSwMx)
Sand	Shallow sand faunal communities (IGS.FaS)
Mud and muddy gravel	*Echinocardium cordatum* and *Ensis* sp. in shallow sublittoral muddy fine sand (IMS.FaMSEcorEns)
	Amphiura filiformis and *Echinocardium cordatum* in circalittoral clean or slightly muddy sand (CMS.AfilEcor)
	Zostera marina/*angustifolia* beds in infralittoral clean or muddy sand (IMS.SgrZmar)
	Ostrea edulis oyster beds on shallow sublittoral muddy sediment (IMX.Ost)
Reefs	Circalittoral *Sabellaria* reefs (MCR.Csab)
	Sabellaria spinulosa and *Polydora* spp. on stable circalittoral mixed sediment (CMX.SspiMx)
	Kelp with cushions fauna, foliose red seaweeds or coralline crusts (exposed rock) (MIR.KR)/(EIR.KfaR)
	Kelp with red seaweeds (moderately exposed rock) (IR.FaSwV)
	Sand or gravel-affected communities on rock, boulders or cobbles (MIR.SedK)
	Silt-influenced ascidian communities (MCR.As)
	Soft rock communities (upward-facing chalk or clay) with piddocks (MCR.SfR)
Sea caves	Sponge crusts and anemones on wave surged vertical infralittoral rock (SCAn)
	Sponge crusts, anemones and *Tubularia indivisa* in shallow infralittoral surge gullies (SCAn.Tub)
	Sponge crusts and colonial ascidians on wave surged vertical infralittoral rock (SCAs)
	Dendrodoa grossularia and *Clathrina coriacea* on wave surged vertical infralittoral rock (SCAs.DenCla)
	Sponge crusts, colonial (polyclinid) ascidians and a bryozoan/hydroid turf on wave surged vertical or overhanging infralittoral rock (SCAs.ByH)
Maerl beds	*Phymatolithon calcareum* maerl beds with red seaweeds in shallow infralittoral clean gravel or coarse sand (IGS.MrlPhy.R)
	Lithothamnion corallioides maerl beds on infralittoral muddy gravel (IMX.Lcor)
Seagrass beds	*Zostera marina*/*angustifolia* beds in lower shore or infralittoral clean or muddy sand (IMS.SgrZmar)

Table 4.2 Summary of nature conservation measures.

	EU Habitats Directive[1]					UK Biodiversity Action Plan[2]				
	Sandbanks which are slightly covered by seawater all the time[a]	**Large shallow inlets and bays**	**Reefs[a]**	**Submerged or partially submerged seacaves[a]**	**Sublittoral sands and gravels**	**Mud habitats**	***Sabellaria spinulosa* reefs[c]**	**Littoral and sublittoral chalk**	**Seagrass beds**	**Maerl beds**
Gravel habitats		•	• Boulders and cobble		•					
Sand habitats	•	•			•					
Mud habitats		•				•				
Reefs			•					•		
Sea caves				•				•		
Maerl beds	• [b]									•
Sabellaria reefs			•				•			
Seagrass beds	•								•	

[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.
[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.
[a] Annex I natural habitat of community interest whose conservation requires the designation of special areas of conservation.
[b] Also included in Annex V of EU Habitats Directive which includes animal and plant species of community interest whose taking in the wild and exploitation may be subject to management measures.
[c] Priority habitat which has been identified as being rare or in sharp decline.

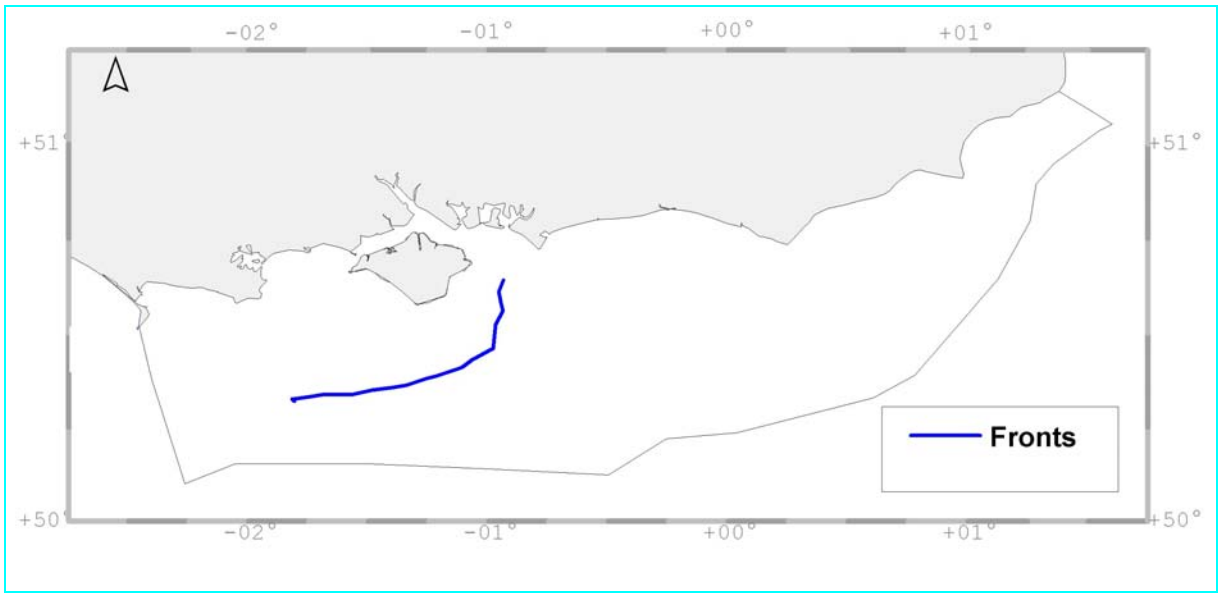


Figure 4.1 Distribution of fronts in the Eastern Channel Natural Area.

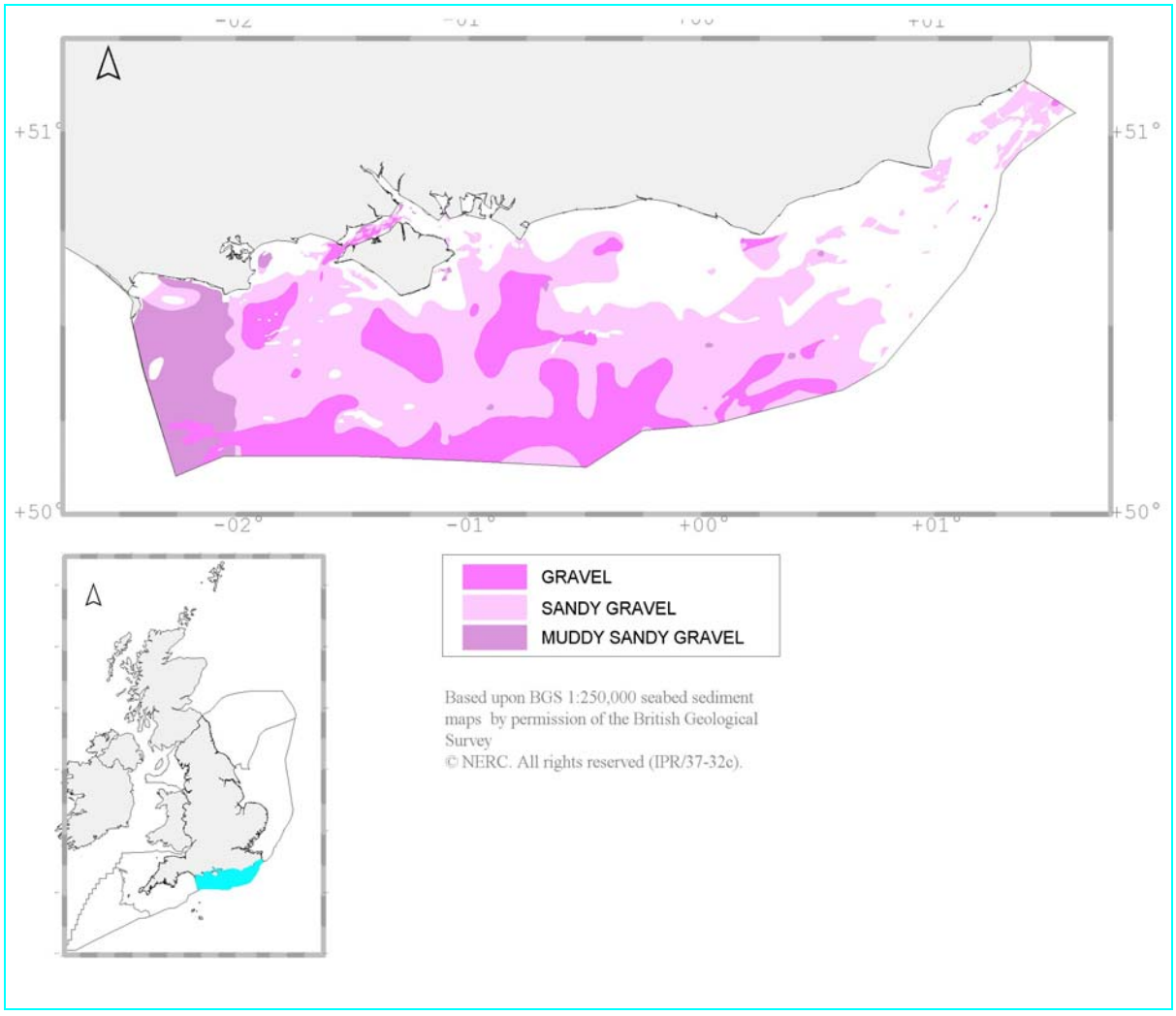


Figure 4.2 Gravel habitats in the Eastern Channel Natural Area.

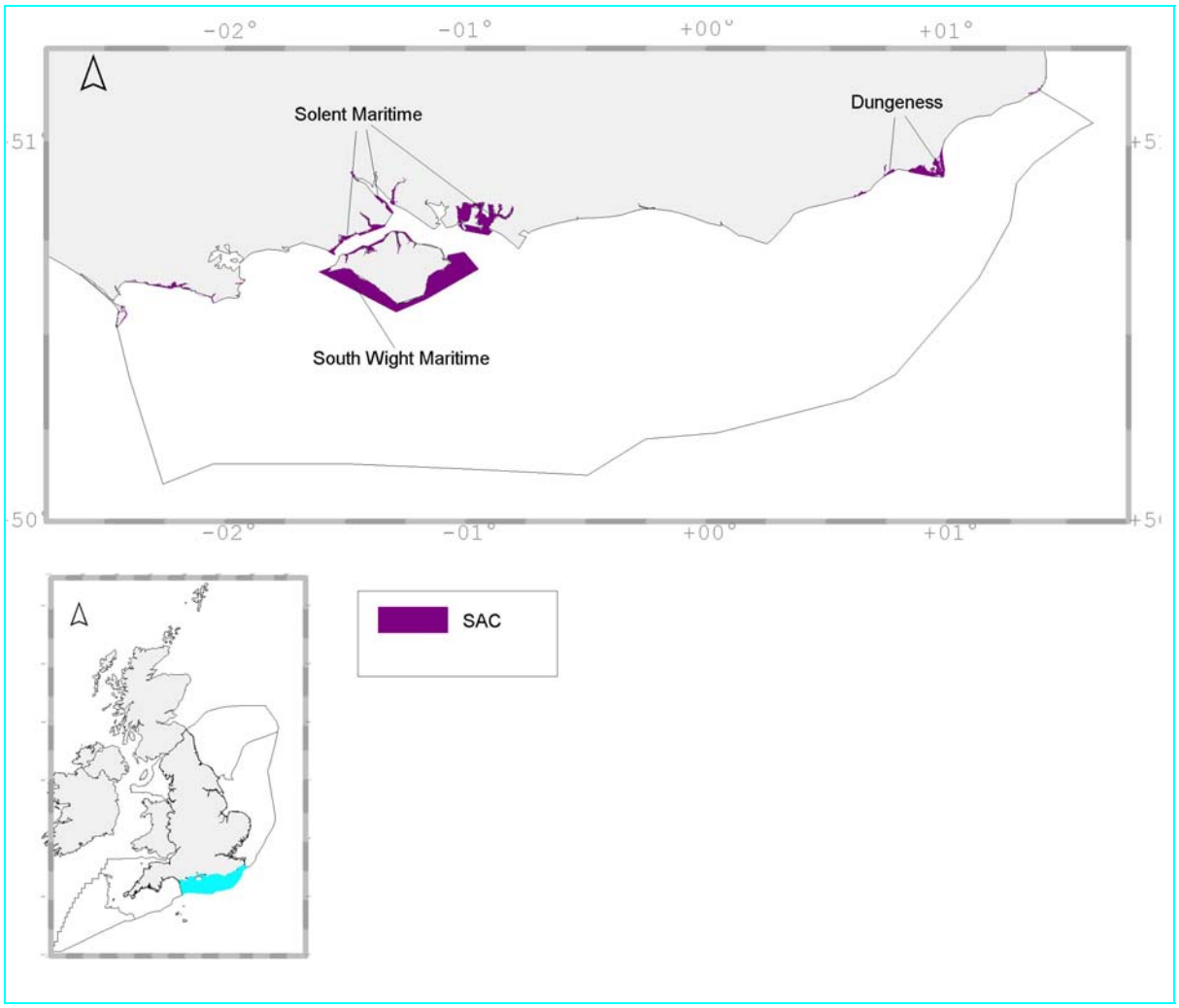


Figure 4.3 Candidate Special Areas of Conservation of relevance to the Eastern Channel Natural Area.

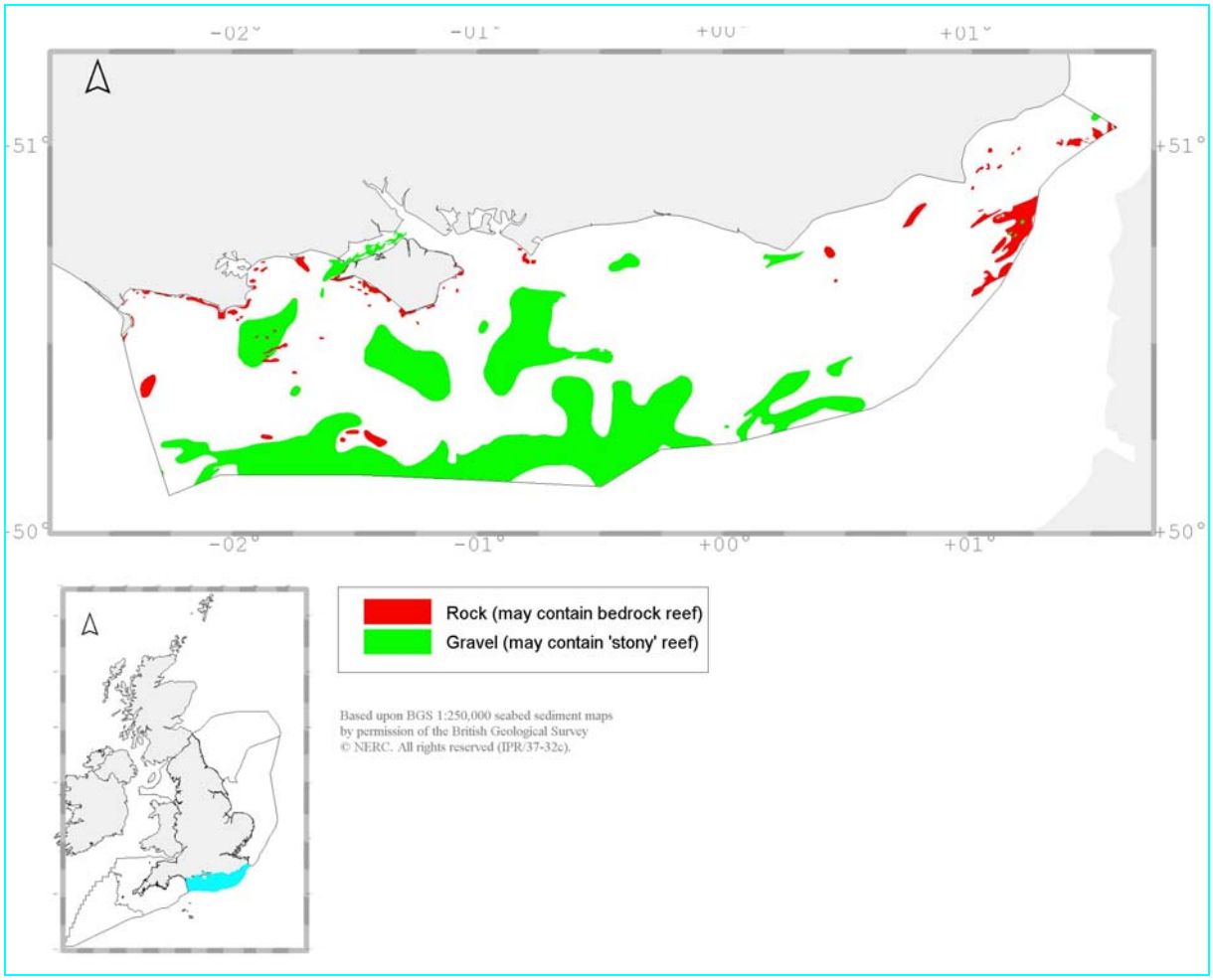


Figure 4.4 The distribution of rocky habitat and gravel which indicates the potential location of 'reef' (*sensu* the Habitats Directive) in the Eastern Channel Natural Area. Further refining of these areas will define seabed which qualifies as Habitats Directive habitat. Gravel is included here as some gravel habitat may meet the definition of 'Reefs' under the Directive, where they are predominantly composed of stable boulders and cobbles as these are stable and can form a reef-like structure (ie 'Stony' reef).

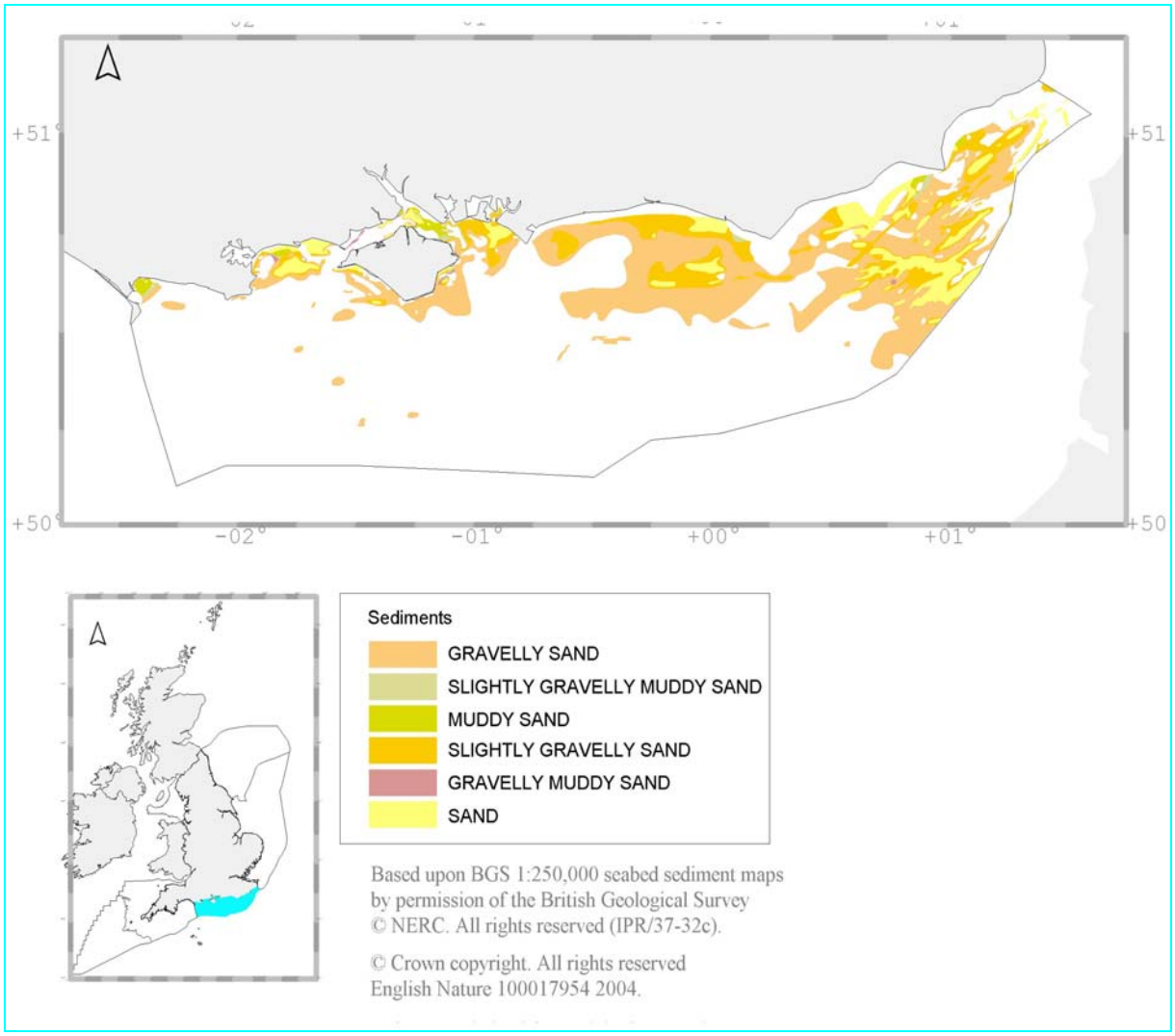


Figure 4.5 Sand habitats in the Eastern Channel Marine Natural Area.

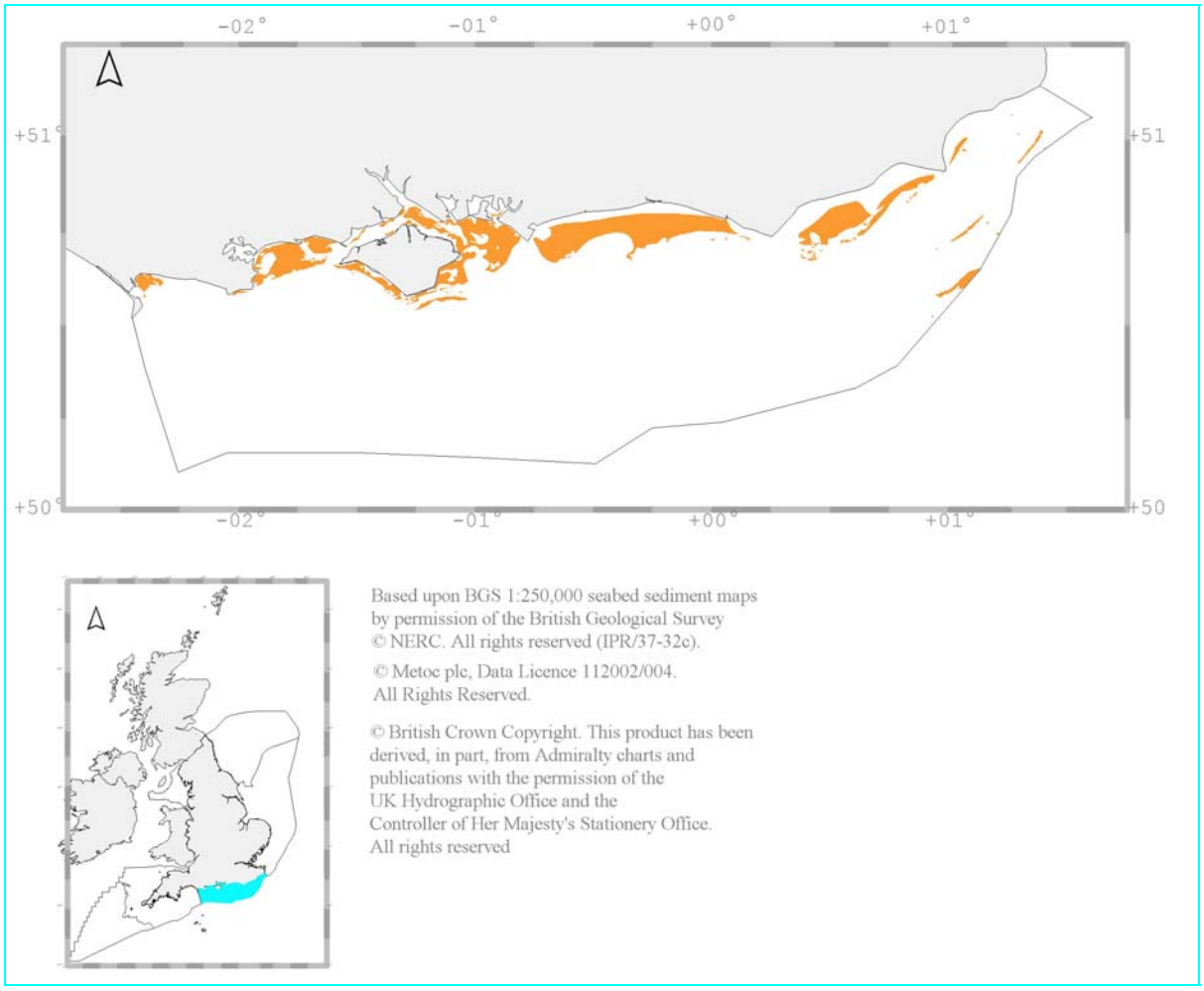


Figure 4.6 The distribution of shallow (<20 metres) sandy seabed areas, which indicates the potential location of 'Sandbanks which are slightly covered by sea water all the time' (*sensu* Habitats Directive) in the Eastern Channel Marine Natural Area. Further refining of these areas will define seabed which qualifies as Habitats Directive habitat.

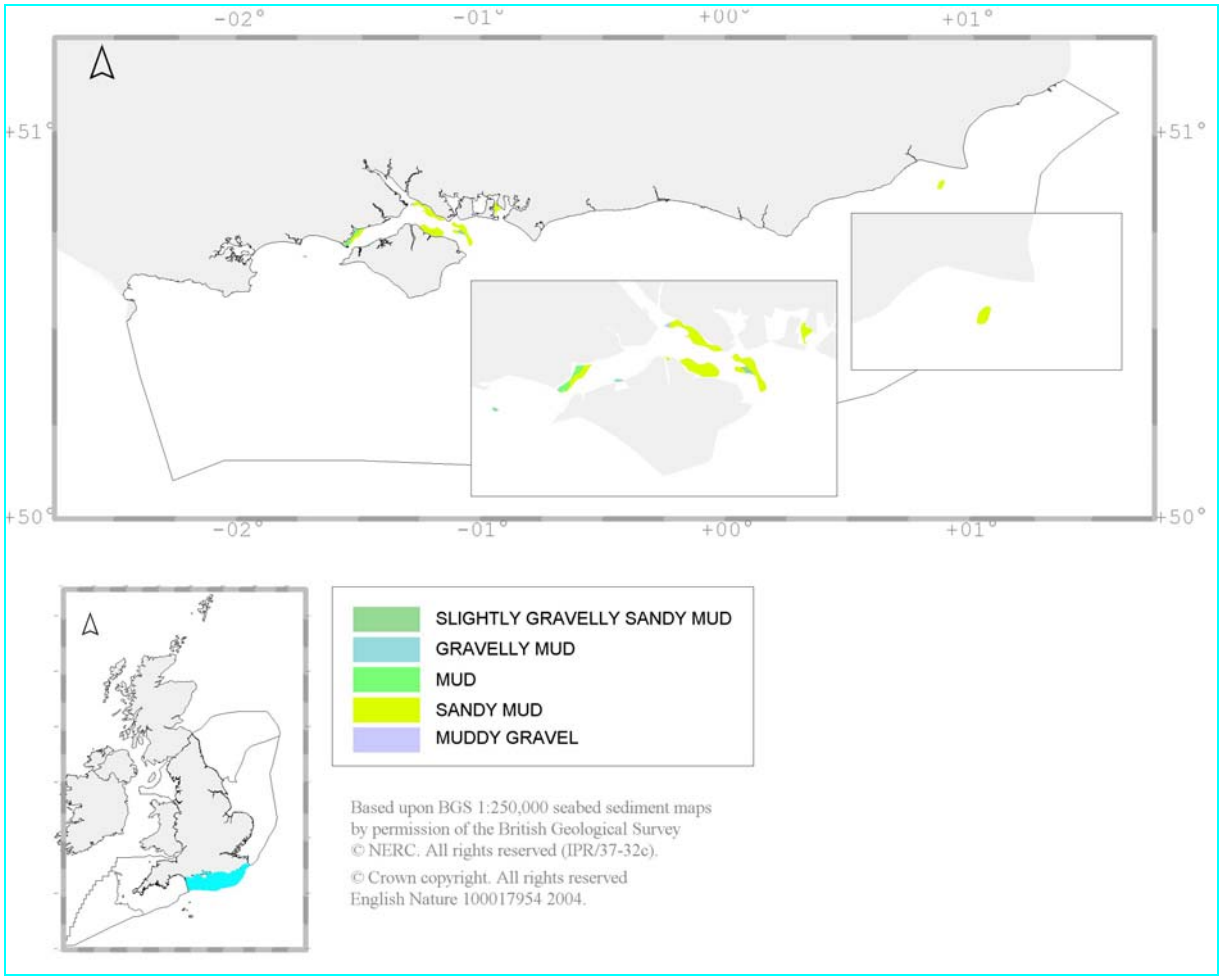


Figure 4.7 Mud habitats in the Eastern Channel Marine Natural Area

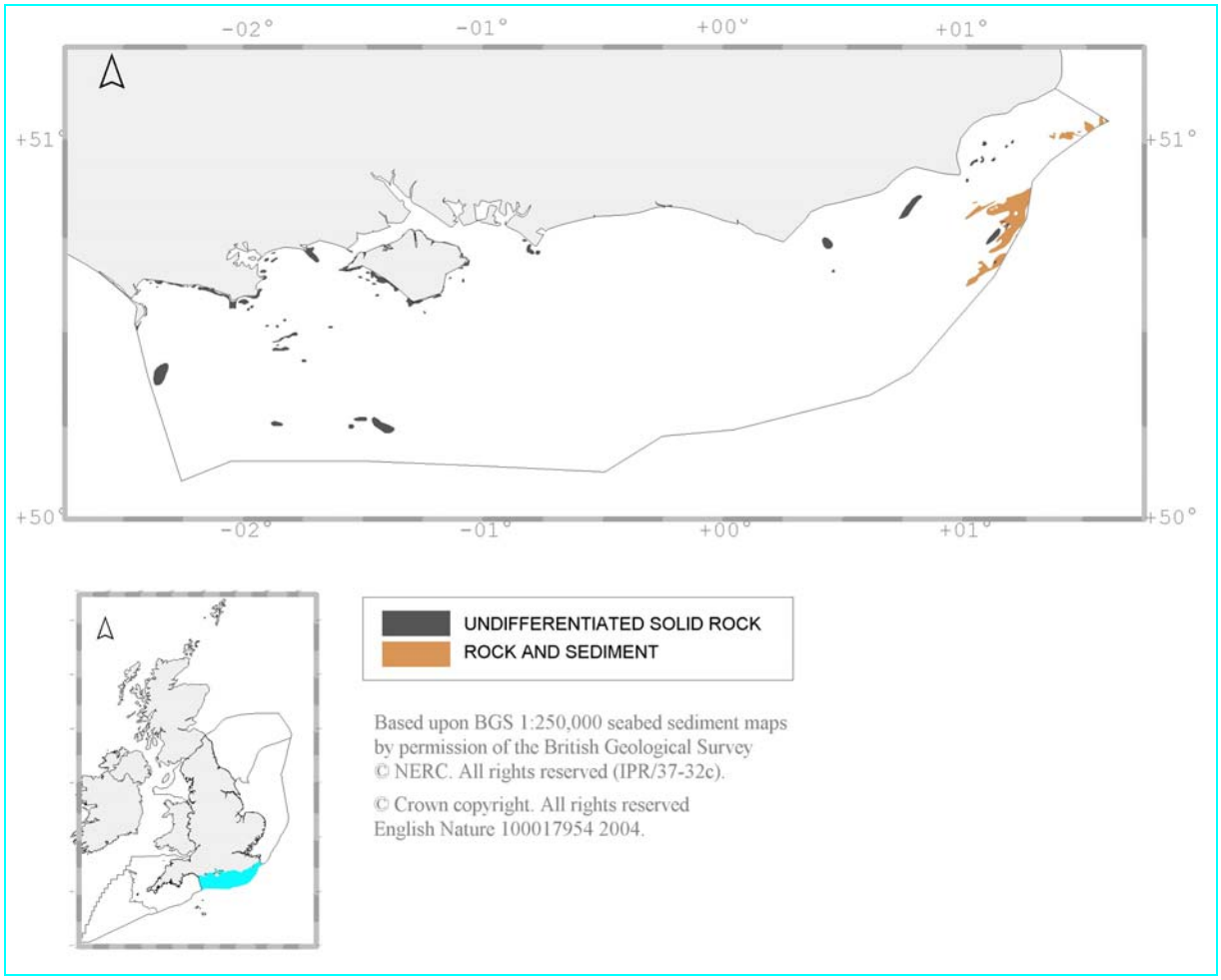


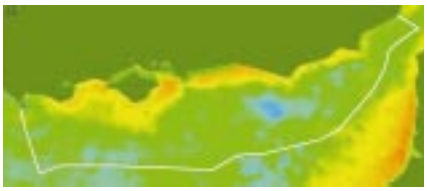
Figure 4.8 Rock habitat within the Eastern Channel Marine Natural Area.

Figure 4.9 Dive sites where *Sabellaria spinulosa* has been recorded off Swanage Bay, Dorset (Dorset Environmental Records Centre, pers. comm.).

Eastern Channel

Fishermen lifting a lobster pot. Lobsters are the mainstay shell fish species and provide the greatest revenue for fishermen in this Natural Area. Robert Irving/Seascope (right)

Container vessel in Eastern Channel. Cargo vessels are the second largest users of the waters of this natural area. P&O Nedlloyd (below)



Seawater surface temperature for Eastern Channel Natural Area in June 1997.
© Natural Environment Research Council (NERC) & Plymouth Marine Laboratory (PML) 2004 (above)

Atlantic Salmon spawn in rivers adjacent to this Natural Areas and afterwards swim to the open sea.
J. Moreau (right)

Native oysters are dredged from the Solent.
Keith Hiscock/MarLIN (above)

Sabellaria spinulosa with bloody henry starfish, sea beard hydroid, deadman's fingers and sea anemones on sublittoral rock in Swanage bay, Dorset.
Colin Froud (below)

Fulmar is highly dependent on the waters of this Natural Area.
English Nature (above)

Reticulated dragonet on gravel. Distribution of this species is restricted to the south and west coasts of Britain.
Robert Irving/Seascope (right)

5 Key species

This section describes key species of nature conservation value in the Eastern English Channel. 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]. 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 *Ammodytidae*, herring *Clupea harengus*, sprat *Sprattus sprattus* and mackerel *Scomber scombrus* (Skov *et al* 1995). The larvae of many of these species feed on plankton and occur at 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 (eg Bourne 1982).

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

Many species congregate at high densities to feed, nest and moult. In such situations a large proportion of the total population is susceptible to local incidents, such as oil spillages. The majority of marine birds are long-lived 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

[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.

another 35 years (Dunnet & Ollason 1982). Many marine birds also have low reproductive rates. Hence, even highly localised incidents can have a significant impact upon a population (Tasker *et al* 1995). Several species of marine bird, most notably the auks, divers, grebes and seaducks, moult their flight feathers simultaneously, becoming temporarily flightless. Such species are particularly vulnerable at this time.

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

5.1.2 Distribution of marine birds

The Eastern Channel Natural Area is important for marine birds. The 30 species that occur regularly in this area are listed in Table 5.1, together with a summary of their distribution and abundance. Of these, 18 species nest on the adjacent shoreline, the remaining 15 species occurring whilst migrating and/or during winter.

Marine birds are unevenly distributed, both geographically and in time, throughout the area (Stone *et al* 1995).

As a result of its geographical location, many marine birds pass through the Natural Area on route to breeding/wintering grounds elsewhere. The main passage route of several of these species is adjacent to the continental coast. However, in adverse weather conditions such species can occur in large numbers, eg an autumn total of 227 little gulls was recorded off the Sussex coast in 1987 (James 1996).

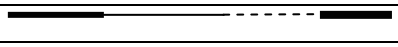
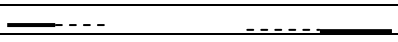
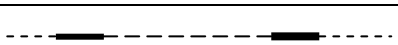
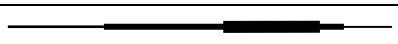
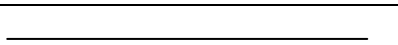
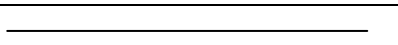
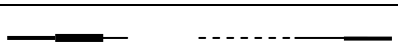
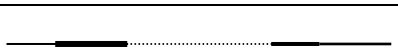
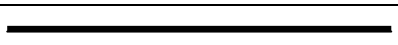
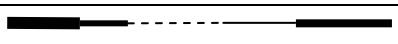
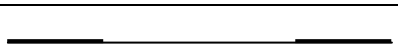
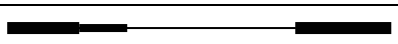
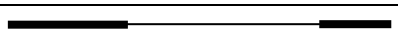
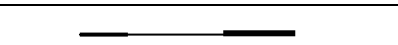
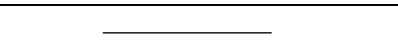
The varied adjacent shoreline provides suitable breeding conditions for a wide range of marine bird species. All of these birds rely upon the marine waters of the Natural Area to a greater or lesser extent for feeding, preening, mating and resting. The majority, including fulmar *Fulmarus glacialis* and guillemot *Uria aalge*, are highly dependent on marine waters in the Natural Area throughout the year. Other species, notably the terns *Sterna* spp., are seasonally dependent, migrating to more distant waters outside the breeding period.

5.1.3 Nature conservation measures

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

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

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			PM, A1
Black-throated diver			PM, A1
Great northern diver			M, A1
Little grebe		Preference for sheltered inshore waters.	
Great crested grebe		Preference for sheltered inshore waters.	PM
Red-necked grebe		Preference for sheltered inshore waters.	M
Slavonian grebe		Preference for sheltered inshore waters.	
Black-necked grebe		Langstone Harbour. Up to 30% British winter population.	
Fulmar			PM
Gannet			PM
Cormorant			PM
Shag			
Common scoter			PM
Velvet scoter			M
Red-breasted merganser		Highest numbers during passage.	PM
Skua (Arctic and Great)		Numbers peak during passage to and from breeding grounds.	M
Mediterranean gull			
Little gull		Large numbers in prevailing wind during passage.	M
Black-headed gull		Mainly coastal, throughout year.	PM
Common gull		Mainly coastal, highest numbers Oct-Feb.	PM
Lesser black-backed gull			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			PM
Sandwich, common, little tern		Shallow areas adjacent to colonies. Migrate after breeding.	M, A1
Roseate and Arctic tern		Shallow areas adjacent to colonies. Migrate after breeding.	M, A1

(Table notes overleaf)

Table 5.1 notes:

Graded lines indicate relative seasonal abundance within a species.

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

Status: A1 = Annex 1 species.
M = Migratory species (as cited in Stroud *et al* 2001).
PM = Partially migratory species (as cited in Stroud *et al* 2001).

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 Eastern Channel 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.

Relatively few cetacean species are sighted in the Eastern Channel Natural Area, with only four out of 26 species of the UK cetacean fauna (about 15%) being recorded regularly in the region since 1980. The waters within the Natural Area are mostly shallow (ie less than 50 metres deep) and are favoured primarily by those cetaceans that are frequently associated with relatively shallow continental seas, such as the harbour porpoise *Phocoena phocoena* and bottlenose dolphin *Tursiops truncatus*.

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 dataset 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

The humpback whale *Megaptera novaeangliae* is the only species of baleen whale that has been found within this Natural Area, but then only rarely, as the waters tend to be too shallow for larger species such as this.

5.2.2 Toothed whales

Most sightings of cetaceans within 60 kilometres of the coast are of the bottlenose dolphin. The remainder comprising almost entirely (in descending order of relative abundance) long-finned pilot whale *Globicephala melas*, harbour porpoise, common dolphin *Delphinus delphis,* white-beaked dolphin *Lagenorhynchus albiorostris*, Atlantic white-sided dolphin *Lagenorhynchus acutus* and killer whale *Orcinus orca* (Evans 1996).

The bottlenose dolphin *Tursiops truncatus* seems to favour prominent headlands and enclosed bays. These dolphins have been recorded annually in small numbers during the summer (July-September) in the Solent, and also around Hengistbury Head and St Catherine's Point in late summer (August-September). Every year, bottlenose dolphins are observed in the waters around Durlston Head, with peak numbers generally in spring (March-April) and autumn (September-December). They are also seen annually around Portland Bill, with peak numbers in the spring (March-April) and autumn (October) (Evans 1996). The small numbers observed throughout the Channel may reflect the movements of only a few groups.

The harbour porpoise *Phocoena phocoena* occurs in small numbers in nearshore waters, mainly during April and between August and October. Numbers of harbour porpoises appear to 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* is a relatively deep-water species recorded mainly offshore, but with small numbers observed in the vicinity of Durlston Head and Poole Bay between October and January.

The long-finned pilot whale *Globicephala melas* is another deep-water species recorded mainly more than 10 kilometres from the coast. Sightings in the Western Channel occur throughout the year, but with the largest numbers between May and October. An easterly movement into the Natural Area appears to occur around October, the species remaining in those waters until December or January. There is a secondary peak in numbers during April.

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 UK protected waters.

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

Table 5.2 Summary of cetacean protection measures (see notes below 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)	Biodiversity Action Plan
Humpback whale *Megaptera novaeangliae*	•	IV	I	I	VU	II	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 overleaf)

Table notes:

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

CITES (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

There are no significant haul-out or breeding sites for either common seals *Phoca vitulina* or grey seals *Halichoerus grypus* within the Natural Area. However, seals of both species are occasionally recorded throughout the region, and in some cases have remained for prolonged spells in certain areas (eg within Poole Harbour). A small group of common seals is regularly seen at the entrance to Chichester Harbour. There are also very occasional sightings (about 12 individuals per year) of common seals in Pagham Harbour (Duck 1998), which lies within an adjacent coastal Natural Area.

5.3.1 Nature conservation measures

Both the grey and common seals are listed under Appendix III of the Bern Convention. This appendix requires 'appropriate and necessary legislative and administrative measures to 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.

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 species are listed on Annex II of the Habitats Directive which requires 'animal and plant species of community interest whose conservation requires the designation of special areas of conservation'. No areas essential to life and reproduction have been identified for Habitats Directive Annex II cetacean species in this Natural Area. If areas are identified in the future, they could be designated as Special Areas of Conservation.

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 Turtles

Individuals of two species of marine turtle, the leatherback *Dermochelys coriacea* and the loggerhead *Caretta caretta*, have occasionally been reported from this Natural Area. Typically, dead specimens are encountered, either washed up on the shore or caught in nets at sea, but live individuals have been sighted too. Although all the turtles are believed to arrive in UK waters accidentally (with the possible exception of the loggerhead which may be at the extreme limit of its range), the occurrence of the leatherback is almost certainly the result of a deliberate, migratory movement (UKBAP website).

5.4.1 Nature conservation measures

The leatherback turtle and the loggerhead, are listed on Appendix I of the Convention on the International Trade in Endangered Species of Flora and Fauna (CITES) 1975, Appendix II of the Bern Convention 1979, Appendices I and II of the Bonn Convention 1979 and Annex IV of the EC Habitats Directive. The loggerhead is also listed as a priority species on Annex II of the EC Habitats Directive. All five species are protected under Schedule 5 of the Wildlife and Countryside Act 1981 and the Conservation (Natural Habitats & c.) Regulations 1994.

5.5 Fish

Populations of a number of commercial fish species are present within the Eastern Channel Natural Area, the region being important for providing spawning grounds, nursery and feeding areas. Fish are referred to here in terms of being pelagic or demersal (ground fish) species. Pelagic species are generally found in shoals swimming in mid-water, whereas demersal species are found living on or near the seabed.

Within the Natural Area the following species are of commercial importance: the pelagic species horse mackerel *Trachurus trachurus* and sprat *Sprattus sprattus*; and the demersal species dab *Limanda limanda*, lemon sole *Microstomus kitt*, turbot *Psetta maxima*, brill *Scophthalmus rhombus*, flounder *Platichthys flesus*, whiting *Merlangius merlangus*, pollock *Pollachius pollachius*, bass *Dicentrarchus labrax*, black bream *Spondyliosoma cantharus* and the grey mullets *Chelon labrosus*, *Liza ramada* and *L. aurata* (Pawson & Robson 1998). Only those species which are covered by the 'Commercial marine fish grouped species action plan' are featured below.

5.5.1 Pelagic

Mackerel *Scomber scombrus* are present within this Natural Area during their migration between spawning and over-wintering areas. Two stocks of mackerel are found in north west European waters: the North Sea stock and the continental western stock. The western stock spawns along the edge of the continental shelf, to the west of Britain, between February and June. Some of the stock then migrates eastwards through the English Channel into the central North Sea, while some remains in the west. The spawning is wide ranging and includes, in low intensity, areas offshore within this Natural Area (Pawson & Robson 1996) (see Figure 5.3a).

Herring *Clupea harengus* are locally abundant in the summer and autumn in feeding areas throughout the Natural Area. There are no distinct autumn/winter spawning areas in the Area, but there are two south of the region, off the coast of France (Lee & Ramster 1981) (Figure 5.3b).

Two non-commercial species, twaite shad *Alosa fallax* and allis shad *Alosa alosa* are anadromous: they spawn in freshwater, where the young feed and grow for approximately five months, before heading downstream to the sea. These species are declining throughout the UK although they have been recorded within this Natural Area (Potts & Swaby 1993). The occurrence of shad during the autumn is noteworthy because most of the shad in the UK are recorded in spring (mostly during late April and May). The Atlantic salmon *Salmo salar* and the sea trout *Salmo trutta* are also anodromous and may be found in the coastal waters of this Natural Area. They are found in Solent rivers such as the Test.

Perhaps the most notable (and certainly the largest) pelagic fish species which occasionally enters the eastern English Channel from the west is the basking shark *Cetorhinus maximus*. Although this is the largest fish in British waters (growing up to 12 metres in length), relatively little is known of its reproductive biology and population dynamics. The basking shark feeds on plankton which it filters from the water as it swims along with its mouth open. The common name comes from its habit of 'basking' on the surface during the summer months as it feeds. In these situations, it is often seen in association with shoals of herring and mackerel which are also plankton feeders. Adult fish can filter 330,000 gallons of water an hour to extract plankton, but they are unable to feed over the winter period as they shed their gill rakers (Gubbay 1988). Basking sharks have, on occasion, been recorded from as far up the Channel as off Brighton.

5.5.2 Demersal fish

Cod *Gadus morhua* are widely distributed and reputed to be seasonally abundant throughout the Natural Area (Pawson & Robson 1996), but far fewer are being caught these days when compared to landings 10 or 15 years ago. The only pronounced spawning aggregation of cod is off East Sussex (south of Rye Bay), though further west (west of Selsey Bill to beyond Portland Bill) a nearshore area is within the limit of possible spawning (Lee & Ramster 1981) (see Figure 5.3c). The North Sea cod stock is at an all-time low and a fish stock recovery plan has been put in place.

Plaice *Pleuronectes platessa* are most often found on sandy substrates 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 from December to March, the spawning peak being in January and February towards the centre of the English Channel (Figure 5.3d). These spawning grounds cover a large proportion of the offshore area found within the Natural Area. The juveniles remain in shallow waters close to the shore in the same nursery areas as Dover sole, gradually moving into deeper water as they grow.

Dover sole *Solea solea* is an important commercial species within the Natural Area. The nearshore area throughout the mid- and eastern Channel are used as spawning grounds in the early summer (April to June), an area which expands southwards east of Worthing as one travels up the Channel. Juvenile Dover sole may spend up to two years in inshore nursery

areas. This species is particularly abundant in areas of muddy sand and fine sand where the polychaete worms that it feeds on are also abundant (Figure 5.3e).

Sandeels *Ammodytes* spp. are distributed widely throughout the Natural Area and are common in the shallow harbours and bays. Sandeels provide an important food source for many other exploited fish species as well as certain seabirds. They burrow in coarse sand at night and during the winter. Their distribution is thus influenced by that of coarse sand (Pawson & Robson 1998).

5.5.3 Conservation measures

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

5.5.3.1 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 (TACs) and quotas has been implemented. 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 a 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.

5.5.3.2 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 spawning stock. In addition it avoids catching

unmarketable fish that would be discarded. However, as fisheries consist of mixed species of varying sizes, immature fish of larger species, such as cod, may be caught. The current minimum mesh size for a white fish trawl net is 100-millimetre diamond mesh.

Minimum size (MS)

Another fisheries conservation measure is concerned with regulating the Minimum Landing Size (MLS) of fish. Fish not attaining the MLS 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.

Sea Fisheries Committees' byelaws

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

5.5.3.3 Other conservation measures

Closed areas

Closures of a fishery can be spatial or temporal. There 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 may also be voluntary or statutory.

The South West Mackerel Box (Fig 5.4) was introduced in 1986 by Council Regulation (EEC) No. 3094/86. It is intended to protect juvenile mackerel by diverting fishing effort away from juvenile stocks to older fish. Vessels are prohibited from retaining mackerel caught in the Box if it exceeds 15% by weight of the total catch on board taken in the area (10% by weight of the total catch of mackerel, horse mackerel and pilchards for vessels of flags which have no quota for mackerel). Fishing by hand line is still permitted within the Box. The South West mackerel season is usually from October to April, and considerable resources are devoted to ensuring that the integrity of the Mackerel Box is maintained and that pelagic vessels fishing in and around the area comply with the rules.

Closure of areas to certain types of gear

The Sea Fisheries Committees (SFC) are able to ban certain types of gear to protect stocks or other static gear. Details will be contained within individual SFC byelaws.

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, such as Portsmouth, or to ensure safety near oil and gas installations or other pipelines.

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 this Natural Area, France has a right to fish all species within the 6-12 nautical mile belt, and Belgium has an historic right to fish for demersal species in the area between Dungeness and Selsey Bill. From Dungeness to the eastern boundary of the Natural Area, the Netherlands and Germany have rights to fish only herring.

5.5.4 Nature conservation measures

A summary of the conservation measures can be seen in Table 5.3. Only three species found within this Natural Area are protected by the EC Habitats and Species Directive - twaite shad *Alosa fallax* , Allis shad *Alosa alosa* and Atlantic salmon *Salmo salar*. All species are listed on Annex II (species 'of community interest whose conservation requires the designation of special areas of conservation') and Annex V (species 'of community interest whose taking in the wild and exploitation may be subject to management measures'). There are no SACs designated for shad species or Atlantic Salmon within or adjacent to this Natural Area (the latter only qualifies as an interest feature of an SAC in freshwater).

Both shad species are 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 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 action plan differs from others in that it is aimed at particular stocks rather than the all species. Within this Natural Area, stocks of cod, herring, mackerel, plaice and sole are included in the plan. There are also Species Action Plans for the common skate *Dipturus batis*, the twaite shad *Alosa fallax* and the allis shad *Alosa alosa.*

The basking shark is a species protected under Schedule 5 of the 1981 Wildlife & Countryside Act (1998 Amendment), which prohibits the intentional killing, capture or disturbance within 12 nautical miles of the coast. The shark also has its own Species Action Plan (see Table 5.3). In November 2002 the basking shark was added to Appendix II of the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES), which prohibits sale of the shark's body parts (liver, cartilage, meat and particularly its fins).

Table 5.3 Summary of fisheries conservation measures.

Species	EC Habitats Directive (Annex no.)	Wildlife & Countryside Act (schedule 5)	IUNC Red Data List Species	Bern Convention (Appendix III)	CITES (Appendix II)	Biodiversity Action Plan
Common skate *Raja batis*			Endangered (Provisional)			Common skate Species Action Plan
Allis shad *Alosa alosa*	II & V	•		•		Allis shad 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 scombrus*						Commercial marine fish grouped Species Action Plan
Plaice *Pleuronectes platessa*						Commercial marine fish grouped Species Action Plan
Sole *Solea solea*						Commercial marine fish grouped Species Action Plan
Basking shark *Cetorhinus maximus*		•	Vulnerable		•	Basking Shark Species Action Plan

(Table notes overleaf)

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.

5.6 Shellfish

Beds of native oysters are found at a number of locations including Chichester Harbour and Poole Harbour (in the adjacent coastal Natural Areas), and the Solent. Indeed, the populations of native oyster found within the Solent are of national significance, being one of the few remaining beds of naturally occurring stock in Britain (English Nature 1998). The oysters are dredged over the winter period (November to April) and are 'naturally replenished' – ie they rely on the successful spawning of the remaining wild stock. Crushed oyster shells ('cultch') are specifically laid down as a substrate to encourage this 'spatfall'. Cultivation of native oysters occurs at Calshot and Stanswood Bay in the north Solent.

The sudden decline in a once abundant supply of oysters during the mid-nineteenth century has been put down to overfishing, which indirectly resulted from the rapid development of the railway network, meaning that oysters could be rapidly transported to inland markets. More recently, oysters have been adversely affected by the anti-fouling agent TBT and a number of introduced species. The American oyster drill *Urosalpinx cinerea* is a predator on oysters (alongside native species such as crabs, starfish, dogwhelks, shell-boring worms and sponges). The slipper limpet *Crepidula fornicata* (another introduced species) is a filter feeder that creates 'mussel mud'. This mud degrades the oyster grounds and hinders recruitment, although dead slipper limpet shells can add to the cultch upon which oyster spat may settle.

There are also significant commercial populations of scallops, queen scallops, mussels, whelks, lobsters, crabs and spider crabs which are exploited within the Natural Area, though these are not of particular nature conservation importance.

5.6.1 Conservation measures

Of the species of shellfish for which priority Species Action Plans have been drawn up, the native oyster *Ostrea edulis* is the only shellfish species of commercial importance and the only molluscan BAP species present within this Natural Area.

Native oyster fisheries in the UK are managed by a mixture of national legislation (eg in Great Britain by the Sea Fisheries (Shellfish) Act 1967) and, in England and Wales, local Sea Fisheries Committees byelaws. Many of the principal oyster fisheries in England and Wales are managed through Regulating or Several Orders (the latter exclude the public right to fish).

There is a Regulation Order in Chichester Harbour and there are Several Orders in place at Calshot and Stanswood Bay in the north Solent. There is a national closed season (14 May to 4 August) to protect native oysters during the spawning season, though a dispensation exists for cultivated stock.

5.7 Other invertebrates

The pink sea fan *Eunicella verrucosa* has recently been found in Poole Bay and in Warbarrow Bay to the west of Kimmeridge in Dorset (pers. comm., P. Tinsley, Dorset Wildlife Trust). These are the most easterly records to date of this species. The pink sea fan, which has its own Species Biodiversity Action Plan, grows on bedrock outcrops in the circalittoral zone (the zone dominated by attached animals which extends below the zone dominated by algae). The pink sea fan is more frequently encountered further west, though its range is restricted to the south west peninsula, southern Wales and south west Ireland.

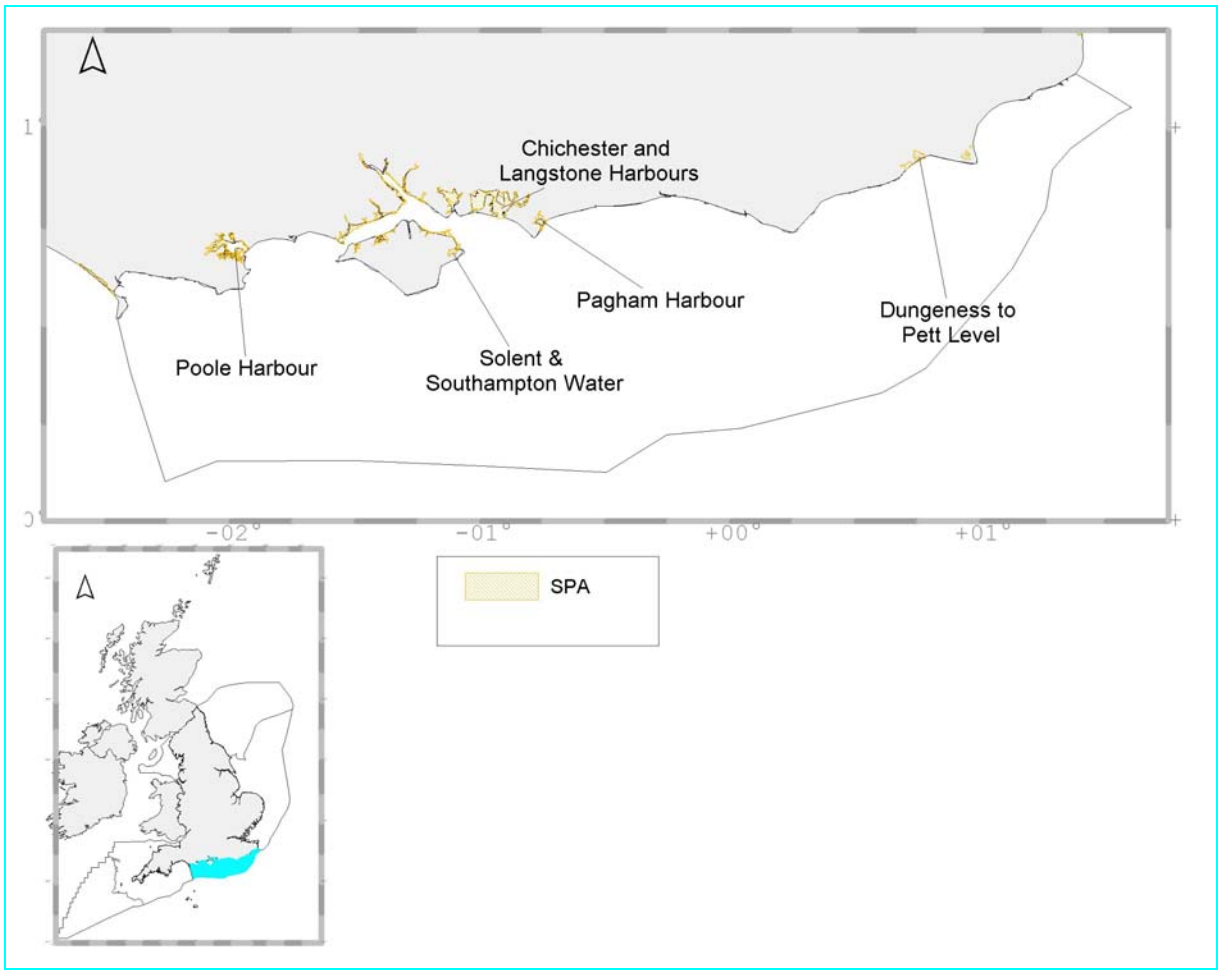


Figure 5.1 Location of Special Protection Areas within the Eastern Channel.

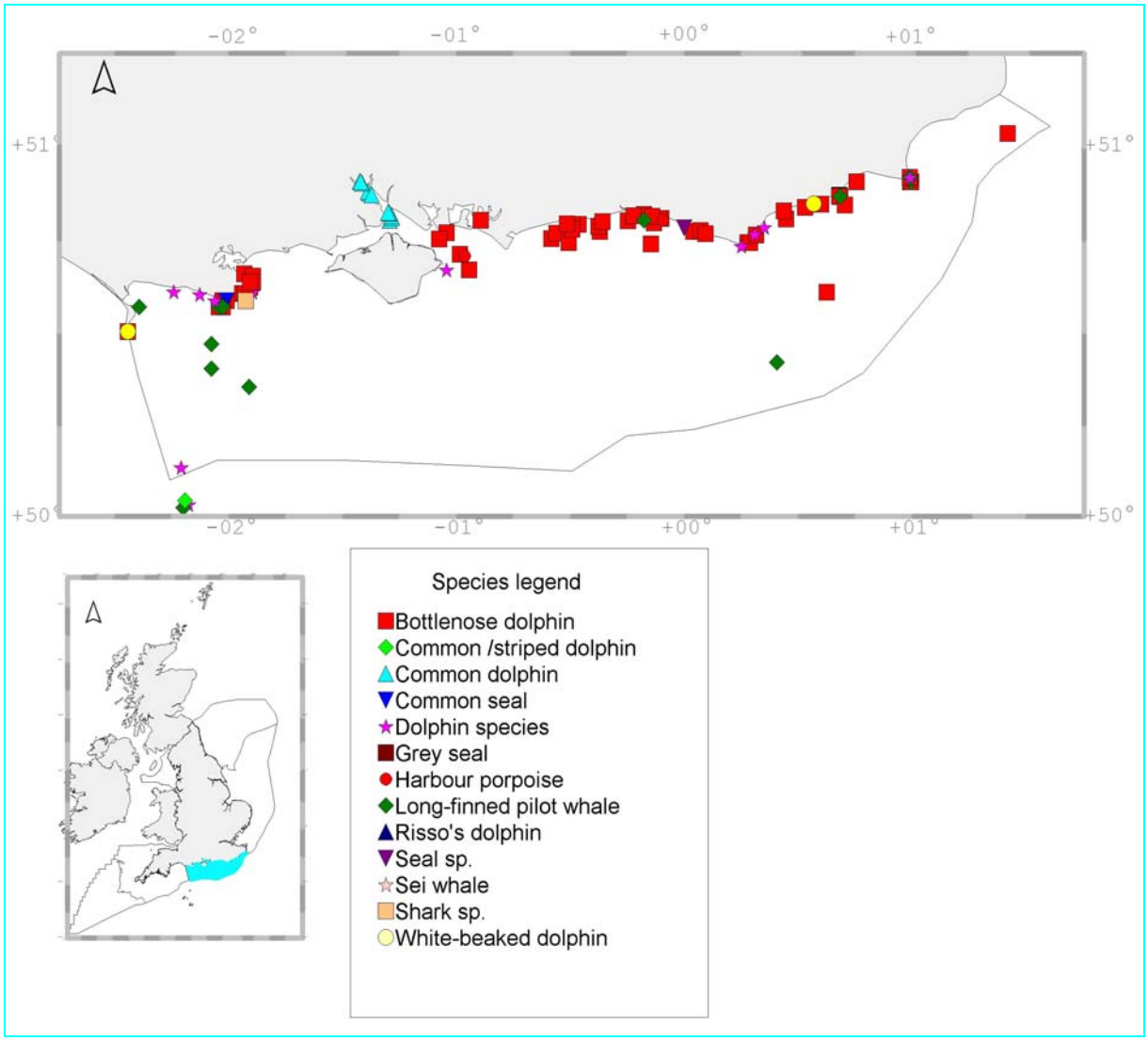
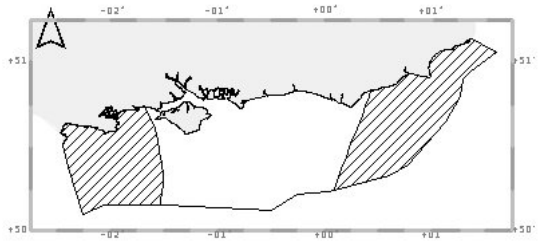
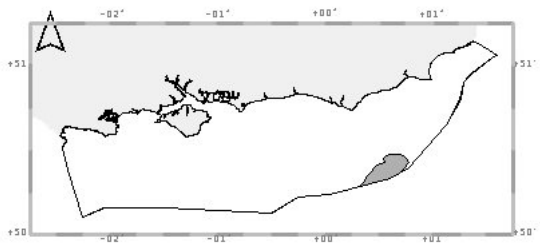


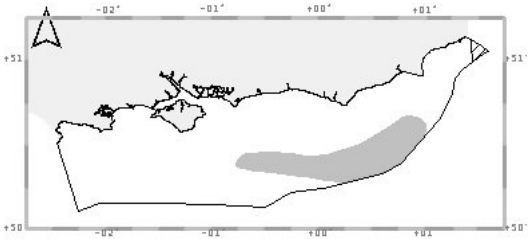
Figure 5.2 Records of cetacean and seal species seen in the Eastern Channel (after Evans *et al* 2003).



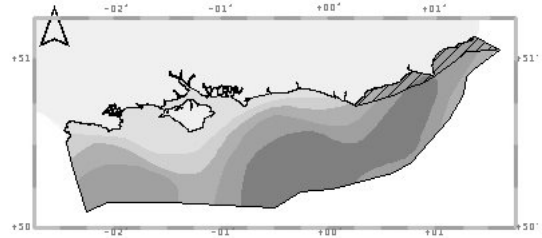
a) Distribution of **mackerel** spawning (May–Aug) and nursery areas within the Eastern Channel Natural Area.



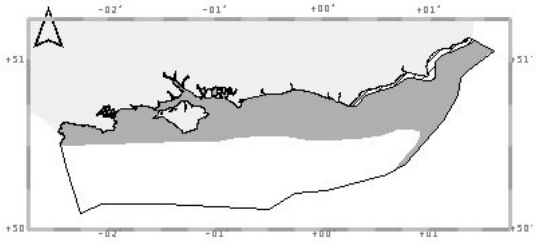
b) Distribution of **herring** spawning (autumn–winter) and areas within the Eastern Channel Natural Area.



c) Distribution of **cod** spawning (Feb–Apr) and nursery areas within the Eastern Channel Natural Area.



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



e) Distribution of **sole** spawning (March–May) and nursery areas within the Eastern Channel Natural Area.

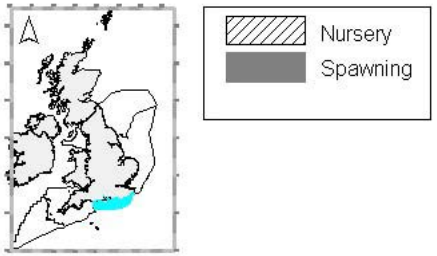


Figure 5.3 Maps showing the distribution of spawning areas within the Eastern Channel Natural Area (data taken from Coull *et al* 1998 and provided by CEFAS).

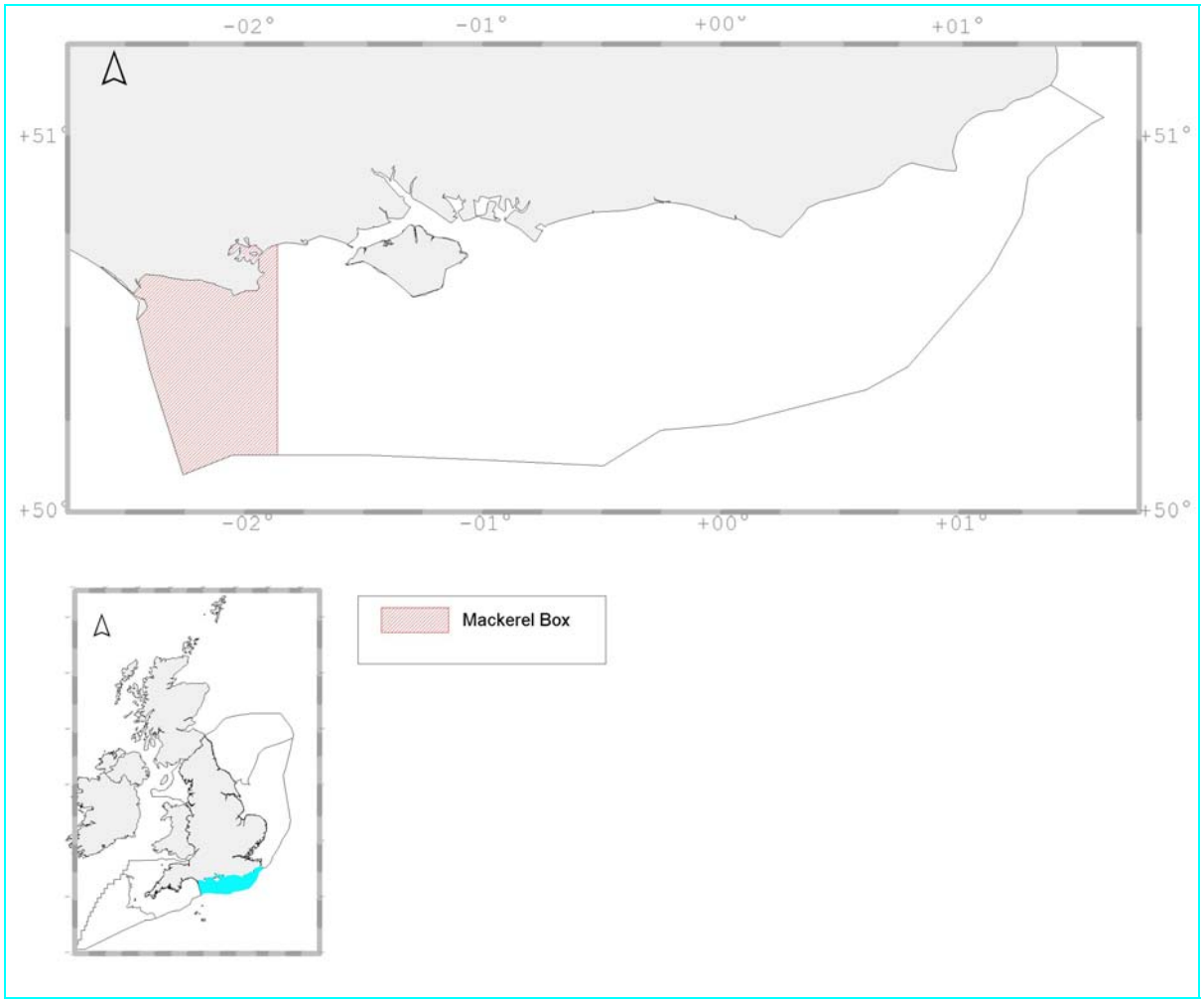


Figure 5.4 Location of Mackerel Box within the Eastern Channel Natural Area.

6 Human activities and uses

This section outlines significant human activities in the Eastern English Channel 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 values of the Eastern Channel, 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 effective sustainable use of the environment and its biodiversity.

6.1 Fisheries

This region of the mid and eastern English Channel is only moderately important for fishing activity when compared to other parts of the English coast. Populations of a number of commercial fish species are present, together with their spawning grounds and nursery and feeding areas (see section 5.5). There are four 'major' fishing ports (as defined by Defra) within this Natural Area (Shoreham, Portsmouth, Poole and Weymouth) and numerous other smaller ports where fish are landed (see Figure 6.1). However, the majority of fishing carried out in the Channel is by French vessels, even within UK jurisdiction.

Along the coast of Sussex, most fishing activity is undertaken by beach boats setting nets out to six miles offshore, with larger boats of over 10 metres working from a few harbours, eg Rye, Newhaven and Shoreham. The Solent is relatively sheltered, allowing small boats to operate safely and in relative comfort. Further to the west, the coast is more exposed to the prevailing south westerly winds.

Within the Sussex Sea Fisheries District (Dungeness to Chichester Harbour), during the early 1990s 60% of the fishing fleet was estimated to be setting nets (trammel and gill) for most of the year (Pawson *et al* 2002). These catch mostly sole and plaice, with some rays, cod and bass. The other main fishery is, and has been, potting for crabs and lobster. Lobsters are the mainstay shellfish species and provide the greatest revenue for fishermen in the region. The shellfish are caught all year round, though the effort is maximised during the summer when part-time fishermen join the full-time boats. Further west within the Southern Sea Fisheries District (Chichester Harbour to Lyme Regis), crab and lobster provide half the value of all landings, with other shellfish making up a further 25% and finfish the balance (Pawson *et al* 2002).

Fishing activity impacts on the environment producing direct and indirect effects. 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 and 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. 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 substrate and its physical characteristics (Jennings & Kaiser 1998; Lindboom & De Groot 1998). The tracks will gradually fill in over time depending on the type of ground, water depth (usually less than 20 metres), the strength of the tide and overall weather conditions. Other types of towed gear can also alter the substrate. The impact appears to be greatest on densities of small fragile benthic species, possibly because larger animals live deeper in the sediment or are better able to escape (Bergman & Hup 1992). Changes in benthic community structure occur following beam trawling but the effects can be variable (De Groot 1984; Jennings & Kaiser 1998; Lindeboom & De Groot 1998). In intensively trawled areas it has been suggested that the community shifts towards being dominated by highly productive, opportunistic species such as polychaetes.

Within the Natural Area, beam trawling is restricted in certain areas (under Sea Fisheries Committee byelaw) while physical restrictions on the seabed can also limit the use of gear. Although visiting boats compete for local resources, most[8] are not allowed within the 12 nautical mile limit (Pawson *et al* 2002). The main target species for beams trawls is Dover sole, though plaice, turbot, brill, rays and lemon sole are also taken. However, the preferred methods for catching these other species tend to be otter trawls, tangle and trammel nets (see below).

Otter trawls - The otter trawl is a large cone-shaped net, which is towed across the seabed. The mouth of the net is kept open by otterboards. These are in contact with the seabed. They may mound the sediment as well as creating a scour furrow (Gilkinson *et al* 1998). This may alter the surface roughness of an area as well as the sediment structure. Otter trawling also results in the capture of a considerable amount of by-catch species, though certain selectivity measures (such as incorporating square mesh 'windows' in the top of trawl nets which allow the release of non-target species) are now being more readily used. Trawls can sometimes be fitted with rock-hopper gear to enable them to traverse reefs.

Otter trawls are mainly used to target species such as lemon sole and plaice during the warmer months, and for cod and whiting in winter (Pawson *et al* 2002). Trawls may also be used to catch cuttlefish and squid during the summer months. Otter trawling is carried out throughout the Natural Area.

Dredges – These are used mainly to catch scallops and oysters. Most scallop dredges now have spring-loaded teeth which reduces bottom snagging, thereby allowing the gear to be used over rough ground. The size of the teeth and the width of the belly rings (mesh size) determines the size of the animals captured. A scallop dredge causes considerable

[8] Beam trawlers whose engine size is less than 221 kws and whose aggregate beam length is less than 9 metres are permitted inside the 12-mile limit. Sea Fisheries Committees restrict access within the 6-mile limit mainly on vessel length, but in Sussex also prohibiting trawling in some areas within 0.5 miles of LWM.

disturbance to the ground over which it is towed, overturning rocks and dislodging and crushing many organisms in its path (Moore & Jennings 2000). Within Poole Harbour, 'pump scoop' dredges are currently used to fish for manila clam and cockles. These use jets of water to disturb the ground in front of the dredge.

Most scallop dredging takes place from Rye and between Eastbourne and Shoreham. Large beam trawlers from Shoreham and Portsmouth dredge for scallops from January to May (Robson 1998). Pacific and native oysters are cultivated within Chichester Harbour, and native oysters are dredged from natural beds there too, as well as from within the Solent and Poole Bay. Mussels are dredged from beds in deep water off Portland Bill.

6.1.1.2 Static gear

Gill nets can be set at or below the surface, on the seabed, or at any depth inbetween. This type of gear can result in the incidental capture of marine life, most notably marine mammals and seabirds. They also have the potential to continue fishing if lost or discarded, an effect which has been described as 'ghost fishing' (Kaiser *et al* 1996) (see section 6.1.2). Static gear fishing is practised throughout the Natural Area, its intensity decreasing with distance from the coast. The main target species of set nets are sole and plaice (mostly using tangle and trammel nets over the summer months), with larger-meshed tangle nets being set for rays, turbot and brill during this period too. Gill nest are used for cod and whiting during the colder period of the year, when shoals appear close inshore.

Potting for lobster *Homarus gammarus* and crab (various species) is practised in areas around Eastbourne, Newhaven, Brighton, Shoreham and Selsey, with the brown or edible crab *Cancer pagurus* being caught on cleaner grounds further offshore. Within Sussex, fishing for lobsters requires a permit issued by the Sussex Sea Fisheries Committee which restricts the number of lobster pots set per boat within three miles of the coast to 100 per crew member and up to a maximum of 300 per boat. As a consequence, most boats set pots both with and outside the three miles (Pawson *et al* 2002). Whelks have become an important resource too and a small number of boats also set pots for prawns.

6.1.2 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, 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.

6.1.3 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. In particular, concern has grown over the by-catch of cetaceans

in a number of different types of gear, including bottom-set gill nets and trawl nets. 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).

Various methods and devices have been trialled in order 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, or making nets more 'reflective' (by coating nets with a layer of iron oxide or barium impregnated nylon to make them stiffer (Larsen *et al* 2002)).

6.1.4 Ecosystem effects

Intense fishing activity has in some areas, resulted in the 'fishing down' of the food web (Pauly and Maclean 2003). This is where 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 focused on sandeels though this is not practiced in the Channel). However, these 'industrial fisheries' are also of concern because species near the base of the food chain are removed in vast quantities and may impact the breeding success of bird species that rely on them as a food source. This could have implications for relevant species which use neighbouring Marine Natural Areas where 'industrial fishing' is practiced.

6.2 Oil and gas extraction

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. There are no offshore gas fields in production or under development in the Eastern Channel. However, several blocks have been licensed between the Isle of Wight and Portland Bill, and there have been a number of exploratory wells (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.

Further information can also be obtained from the DTIs Strategic Environmental Assessment reports which are available via the SEA website at http//www.offshore-sea.org.uk/sea/index.php.

Any activities for or in connection with the exploration for or production of petroleum which are situated wholly or partly in the UK Continental Shelf Designated Area are subject to the application of the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001

which apply the Habitats and Birds Directive to the offshore waters in relation to oil and gas activity. In addition to provision for features covered by the Habitats and Birds Directives, all activities are required to submit a notification to the Consent Authority and an Appropriate Assessment may be required before consent is granted.

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

6.2.1 Evaluation

During the initial surveys to locate reserves, seismic surveys are carried out using air guns, which can disturb fish and cetaceans. Underwater sounds from seismic activities are most likely to affect baleen whales, which communicate primarily at similar frequencies to those produced by air guns (Baines 1993). However, our understanding of cetacean communication and sensitivities is currently restricted 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 where seismic 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.

6.2.2 Exploration

One of the most significant impacts of the exploration stage is the effect of drill cuttings on marine wildlife. Acording to Hailey (1995) 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 rarely used now).

It has been suggested that contaminated cuttings quickly disperse causing little impact on the seabed around the drilling area, 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. (See also section 3.7.3.1.)

6.2.4 Abandonment and decommissioning

The process of decommissioning can also have detrimental effects on the marine environment, in particular the benthos and the pelagic species in the water column. The main source of concern is the level of toxic substances that can be released. These substances may consist of 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 could release substantial amounts of oil into the environment. However, decommissioning applications are considered on a case-by-case basis by the Department of Trade and Industry in full consultation with JNCC, English Nature as well as 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. Currently, 36% of sand and gravel demand in the south east region (which includes London) is met from marine sources (pers. comm., M. Russell, British Marine Aggregate Producers Association).

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 Interim and Statutory Procedures have provision to hold a public inquiry if necessary.

Within this Natural Area, licensed extraction areas lie to the south west, south and east of the Isle of Wight, off the coast of West Sussex and to the south east of Beachy Head off the coast of East Sussex (see Figure 6.3). In addition to these, there are a number of areas where aggregate extraction is proposed in the future – application areas. Indeed, the East Channel region may become the most significant aggregate extraction area around the whole coast.

The physical impacts of marine aggregate extraction arise from removing the substrate and altering the seabed topography; creating a turbidity plume within the water column in the area of activity, and sediment re-deposition. Dredging disturbs the benthic community and can reduce the number and diversity of benthic species (ICES 2001). The main fish species which is 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. Another fish species, the black bream *Spondyliosoma cantharus*, is not directly threatened by substrate removal, but may be affected by sediment re-deposition. It builds circular 'nests' in which to lay its eggs in nearshore gravel areas off the West Sussex coast during April and May.

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

John *et al* (2000) identified 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). However, this is likely to be more significant when considering the suspension of finer material, as is produced by the deposition of maintenance and capital dredgings (see section 6.5).

Re-deposition of the particles from sediment plumes will also occur and, once settled on the seabed, will be liable to re-suspension or transport over the substrate. The extent and magnitude of this will depend upon the interaction between the local hydrodynamic situation and the characteristics, volume and particularly the rate of input of the re-deposited sediments. Whilst this process occurs naturally anyway, the greater loading of sediment can, in severe cases, smother benthic species and fish eggs on spawning grounds (see also section 6.5 on the disposal of maintenance and capital dredged material). Appropriate selection of extraction sites, and possible seasonal restrictions on working the sites, should minimise the risk of this happening.

6.4 Shipping

6.4.1 Commercial

The Dover Strait is one of the world's busiest shipping lanes, and there is heavy shipping traffic in the Solent too. 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 with the growth of the petroleum industry and the advent of the oil tanker, which is the largest carrier of cargo. The carriage of goods by sea inevitably places marine and coastal environments at some risk. Almost any vessel anywhere has the potential to cause a degree of environmental damage, either through routine operations or accidents. Despite this, shipping is responsible for a relatively small proportion of all marine pollution in the UK, compared to that from land-based sources. Much of the marine pollution may be traced back to centres of population and to industrial and agricultural operations. Pollution from ships can be categorised in four ways:

- **Historical pollution** - for example, the application of TBT has now been banned on vessels of all sizes by the International Maritime Organisation, with a global ban due to come into force in 2008.
- **Operational pollution** – this consists of oil and oily wastes, noxious liquid substances, sewage, garbage.
- **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 ferries and 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 15 oil spills that occurred in and around this Natural Area during 1989-1998, a total of 90 tonnes of oil were released into the environment (SAFETEC 2000). The largest of these spills occurred in the Dover Strait where 50 tonnes were spilled from a tanker.

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 divers and grebes that are found within this Natural Area, moult their feathers simultaneously, becoming temporarily flightless (Tasker *et al* 1995). 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 highly localised incidents can have a significant impact upon a population.

In an attempt to address some of the problems caused by shipping, the Donaldson Inquiry was initiated to 'identify what can reasonably be done to protect the UK coastline from pollution from merchant shipping' (Donaldson 1994). The Inquiry, initiated after the *Braer* disaster, provided an overview of the use of routeing measures aimed at accident prevention and subsequently dangers of pollution and loss of life. Routeing measures ensure that ships are kept outside areas where pollution would cause particular damage to the environment. One of the major recommendations of the inquiry was the establishment of Marine Environmental High Risk Areas (MEHRAs). These are comparatively limited areas of high environmental sensitivity that are at risk from shipping. The idea was that identifying MEHRAs would give ship masters additional information relevant to passage planning, which would result in the usage of the recommended routeing and reduce pollution risk at these sites. The process of identifying MEHRAs is well advanced though the timescale for their introduction has not been decided.

Table 6.1 Annual total of number of vessels passing through the Eastern Channel Natural Area in 1999. (Data taken from COAST database.)

Vessel type	**Annual total of number of vessels passing through the Natural Area**
Bulk	10,186
Cargo	56,058
Ferry	79,779
Gas carrier	3,926
Ro-Ro	10,524
Standby	0
Supply	0
Chemical tanker	7,590
Oil tanker	11,052
Shuttle tanker	344
All	179,459

6.4.2 Ferries

A large proportion of the marine traffic within this Natural Area is composed of ferries that transport cars and passengers across the English Channel to the adjacent mainland Europe. There are also shuttle ferry services running between Portsmouth/Southampton and the Isle of Wight. In excess of 500 ferries pass through this Natural Area per week (see Figure 6.6). Passenger and car ferries pose very little threat to the marine environment when compared with tankers or cargo vessels, as they tend not to carry hazardous chemicals. However, grounding incidents can have an impact on the marine environment and may result in large areas of the seabed being damaged. In shallow water, propellers can also cause disturbance. Information taken from Lloyd's Register Casualty Database (Safetec 2000) shows that 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, or under the seabed, 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). The disposal of sewage sludge has been banned under the OSPAR Convention since 1 January 1999.

Historically the largest of the mid-Channel sewage disposal sites was within this Natural Area – at the Nab Tower to the east of the Isle of Wight. In addition, there was one licensed industrial waste disposal site to the south of the Isle of Wight. 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, which requires a licence for the deposit of substances or articles onto the seabed. The principal material that continues to be disposed of is either material removed to keep navigation channels clear (maintenance dredging); or material removed during coastal construction engineering projects (capital dredging), though the latter includes the creation of new navigation channels. 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 consent 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 the 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 pertinent 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 (see section 6.1.2). Fishing debris may also entangle marine life close to the surface, such as seals, cetaceans, turtles and seabirds. In 1991, the North Sea (including the English Channel) was designated a MARPOL Special Area (Annex V), where the dumping 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 Eastern Channel 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 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 that 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 coastal and inshore waters, we have not dealt with them in any great detail. Further information can be found in other publications such as the JNCC's Coastal Directories (Barne *et al* 1996 and English Nature's regulation 33 packages (English Nature 2001).

Sailing and boating is extremely popular in the Marine Natural Area, and the Solent and Chichester Harbour together represent one of the densest concentrations of water recreation in Europe (Fowler & Everett 1998). Additionally, the British Marine Police estimate that the Solent area ranks fourth in the world behind Hong Kong, Sydney and San Francisco for vessel ownership (pers.comm.) (this includes jets ski and other types of small craft). This high demand has lead to 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 part of schemes to regenerate run-down waterfronts. Whilst sailing itself has limited impact on the marine environment, power-boating, water-skiing and jet skiing cause concern in many coastal locations as these activities often conflict with quieter traditional beach activities as well as with nature conservation. In some places, just the sheer number of boats and other craft can have a significant effect on the displacement and disturbance of inshore birds.

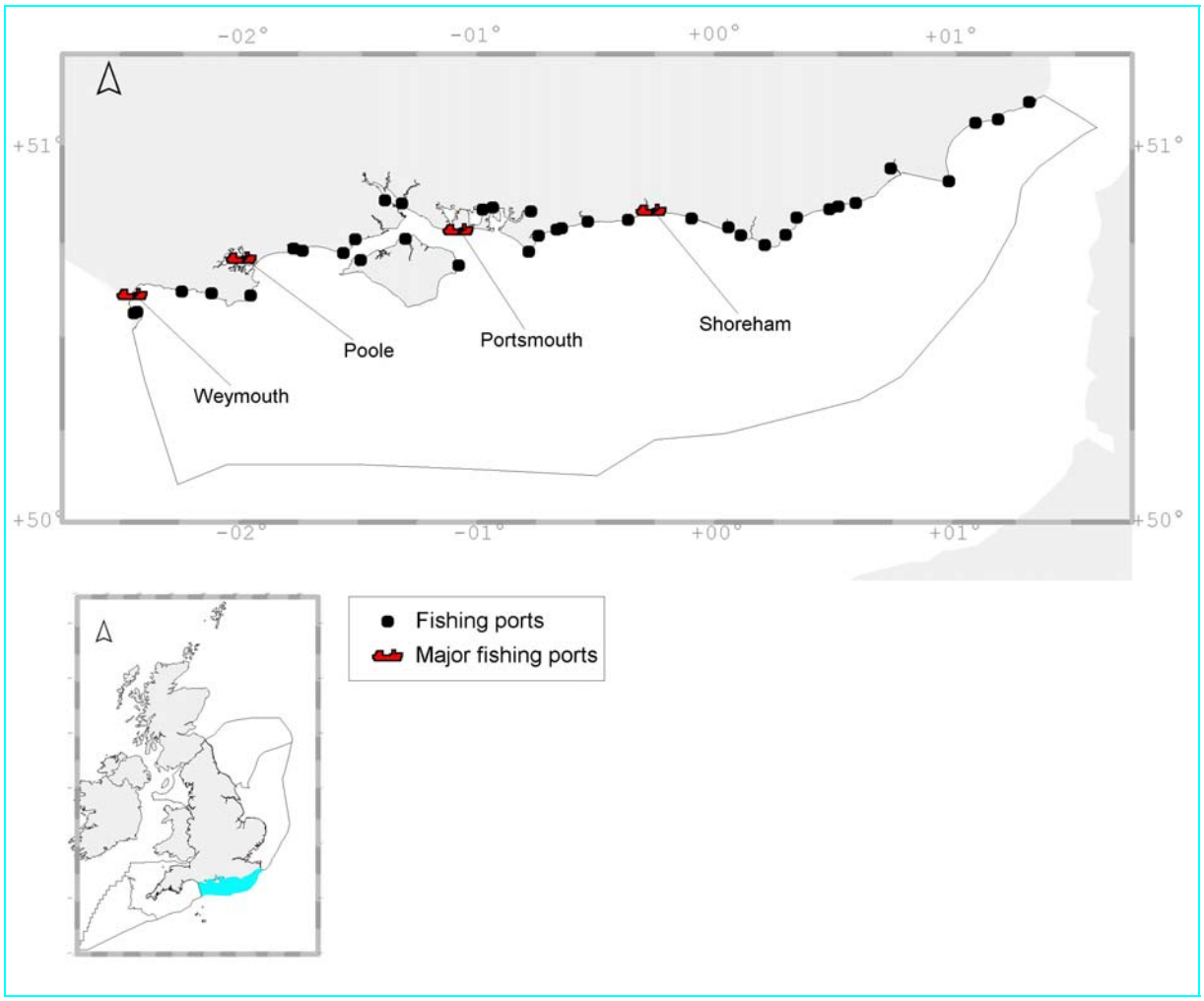


Figure 6.1 Distribution of fishing ports in the Eastern Channel Natural Area (data provided by CEFAS).

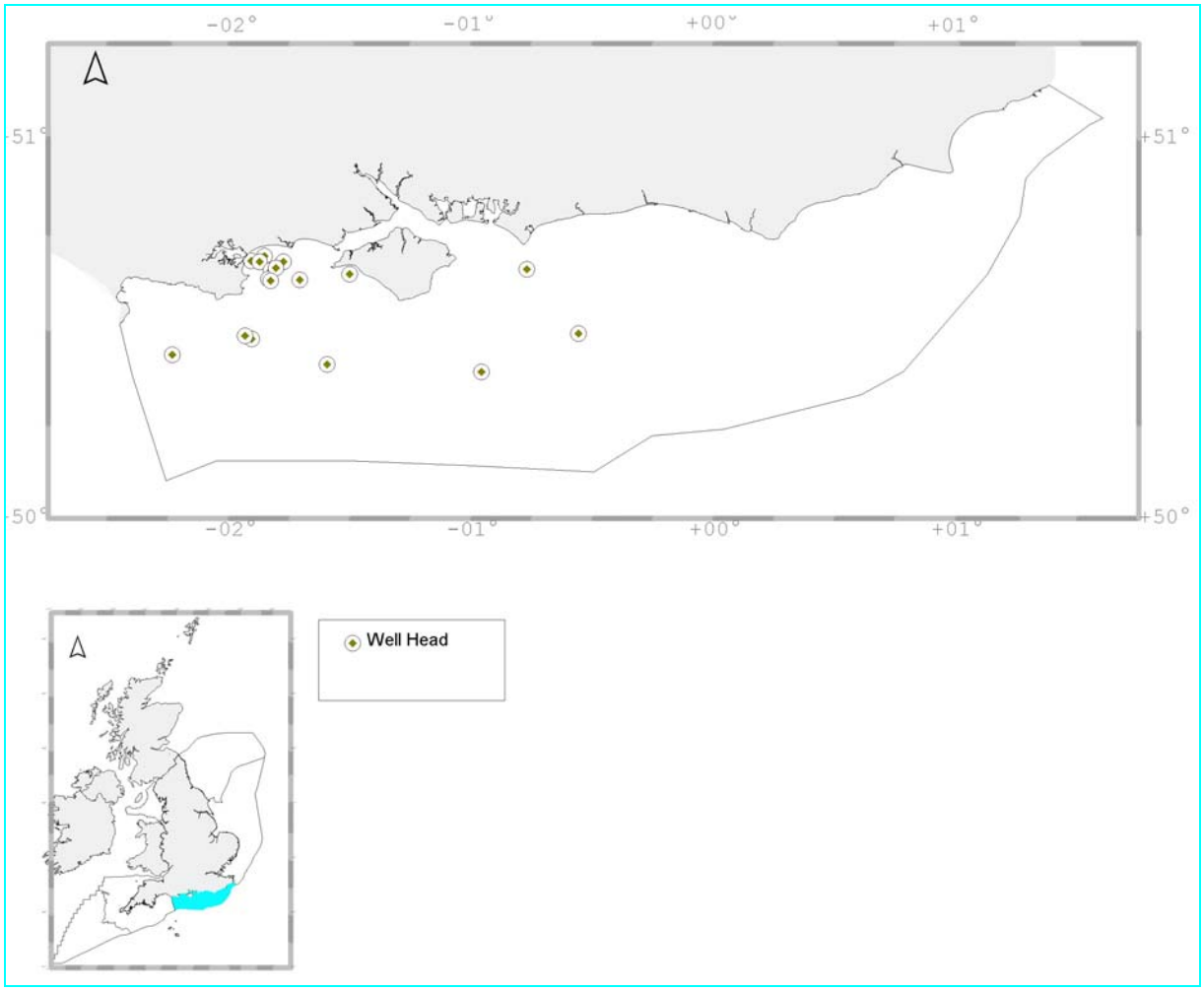


Figure 6.2 Map showing the distribution of oil well heads (for exploration purposes) in the Eastern Channel Natural Area.

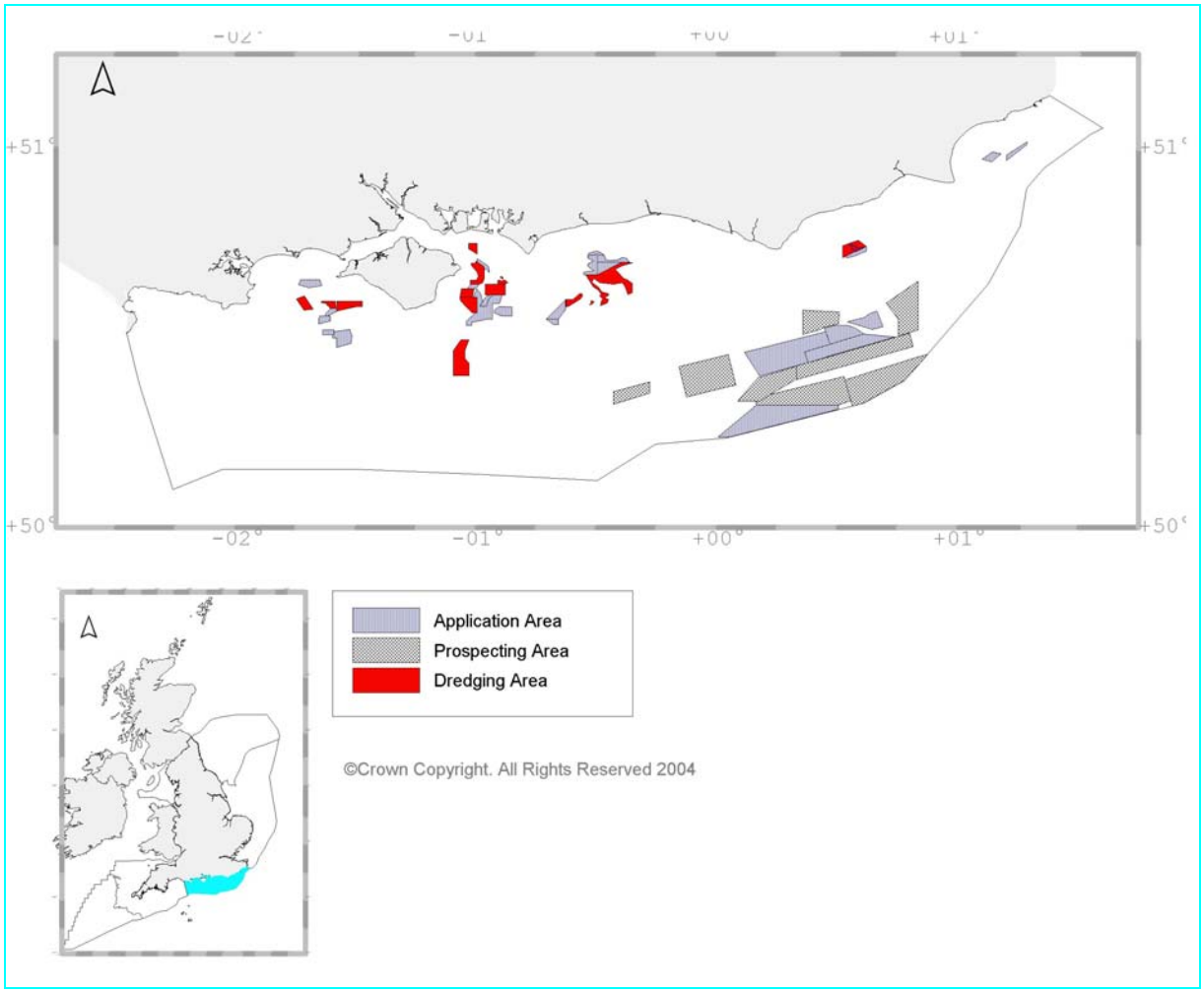


Figure 6.3 Map of licensed, application and prospecting aggregate dredging areas in Eastern Channel Natural Area (data provided by Crown Estates in 2003).

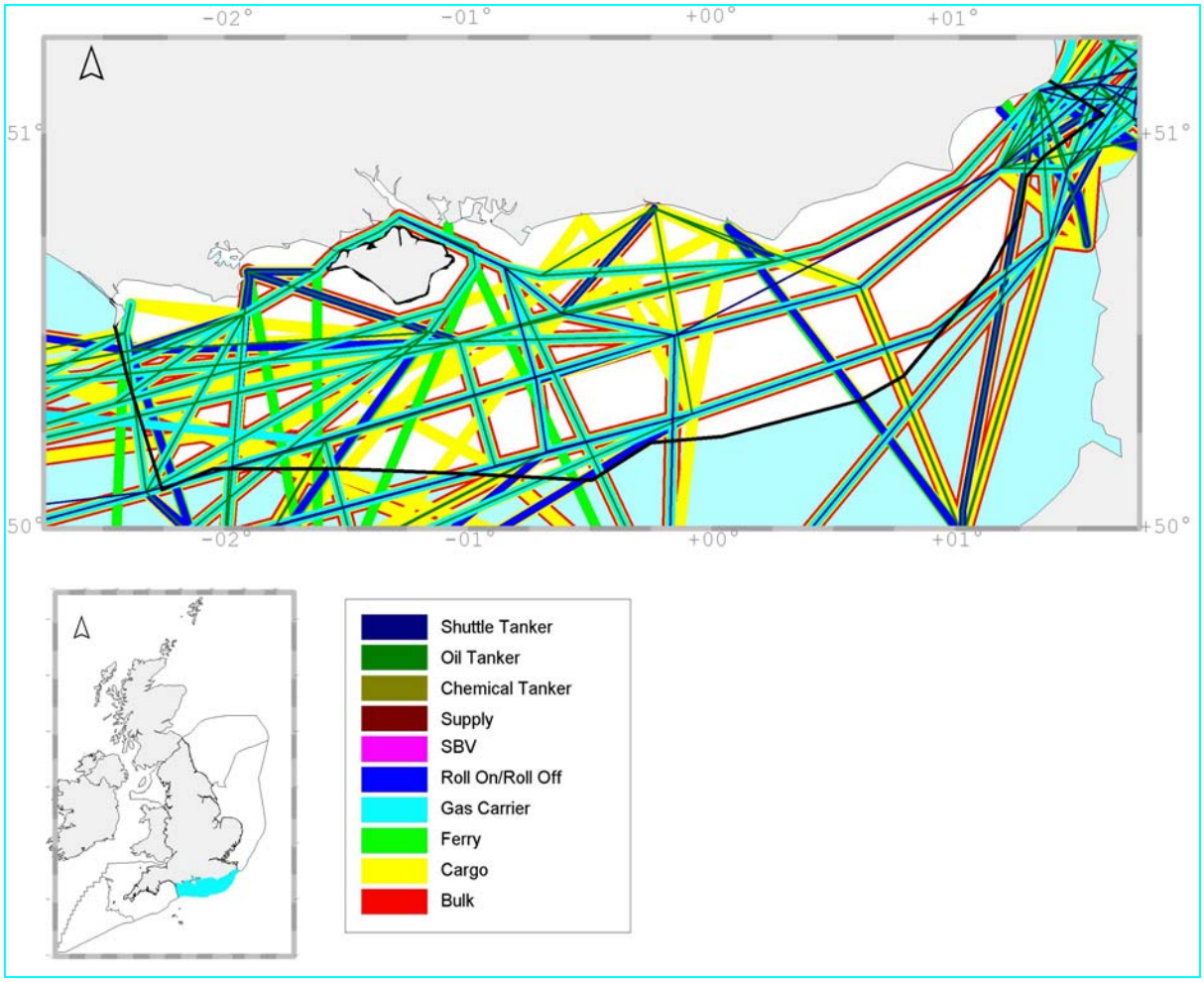


Figure 6.4 Map showing the various types of vessel operating with the Eastern Channel Natural Area during 1999. (Data taken from COAST database.) (SBV = Standby vessel)

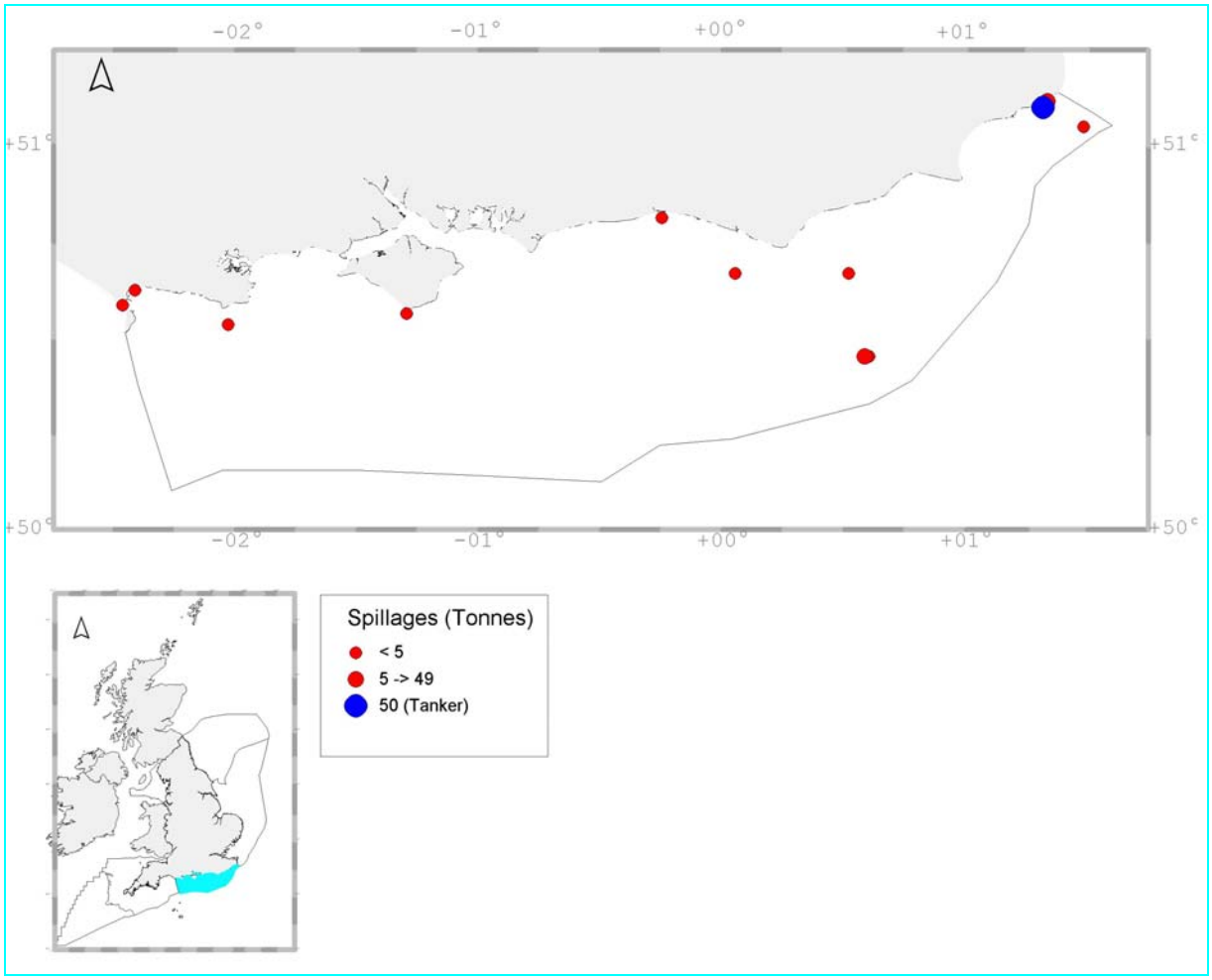


Figure 6.5 The distribution and severity of oil spills in the Eastern Channel Natural Area in the period 1989–1998 (ACOPS data from COAST database).

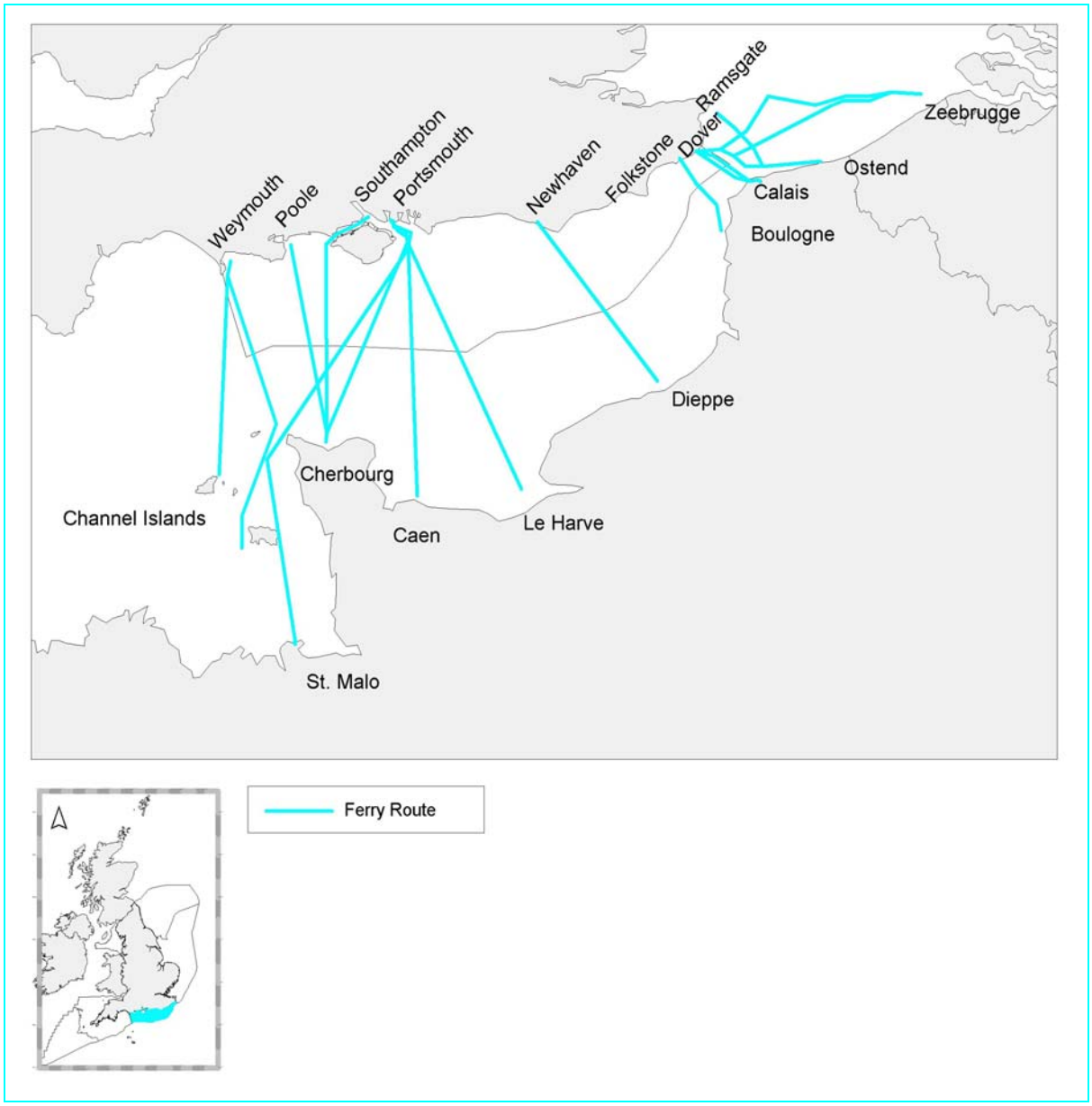


Figure 6.6 Map of ferry routes crossing the Eastern Channel Natural Area.

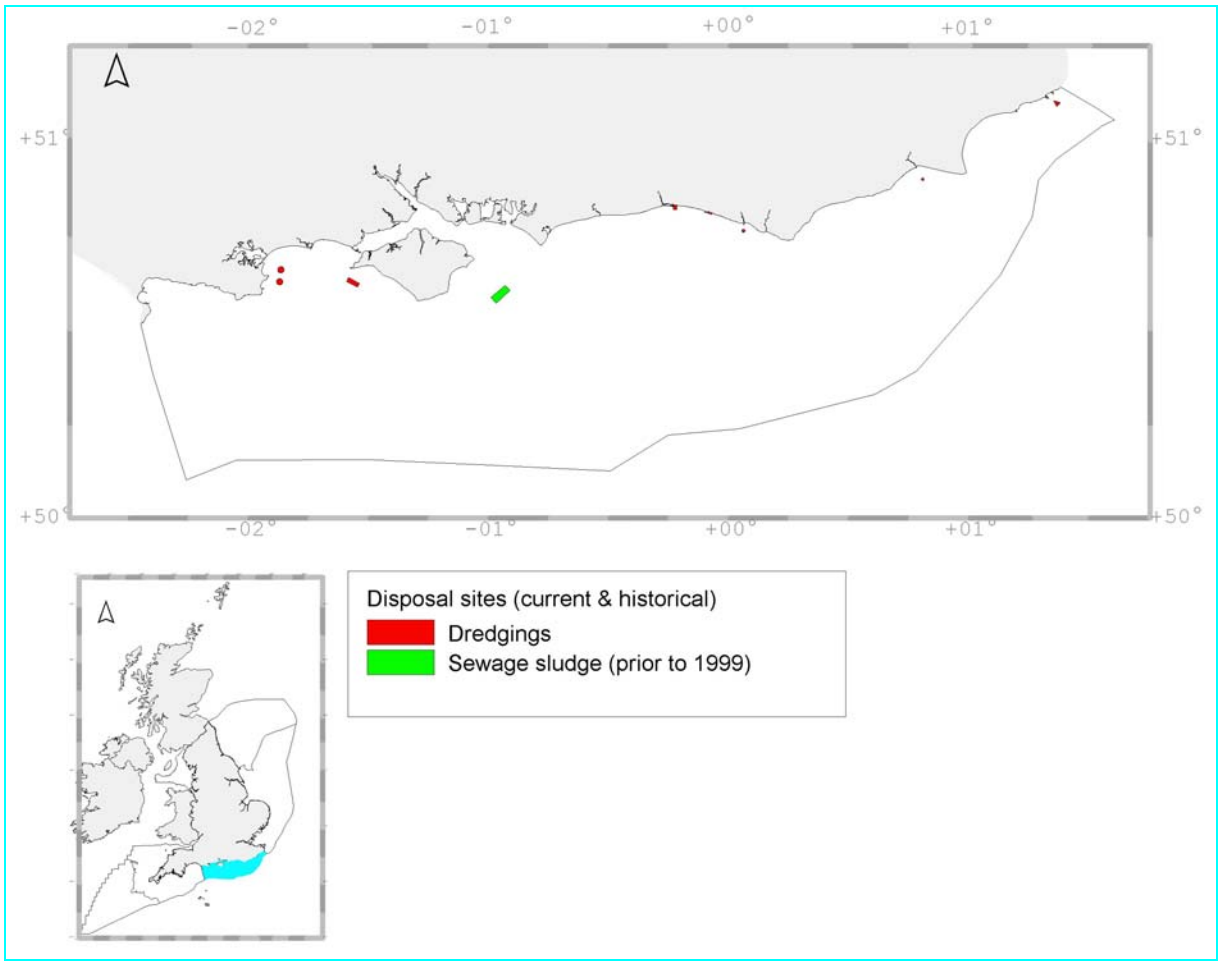


Figure 6.7 Distribution of disposal sites in the Eastern Channel Natural Area (data provided by CEFAS).

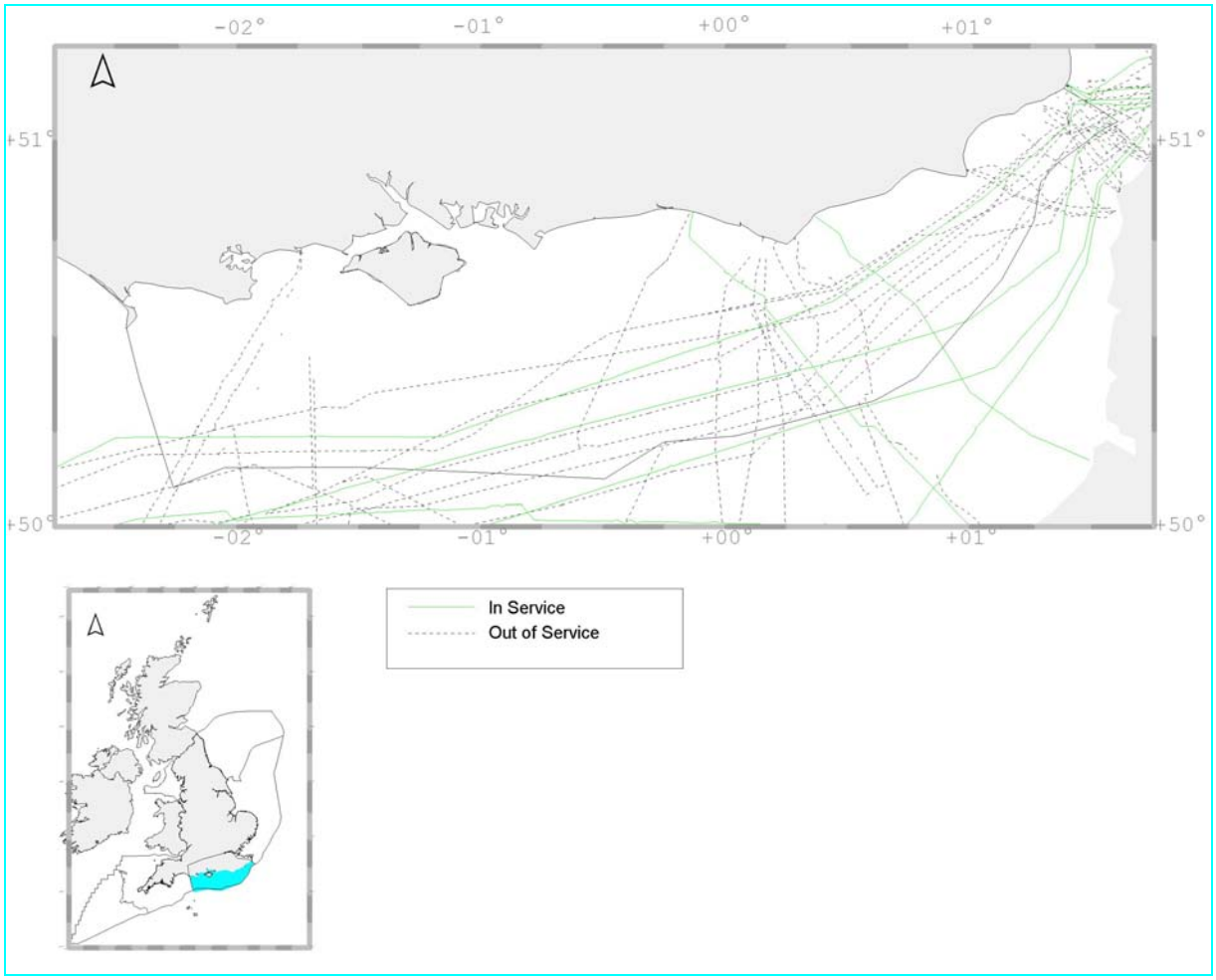


Figure 6.8 Map of submarine cables passing through the Eastern Channel Natural Area (data provided by Global Marine Systems).

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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 through dialogue amongst those stakeholders.
Management should be decentralised to the lowest appropriate level.	The better management of many marine activities around England, such as fisheries, aggregates and energy generation, requires a regional rather than simply a national approach. We feel that the Marine Natural Areas framework is at a scale that is appropriate for managing and governing the seas around England.
The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.	Marine Natural Areas are a broad scale, ecologically meaningful framework. Although some boundaries of individual Marine Natural Areas may need further refinement, we feel that this initial framework provides a good basis for testing and applying the ecosystem approach at an appropriate, ie regional, scale.
Recognising the varying temporal scales and lag-effects that characterise ecosystem process, objectives for ecosystem management should be set for the long-term.	Marine Natural Areas reflect broad scale factors and processes, some of which change only in the long-term, eg current patterns. Consequently objectives to guide management of human activities in Marine Natural Areas should consider a long-term as well as short-term perspective.

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

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

Appendix 2 Biodiversity Action Plan and Habitats Directive Classifications

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

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

Physiographic features	Habitats
Large shallow inlets and bays	Sandbanks which are slightly covered by seawater 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
CROW	Countryside Rights of Way Act 2001
cSAC	Candidate Special Area of Conservation
Defra	Department of Environment, Food and Rural Affairs
DoE	Department of the Environment (now subsumed by Defra)
DTI	Department of Trade and Industry
EEC	European Economic Community (later the European Community, now the European Union)
EEZ	Exclusive Economic Zone
EQS	Environmental quality standards
EU	European Union
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine environmental Protection (until about 1991, the Joint Group of Experts on the Scientific Aspects of Marine Pollution) (an advisory body to the Heads of eight organisations of the United Nations System).
GIS	Geographic Information System(s)
ICES	International Council for the Exploration of the Sea
IUCN	International Union for the Conservation of Nature and Natural Resources (now IUCN – The Conservation Union)
JNCC	Joint Nature Conservation Committee
MAFF	Ministry of Agriculture, Food and Fisheries (now subsumed by Defra)
MAGP	Multi-annual Guidance Programme

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

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Top left: Fully loaded aggregate dredging barge in Eastern Channel. Phil Gilliland/English Nature 00,000
Bottom left: Seawater surface temperature for all Natural Areas in June 1997. © Natural Environment Research Council (NERC) & Plymouth Marine Laboratory (PML) 2004
Main: Bottlenose dolphins are frequently sighted throughout this Natural Area. Mick Barnes

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