DEPARTMENT OF ENERGY & CLIMATE CHANGE

UK Offshore Energy Strategic Environmental Assessment

OESEA2 Appendix 3 Environmental baseline

Future Leasing/Licensing for Offshore Renewable Energy, Offshore Oil & Gas, Hydrocarbon Gas and Carbon Dioxide Storage and Associated Infrastructure

February 2011

URN 10D/1024

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APPENDIX 3 – ENVIRONMENTAL BASELINE AND ADDENDUM TO APPENDIX 3 OF OESEA

The baseline of the OESEA remains substantially current, although there is new information of importance to the elements of the draft plan/programme covered in OESEA which are also of relevance to the OESEA2 (offshore oil and gas, gas storage and offshore wind). Additional information is also required to characterise those parts of the environmental baseline specifically relevant to the new elements of this draft plan/programme, namely carbon dioxide storage, and wave and tidal renewable devices.

The approach being taken for OESEA2, adopted from suggestions provided in scoping responses, is to build on the OESEA baseline through the production of addendum sections rather than a complete revision of the baselines. This will minimise the requirement for readers to search through the sections for new information, whilst providing suitable links (through referencing specific sections and electronic links where relevant) back to the OESEA baseline. Continuity between the previous baseline and this addendum is achieved through the use of a common format and presentation style.

Contents

APPENDIX 3A – BIODIVERSITY, HABITATS, FLORA & FAUNA

The following sections provide an update to information presented in Appendices 3a.1-3a.7 of the OESEA Environmental Report (DECC 2009b).

A3a.1 UPDATE TO BASELINE INFORMATION

A3a.1.1 Relevant Initiatives

Since the OESEA, there have been a number of updates/revisions to initiatives of relevance to biodiversity, habitats, flora and fauna. A full list of relevant initiatives is presented below, with those which are new, updated, or now of relevance due to the new elements of the plan, distinguished below those previously considered in OESEA. Note that only those new items are discussed below. A full narrative relating to these initiatives is given in Appendix 4.

Biodiversity, Habitats, Flora & Fauna OESEA OESEA2

International

Convention on International Trade in Endangered Species of Wild Fauna and Flora (1973)
Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat (1971, 1982)
United Nations Convention on Biodiversity (the Rio Convention, 1992)
Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention, 1979)
The International Council for the Exploration of the Sea (ICES) Code of Practice for the Introduction and Transfer of Marine Organisms
International Convention for the control of ships ballast water and sediments (adopted 2004, still to enter into force)

Regional

Convention for the Protection of the Marine Environment of the North East Atlantic (the OSPAR Convention, 1992)
OSPAR Recommendation 2003/3 on a Network of Marine Protected Areas
OSPAR Agreement 2005-6 on the Agreement on Background Concentrations for Contaminants in Seawater, Biota and Sediment
OSPAR List of Threatened and/or Declining Species and Habitats.
Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention, 1979)
Agreement on the Conservation of Small Cetaceans of the Baltic North East Atlantic, Irish and North Seas (1994)
Convention for the Conservation of Salmon in the North Atlantic Ocean (1983)
Council of Europe Strategy on Invasive Alien Species (2003)

OSPAR Quality Status Report 2010

Europe

Directive 92/43/EEC, on the Conservation of Natural Habitats and of Wild Fauna and Flora
Directive 2004/35/EC, on environmental liability
The WFD with respect to achieving good ecological status in transitional waters.
Marine Strategy Framework Directive 2008/56/EC
Council of Europe Strategy on Invasive Alien Species (2003)
EU Biodiversity Communication (2006)
The Sixth Environment Action Programme of the European Community 2002-2012
Action Plan: Halting the loss of biodiversity by 2010 and beyond (2006)

Directive 2009/147/EC, on the Conservation of Wild Birds

UK

UK Government Sustainable Development Strategy: Securing the Future (2005)
The Wildlife and Countryside Act (WCA)1981
National Parks and Access to the Countryside Act 1949
Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended)
Natural Environment and Rural Communities Act 2004
Biodiversity: UK Action Plan (1995, 2005)
Safeguarding our Seas: A strategy for the conservation and sustainable development of our marine environment (2002)
Invasive non-native species framework strategy for Great Britain (2008)

Marine and Coastal Access Act 2009
The Conservation of Habitats and Species Regulations 2010
The Marine Strategy Regulations 2010
The Offshore Marine Conservation (Natural Habitats &c.) (Amendment) Regulation 2010
Our Seas - a shared resource. High Level Marine Objectives (2009)
Charting Progress 2 - An Assessment of the State of UK Seas (2010)
Natural England and JNCC Marine Conservation Zone Project (England terrirorial and offshore waters, and the Irish Sea)
The Eels (England and Wales) Regulations 2009
Marine Aggregate Levy Sustainability Fund (MALSF) Regional Environmental Characterisations , inlcuding the South Coast and Thames and forthcoming East Coast and the Humber studies.
NERC Marine Environmental Mapping Programme (MAREMAP)
Draft Marine Policy Statement
Draft National Energy Policy Statements

Local

Working with the grain of nature: a biodiversity strategy for England (2002)
Scotland's Biodiversity: It's In Your Hands (2004)
A Follow up to Seas the Opportunity: A Strategy for the Long Term Sustainability of Scotland's Coasts and Seas 2007
Northern Ireland Biodiversity Strategy (2002)
Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (as amended)
Countryside and Rights of Way (CRoW) Act 2000 (England and Wales)
Nature Conservation and Amenity Lands (Northern Ireland) Order 1985
Wildlife (Northern Ireland) Order 1985
Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (as amended)
Nature Conservation (Scotland) Act 2004
Planning Policy Statement 1: Delivering Sustainable Development (England)
Planning Policy Statement 9: Biodiversity and Geological Conservation (England)
Technical Advice Note 5: Nature Conservation and Planning (Wales)
Planning Policy Statement 2: Planning and Nature Conservation (Northern Ireland)
Draft list of Priority Marine Features within Scottish waters (available June 2010)
Local Biodiversity Action Plans
Wales Biodiversity Framework
Environment Strategy for Wales and One Wales, One Planet: Sustainable Development Scheme for Wales

Consultation on Planning Policy Statement: Planning for a Natural and Healthy Environment (2010)
Technical Advice Note 5: Nature Conservation and Planning (Wales) (2009)
Marine (Scotland) Act 2010
Scottish Planning Policy (2010)
The National Planning Framework for Scotland 2 (2010)
Planning Circular 1/2009: Development Planning Appendix 1: The Habitats Regulations (Scotland)
Planning Policy Statement 2: Planning and Nature Conservation (Northern Ireland)
Draft list of Priority Marine Features within Scottish waters (2010)
Planning Policy Wales Edition 3 (2010)

Article 3 of the Habitats Directive 92/43/EEC (as amended) provides for the creation of a coherent ecological network of European sites (Natura 2000) made up of Special Areas of Conservation (SACs), which are set up to conserve those habitats listed in Annex I and species listed in Annex II of the directive; and those sites designated as Special Protection

Areas (SPAs) for bird species under Annex I (rare or vulnerable) and II (migratory) of the Wild Birds Directive 2009/147/EC.

The Conservation of Species and Habitats Regulations 2010 consolidates the Conservation (Natural Habitats, &c.) Regulations 1994 and also implements certain aspects of the Marine and Coastal Access Act (above), principally the transfer of certain licensing functions from Natural England to the Marine Management Organisation, and the recognition of Marine Enforcement Officers to be able to use powers under the Marine and Coastal Access Act 2009 and to enforce offences under the Habitats Regulations, within England, Wales and Scotland and their respective territorial seas (though Scotland maintains some devolved functions). The Conservation of Species and Habitats Regulations 2010 transpose the Habitats Directive into legislation in England, Wales and Scotland, including their territorial seas out to 12nm, as do, in Northern Ireland and its adjacent territorial seas, the Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (as amended). Under the Conservation of Species and Habitats Regulations 2010, Regulation 35 (formerly 33 in the 1994 Regulations) requires that Natural England and CCW produce advice for relevant authorities on the conservation objectives and activities likely to cause deterioration/disturbance to those habitats and/or species associated with Natura 2000 or Ramsar sites in England and Wales. CCW has produced such advice for a range of marine sites, referred to as the 'Regulation 33 pack'.

The Wild Birds Directive is implemented through the above regulations, and also through the Wildlife & Countryside Act 1981 (as amended), the Wildlife (Northern Ireland) Order 1985 and the Nature Conservation and Amenity Lands (Northern Ireland) Order 1985. The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 as amended apply the Habitats Directive and the Birds Directive beyond territorial waters (beyond 12nm). These Regulations together provide for the designation and protection of European sites and the protection of European Species in the UK and UK waters.

The Wildlife and Countryside Act 1981 (as amended) (WCA) is one of the principal pieces of legislation relating to nature conservation in Great Britain. Although protection under the WCA generally includes adjacent territorial waters (12nm), for certain species, protection is limited to 6nm from coastal baselines due to the interaction with the Common Fisheries Policy and for the designation of Marine Nature Reserves out to 3nm. The WCA is supplemented by various other pieces of legislation including the Countryside and Rights of Way (CRoW) Act 2000 (in England and Wales), and the Nature Conservation (Scotland) Act 2004 (in Scotland). In Northern Ireland, the main legislation is contained in the Wildlife (Northern Ireland) Order 1985 (as amended) and The Environment (Northern Ireland) Order 2002. This legislation provides for the protection of species and the designation of nationally important sites known as Sites of Special Scientific Interest (SSSI) in England, Wales and Scotland and as Areas of Special Scientific Interest (ASSI) in Northern Ireland. Many SSSIs and ASSIs are also designated as European Sites. SSSI sites have until present extended only to Mean Low Water Mark, though the Marine and Coastal Access Act (see below for further details) has allowed for the all new SSSIs to extend below this line.

The Marine Strategy Framework Directive establishes a framework within which Member States must take measures to achieve or maintain good environmental status in the marine environment by the year 2020. These measures include the establishment of a cohesive network of Marine Protected Areas (MPAs) which is intended to build on the areas already protected as European marine sites under the Birds and Habitats Directives.

Directive 2004/35/EC on environmental liability with regard to the prevention and remedying of environmental damage (transposed through the Environmental Damage (Prevention and Remediation) Regulations 2009 – separate regulations apply in the devolved administrations) applies to environmental damage caused to *inter alia* species and habitats protected at the community level, i.e. those covered under the Birds and Habitats Directives.

The Marine and Coastal Access Act 2009 (and equivalent Acts/Bills of the devolved administrations) will aid the completion of an ecologically coherent and well-managed network of Marine Protected Areas, suggested as a contributory measure to achieving good environmental status in the Marine Strategy Framework Directive, and as required in similar commitments regarding MPAs under international conventions such as the Convention on Biological Diversity. These sites will be known as Marine Conservation Zones (MCZs) in England and Wales and Marine Protected Areas (MPAs) in Scotland, administered at the local level in each UK constituent country. The Marine Conservation Zone project in England and Wales is delivered through four regional projects administered by Natural England and the JNCC, covering the South-West (Finding Sanctuary), Irish Sea (Irish Sea Conservation Zones), North Sea (Net Gain) and Eastern Channel (Balanced Seas). These projects exclude Scottish territorial and offshore waters, and the territorial waters of Wales which are subject to their own programmes of MCZ/MPA identification and designation. In Wales, the Welsh Assembly Government is running the Wales MCZ Project, which is advised by a Steering Group and a Technical Advisory Group. The former consists of WAG, CCW, the Environment Agency, the Welsh Local Government Association and other relevant bodies in Wales, with the latter having a broader array of advisers including the JNCC and Cefas. The Welsh Assembly Government intends to use the new MCZ powers to supplement the existing network of marine protected areas (e.g. offshore SACs) with a limited number of highly protected sites. The first consultation on possible sites is expected from May to July 2011. In UK offshore waters adjacent to Scotland, MPAs will be identified through a Scottish Marine Protected Area Project. Non-Natura MPAs will be established in Scottish Territorial Waters through the Marine (Scotland) Act 2010. The Department of Environment (DoE) (Northern Ireland) consulted (ending July 2010) on policy proposals which form part of the process contributing to the delivery of a Northern Ireland Bill, likely to be implemented in 2012. The Northern Ireland Government are to implement which should provide details of how they are to implement their part of the UK MPA network using a combination of European protected sites and a new MCZ designation, analogous to that under the Marine and Coastal Access Act for English and Welsh waters. The intention is to have a network of effectively managed sites (European protected and MCZs) by 2020.

Studies and site specific surveys carried out on behalf of conservation agencies in support of site designations including Natura 2000 sites and MCZs continue to contribute to knowledge of the UK context for the range of topics coverd in Appendix 3a. In relation to Natura 2000 sites, Natural England has identified seven 'Areas of Search' (AoS) within English waters, thought to contain outstanding examples of two subtidal Habitats Directive Annex I habitats, Sandbanks covered by seawater at all times and Reefs. Natural England has commissioned studies to investigate the occurrence of Annex I habitat within these areas, and to characterise the Annex I habitat. The seven AoS identified by Natural England are:

Area 1 - Outer Wash Sandbanks
Area 2 - Greater Thames Estuary
Area 3 - Lyme Bay to Poole Bay
Area 4 - Salcombe to Yealm and Eddystone
Area 5 - Lizard Point
Area 6 - Land's End and Cape Bank
Area 7 - Outer Morecambe Bay, Shell Flat and Lune Deep

The UK Biodiversity Action Plan provides a national strategy for the conservation of biological diversity and the sustainable use of biological resources as required under Article 6 of the Rio Convention. A number of species (1,150) and habitats (65) have been identified as being priorities for conservation action in the UK, and these include a number of marine components, for instance 28 BAP habitats are marine. Though the plans for these species and habitats have no statutory status, they are given some legal basis in the Countryside and Rights of Way Act 2000 and the Natural Environment and Rural Communities Act 2006 (e.g. list of species of principal importance designated under Sections 41 and 42 of the Act).

In 2010 the EU published guidance on the development of wind farms in accordance with EU nature legislation, specifically Natura 2000 aimed at (including others) planners, developers and consultants. In addition to planning guidance and policy background, the document identifies potential impacts arising from both onshore and offshore wind farms on birds, bats and aquatic species (e.g. cetaceans), and how strategic planning can help to avoid or minimise environmental conflicts.

Additionally, study programmes to support regional assessments of long-term effects of oil and gas developments (on behalf of Oil and Gas UK and the UK Government/Industry Environmental Monitoring Committee); and studies to support assessment and monitoring of specific offshore or nearshore energy projects (e.g. those associated with the SeaGen development in Strangford Lough) have also contributed to the knowledge in the topic areas covered by Appendix 3a.

Draft National Policy Statements were released for consultation in 2009 and subject to a second round of consultation in 2010. These statements are aimed at providing a policy steer for Nationally Significant Infrastructure Projects (NSIPs) as detailed in the Planning Act 2008 (see Appendix 4 for more details). Those which are of close relevance to OESEA2 are:

- Draft Overarching National Policy Statement for Energy (EN-1)
- Draft National Policy Statement for Renewable Energy Infrastructure (EN-3)
- Draft National Policy Statement for Gas Supply Infrastructure and Gas and Pipelines (EN-4)

Each National Policy Statement was subject to an Appraisal of Sustainability (AoS) incorporating Strategic Environmental Assessment and Habitats Regulations Assessment (HRA). The Overarching National Policy Statement for Energy (EN-1) addresses policy in relation to generic biodiversity impacts; whereas the energy specific policy statements contain more detailed considerations, although still at a high policy level. Each National Policy Statement contains considerations relevant to potential impacts on the natural environment including birds, marine mammals, fish and intertidal habitats.

In addition, the draft Marine Policy Statement (MPS) and its accompanying AoS and HRA were released for consultation in July 2010. This statement is wide reaching and provides a policy steer for marine decision makers (primarily the MMO but also those involved in NSIPs) in relation to most marine activities. A number of potential impacts on the natural environment from energy developments relevant to OESEA2 are similarly identified in the MPS. More widely and in relation to all marine activities, high level environmental considerations are provided by reaffirming the conservation responsibilities of the UK Government which are to be taken account of in the preparation of Marine Plans. This includes the commitment to establishing a UK network of MPAs incorporating the new MCZ designation under the Marine and Coastal Access Act 2009 (see above) and existing and future marine sites including SACs and SPAs.

In addition to threats posed from marine development and climate change, the marine environment has recently been subject to a number of introduced species which have led to a series of localised changes in community composition. The intentional and unintentional introduction of alien non-native species is considered the second biggest threat after habitat loss to biodiversity and may be accentuated by predicted climate change. A number of national and international initiatives exist aiming to recommend and introduce safeguards to limit the transport of invasive species, including the GloBallast Partnership Programme and the Invasive Non-native Species Strategy for Great Britain.

A3a.2 PLANKTON

The following sections provide an update to information presented in Appendix A3a.1 of the OESEA Environmental Report (DECC 2009b).

A3a.2.1 Changes in UK Context

The OESEA (DECC 2009b) and the references therein provide an overview of plankton communities and ecology in UK waters and this should be referred to in conjunction with this update. Plankton (phytoplankton and zooplankton) are free-floating organisms living in the water column and as such are closely coupled to environmental conditions, acting as an important link between marine organisms and the physical environment.

One of the key primary producers in marine ecosystems are the phytoplankton, which respond to the onset of spring and the associated increased light levels and warmer temperatures by blooming. The spring bloom is typically followed by a smaller bloom later in the year as autumn winds mix the water column and re-suspend nutrients. The factors that affect the onset of the bloom are complicated and difficult to resolve. On top of this, different environmental variables will take on greater significance in different locations – for example, in deeper oceanic waters stratification in the water column is a key driver of the spring bloom, while in coastal waters, the amount of incidental light is a more important factor (Wiltshire *et al*. 2008). Research in Helgoland Roads in the German Bight showed that nutrient levels, water temperature, underwater light and wind strength have all changed substantially over the past 30 years, with the effect of making the region less of a coastally dominated system. Despite this, the timing of the phytoplankton bloom was found to have stayed very stable over this period (Wiltshire *et al*. 2008). Nevertheless, the community composition of the bloom was found to have changed, with large diatoms (such as *Coscinodiscus wailesii*) increasing in relative abundance. Larger diatoms are relatively inedible to grazing copepods and so this may be a factor influencing changes in the copepod community observed in the region (Wiltshire *et al*. 2008). A period of stability and stratification in the water column is an important factor in enhancing blooms. Consequently, phytoplankton biomasses may be relatively low in estuarine environments, where there is high turbidity, for example in the Severn Estuary (Underwood 2010).

The zooplankton community is driven to a large extent by the peak of food availability represented by the phytoplankton bloom. Peak female abundance in the *Calanus helgolandicus* population in the English Channel has been linked to the initiation of the thermocline in the water column (Irigoen & Harris 2003). Shifts in the zooplankton community are described in DECC (2009b). Of increasing importance in European waters are jellyfish populations, with a number of blooms of *Rhizostoma* jellyfish recently recorded in the Irish Sea (Lilley *et al*. 2009). The size and occurrence of these blooms is unpredictable, with considerable inter-annual variability. There was a particularly high abundance in 2003, a year which saw high summer temperatures across Europe. For example, Carmarthen Bay had 478 times more *Rhizostoma* jellyfish than in 2005 (Lilley *et al*. 2009). The interannual variability of jellyfish populations has been reported previously in Lynam *et al*. (2004, 2005). Doyle *et al*. (2007) demonstrated distinct species-specific distributions between jellyfish species (described in the paper as “apparent segregation”). The species composition was shown to vary between the northern and southern Irish Sea with physical discontinuities, such as differences in water column stratification, possibly acting as barriers between species.

A3a.2.2 Evolution of the Baseline and Environmental Issues

A3a.2.2.1 Evolution of the Baseline

The information presented in the previous OESEA on the evolution of the baseline remains valid.

In general, the plankton of the British Isles fulfil the criteria for Good Environmental Status put forward by the Marine Strategy Framework Directive (Defra 2010c). The MSFD requires that the biodiversity, distribution and abundance of species be in line with prevailing physiographic, geographic and climatic conditions; this is true of the plankton around the British Isles whose biodiversity, abundance and distributions are primarily affected by hydroclimatic forcing as opposed to anthropogenic influences. Good Environmental Status also requires that ecosystems are not adversely affected by eutrophication, contamination, and non-indigenous species introduced through anthropogenic activities. The planktonic ecosystem of the British Isles meets these criteria as, though eutrophication and contamination may be a threat in some highly localised areas, the majority of plankton are unaffected by nutrient loading or chemical contamination and there is no evidence that non-indigenous organisms have caused negative impacts on the native plankton. Additionally, changes to marine foodwebs caused by alterations in plankton phenology (trophic mismatch) or community composition appear to be related to climatic factors and are not likely to be the result of anthropogenic pressures. Overall, plankton in UK seas are relatively unaffected by anthropogenic factors and appear to fulfil the requirements for Good Environmental Status mandated by the MSFD (Defra 2010c).

A3a.2.2.2 Environmental Issues

Climate

As plankton communities are so closely linked to the physical environment, they can be good indicators of changes in the climate. Long-term trends in phytoplankton communities are not consistent across the North Sea, highlighting the danger of using global influences such as oceanic inflows to explain inter-annual variability and trends, when processes at a smaller, more localised scale are clearly important (Leterme *et al*. 2008). Nevertheless, nearly half of the increase in North East Atlantic temperatures can be related to global temperature rises (Beaugrand *et al*. 2009). The biodiversity of calanoid copepods has moved northwards at a rate of 23km/year in response to rising sea surface temperature (SST), a far greater rate of movement than in terrestrial ecosystems. Indeed, OSPAR’s Quality Status Report (OSPAR 2010a) states that warm water plankton are moving northwards, with a 1,000km northwards shift in the past 50 years.

There have also been changes recorded in the timing of phytoplankton and zooplankton production in response to climate, with some species present 4-6 weeks earlier than 20 years ago, an effect that will impact on fish and other organisms at higher trophic levels (OSPAR 2010a). Trophic amplification of this nature may provide a mechanism to drive ecosystems towards new regimes (Kirby & Beaugrand 2009) and in the North Sea, this new regime appears to favour jellyfish in the plankton and decapods and detritivores (such as echinoderms) in the benthos (Kirby *et al*. 2007).

Climate change is a key factor in the spread of invasive plankton species (although, as discussed in the previous OESEA, human activities such as the dumping of ballast water play a very significant role in this issue). Reid *et al.* (2009) describe a number of non-native species that have recently been recorded in UK waters, including *Mnemiopsis leidyi*, *Coscinodiscus wailesii* and *Sargassum muticum* and suggest that non-native plankton species may extend to cover UK waters within 25 years. The latest SAHFOS report on the Continuous Plankton Recorder Survey (CPR) indicates that a number of warm water *Ceratium* species (*C. arietinum*, *C. lamellicorne* and *C. pentagonum*) were recorded 40-100 miles off the coast of north west Scotland in 2009, the furthest north these species have ever been recorded (Edwards *et al*. 2010). Conversely, the tintinnid species *Parafavella gigantea*, usually an indicator of cold water masses, was recorded off the coast of Brittany in the same year (Edwards *et al*. 2010).

Ocean acidification

Rising carbon dioxide concentrations in the sea (see Appendix 3d Water Environment for details) are expected to reduce levels of calcification by marine organisms, by lowering the calcium carbonate saturation state of seawater. However, laboratory evidence collected by Iglesias-Rodriguez *et al*. (2008) suggests that coccolithophore *Emiliania huxleyii* calcification and primary production has increased with CO_2 partial pressures. Meanwhile, field evidence shows there has been a 40% increase in average coccolithophore mass over the last 220 years, evidence of a rapid and impressive response from coccolithophores to ocean acidification.

The Continuous Plankton Recorder (CPR) has recorded a steady increase in foraminifera, another calcareous taxon, over the past 50 years, although this may be related to temperature. There is evidence from the Southern Ocean that the shell weights of modern foraminifera are less than those recorded in older sediments, a possible effect of ocean acidification (Edwards *et al*. 2010).

Harmful algal blooms

In addition to the information provided in the previous OESEA, the most recent CPR survey report describes the presence in 2008 of particularly large blooms of *Pseudo-nitchia* spp. in the southern North Sea, occurring earlier in the year than normal. In the same year, exceptionally low *Dinophysis* spp. numbers were recorded in the North Sea (Edwards *et al*. 2010).

A3a.3 BENTHOS

The following sections provide an update to information presented in Appendix 3a.2 of the OESEA Environmental Report (DECC 2009b). Since the OESEA, there have been a number of updates/revisions to initiatives of relevance to understanding of the distribution and conservation significance of benthic species and habitats. Where not included in previous SEAs, additional information relating to intertidal habitats in specific Regional Sea Areas is also included below to reflect the scope of OESEA2 and stakeholder comments.

A3a.3.1 Changes in UK Context

Increasing attention has also been focused on the assessment of changes in benthic community structure and function, in relation to the effects of regional climate change (see for example Charting Progress 2 and QSR 2010).

In addition to the faunal considerations presented in the OESEA, benthic flora, whether algal or macrophyte (sea grasses) also have an important influence on the productivity and structure of some habitats and communities, for example through sediment stabilisation in the case of eelgrass beds, or spatial complexity and provision of cryptic habitats in the case of kelp forests. Although confined to relatively shallow water depths (because of light attenuation), benthic flora are a major source of the organic detritus which is a key energy source for benthic faunal communities from the intertidal to abyssal depths.

A3a.3.1.1 Features of Regional Sea 1

Offshore habitats and species

Regional surveys have been carried out on behalf of Oil and Gas UK (representing the oil and gas industry) and the UK Government/Industry Environmental Monitoring Committee, of the Fladen Ground area in 2005, East Shetland Basin in 2007 and central North Sea in 2009. Biological data from the 100 stations sampled by the 2005 Fladen Ground survey indicate weak spatial trends in biological communities across the Fladen Ground, with similarity between samples generally high (50-70%) and no clear grouping or ordering of samples. Diversity and taxonomic distinctness in all samples were relatively high. In the East Shetland Basin 2007 survey, the seabed fauna was found to be diverse and multivariate analyses indicate that the infaunal assemblages vary systematically across the survey area. The fauna across the area is typified by the polychaetes *Minuspio cirrifera*, *Myriochele* spp. *Euchone* sp., *Spiophanes kroyeri* and *S. bombyx* with the different station groupings distinguished by the presence in abundance of various other taxa. High densities of the tubeworm *Ditrupa arietina* were found at 2 stations; this unusual assemblage had previously been recorded to the north and west of Shetland, in the Celtic Sea and the Mediterranean.

Nearshore and coastal habitats and species

The major firths of the Scottish east coast – the Moray Firth and Firths of Tay and Forth – together with other significant inlets on the mainland coast (e.g. the Ythan estuary and Montrose Basin) all support habitats which may be characterised as estuarine and sheltered from wave action. These habitats include extensive intertidal sand and mudflats which are of ecological and conservation importance, and sub-littoral habitats which are distinct from those of adjacent coastal areas. Most of the major firths support small areas of eelgrass *Zostera* spp. (Cleator 1993); probably the largest area (1,200ha) of dwarf eelgrass *Z. noltii* and narrow-leaved eelgrass *Z. angustifolia* in Britain is found in the Cromarty Firth. Reed beds and saltmarsh are also characteristic of upper estuary locations, with important examples of the latter found in the Dornoch, Cromarty, Beauly and Inner Moray Firths and the Firths of Tay and Forth.

Open coastlines of the area provide a range of intertidal habitats from bedrock shores, boulders and cobbles, to extensive sandy beaches. Shallow subtidal habitats are predominantly sands, gravels, or a mixture of the two, although extensive areas of exposed rock also occur, with characteristic epifaunal communities. Reasonable survey coverage of rocky intertidal and shallow subtidal habitats in the area has been produced, in part due to work related to the MNCR (Hiscock 1998, Bennett & Foster-Smith 1998). On a UK-wide basis, this work has been the basis for a classification of biotopes (i.e. distinctive habitat with associated flora and fauna) and regional reports. However, Eleftheriou *et al*. (2004) note that important stretches of hard substrata on the east coast of Scotland were either scantily surveyed or in some cases there is no information available. Recent intertidal biotope mapping and monitoring studies (ASML 2008, 2009 and unpublished) have been carried out in the vicinity of the cooling water discharge from Peterhead power station.

A3a.3.1.2 Features of Regional Sea 2

Offshore habitats and species

Broadscale characterisation of seabed habitats, their biological communities and potential historic environment assets within several regions has been funded through the Marine Aggregate Levy Sustainability Fund (MALSF). The Thames Regional Environmental Characterisation (REC) is completed and the East Coast and the Humber data acquisition work finished in June 2009 with geophysical and biological survey data now available at www.marinealsf.org.uk. The East Coast and Humber REC projects are due to produce final reports and seabed maps in February 2011.

Offshore sandbanks

Over the last two years, there has been a considerable further effort to characterise faunal distributions on and adjacent to the Dogger Bank, in relation to potential designation as a Natura 2000 site (and identification of appropriate site boundaries). Additional survey work was undertaken on behalf of JNCC in 2008 and various statistical analyses have been conducted which indicate that the biological assemblages of the shallowest parts of the Dogger Bank are different to those of intermediate and deeper areas. This is attributable to periodic disturbance from waves because of the exposed nature of the area and shallow water depths. Several species indicative of such exposed conditions have been consistently found on the shallowest parts of the Dogger Bank in surveys spanning some 90 years. These species are more typically found in sands in shallow coastal waters which are similarly subject to extremes of wave action and wide range of seawater temperature over the annual cycle.

Estuarine habitats and species

Saltmarshes in the region include sites of exceptional interest (Hill 1995). There are two major estuaries, the Wash and the Humber, with open embayments and fringing saltmarshes. The Wash marshes (totalling more than 4,000ha) are the largest continuous expanse of saltmarsh anywhere in Britain, despite extensive land reclaim which began in Roman times and has produced some 32,000ha of agricultural land since the 16th Century. The north Norfolk coast contains saltmarshes on the open coast and landward of barrier islands and spits; they are the most diverse in Britain in terms of their geomorphology and biology. The three British species of eelgrass *Zostera* are also present in the region (Davison 1997).

A3a.3.1.3 Features of Regional Sea 3

The MALSF during the last five years have funded in the English Channel, two regional characterisation studies, the South Coast REC and Eastern English Channel Marine Habitat Map (EECMHM). The South Coast REC area extends to the coast between Swanage and Saltdean, near Brighton; the EECMHM mapped the Eastern English Channel between Selsey Bill (Longitude 0° 47'W) and Dungeness (Longitude 1° 05'E) out to the median line and was funded by the MALSF. A current project is underway (South Coast and Eastern English Channel Synthesis, MALSF project 09/P92) to extend the mapped coverage of the EECMHM to include the coastal platform from Saltdean east to Dungeness and provide an integrated map dataset covering this extension area, the South Coast REC and the EECMHM. Previous habitat mapping was also carried out under the UKSeaMap marine landscape classification (Connor *et al.* 2006) and the Mapping European Seabed Habitats (MESH) programme (MESH Partnership 2008).

Nearshore habitats and species

Backed by a World Heritage Site (Dorset Jurassic Coast) the benthic habitat of Weymouth Bay contains numerous reef and sea cave structures for which the region is being considered for SAC designation. The mosaic of rocky and soft sediment habitats support a variety of species (Pinnion *et al*. 2007, English Nature 2009, Emu Ltd 2010). The elevated water temperatures allow the presence of species more common to the Mediterranean with a limited distribution around Britain including the octocoral *Cervera atlantica*, Ross coral *Pentapora (foliacea) fascialis*, the barnacle *Solidobalanus fallax*, and the nationally rare polychaete *Sternaspis scutata*. However, new information on the taxonomy and distribution of *Pentapora* species (Lombardi *et al*. 2010) necessitates reconsideration of the conservation perspectives of the UK species; but regardless of nomenclature, the growth form of *Pentapora* means it is vulnerable to physical damage. There are also *Zostera* (sea grass) beds within Weymouth Bay which is a highly productive habitat supporting numerous associated species.

To support SEA 8, Pinnion *et al*. (2007) undertook a comprehensive benthic data review of marine communities and habitats. To facilitate this, a series of hydrographic and benthic ecology surveys were conducted at specific sites potentially supporting tidal stream energy development. Emu Ltd was commissioned to perform hydrographic and ecological surveys in and around Weymouth Bay at the Shambles Bank, Adamant Shoal, Kidney Bank and the Race (off Portland Bill) to acquire data to improve understanding of regional processes around the tidal headland. Survey work, undertaken in September 2006 and March 2007, was scoped specifically to investigate sediment processes and seabed habitats present. In addition, Emu Ltd were commissioned to provide a more focused data review to synthesise available benthic species, community and habitat information for the region; interpretation of sediment processes and archaeology has been undertaken separately. Four historic quantitative datasets were found with species lists obtained by identification from grab samples (total 142 samples). Temporal and methodological differences between surveys were noted and mitigated, as far as practicable, through a process of data rationalisation and the data was analysed using a suite of multivariate methods.

A total of twelve epibenthic habitats and biotopes were classified following initial review of video data (Emu Ltd 2007). Subsequent analyses of the grab samples permitted allocation of higher resolution biotope classifications for the benthic sediment habitats present.

A gradient of habitats was observed from sublittoral coarse sediment on the Shambles Bank, to coarser sediment biotopes on the edges of the Bank. Video sites located at the eastern and northern extents of the Bank indicated a seabed comprised a mosaic of sublittoral coarse sediments overlying *Sabellaria spinulosa* (tube-building worm) encrusted circalittoral rock. The infaunal data revealed large areas of coarse sand and broken shell with large sand waves, ripples and megaripples inhabited by the lancelet *Branchiostoma lanceolatum*. On the western edge, more isolated areas of mobile cobbles and pebbles, colonised by robust species, such as the tubiculous worm, *Pomatoceros* sp., barnacles and encrusting sea mats (bryozoans), were found interspersed with patches of *Sabellaria spinulosa* on stable circalittoral mixed sediment. Beds of the mussel *Mytilus edulis* with hydroids and ascidians on tide-swept exposed to moderately wave-exposed circalittoral rock were recorded on the south-western corner of the Shambles Bank.

Within 1.5km of Portland Bill the seabed consists of a series of wave cut rock platforms with very little sediment. These rock platforms were covered with dense *Mytilus*, with tide-swept tolerant species present, such as the hydroid, *Tubularia indivisa*. Within the infralittoral zone, kelp was found associated with the bedrock in conjunction with mussel beds. To the south of Portland Bill, in general, the mussel beds were less dominant, with sediments overlying bedrock colonised by mixed faunal turfs.

The Kidney Bank feature west of Portland Bill appears to consist of shell gravel with no conspicuous epifauna; however, the infauna was characterised by the polychaetes *Mediomastus fragilis* and *Lumbrineris spp*. and venerid bivalves in coarse sand or gravel. Fine to medium sediments with ripples and mega-ripples in the central bank contained communities typical of mobile sand. To the west of the Kidney Bank, sediments were found to be more mixed and coarser in nature, with pebbles and cobbles colonised by *Sabellaria spinulosa* over a relatively large area, although they did not form continuous reef features; mussel beds were also found in mixed sediments overlying the bedrock. To the south of the Kidney Bank, where water depths were at their greatest, the sites sampled showed the greatest amount of variability in terms of both sediment type and associated faunal communities. Areas of clean bedrock were evident in places, with mobile pebbles and cobbles, as identified to the west of the Bank, also present. The deepest areas surveyed were in general found to have a rich mixed faunal turf associated with bedrock.

Sediments in the vicinity of Adamant Shoal in Weymouth Bay comprised varying proportions of silt, gravel, sand, pebbles, cobbles and boulders with localised bedrock outcrops. Within the western extents of the Adamant Shoal survey area, localised areas of thick encrustations of *Sabellaria spinulosa* were apparent. The central area of the Shoal was fine sand with sandwaves, ripples and megaripples classified as with medium coarse sediments to the east.

Mud-dominated sediment in Regional Sea 3 are located in estuarine harbours and in deeper water ‘troughs’ or ‘deeps’ (although these are not deep in the context of other Regional Sea Areas). The fauna of muddy sediments in this area are generally dominated by polychaete worms, bivalve molluscs such as cockles, and brittlestars. Portland Harbour, on the east side of the Portland peninsula, is a large sheltered water mass enclosed by man-made breakwaters. It is the only location along the south coast of England that provides a fine mud habitat, and has a unique flora and fauna, including notable stands of the sea pen *Virgularia mirabilis*, high numbers of the sea squirt *Phallusia mammillata*, and the only known population in Britain of the rare black-faced blenny *Tripterygion delaisi*.

Intertidal habitats and species

The shores of both East and West Sussex are mostly of mobile shingle, formed of rounded flint pebbles, with occasional patches of muddy sand, particularly on the lower part of the shore (Irving 1998). A large expanse of intertidal sand stretches from Broomhill Sands (close to the Kent/East Sussex border) westwards to Pett Level, where it becomes muddy sand mixed with shingle. Areas of rock and boulder also occur, with characteristic fauna dependent on the substrate geology. For example, between Brighton and Eastbourne extensive wave-cut chalk platforms extend up to 500m beyond low water mark. A wave-cut sandstone platform with angular boulders (some very large - over 3m high) is located north-east of Hastings, with areas of sand or shingle, and is dissected by rocky reefs and ridges. Between the exposures of sandstone rock on the sheltered shore at The Pound, Eastbourne, are channels, pools and a large shallow lagoon on the lower shore, all floored with soft clay and chalk and supporting rich faunal communities, though only a limited diversity of algae.

At Head Ledge at the eastern end of Beachy Head there is an exposure of greensand jutting out into the sea and exposed to strong currents and wave action. The sandstone, which is relatively hard, does not support the piddocks and other boring organisms that are typical of softer substrata such as chalk and clay. The Gault Clay exposed on the shore is easily eroded and extensively burrowed by piddocks, especially *Barnea candida* low on the shore, to the extent of hundreds of individuals per square metre. Near low water, empty piddock holes in the clay support a rich burrow/crevice fauna.

Further west, littoral rock is limited to limestone outcrops at the eastern end of the Isle of Wight, the Purbeck coast and Portland Bill, the boulder shore along the Undercliff between Ventnor and St. Catherine's Point, the ironstone reefs at Hanover Point, and softer chalk outcrops at both the east (very restricted) and west ends of the Isle of Wight, at Handfast/Ballard Points and along the southern Purbeck coast. The range of intertidal chalk, cliff and cave habitats on the Isle of Wight is of international nature conservation importance. Littoral sediment is widespread, occurring as mixed sediments on Solent shores, as mud and sandy mud in the large shallow harbours, including Poole Harbour, Weymouth Bay and Portland Harbour, and forming a number of sandy beaches.

A3a.3.1.4 Features of Regional Sea 4 and 5

Nearshore habitats and species

Several areas of gravel occur offshore towards the east of Regional Sea 4. Inshore and adjacent to Chesil Beach, gravels occur out into Lyme Bay, though as a result of their mobile nature these support a relatively impoverished epifauna. The Fleet, enclosed by Chesil Bank, is the largest tidal lagoon in Britain and is of international importance for its plant and animal communities. The outer (easternmost) section of the Fleet lagoon is characterised by tidal rapids supporting highly unusual benthic communities. These contain a substantial number of rare and/or warm-water algae, invertebrates and fish (Dyrynda & Farnham 1985; Dyrynda & Cleator 1995).

Several areas have been characterised within Regional Sea Area 5 as containing tidal rapid systems, including the Fal, Dart and Tamar estuaries and channels between several of the Isles of Scilly. The marine life associated with these habitats is abundant in animals fixed on or in the seabed, and typically include soft corals, hydroids, bryozoans, large sponges, anemones, mussels and brittlestars in dense beds. Maerl beds are also closely identified with the conditions found in tidal narrows and rapids in the south-west (the Fal estuary).

Intertidal habitats and species

Within Regional Sea Area 5, there is a mix of shore types, from sand and pebbles through to boulder and bedrock. The degree of exposure to wave action is one of the main factors determining the types of community present on rocky shores, and around the coasts of Devon and Cornwall it is only within inlets and estuaries that shores can be described as sheltered. Other physical parameters affecting the composition of communities both on the shore and below low water mark include tidal currents and salinity gradients, especially within the marine inlets.

Chesil Bank stretches for some 28km and is noted for its paucity of intertidal flora and fauna, due to the mobile nature of the pebbles. From Lyme Regis to the Axe Estuary the lower shore is characterised by boulders on bedrock ledges, where rich and diverse communities occur, particularly where the honeycomb worm *Sabellaria alveolata* is present. The sand reefs of *S. alveolata* found on the midshore at Hele Rock Bay are considered to be some of the best examples in Britain.

Wide, wave-cut platforms with numerous rockpools are typical of much of the coast west of Start Point, with rich algal communities in relatively sheltered areas and rockpools, and communities in moderately exposed to exposed conditions, increasingly dominated by limpets *Patella vulgata* and barnacles, particularly *Chthamalus montagui*. Boulder shores and local shelter may lead to the development of a rich under-boulder fauna with abundant crustacea, such as the furrow crab *Xantho incisus*, the squat lobster *Galathea squamifera* and the broad-clawed porcelain crab *Porcellana platycheles*. Further west, the Lizard Peninsula and Land's End have some of the finest examples of very exposed rocky shore communities in Britain, with upper shores dominated by the barnacles *C. montagui* and *C. stellatus*, limpets and winkles. North of the Bristol Channel. the Gower peninsula exhibits some of the best moderately-exposed limestone shores in Britain.

Extensive mud and sandflats are present in the major estuary and ria systems of the coast in Regional Sea Area 5, including the Exe, Dart, Salcombe-Kingsbridge inlet, Plymouth Sound, Fal and Helford and inner Bristol Channel / Severn Estuary. Extensive intertidal flats are also present in sheltered areas of the Isles of Scilly. The rich invertebrate biomass present within these extensive intertidal sediment flats supports internationally important numbers of wading birds. Eelgrass (*Zostera*) beds are also present in several lower intertidal and shallow subtidal estuaries and rias, notably in Salcombe Harbour, the Yealm Estuary, Looe Island, Isles of Scilly and Severn Estuary.

The Severn estuary contains a variety of intertidal habitats, which together with the very large tidal range makes it one of the largest and most important intertidal zones in Britain. Thirteen community types have been identified from areas of littoral sediment within the Severn Estuary (Severn Tidal Power Group 1989). Their distribution appears to be determined primarily by sediment type and the level of consolidation, with salinity being of lesser importance.

A3a.3.1.5 Features of Regional Sea 6

Subsequent to previous SEAs, additional sources of information include:

- Studies to support Environmental Assessment of proposed marine current turbines in the entrance to Strangford Lough (e.g. Royal Haskoning 2005)
- Irish Sea regional survey carried out on behalf of Oil and Gas UK (representing the oil and gas industry) and the UK Government/Industry Environmental Monitoring Committee, in 2008.

Offshore habitats and species

An Irish Sea regional survey carried out on behalf of Oil and Gas UK (representing the oil and gas industry) and the UK Government/Industry Environmental Monitoring Committee, in 2008. Sample analysis and preliminary statistical analyses of the biological data from this survey have been completed, but not yet fully reported.

Nearshore habitats and species

Nearshore habitats along the west coast of Wales from Milford Haven to the Lleyn Peninsula are characterised by a mixture of sandy gravel and gravel. Near shore sediments in the northern limits of the area comprise mainly sand and gravel. Further south in the Cardigan Bay area, sediments are primarily sandy in nature. Large glacial features known as sarns in the north of Cardigan Bay consist of long (>10km), narrow ridges of poorly sorted glacial outwash and moraine, frequently 6-8m in height and up to 500m across. Sarn environments are occasionally exposed during low spring tides and as a consequence the associated biota is somewhat ephemeral in nature. Most of the coastline is exposed or very exposed, the one exception being Milford Haven which is very sheltered, although with strong tidal currents in places. Nearshore sediments in the area are generally of a coarse nature, composed of gravel and sand although the substratum around Skomer to Strumble Head is rock based. The area around Strumble Head and Skomer consists of a series of bays separated by headland characterised by a relatively impoverished fauna determined by the degree of exposure. Tide-swept circalittoral communities on bedrock, boulders, cobbles and pebbles include those in Menai Strait, Bardsey Sound, Ramsey Sound and Milford Haven. Survey work of tide-swept regions of North Wales and Pembroke by Moore (2004) noted the presence of five species that are considered scarce or rare: the sponges *Axinella damicornis* and *Tethyspira spinosa*, the sea squirts *Pycnoclavella aurilucens* and *Polysyncraton lacazei* and the brown seaweed *Carpomitra costata*. The south-west entrance to the Menai Strait was also reported to contain the highest number of sea cucumbers (Holothuroidea) in the Irish Sea (Ellis & Rogers 2000).

Extensive areas of sublittoral rocky reef stretch offshore from the west Pembrokeshire coast and between the Pembrokeshire islands and many small rocky islets. Limestone reefs occur in the south of the site. Reefs also extend through Milford Haven and into the variable salinity conditions of the Daugleddau estuary. Reefs within the site are subject to an exceptional variation in strength of tidal streams and wave exposure. The highly variable rocky seabed topography, together with the indented coastline and extreme tidal range, cause strong tidal streams, particularly around headlands, through sounds and in tidal inlets. The shallower and south-west-facing rocky reefs are exposed to severe wave action, while many others are extremely wave-sheltered. Many of the reefs extend onto the shore and provide examples of both the most exposed and the most sheltered intertidal rock communities in southern Britain. Reef habitat diversity is increased by caves, tunnels and surge gullies in both subtidal and intertidal zones. The wide variation in exposure to water movement, the range of rock type, slope, aspect and topography, and the high water quality, together with local exposure to abrasion from adjacent sediments and reduced salinity in the Daugleddau, are reflected in the wide diversity and species abundance of biological communities. Offshore there are particularly extensive areas of tide-swept kelp and species-rich red algal populations and, across the large areas of deeper rock reef, a wide range and abundance of invertebrate animal communities, with hydroid, bryozoan, soft coral and anemone species. More sheltered reefs, including those in lowered salinity and higher turbidity, typically support diverse and species-rich sponge and ascidian-dominated communities.

Strangford Lough is situated in County Down and is a shallow, glacially formed sea lough 24km long, 4-8km wide and linked to the Irish Sea via the 'Narrows'. The lough is a complex tidal estuary and tidal flows through the narrows can reach 4.1 metres/second (Nunn 1994). The wide variety of habitats and conditions in the lough makes it an area of high biological diversity. Reefs in Strangford Lough vary from tide-swept bedrock and large boulders in the main channel of the Narrows, through sand-scoured bedrock and boulders at either end of the channel, to more sheltered bedrock and boulders in the main central portion of the Lough and in parts of the intertidal area. Beds of horse mussels *Modiolus modiolus* form extensive biogenic reefs within the central portion of the Lough. Tide-swept bedrock is restricted to the Narrows, where rock surfaces are entirely clothed in suspension-feeding species, notably the soft coral dead-men's fingers *Alcyonium digitatum*, sponges, especially *Pachymatisma johnstonia* and the rock-boring *Cliona celata* (which reaches massive proportions), ascidians, particularly *Dendrodoa grossularia* and *Corella parallelogramma*, and sea-anemones including *Metridium senile*. Very large boulders strew much of the bed of the Narrows, and are subject to strong tidal streams. These boulders are clothed with encrusting sponges, such as *Myxilla incrustans* and *Myxilla fimbriata*, with abundant hydroids, especially *Tubularia indivisa*, and sea anemones, including *Sagartia elegans*, *Corynactis viridis* and *Actinothoe sphyrodeta*. Coarse sand scours rock surfaces at the sides and either end of the Narrows

The 'Dorn' is a silled lagoon on the eastern side of Strangford Lough. Near the mouth, rock barriers or sills hold back water as the tide falls, creating saltwater rapids, unique in Ireland. In the area of the Dorn rapids, abundant growths of sea anemones, sponges and ascidians clothe the rock and boulders. Several of the animals found in the area of the rapids normally occur in relatively deep water. These include the featherstar *Antedon bifida*, purple sun-star *Solaster endeca*, sting winkle *Ocenebra erinacea*, king scallop *Pecten maximus* and light-bulb sea-squirt *Clavelina lepadiformis*. The main trough of the Dorn supports a dense forest of sugar kelp *Laminaria saccharina* and sea-oak *Halidrys siliquosa*. The gravelly-sand bottom has unusually dense colonies of peacock worm *Sabella pavonina* and sand gaper *Mya arenaria*, with occasional native oysters *Ostrea edulis* and *P. maximus*. The channel immediately above the sill has fast tidal streams without turbulence, enabling sponges to grow to exceptional proportions. The sheltered marine 'ponds' feeding the Dorn feature beds of common eelgrass *Zostera marina* and the green alga *Codium fragile* ssp. *tomentosoides*.

Carlingford Lough harbours a number of interesting warm-water species, both intertidally and subtidally. The entrance is a complex of channels, with cobbles, boulders and patches of bedrock, dominated by sponge and hydroid associations. The central section has a mixed range of substrata with a wide range of species, while the inner part of the lough is mud, with the sea pen *Virgularia mirablis* and the mollusc *Philine aperta* abundant.

Sediments around the Isle of Man are predominantly sand and gravel mixed with various quantities of shell fragments (Bradshaw *et al.* 2003) or exposed bedrock.

The coastal area from the Mull of Galloway and the Solway Firth to Morecambe Bay, the Ribble Estuary, Liverpool Bay, the Dee Estuary, Colwyn Bay and the northern entrance to the Menai Strait encompasses a range of habitats but is predominantly sedimentary in nature and includes some of the UK's most extensive sand/mud flats. Polychaete and cockle communities dominate much of the central intertidal area of Morecambe Bay and form the basis of an extensive fishery.

Between Auchencairn Bay and the Mull of Galloway, hard substratum habitats and communities are strongly influenced by two factors: the strength of tidal streams and the turbidity of the water column. A distinct discontinuity occurs at the Isle of Whithorn: to the west, communities are richer and dominated by tunicates and sponges; and to the east, erect bryozoans and hydroids dominate. In Luce Bay, sediments are of fine sand with small amounts of mud and shell-gravel, supporting a rich infauna.

Loch Ryan's subtidal communities show a closer affinity to warmer inlets in southern Britain than to other sealochs (Howson 1989) and contains eelgrass (*Zostera spp*.) beds and the largest natural oyster (*Ostrea edulis*) beds in Scotland.

The Clyde Sea, defined as the area enclosed by a line drawn from the Rhinns of Galloway to the Mull of Kintyre, encompasses a wide variety of habitats, ranging from the estuarine mudflats of the Clyde Estuary upstream of Greenock to the deep fjordic sea lochs such as Loch Fyne, and the open coast of the Mull of Kintyre. Much of the area is sheltered from wave action and some areas are very sheltered. The area generally lacks the very strong currents found on the coast further north, but strong tidal streams run in the Kyles of Bute and in the two stretches of narrows of Loch Fyne. There appears to be a biogeographic separation of the area both from the Irish Sea to the south and from the coast to the north, which may be linked to a salinity barrier and to a bathymetric sill.

The spiny spider crab *Lithodes maia* and the large anemone *Bolocera tuediae* are both cold-water species recorded in the Clyde but more commonly found around Shetland and the North Sea, and quite rarely on Scotland's west coast. There are fewer red algae but more brown algae than would be expected for this part of the British Isles, and a number of conspicuous and generally widespread red algae are apparently absent.

Intertidal species and habitats

Important intertidal species and habitats within Regional Sea 6 were also reviewed by SEA 6 (included under the heading *Inshore Waters*), and as with the other Regional Sea area, include a range of rock and sedimentary habitats indicative of varying degrees of wave and tidal exposure.

Within Milford Haven, several intertidal sediment areas are of particular biological interest: Angle Bay, the embayment of the Pembroke River, sediment shores at Lawrenny and the 'Arenicola' and 'Pullastra' communities present at Dale/Gann Flats. Outside Milford Haven, to the west, rocky shores are present around Marloes peninsula and St David's peninsula at the northern end of St Bride's Bay. Skomer Island's rocky shores provide a wide variety of habitats and communities, as well as providing classic examples of extremely exposed shores; and both Grassholm and Skokholm also exhibit good examples of very exposed rocky shores.

The shores of Cardigan Bay range from rock, boulders and shingle (mostly found in the south), backed by low cliffs, to extensive sandy beaches (predominating in the north). At a number of locations, for example at Criccieth, patch reefs of the polychaete *Sabellaria alveolata* occur.

The Lleyn Peninsula and Anglesey littoral environment is predominantly exposed with typical wave/tide exposed biological communities. The south-west coast of Anglesey also contains sandy estuaries, salt marshes and sand dune systems. Beaches in this area are sandy in nature, containing a typical fauna including cockles, amphipods (*Bathyporeia pilosa* and *Corophium arenarium*) and the polychaete *Scoloplos armiger*. The Lafan Sands are extensive sediment flats at the northern entrance to the Menai Strait, whose invertebrate macrofauna was described by Eagle *et al*. (1974). Beyond the peninsula of the Great Orme, a small area of peat beds (a rare intertidal habitat) is present at Penrhyn Bay, near Little Orme's Head.

On the coast of Northern Ireland between Strangford Lough and St. John's Point there are a wide range of beach types, from cliff to sand, while boulders, coarse sand and mud predominate subtidally. On the east coast of Ireland the distribution of the topshell *Monodonta lineata*, which seems to prefer water columns that are stratified in summer, lies inside the mobile front that usually develops south of Strangford Lough. This area also represents the northern limit of the reef-building worm *Sabellaria alveolata*, which has its most northern site at Rossglass, Co. Down.

The intertidal mudflats and sandflats in the north of Strangford Lough represent the largest single continuous area of such habitat in Northern Ireland. There are very extensive areas of muddy sand from Newtownards to Ardmillan Bay in the west and to Greyabbey in the east. The habitat also occurs in the south-west reaches of the Lough along the northern shore of Lecale. The northern flats support luxuriant beds of the eelgrasses *Zostera noltei* and *Z. angustifolia*. Common eelgrass *Z. marina* and tasselled pondweed *Ruppia maritima* are also present, the latter being widespread but quite local in its distribution. Such extensive beds are rare in the British Isles. The green algae *Enteromorpha spp*. and *Ulva lactuca* tend to occur where there is seepage of nutrient-enriched freshwater. Many of the invertebrate species present in muds also occur in muddy sand. However, lugworm *Arenicola marina* and nereid worms are generally dominant, along with bivalve molluscs such as *Angulus tenuis*, *Mya arenaria* and *Cerastoderma edule*.

Monitoring in relation to the installation of the SeaGen wave turbine in Strangford Narrows in 2008 currently comprises baseline, first, second, third and fourth post installation surveys by diver video (Kennedy 2010). The epifaunal communities of Strangford Narrows conform to EUNIS biotopes encompassed by CR.HCR.FaT (very tide-swept faunal communities). The latest survey (the fourth post installation) was carried out in April 2010 and a further survey is planned for May 2011. Four stations were occupied for video quadrat survey: a reference station 50m east of the turbine and stations 20m, 150m and 300m south southeast of the turbine along the axis of the Narrows. The stations sampled in the baseline survey were strongly differentiated and only overlapped occasionally in terms of community composition with their nearest neighbours. This pattern was generally maintained throughout the sampling program, though there was a seasonal shift in the communities in the summer months that confounded this somewhat. The relative distribution of the stations in March 2008, March 2009 and April 2010 was very similar. In July 2008 and July 2009, the summer growth of epizooids was substantial. Random effects of the settlement of opportunists caused a change in the spatial pattern of the macrofaunal communities. There appears to be no significant deleterious effect of the turbine installation.

The mainland shores of Liverpool Bay, the Cumbrian coast and the Solway are largely sedimentary, and although there are areas of shingle and boulders, known as ‘scars’, the extent of littoral rock is very limited. Hilbre Island at the mouth of the Dee Estuary (Clwyd) provides one of the few littoral bedrock sites in Liverpool Bay. The only extensive area of rocky shore on the Cumbrian coast is at St. Bees Head. Some rocky shores are also present along the north Solway coast. By contrast, extensive tracts of intertidal sand and mudflats occur in the estuaries of the Dee, Mersey and Ribble; in Morecambe Bay (where the intertidal area extends to 33,750 ha, the largest single area of intertidal sand and mudflats in Britain (Davidson *et al*. 1991)) and the Solway Firth; and in Wigtown Bay, Luce Bay and the smaller embayments of Dumfries & Galloway. Benthic invertebrate associations correspond to gradients in wave exposure, salinity, height on the shore and particle size, with hard substrates and artificial structures being encrusted with mussels, barnacles and stunted fucoid algae.

Between Auchencairn Bay and Loch Ryan, shores are generally composed of boulders with occasional bedrock outcrops, with conditions ranging from exposed on the open coast to sheltered in embayments. Open coast littoral communities are typical, though markedly richer than sites in south Cumbria.

Within the Clyde Sea there is a highly variable mix of rock and sediment shores which range from moderately exposed (in the outer Firth of Clyde) to sheltered (within the sea lochs). The richest sedimentary shores of this area occur in the more sheltered parts of the Firth of Clyde, in Lochs Fyne, Riddon, Striven and the Gare Loch. The infauna at most sites is dominated by bivalves (e.g. *Angulus tenuis* and the cockle *Cerastoderma edule*), amphipods (*Bathyporeia spp*.) and polychaete worms. The large mud and sand flats of the lower Clyde Estuary are dominated by the amphipod *Corophium volutator*, the mud snail *Hydrobia ulvae*, mussels *Mytilus edulis* and ragworm *Hediste diversicolor*. The broken rocky shores of the lower estuary support fucoids and associated red algae (Wilkinson 1973), while the shores of the upper estuary (upstream of West Ferry) lack red algae and are characterised by blue-green algae and high densities of the diatom *Melosira nummuloides*.

A3a.3.1.6 Features of Regional Sea 7

In addition to habitats and species reviewed in previous SEAs, an important range of tidal rapid habitats are found in Scottish fjordic and fjardic sea lochs. Fjordic sea lochs occur in the more mountainous areas of the Scottish west coast and typically contain an over-deepened basin (with some examples recording a charted depth of 200m) or a series of basins connected to each other and the open sea by narrow and shallow 'sills' at depths of less than 30m, with many less than 20m. It is this high energy sill habitat, over which the tide flows, that produces the diverse communities that inhabit this environment. A considerable volume of water may move over the sill during the tidal cycle, with a tidal range in some Scottish sea lochs of up to 5m on spring tides, generating tidal flows of up to 10 knots and making these locations of interest for tidal power generation. The variability of sea lochs in size, shape, number of basins and length and depth of sills, produces a wide range of marine communities. The seabed may be of bedrock and boulders, or a range of mixed material down to coarse shell gravel. The species composition of tidal rapids in some sea lochs may also be influenced by marked variations in salinity.

Fjardic sea lochs are much shallower often with a maze of islands and shallow basins connected by rapids, which are usually less than five metres deep and often intertidal. Fjardic sea lochs are found mainly in the Western Isles.

The most notable tidal rapid systems in Regional Sea 7 include:

- **Sound of Islay**, with substrates consisting of bedrock, maerl (mostly dead), sand and tide-swept pebbles, the latter being richly colonised by hydroids and bryozoans
- **Loch Sween** (Linne Mhuirich), containing very rich sponge-dominated communities, adjacent populations of maerl and a loose-lying growth of the calcareous alga *Corallina officinalis*.
- **Firth of Lorne**, an area of complex hydrography supporting some of the richest and most varied epifaunal communities in Scotland; e.g. in the Gulf of Corryvreckan where species which normally thrive in current-swept areas, such as the soft coral *Alcyonium digitatum*, are confined to relatively sheltered places on a pinnacle that rises to within 27 m of the surface in the middle of the sound. Large boulders and bedrock gullies are dominated by dense turfs of the hydroid *Tubularia indivisa*, the bushy bryozoan *Securiflustra securifrons* and the hydroid *Sertularia cupressina*, together with extensive cover of the barnacles *Balanus crenatus* and *B. hameri* (= *Chirona hameri*).
- **Sound of Mull**
- **Loch Etive** (Falls of Lora), where the upper loch basin is characterised by restricted flow and brackish conditions
- **Kyle Rhea,** where communities on cobbles are rich in hydroids such as *Tubularia indivisa* and *Sertularia argentea*, as well as the barnacle *Balanus crenatus*, anemones and sponges; unusual populations of the brittlestar *Ophiopholis aculeata* are also present here
- **Loch Maddy,** a complex fjardic system where two areas of tidal rapids, at Sponish and Leiravay, support a very rich fauna, with underboulder communities dominated by several species of sponge (particularly *Halichondria panicea*) and encrusting ascidians (including *Botryllus schlosseri* and *Dendrodoa grossularia*); elsewhere in the subtidal area there are channels of tide-swept stones and gravel with ‘hedgehog’ rhodoliths (spiked pebbles) formed by maerl *Lithothamnion glaciale* and *Phymatolithon calcareum.*

A3a.3.2 Evolution of the Baseline and Environmental Issues

A3a.3.2.1 Evolution of the Baseline

Over recent geological timescales (ca. 11,000 years) seabed habitats around the UK have been subject to continuous processes of change associated with post-glacial trends in sea level, climate and sedimentation. In the shorter term, seasonal, inter-annual and decadal natural changes in benthic habitats, community structure and individual species population dynamics may result from physical environmental influences (e.g. episodic storm events; hydroclimatic variability and sustained trends) and/or ecological influences such as reproductive cycles, larval settlement, predation, parasitism and disease.

Clark & Frid (2001) reviewed long-term changes in the North Sea ecosystem, at all trophic levels, and concluded that in the northern, western and central areas of the North Sea, longterm changes are predominantly influenced by climatic fluctuations. Here, primary productivity during a particular year is related to the effect of weather on the timing of stratification and the resulting spring bloom. In the southern and eastern areas of the North Sea, the lack of stratification and the large inputs of nutrients mean that primary productivity is more strongly influenced by variations in anthropogenic nutrient inputs, and is only weakly related to climatic variation. However, the weight of evidence shows that long-term changes in the ecosystem may ultimately be related to long-term changes in either climate or nutrients, although the long-term dynamics of certain taxa and communities do show evidence of being influenced by both anthropogenic factors and/or internal factors such as competition and predation.

The Marine Climate Change Impacts Partnership Annual Report Card 2007-2008 Scientific Review - Seabed Ecology (Frid & Moore) concluded that:

- The available data show that climatic processes, both directly, e.g. winter mortality, and indirectly, via hydrographic conditions, influence the abundance and species composition of sea bed communities.
- These variations will directly affect the availability of food for bottom feeding fish such as cod and haddock, impact on shellfish populations (*Nephrops* and scallops/clams) and potentially alter patterns of biodiversity and ecological functioning.
- The alteration in the seafloor communities could alter rates and timing of processes such as nutrient cycling, larval supply to the plankton and organic waste assimilation.
- At local (although still large) spatial scales there is also evidence of effects resulting from fishing impacts and at smaller scales habitat modification e.g. wind farms, aggregate extraction and impacts from contaminants e.g. oil and gas exploration, waste dumping.

A3a.3.2.2 Environmental Issues

Damage to seabed habitats

Significant damage has occurred to shallow sediment habitats and reefs as a result of bottom fishing practices especially beam trawling (OSPAR 2010a). Around the UK, coastal and offshore seabed sediment habitats such as sands and muds are impacted by bottom trawling activity, which may damage ecosystem functioning (Defra 2010a).

A3a.4 CEPHALOPODS

The following sections provide an update to information presented in Appendix A3a.3 of the OESEA Environmental Report (DECC 2009b).

A3a.4.1 Changes in UK Context

OESEA (DECC 2009b) and the references therein provide an overview of cephalopod communities and ecology in UK waters and should be referred to in conjunction with this update. In addition, Hastie *et al*. (2009b) provides a comprehensive overview of cephalopod species in the north east Atlantic.

Cephalopods are a class of mollusc, including the squids, octopuses, cuttlefish and bobtail squids (sepiolids). Cephalopod ecology displays a wide range of trophic interactions, life-history strategies and behaviours across a number of species. Recruitment strategies are often complicated, with some species producing two or more cohorts of offspring in the year. One of the most important and abundant species, particularly in southern UK waters, *Loligo vulgaris*, was found to hatch throughout the year in waters off northern Spain, with a peak of hatching taking place in spring and a smaller peak in the autumn, possibly to coincide with plankton blooms. The newly hatched larvae remain in the plankton for up to 3 months (González *et al*. 2010).

Cephalopods are highly intelligent invertebrates and as such display a wide range of behaviours. Recently it has been discovered that the common octopus (*Octopus vulgaris*) can both detect (Hu *et al*. 2009) and generate (Guerra *et al*. 2007) sound. When stressed, the species was found to expel water through its funnel with sufficient velocity to cause cavitation in the surrounding water, resulting in a noise described as being “like a gunshot” (Guerra *et al*. 2007). This behaviour may act as a defence strategy to deter predators.

A3a.4.2 Evolution of the Baseline and Environmental Issues

Fishing

There are a small number of commercially valuable species targeted and caught around UK waters. *Loligo forbesii* is a common component of catches, particularly in the northern North Sea, while the English Channel cuttlefish fishery provides one of the largest cephalopod yields in the North East Atlantic (Royer *et al*. 2006) and although these stocks are not currently thought to be over-fished, responsible management remains important.

Contamination

The bioaccumulation of contaminants, such as trace metals and minerals are magnified through the food web and consequently affect many cephalopods which operate at higher trophic levels. The type and amount of accumulation will be related to diet, habitat and behaviour. For example, cadmium concentration in *L. forbesii* generally decreases with increasing body size, as smaller squid have a higher proportion of cadmium contaminated benthic invertebrates in their diet. Mercury however is retained in the tissues and so contamination increases with age and size (Pierce *et al*. 2008).

Acoustic disturbance

A study conducted by Hu *et al*. (2010) demonstrated that the brainstem of the common octopus (*O. vulgaris*) displayed auditory responses at frequencies between 400-1,000Hz.

This raises the possibility of this species and other cephalopods being disturbed by human activities generating noise in the marine environment, including boat traffic, exploration, drilling or construction work.

Climate

Cephalopods have been shown to respond both actively and passively to environmental variations. Typically, oceanographic conditions will particularly affect pelagic species, while benthic species distribution tends to be driven more by the physical habitat (*i.e.* seabed conditions) and coastal species by water quality and salinity (Pierce *et al*. 2009). Due to the complicated life-histories and reproductive strategies displayed by many species, the response to changing climate is likely to be equally complex. Peel & Jackson (2008) conclude that elevated water temperatures will result in larvae hatching at a smaller size, with a subsequent effect on the size-at-age of adults and the structure of the population. Squid will be smaller, will mature earlier and grow faster over a shorter life-span and so will require more food and oxygen per unit body size.

In the European common squid, *Alloteuthis subulata*, there is a predominance of small individuals in the Irish Sea during autumn months and more matureindividuals during spring and summer, in line with patterns of spawning and hatching in the species. Warmer water may therefore result in an increase in the complexity of the size structure and reproductive cohorts within the population (Hastie *et al*. 2009a).

A3a.5 FISH AND SHELLFISH

The following sections provide an update to information presented in Appendix A3a.4 of the OESEA Environmental Report (DECC 2009b), and this should be referred to in conjunction with this update.

A3a.5.1 Changes in UK Context

Demersal assemblages

A number of recent studies have surveyed and defined fish assemblages in the North Sea, similar to the regional study carried out by Callaway *et al*. (2002). Ehrich *et al*. (2009) identified 5 significant and separate assemblages of benthic fish species in the North Sea (Continental Coast, Central North Sea, Channel, Northern North Sea and Northern Atlantic clusters), each associated with water masses and particular habitat features. A community analysis carried out by Reiss *et al*. (2010) identified 10 main assemblages, with diversity hotspots of demersal fish typically found near inflows of Atlantic water, where immigration from adjacent regions will affect community composition.

Table A3a.5.1 (below) shows an assessment of the state of demersal fish species around the UK coast (adapted from Defra 2010c). The areas thought to be in the least favourable state when compared to a historic baseline based on catch data from 1880-1900 are the southern North Sea and the Celtic Sea. These areas are exposed to significant human pressures and size composition and productivity metrics of the demersal fish community indicate long-term deterioration (see also Table A3a.5.2 below, Defra 2010c).

Table A3a.5.1 – The state of UK demersal fish assemblages compared to an historic baseline

Region	State relative to historic baseline (1880-1900)	Level of uncertainty
Northern North Sea		Low – Medium
Southern North Sea		Low – Medium
Eastern Channel		Medium
Celtic Sea		High
Irish Sea		Medium
Minches		High
Scottish Continental Shelf		High
Rockall and Offshore		High

Note: Amber indicates little change in the baseline, red indicates a detrimental change
Source: Adapted from Defra (2010c)

Pelagic species

Information on the natural history and distributions of key pelagic species (herring, mackerel and horse mackerel) are described in the previous OESEA. Pelagic species are less closely associated with particular habitats and geographic locations than demersal species, so assemblage assessments are less appropriate for them.

Estuarine/migratory fish

Roberts (2008) suggested that historical damage and depletion to estuarine fish communities was so great and far-reaching that recent increases in abundances still leave communities considerably weaker than those that existed before human interference associated with industrial development, water course alterations (such as the construction of dams) and fishery exploitation. Nevertheless, in recent years efforts to protect vulnerable estuarine species have increased and there are some signs of improvement. Henderson & Bird (2010) described the fish community of the Severn Estuary. It contains over 100 species, and diversity in the estuary is increasing at a rate of 1 new species every 2 years, with 20% of the fish and macro-crustacean species currently undergoing rapid changes (positive and negative) in abundance, suggesting that the system is not currently at a stable equilibrium.

Elasmobranchs

Over 50 species of elasmobranch species are found in UK waters, as described in the previous OESEA, with further details of the distribution of these species available in Ellis *et al*. (2005). Recent satellite tagging studies have increased knowledge of some of these species, including the porbeagle (Pade *et al*. 2009) and basking sharks (Priede & Miller 2008). Basking sharks follow the greatest abundances of zooplankton prey and surveys conducted by the Wildlife Trust suggest that in recent years shark sightings have increased in Scottish waters and decreased off the south west of England (Speedie & Johnson 2008).

Shellfish

Information on the natural history and distributions of key shellfish species is provided in the previous OESEA.

A3a.5.2 Evolution of the Baseline and Environmental Issues

A3a.5.2.1 Evolution of the Baseline

The information presented in the previous OESEA on the evolution of the baseline remains valid.

In general, the fish and shellfish of the British Isles may not fulfil all the criteria for Good Environmental Status put forward by the Marine Strategy Framework Directive (Defra 2010c). The MSFD requires that the biodiversity, distribution and abundance of species be in line with prevailing physiographic, geographic and climatic conditions and that all commercially exploited species are within safe biological limits; this is not true of all fish communities around the British Isles whose biodiversity, abundance and distributions are heavily affected by anthropogenic influences as well as hydroclimatic forcing. Good Environmental Status also requires that ecosystems are not affected adversely by eutrophication and contamination through anthropogenic activities, and some fish communities, particularly estuarine species are likely to be impacted by estuarine inputs and coastal development. According to OSPAR's Quality Status Report 2010 (OSPAR 2010a) there has been slow progress on the protection of species and habitats, with many problems remaining, the impact of coastal activities on marine and estuarine communities still increasing and a number of fish species in UK waters still listed as under threat and/or in decline (see Appendix 3j Conservation).

Table A3a.5.2 (below) gives a generally positive impression of changes to the structure of the demersal fish community over the past decade. As demersal fish species are often closely associated with particular habitats and regions, an assessment of whole geographic assemblage can be used to complement the single-species assessments typically used in fisheries management (Defra 2010c). Judgement on the status of the demersal assemblages of UK waters was based on 5 aspects of community composition, structure and function, based on a statistical analysis of 15 indices. The emphasis of the assessment was on conserving and restoring biodiversity. Consequently, declines in species diversity were considered undesirable. Species diversity can be measured by two indicators: species richness (the number of different species in an assemblage) and species eveness (the relative abundance of these species within the assemblage). The assessment of life history trait composition considered declines in population age and length at maturity, decreased average ultimate body length in the community and increases in average growth rate to be detrimental. Increases in biomass, abundance and productivity were also interpreted as being detrimental, as heavy exploitation will typically result in a depletion of low-productivity, high trophic level species and their replacement with high-productivity species operating at lower trophic levels – often pelagic species (Defra 2010c).

Table A3a.5.2 – Assessment of changes in the structure of the demersal fish community in UK waters since 1999

Region	Abundance, biomass and productivity	Size composition	Species richness	Species evenness	Life history trait composition
Northern North Sea					
Southern North Sea					
Eastern Channel					
Celtic Sea					
Irish Sea					
Minches					

Region	Abundance, biomass and productivity	Size composition	Species richness	Species evenness	Life history trait composition
SW Scottish shelf					
NE Scottish Shelf					
Rockall and offshore					
UK EEZ Assessment					

Note: Green cells indicate beneficial changes, Amber indicates little change in the baseline or no discernible trend, red indicates a detrimental change
Source: Adapted from Defra (2010c)

Most indices are judged to have shown some improvement, with only the abundance, biomass and productivity of fish in the Celtic Sea and the life history trait composition of fish in the southern North Sea and the Rockall Trough judged to have undergone detrimental changes (Defra 2010c). These regions are intensively fished. In the Celtic Sea, there has been a decline in landings of large predatory fish and an increase in small pelagic species over the last 30 years. The southern North Sea is heavily impacted by fishing and other human activities and there is a high proportion of small fish in the community. The Rockall and offshore region is characterised by deepwater species which are typically slow growing. Indicators suggest a decrease in the number of fast-growing, opportunistic species at the expense of higher-trophic level, climax species (Defra 2010c).

A3a.5.2.2 Environmental Issues

Table A3a.5.3 (below) highlights key pressures on UK demersal fish communities and provides an assessment of changes in the fish communities around the UK. The table indicates that the majority of demersal fish communities show a positive trend (in terms of reduction in pressure or improvement in community) or no discernable change, although climate change, the development of offshore wind farms and the introduction of non-native species are examples of pressures that are increasing in a number of regions.

Estuarine fish communities are still under increasing pressure or undergoing deleterious changes in a number of regions, with estuarine inputs and coastal developments affecting these communities. There are estimated to be over 3,000 barriers, including dams, weirs, sluices and bridges, in England and Wales restricting the movement of diadromous fish and preventing passage of salmon to spawning grounds in the upper reaches of rivers and eels reaching the sea (Defra 2010c). The status of UK eel populations is a major concern and the decline in the European eel population is a matter of international concern. The Environment Agency developed a National Eel Management Strategy in 2001, and has introduced a national package of eel fishing byelaws, with the latest byelaws passed in July 2010 (Environment Agency website). In addition, 15 Eel Management Plans for each of the River Basin Districts in England, Wales, Scotland and Northern Ireland were submitted by the UK to the European Commission and these were approved in March 2010. The Eels (England and Wales) Regulations 2009 (No. 3344) implement the measures set out in the management plans and these came into force in January 2010 (Defra website).

Table A3a.5.3 – Pressures on fish communities in UK waters and the change in state of fish stocks (marine and estuarine) over the past decade

Pressure	Activity	Regional Seas							
		1	2	3	4	6	7	8	UK
Fishing	Fishing	Green	Green	Red	Green	Green	Green	Green	Green
Climate change	Temperature	Red	Red	Red	Red	Red	Red	Red	Red
	River flows	Amber	Green	Green	Amber	Amber	Amber	Amber	Amber
Energy production	Offshore wind farms	Amber	Red	Amber	Red	Red	Amber	Amber	Red
Habitat loss	Offshore	Green	Green	Amber	Amber	Amber	Amber	Amber	Amber
	Estuaries	Amber	Red	Amber	Amber	Amber	Amber	Amber	Amber
Pollution	Estuarine inputs	Green	Green	Green	Green	Green	Green	Amber	Green
	Offshore contaminants	Amber	Green	Green	Amber	Red	Amber	Amber	Amber
	Nutrient inputs	Amber	Green	Amber	Amber	Green	Amber	Amber	Amber
Trans-locations	Non-native species	Amber	Red	Red	Amber	Amber	Amber	Amber	Amber
Overall assessment (marine)	Abundance	Green	Amber	Amber	Red	Green	Green	Amber	Green
	Diversity	Amber	Green	Green	Green	Green	Green	Amber	Green
	Size structure	Amber	Amber	Amber	Amber	Green	Green	Amber	Green
	Life-history	Amber	Red	Red	Green	Amber	Green	Amber	Amber
Overall assessment (estuarine)	Assemblage	Green	Amber	Amber	Green	Green	Amber	Amber	Amber
	Salmon	Green	Red	Red	Amber	Amber	Red	Amber	Amber
	Eels	Amber	Red	Red	Red	Amber	Red	Red	Red

Note: Green cells indicate a decrease in pressure or improvement in the community, Amber indicates little change or no discernible trend in pressure and community, red indicates an increase in pressure or detrimental change in the community
Source: Adapted from Defra (2010c)

The following sections provide information updates on some of the key relevant environmental pressures affecting fish and shellfish communities. It should be remembered that the interaction of combinations of these factors will be responsible for a number of effects on communities and species. For example, van Deurs *et al*. (2009) indicated that recruitment success of North Sea sandeels was determined by a combination of the parental spawning stock (directly affected by fishing pressure) and the survival of young larvae (affected by climate), while the early egg production of the copepod *Calanus finmarchicus* was key to successful year classes.

Fishing pressure and management

Appendix 3a.4 of OESEA indicated that fishing might affect the abundance, diversity, size composition and life-history of fish communities, through the pressure exerted and the selective removal of larger, mature individuals from populations. The impacts of long-term exploitation of a fish stock are typically a decrease in body size, age of maturation and productivity and are generally thought to be irreversible. However, Conover *et al*. (2009) suggest that this may not be entirely the case. They artificially imitated fishing pressure in a captive population of silverside fish for five generations and showed that when the pressure was lifted, evolutionary changes began to reverse, with a full recovery predicted within 12 generations. However, it should be noted that 12 generations is still a number of decades in a commercial species with a typical generation time of 3-7 years.

Bailey *et al*. (2009a) showed that fish abundance recorded from depths of 800-2,500m, in the Porcupine Seabight and Abyssal Plain (south west of Ireland), has fallen significantly since 1977, possibly as a result of impacts on a shallow part of a species range resulting in declines in the deeper parts of the range. This is considerably deeper than the maximum depth of commercial fishing (approximately 1,600m), indicating that the effects of fishing extend into deep, un-fished waters, where there is little or no routine monitoring or management. Wright *et al*. (2010) demonstrated the importance of management, and in particular closed areas, concluding that temporary area closures which vary in location relative to juvenile settlement concentrations may be more beneficial for haddock stocks than permanent closures. This system of "live-closures" has been adopted by the MMO with a list of closed areas available from their website and updated monthly (MMO website).

Discarding of bycatch continues to be a major concern in UK waters. The North Sea accounts for the highest level of discarding anywhere in the world (Kelleher 2005) with an estimated 36% of all fish caught there by the English and Welsh fleet between 2003-2006 subsequently discarded (Enever *et al*. 2009). Survival rates of discarded fish vary between species and fishing method. The process of being captured can cause the loss of scales, crush injuries, rupture of swim-bladders due to rapid pressure changes, and increased predation rates on re-introduction to the water (Defra 2010c). Monitoring programmes to determine the quantity and species composition of discards are now in place for most UK fisheries.

Climate change effects

Species richness in the North Sea has increased over the last 22 years, with 8 times more species increasing their distributions than have decreased their distributions (Hiddink & ter Hofstede 2008). However, of the 34 species recorded as expanding their range in the North Sea, less than half are of commercial value, while all the species showing a reduction in their North Sea range are valuable. Species richness shows a positive correlation to average bottom temperature over the last 5 years (Henderson 2007), with prediction that a 2^{o}C rise in sea bottom temperature would result in an increase in species richness in the Bristol Channel of 10% (Henderson 2007, Henderson & Bird 2010). The increase in species richness, along with an increase in small, southerly species is possibly influenced by the release of predation pressure from large, exploited commercial fish, acting in combination with the changing climate (Hiddink & ter Hofstede 2008).

The importance of temperature and climate patterns in influencing fish communities is highlighted by Thresher *et al*. (2007), who showed a correlation between surface temperatures and growth rates of species found at depths of less than 250m (based on data collected since 1861). In contrast, the growth rates of species found deeper than 1,000m have decreased, correlating with a long-term pattern of cooling at these depths. Global climate change may act to enhance elements of the productivity of some fish stocks, but there appears to have been a negative impact on already vulnerable deep-water stocks.

Food availability may also be affected by temperature. Drinkwater *et al*. (2009) identified different driving factors behind increases in cod abundances in the North Atlantic in the 1920s-1960s and the 1990s-2000s. Modelling indicates that these increases were probably driven by bottom-up processes, i.e. an increase in the abundance of zooplankton prey. The more recent period of growth, over the past two decades is likely to have been driven largely by top-down processes, i.e. the reduction in fishing pressure over this period.

Appendix 3d Water environment of the previous OESEA indicated that sea surface temperatures are driven by the North Atlantic Oscillation (NAO). Increased mortality in Atlantic salmon has been shown to be linked strongly to a positive phase in the NAO and the associated increase in sea surface temperature (Peyronnet *et al*. 2008). Multivariate modelling showed that about 70% of variation in the data could be explained by the phase of the NAO in the winter before smolts migrate to the sea, while 25% could be explained by the abundance of *C. finmarchicus*, a key prey item (Peyronnet *et al*. 2008). The importance of prey availability in survival rates was also demonstrated by Bonhommeau *et al*. (2008) who showed that the survival of eel (*Anguilla* spp.) correlates strongly with availability of food during the early stages of the life-cycle.

The net impacts of all these variable factors can be difficult to predict. However, Jennings & Brander (2009) suggested that the effects of climate change on marine communities can be predicted, provided the effects of climate on primary production are known. A number of reviews and summaries cover the potential effects of climate change on marine fish communities in greater depth and breadth than is possible here, including Graham & Harrod (2009) and Rijnsdorp *et al*. (2010).

EMF sensitivity

Gill *et al*. (2009) showed that some species of elasmobranchs are affected by electro-magnetic fields from undersea cables, with the behaviour of a number of species affected. The authors indicate that that the effect is only likely to be observed within a very small distance around the cable and it is unclear whether the effect is positive, negative or neutral.

Noise

Research on the effects of noise on marine fish continues to improve our understanding of this potential issue. Mueller-Blenkle *et al*. (2010) played recordings of pile-driving noise to captive cod and sole, and observed the responses of the two species. Both species displayed significant, but different, behavioural responses at relatively low sound pressure levels. Cod showed a freezing response at the onset and cessation of the noise stimulus, while sole showed an increase in swimming speed for the duration of the stimulus. Both species made movements away from the source of the noise. A study conducted by Buscaino *et al*. (2010) exposed European sea bass and gilthead sea bream to acoustic stimulus of a frequency typical of vessel traffic, with the noise resulting in increased motility and intense muscle activity in both species.

Habitat impacts

Stelzenmüller *et al*. (2010) present maps of the sensitivity of 11 fish and shellfish species to aggregate extraction around the southern and western coasts of England and Wales. The maps indicate that the highest sensitivity is typically in coastal regions where spawning and nursery areas are found. The most sensitive species to extraction were scallop, lobster and queen scallop with whiting and plaice the least sensitive. Shellfish are particularly sensitive to habitat disturbance as they are relatively immobile and their distribution is closely linked to seabed conditions, as are fish, such as herring, which lay eggs in the substrate (Defra 2010c). It is estimated that it would take between 2-3 years after a cessation of aggregate extraction for signs of community recovery to show in sandy gravel habitats with moderate wave exposure and tidal currents (Defra 2010c).

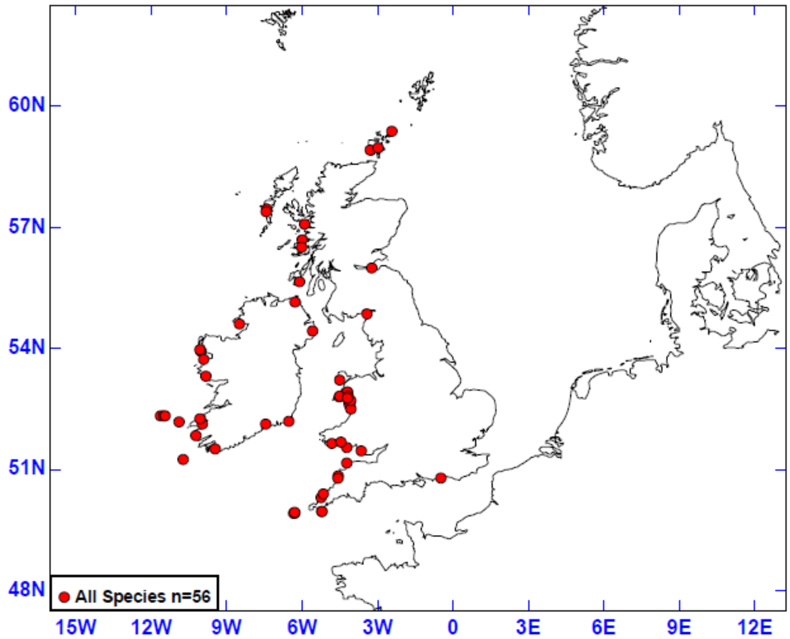
A3a.6 MARINE REPTILES

The following sections provide an update to information presented in Appendix 3a.5 of the OESEA Environmental Report (DECC 2009b).

A3a.6.1 Changes in UK Context

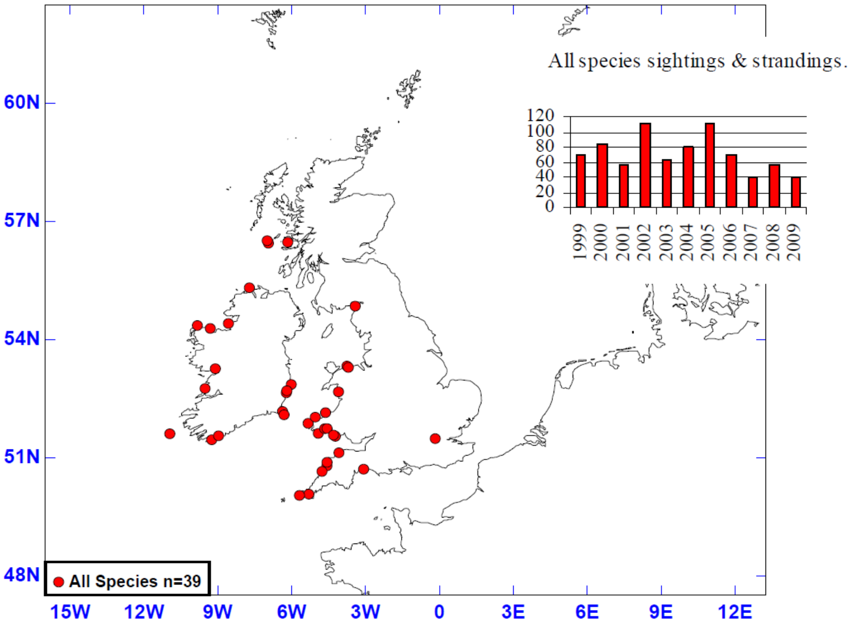
In general, the contextual information on the distribution and abundance of marine reptiles in UK waters presented in OESEA remains unchanged. The most recent updates to turtle sightings and strandings for 2008 (total of 56 turtles, Figure A3a.6.1) and 2009 (total of 39 turtles, Figure A3a.6.2) highlight a similar trend to the previous ten years (Figure A3a.6.3), with the majority of sightings and strandings recorded on westerly coasts of the UK and Ireland (Penrose & Gander 2009, 2010). Leatherback turtles are the most commonly recorded species and there has been an average of 33 sightings/strandings of leatherbacks per year since 1999.

Figure A3a.6.1 – Distribution of all turtle species for 2008



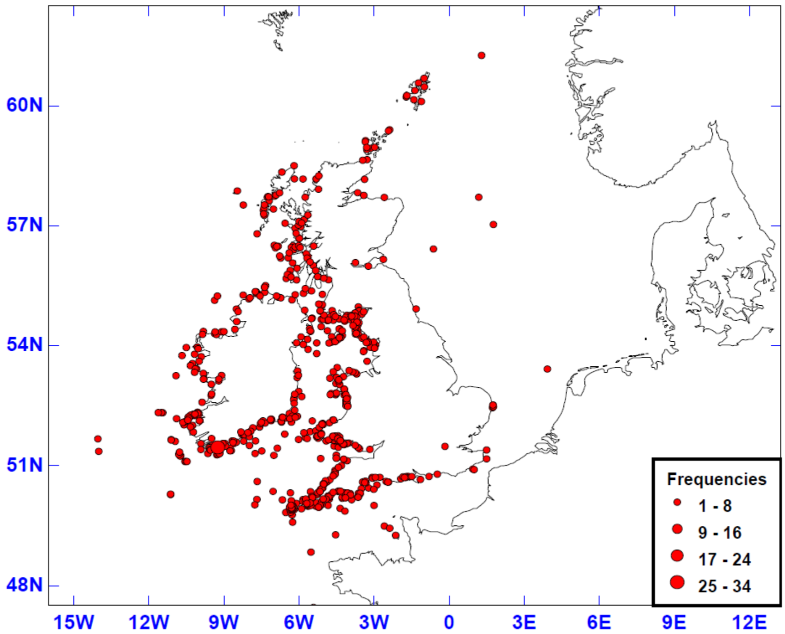
Satellite tracking of a small number of leatherbacks released from south west Ireland (Doyle *et al*. 2008), suggest that there may be individual differences in space utilisation by leatherback turtles in the North East Atlantic. For example, previous studies have shown that distinct coastal 'jellyfish hotspots' in the Irish Sea may be important foraging areas (Houghton *et al.* 2006) with associated coastal foraging behaviour. Doyle *et al*. (2008) indicate that alternative strategies may exist including foraging in mesoscale features (large eddies within the water column which may be associated with higher prey abundance) in the Bay of Biscay region. Based on calculations of distance from their tropical or subtropical nesting beaches, the timings of seasonal migrations and swimming speeds, Doyle *et al.* (2008) suggest that female leatherbacks might very rarely travel as far north as the coast of Ireland in the year they nest. However, in their 'sabbatical years' away from the nesting beaches, females probably initiate their northerly migration sooner, and hence can arrive in northern Europe earlier in the season. For male leatherbacks, however, it is far more likely that they might reach the North East Atlantic in the years that they have bred, as they may leave the breeding grounds much earlier in the year than females (James *et al.* 2005).

Figure A3a.6.2 – Distribution of all turtle species for 2009



A study by Fossette *et al*. (2010) analysed long-term tracking data for 21 leatherback turtles, a number of which were tracked from the west coast of Ireland. The spatio-temporal foraging patterns observed in this study seem to match closely the main features of the integrated mesozooplankton distribution in the North Atlantic. These findings support those presented in the OESEA after Houghton *et al*. (2006) which suggest that leatherback distribution and sightings is linked to the availability and distribution of gelatinous zooplankton.

Figure A3a.6.3 – Distribution of all turtle species, 1999-2009



Note: includes sightings and strandings (live and dead).
Source: Penrose & Gander (2010)

A3a.6.2 Evolution of the Baseline and Environmental Issues

A3a.6.2.1 Evolution of the Baseline

The low number of turtles recorded in UK waters combined with their widespread distribution makes it extremely difficult to determine any population trends. Defra (2010c) suggests that an international monitoring programme of the whole North East Atlantic, including the waters off Portugal, Spain, France, Ireland and the UK would allow population estimates and trends to be described.

A3a.6.2.2 Environmental Issues

Defra (2010c) indicates that the most significant threats to marine turtles in the Atlantic occur at the breeding sites and therefore outside the UK. Issues of significance in the UK waters include: entanglement in fishing gear (the highest known incidence of by-catch in UK fisheries is reported by inshore pot fisheries); ingestion of marine litter such as plastic, and climate change (see below). These issues were discussed in Appendix A3a.5 of OESEA.

The overall effect of climate change on marine turtles is still poorly understood and the information presented in OESEA has not been progressed further. A review of the evidence and likely consequences of present-day trends of climate change on marine turtles can be found in Poloczanska *et al*. (2009). Some of the key points presented in that paper are:

- Marine turtles are generally viewed as vulnerable to climate change because of the role that temperature plays in the sex determination of embryos, their long lifespan, long age-to-maturity and their highly migratory nature;
- Impacts of present day climate change trends are likely to be complex and may be positive as well as negative. For example, rising sea levels and increased storm intensity will negatively impact turtle nesting beaches; however, extreme storms can also lead to coastal accretion;
- The highly migratory nature of turtles and their ability to move considerable distances in short periods of time should increase their resilience to climate change;
- The cumulative effects of other human-induced pressures such as bycatch may seriously reduce the capacity of some turtle populations to cope with the additional pressure of climate change.

A3a.7 BIRDS

The following sections provide an update to information presented in Appendix 3a.6 of the OESEA Environmental Report (DECC 2009b).

A3a.7.1 Changes in UK Context

Wind energy guidance and Natura 2000

In 2010 the EU published guidance on the development of wind farms in accordance with EU nature legislation, specifically Natura 2000. The guidance identified the potential impacts arising from both onshore and offshore wind farms on a number of environmental recoptors including birds. Those potential impacts on birds are stated as:

- Collision fatalities
- Disturbance and displacement

- Barrier effect
- Habitat loss and degradation

Annex II of the guidance presents a list of species considered to be particularly vulnerable to onshore and offshore wind farms, primarily based on the compilation of a number of literary sources listed therein. Those species relevant to OESEA2 that were identified as being at substantial risk of an impact, or those species for which there is evidence for risk or impact, are presented in Table A3a.7.1 below. A complete list of all species assessed including those that are considered to be at potential risk but for which there is no specific data are listed in EU (2010).

Table A3a.7.1 – Bird species considered to be particularly vulnerable to wind farms

Species	Conservation status in Europe[1]	Annex I species	Habitat Displacement[2]	Collision[2]
Red-throated diver (wintering)	(Depleted)	Yes	XXX	
White-fronted goose	Secure	No	XX	
Wigeon	Secure	No	XX	
Long-tailed duck	Secure	No	XX	
Common scoter (wintering)	(Secure)	No	XX	
Golden plover	(Secure)	No	XX	
Lapwing	Vulnerable	No	XX	
Common snipe	Declining	No	XX	
Curlew	Declining	No	XX	
Sandwich tern	Depleted	Yes		XX
Common tern	(Secure)	Yes		XX
Little tern	Secure	Yes		XX
Guillemot/Razorbill	(Secure)	No		XX

Source: EU (2010)
Key: XXX = Evidence on substantial risk of impact, XX = Evidence or indications of risk or impact
Note: [1] after BirdLife International (2004). [2] other categories included barrier effects, change in habitat structure and potential positive impacts, none of which were applicable to the species listed above

Current and future designations

The UK is continuing to identify and designate offshore SPAs as required under Article 4 of the Birds Directive (2009/147/EC). There are currently 262 SPAs designated across the UK and a further 12 pSPAs (see Appendix A3j). Of the 262 SPAs, 107 have a marine component and three are entirely marine (Bae Caerfyrddin/Carmarthen Bay, The Outer Thames Estuary and Liverpool Bay/Bae Lerpw).

The JNCC has recently proposed the seaward extension of 38 seabird colonies of between 2 and 4km from present site boundaries, 31 of which were in Scotland and received classification in 2009 by the Scottish Government (Figure A3a.7.1, also see Figure A3j.1).

The JNCC is continuing to search for SPAs offshore and has published a report on the numbers and distribution of seabirds within the British Fisheries Limit with the aim of identifying potential marine SPAs (Kober *et al*. 2010). Using the extensive European Seabirds at Sea database the report identifies a total of 6,013 hot spots as meeting the 5%

threshold[1] and 2,201 seabird hotspots at the 1% threshold, the results of which are summarised in Figures A3a.7.2 and A3a.7.3.

As yet no further marine pSPAs have been identified, although work is ongoing and it is predicted that further Marine SPAs will be proposed based on the figures below.

Recent bird surveys

Since the publication of OESEA, a significant number of offshore bird surveys have been undertaken or initiated in connection with offshore renewables, particularly Round 3 wind farm zones. The surveys being undertaken are either aerial bird surveys or boat based bird surveys (and often a mixture of both), using standardised methods which, when published, will allow for data standardisation[2]. Aside from the JNCC publication, Kober *et al.* (2010), there has been no new substantial data published on seabird distribution within the UK since the OESEA. Details provided below list relevant publications or work being currently undertaken which will contribute to the present knowledge with regard to the UK context for bird species, and from which final, or preliminary results have been used to inform the assessment of bird sensitivity to elements of this plan/programme. A number of these studies have been commissioned on behalf of the DECC SEA process.

The eleventh *State of UK Birds* report (Eaton *et al.* 2010) describes and analyses the current distribution, abundance and conservation status of UK bird species based on surveys carried out as recently as 2009, and examines how this has changed over recent decades. Further information from this study is detailed in A3a.7.2.1 below.

A number of satellite tagging studies have started at various locations in the UK during 2010:

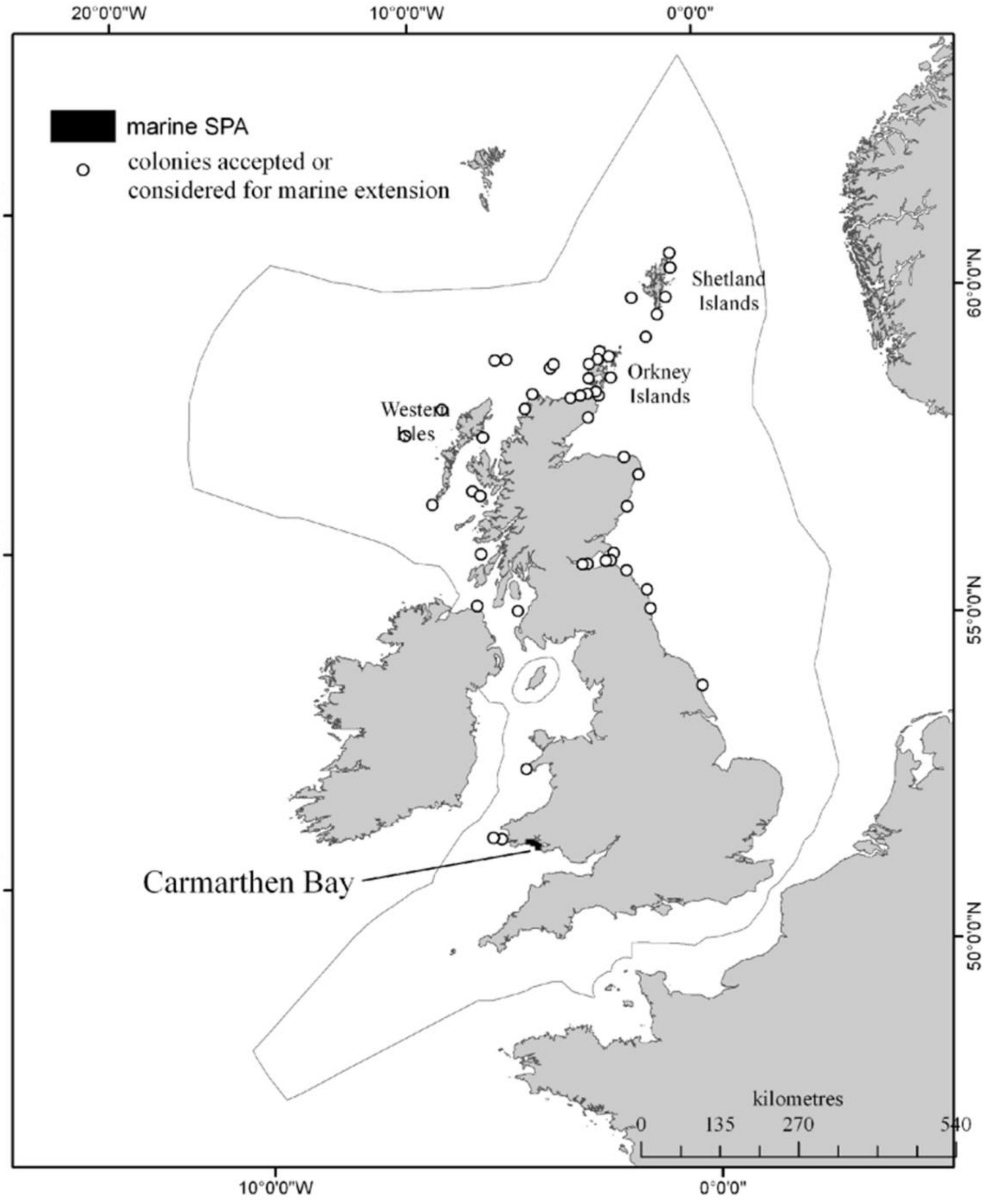
An RSPB-led, EU INTERREG and NERC funded study conducted in collaboration with Birdlife International is tracking five species of seabirds (fulmar, shag, kittiwake, guillemot and gannet) from several UK breeding colonies. A complimentary SEA funded RSPB study, has tagged gannets from Bempton cliffs which will help identify important foraging areas for gannets from the Bempton and Flamborough SPA. In July 2010, 14 satellite tags were fitted to adult gannets breeding at the site which facilitated the collection of data for up to one month during the chick rearing stage. Preliminary results (Figure A3a.7.4) indicate that most foraging trips are within 100km of the coast, with some overlap of the Hornsea offshore wind zone. A few tracks reach the Dogger Bank and some extend southwards.

Tagging has also been undertaken by the JNCC on common terns breeding in the Firth of Forth and guillemot, razorbill and kittiwake were tagged on the Isle of May during 2010. JNCC is also using boat based surveys, visual tracking and radiotracking, towards identifying foraging area extensions to SPAs for breeding red-throated divers (Langston 2010).

[1] Threshold refers to the top 5% and 1% of all Getis-Ord Gi*, which is a statistical measure of how high and clustered values are, calculated for every point on a map. It is defined as a ratio between the values of a variable within a defined radius (in this case 60km) around a central location and the values of this variable in the entire study area, assigned to the central location (see Kober *et al.* 2010, p22).

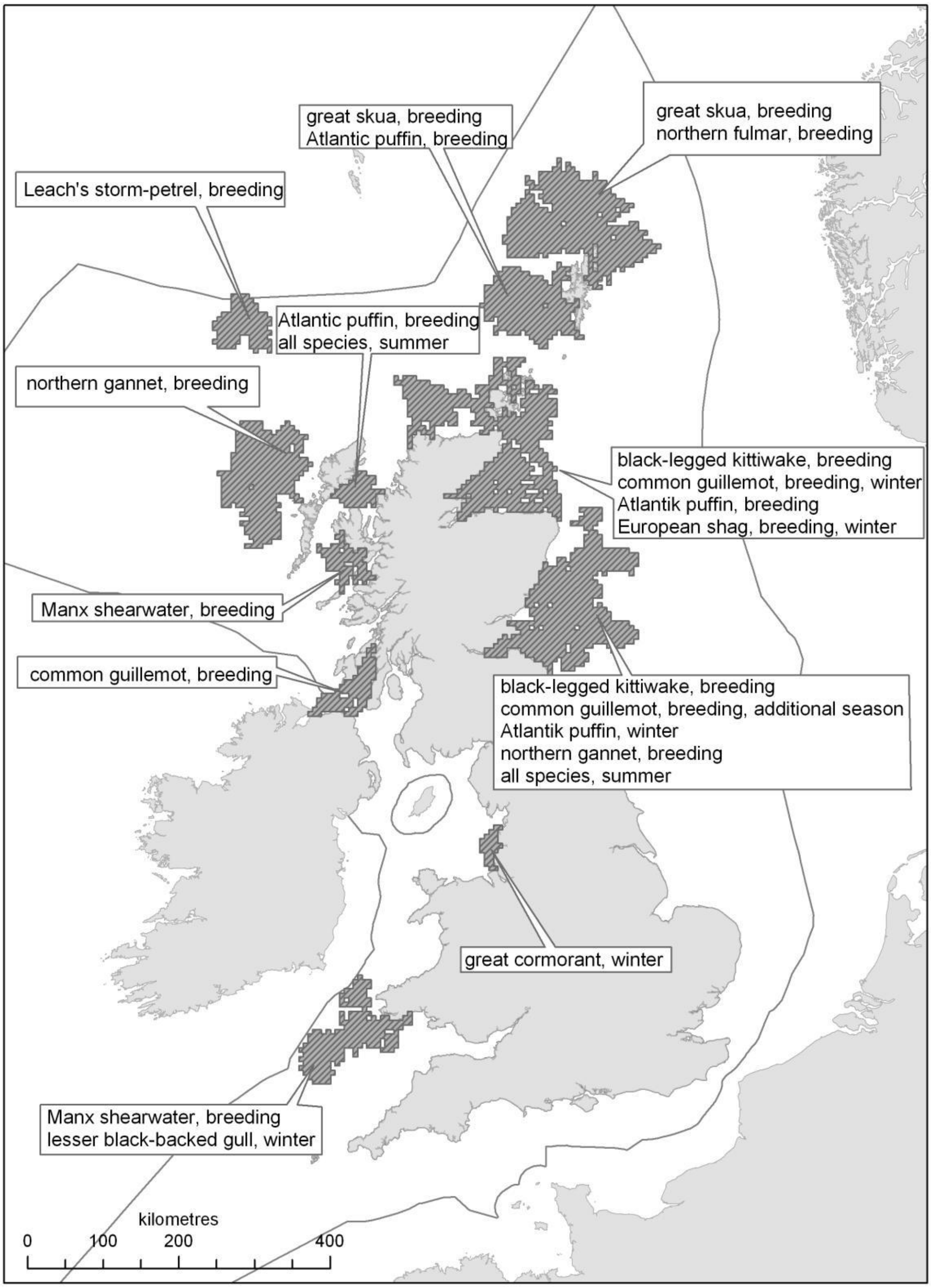
[2] Also see recent COWRIE publications relating to survey methods and design, e.g. Burt *et al.* (2009, 2010),

Figure A3a.7.1 – Existing SPA colonies with proposed colony extensions



Source: Kober et al. (2010)

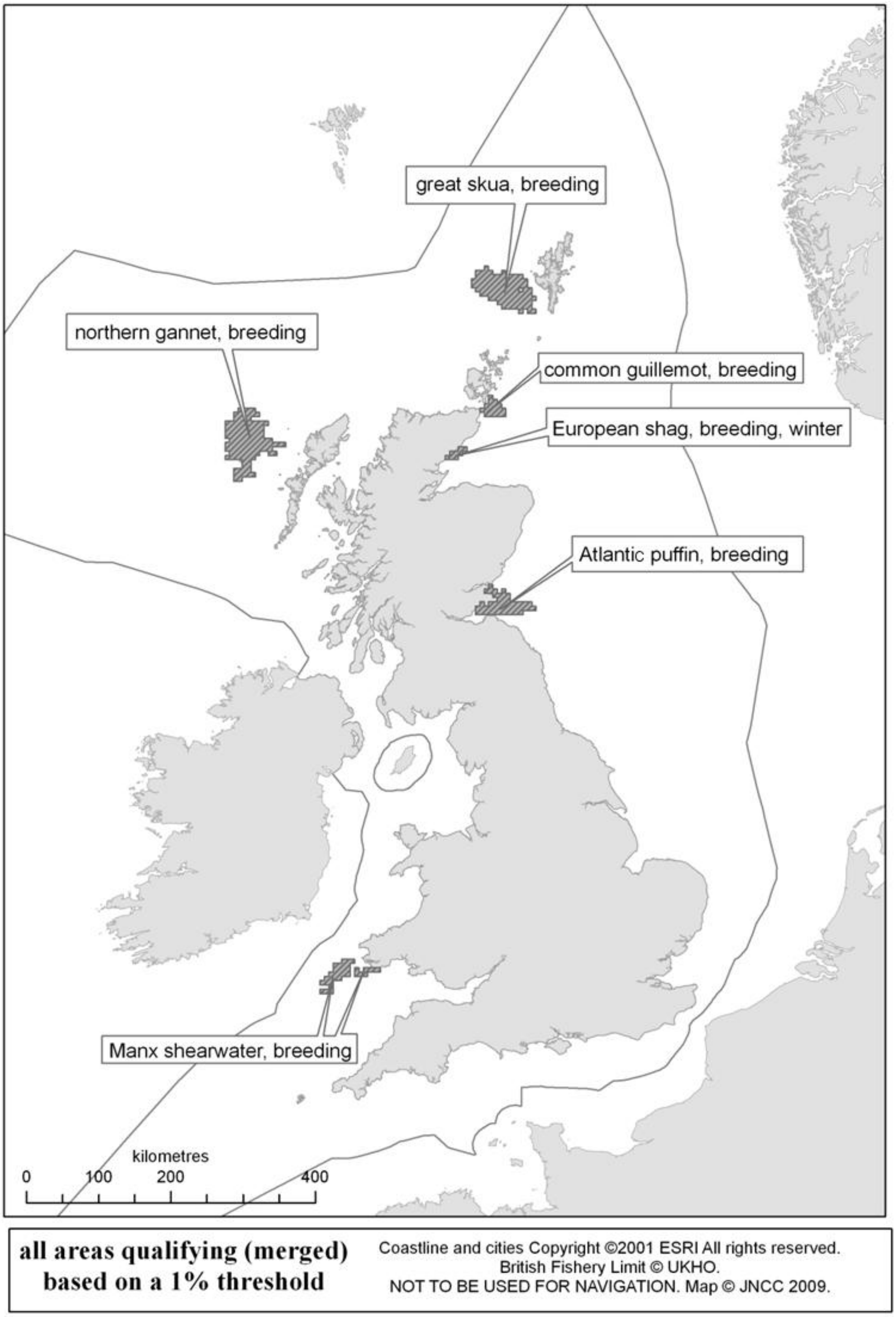
Figure A3a.7.2 – Seabird hotspots within British Fishery Limits based on the 5% threshold



all areas qualifying (merged) based on a 5% threshold

Source: Kober et al. (2010)

Figure A3a.7.3 – Seabird hotspots within British Fishery Limits based on the 1% threshold

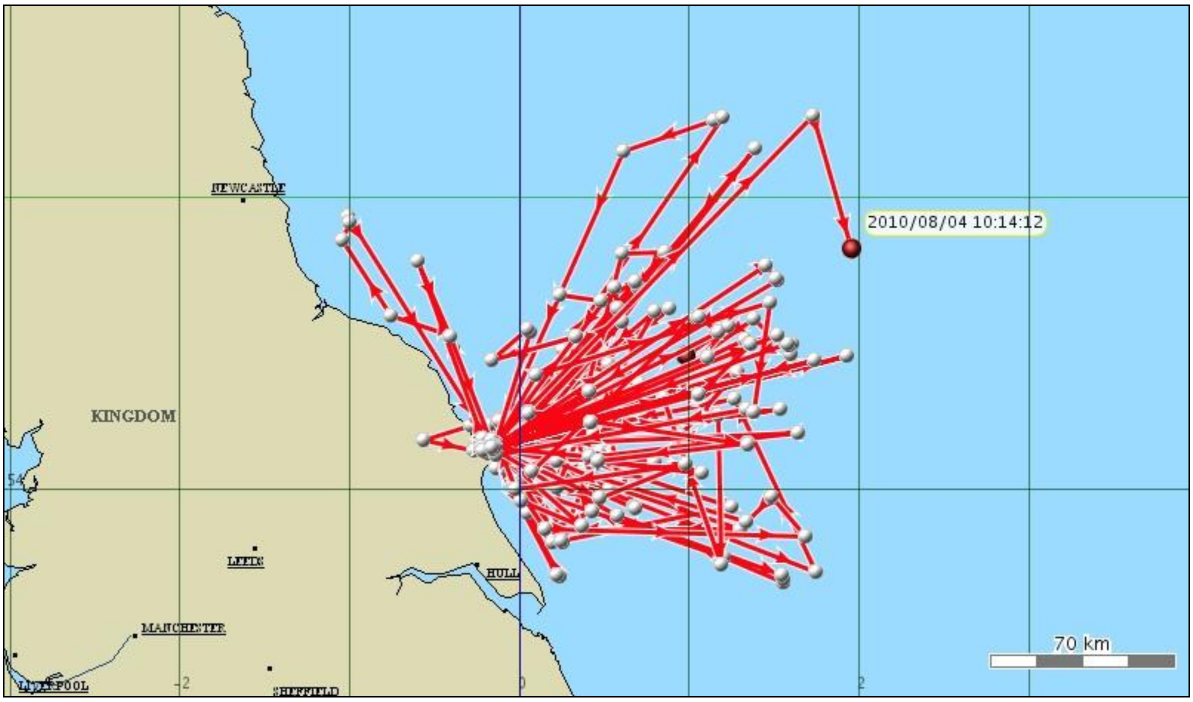


Source: Kober et al. (2010)

Langston (2010) highlights the present status of seabird data applicable to the assessment of possible impacts on bird species from strategic wind farm zones (e.g. Rounds 1, 2 3 and Scottish Territorial Waters). Langston (2010) makes a series of recommendations based around the collation and assessment of existing data along with a coordinated survey programme to collect new data and refresh older and now somewhat dated survey coverage (e.g. the resurvey of areas covered by the European Seabirds at Sea (ESAS) surveys). It is noted that such surveys could have wider applicability, for instance research into foraging areas and those used by priority species in relation to development areas will also be relevant to the identification of marine SPAs.

A COWRIE-commissioned satellite-tracking study has indicated that whooper swans migrating from southeast England (Wlidfowl and Wetland Trust Welney site) generally migrate north along the east coast of Britain whereas those from northwest England and southwest Scotland (Martin Mere and Caerlaverock WWT sites) followed the western coastline (Griffin *et al.* 2010a) en route to Icelandic breeding grounds. The study found that the potential for overlap between whooper swan migration routes and proposed offshore wind farm sites was greater for swans migrating along the west coast of Britain than for those migrating along the east coast. The authors suggest that potential differences in collision risk arising from the installation of wind farms within these two migratory corridors could be assessed by continuing the long-term study of whooper swan survival rates for birds wintering at these WWT sites over the next 5-10 years, during which time many of the proposed wind farms will become operational (Griffin *et al.* 2010a).

Figure A3a.7.4 – Combined gannet tracks for a 10-day period in July-August 2010



Source: preliminary results from the DECC funded RSPB Bempton Cliffs tagging study

DECC has funded an extension to the whooper swan tagging study into migration routes in relation to wind farm footprints, undertaken by WWT. The work includes analyses of existing GPS and conventional satellite tracking data for four key species (whooper swan, Svalbard barnacle goose, Greenland white-fronted goose and light-bellied brent goose) in relation to offshore wind farm locations along their migration flyways. An interim report (Griffin *et al.*

2010b) indicates that of the seven whooper swans tracked in 2010, tracks for six birds appeared to cross five different operational or potential offshore wind farm areas (Ormonde, Robin Rigg, Solway Firth, Islay and Argyll Array). The Kintyre, Islay and Argyll Array sites appear to have the greatest potential to occur on the migration routes of brent geese leaving or arriving in northeast Ireland although no tracks actually crossed the sites. Of 22 Svalbard barnacle geese producing GPS satellite tracks across the North Sea, 17 passed across, or less than, 20km from proposed offshore wind farm areas, either in spring and/or autumn. Twelve extrapolated GPS tracks for ten different birds passed through more than one wind farm footprint with eight tracks passing through both the Firth of Forth and Forth Array; two tracks through both the Firth of Forth and Neart na Gaoithe; one track through both the Firth of Forth and Inch Cape; and one track through/adjacent to the Moray Firth and Beatrice. On reaching and moving up the coast of Norway, the migration route of the Svalbard barnacle goose narrows so that most birds pass within a 10km corridor within which many offshore and small island wind farms are planned or are operational. Griffin *et al.* (2010b) suggest there is significant potential for the combination of inshore or offshore wind farms along the international flyway having a cumulative effect on the Svalbard barnacle goose population.

A3a.7.2 Evolution of the Baseline and Environmental Issues

A3a.7.2.1 Evolution of the baseline

Seabirds

Changes in breeding numbers have varied greatly between individual species, for example between 1999-2009, abundance decreased by more than 10% in seven species (fulmar, Arctic skua, lesser black-backed gull, herring gull, kittiwake, razorbill), increased by more than 10% in five species (gannet, great skua, sandwich tern, roseate tern, Arctic tern) and changed by less than 10% either positively or negatively in six species (cormorant, shag, black-headed gull, little tern, common tern, guillemot) (Eaton *et al.* 2010, see Table A3a.7.3 for a wider range of trends). Both Charting Progress 2 (Defra 2010c) and the OSPAR QSR (OSPAR 2010a) indicate that in the northern North Sea, some seabirds have suffered a decade of breeding failure, possibly due to the combined effects of climate change and fishing on key prey species. Although breeding success was good for the first time in 2009 for some species (e.g. kittiwake and guillemots), the long-term picture is still one of serious concern.

Table A3a.7.3 – UK population trends (as percentage change in breeding numbers)

Species	Population change 1969-70 to 1985-88	Population change 1985-88 to 1998-2002	Population change 1999-2009
red-throated diver*			
northern fulmar	+77	-3	-38
Manx shearwater	n/a	n/a	n/a
European storm-petrel	n/a	n/a	n/a
Leach's storm-petrel	n/a	n/a	n/a
northern gannet	+39	+39**	+22****
great cormorant	+9	+10	-2
European shag	+21	-27	-9
Arctic skua	+226	-37	-33
great skua	+148	+26	n/a
black-legged kittiwake	+24	-25	-40

Species	Population change 1969-70 to 1985-88	Population change 1985-88 to 1998-2002	Population change 1999-2009
black-headed gull	+5	0	-6
Mediterranean gull	n/a	+10,900	n/a
mew gull	+25	+36	n/a
lesser black-backed gull	+29	+40	-31
herring gull	-48	-13	-43
great black-backed gull	-7	-4	-30
Sandwich tern	+33	-15	+22
roseate tern	-66	-83	+81
common tern	+9	-9	+4
Arctic tern	+50	-31	+14
little tern	+58	-23	-8
common guillemot	+77	+31	+3
razorbill	+16	+21	-11
black guillemot	n/a	+3***	n/a
Atlantic puffin	+15	+19	n/a

Source: Eaton et al. (2010), JNCC (2010)
Note: trends derived from complete censuses undertaken in 1969-70 (Operation Seafarer); 1985-88 (Seabird Colony Register); and 1998-2002 (Seabird 2000). Change from 1999-2009 is estimated from trends derived from the SMP sample of colonies.
*Key: *Not included in Operation Seafarer, Seabird 2000 census or Seabird Colony Register. **change between censuses in 1984-5 and 2004-5. ***change between censuses in 1982-91 and 1998-2002. ****trend derived from census interpolations and extrapolations.*

Eaton *et al*. (2010) examined trends in abundance and breeding success of six widespread seabird species, which represent a range of foraging niches, to investigate possible common factors responsible for change across species. Kittiwakes and gannets represent the offshore surface-feeder niche; fulmars the offshore surface feeder/scavenger niche; sandwich terns the inshore surface-feeder niche; guillemots the offshore diving niche, and shags the inshore diving niche.

Kittiwakes have undergone a major population decline since 1986. They rely largely on small shoaling fish, especially sandeels, to be present at the sea surface and there is evidence that increases in sea surface temperature (SST) have reduced the abundance of sandeels and therefore the productivity (and adult survival) of kittiwakes. Gannet numbers have increased substantially over the period monitored. Unlike kittiwakes, gannets can travel great distances from the colony to find food and their diet is varied, including mackerel, herring and other large fish. These factors help gannets to maintain consistently high productivity. Fulmar breeding numbers in the UK have undergone a long term increase, which continued until the end of the 1990s, after which a decline was apparent. As fulmars gain a large proportion of their food from fishery discards, the recent decline may in part be a result of reductions in fishing activity. Indeed it is possible that fulmar populations have been bolstered by historically high fishing levels. Since many tern species nest near the tide edge on sand or shingle spits and islands, they are vulnerable to tidal inundation; this threat is likely to increase in some areas given climate change predictions of rising sea levels and increased incidence of storm events, although managed realignment of coastal defences may create new opportunities for nesting. Declines in guillemot productivity are associated with reduced sandeel availability, probably mediated by increases in SST. As with other sandeel feeders (e.g. kittiwake), productivity of guillemots increased markedly in 2009, when sandeel abundance appeared to be high. Population change in the shag is heavily affected by the incidence of mass mortality events – or "wrecks" – which occur during prolonged periods of onshore gales, when birds such as shags find it hard to forage. Severe events, such as those in 1994 and 2005, knocked back the population considerably, and subsequent recovery has been slow. Predictions of increased storminess due to climate change suggest such mortality events may become more frequent (Eaton *et al*. 2010).

Waterbirds

Trends in overall abundance for 46 native species or populations, derived from the Wetland Bird Survey (WeBS) Core Counts and the Goose & Swan Monitoring Programme indicate that there was a steady increase in wintering waterbirds in the UK from the mid-1970s to the mid-1990s, due in part to a network of protected wetland sites. For some species, reductions in shooting pressures have also contributed to the increases. However, since the mid-1990s, the indicators suggest that average waterbird numbers have levelled off, both for wildfowl and waders, and are now indicating an overall decline, particularly for wildfowl. Results from waterbird monitoring schemes in other parts of Europe have demonstrated that this is at least partly attributable to "short stopping", whereby an increased proportion of a waterbird population is able to winter closer to its breeding area (usually further east or north) due to milder winters. However, it is crucial that the influence of short stopping on observed waterbird trends in the UK is understood so that true declines are not overlooked. Careful monitoring and research is needed, both in the UK and elsewhere on flyways, to determine whether the recent declines are the result of climate-mediated range shifts, or indicative of population-level declines (Eaton *et al*. 2010).

A3a.7.2.2 Environmental Issues

Those environmental issues in relation to seabirds (e.g. vulnerability to surface pollution) and waterbirds described in Appendix 3a.6 of OESEA remain current.

Seabirds

A number of pressures which could result in impacts on the UK seabird populations are prevalent, with impacts from the introduction of non-indigenous species and climate change (already introduced above) considered to be of high importance. The long-term existence of non-indigenous predatory mammals (e.g. brown rats) on offshore islands following intentional or accidental introductions has significantly depressed the numbers of ground-nesting seabirds (e.g. Atlantic puffins) by reducing the amount of safe nesting habitat available. This is compounded by more recent introductions of non-indigenous mammals (e.g. mink) with resulting destruction of seabird eggs, chicks and adults which has led to reductions in seabird breeding success, breeding numbers and eventual extinction of whole colonies (Defra 2010c).

The warming of the seas around the UK as a result of climate change (see Appendix 4d and 4f) has contributed to a reduction in the number and quality of prey fish, namely lesser sandeel. For instance a warmer North Sea in the 1980s affected zooplankton abundance and the larval fish which feed on them, which had a resultant impact on sandeel population (Defra 2010a). As a result, species for which sandeels are primary prey (e.g. kittiwakes, common guillemot) have experienced lower breeding success and survival. As sea temperatures continue to rise, it is likely that these and other seabirds that feed on sandeels will continue to experience poor breeding seasons with increasing frequency. The combination of reduced recruitment and lower adult survival will lead to further declines in population size (Defra 2010c). The impact of a sandeel fishery off eastern Scotland, which operated in the 1990s, was notable on the adult survival and breeding success of kittiwakes. A ban on such fisheries off eastern Scotland and NE England has been in place since 2000 (Defra 2010c).

Conversely, some seabirds have benefited from fisheries through food provided at sea by discharging offal and discarding undersize fish. As a result, the abundance of scavenging species (e.g. great skua, northern fulmar) may have increased above that which would be sustained by natural food sources. The introduction of measures to conserve fish stocks has reduced the amount of discards, as has the decline of some commercial fisheries, which has also resulted in less offal being discharged. It is conceivable that the reduction in food provided by the fishing industry may have contributed to a population downturn of northern fulmars and other offshore surface-feeders since the mid-1990s (Defra 2010c).

Defra (2010c) considered impacts on seabirds from contamination by hazardous substances, litter, visual disturbance and habitat loss to be low at present. Disturbance from offshore renewable energy development could lead to the loss of foraging habitat for inshore feeders (e.g. terns). CEFAS (2010) undertook a critique of the monitoring data collected as required by FEPA licence conditions for Round 1 and Round 2 wind farms. The report found no evidence of any impacts on birds from offshore wind farms but highlighted the weaknesses in the data obtained by the monitoring that has been undertaken and made a series of recommendations to strengthen future monitoring results (CEFAS 2010).

Waterbirds

Defra (2010c) consider climate change, contamination by hazardous substances, removal of species (target and non-target), habitat damage and habitat loss to be of high significance to waterbird populations. There is clear evidence in the UK of a south-westwards to north-eastwards shift in the centres of abundance for some species of wader in line with climate change predictions (Defra 2010c). These changes in distribution appear to be driven by waders taking advantage of new opportunities to over-winter on sites offering better feeding conditions closer to their Arctic and sub-Arctic breeding ranges rather than being negative impacts, though these new distributions may make populations more susceptible to intermittent severe weather events during which mortality has been shown to be high (Clark 2004).

Water birds such as seaduck, divers and grebes have a low resistance to the effects of contamination by surface pollutants such as oil (in that individuals affected suffer reduced chances of survival), though resilience is likely to be moderate, since their breeding grounds are distant from their wintering grounds (Defra 2010c).

Analogous to fishery impacts on seabirds, marked reductions in waterbird survival have been shown to occur as a result of shellfish harvesting. Shellfisheries can also cause substantial changes to marine ecosystems (disturbance of the seafloor leading to mortality of benthic organisms, and re-working of sediment) leading to reductions in food availability to waterbirds. Both resistance and resilience to these pressures are low (Defra 2010c).

Most species of waterbird, but especially waders, can be expected to be affected by habitat loss due to activities such as coastal defences and the construction of tidal barrages, (i.e. engineering used to try and abate some of the effects of sea-level change; Austin 2010) and the construction and extension of marinas or harbour developments. Habitat damage may be caused by bottom trawling, shipping activities, dredging and sand/gravel extraction, leading to changes in numbers and distribution of seaduck, divers and waders (Defra 2010c).

A3a.8 MARINE AND OTHER MAMMALS

The following sections provide an update to information presented in Appendix 3a.7 of the OESEA Environmental Report (DECC 2009b).

A3a.8.1 Changes in UK Context

Cetacean distribution and abundance

The current understanding of the distribution, abundance, ecological importance and main environmental issues relating to cetaceans in UK waters presented in OESEA remains unchanged, although there are a number of new studies of relevance since its publication. Those studies that present new information or improve our understanding of the baseline are discussed below.

The SCANS (1994) and SCANS-II (2005) survey programmes (Small Cetacean Abundance in the European Atlantic and North Sea) and the Cetacean Offshore Distribution and Abundance (CODA) survey in 2007, as presented in the OESEA, remain the most comprehensive and up-to-date information available on cetacean distribution in UK waters, with a comprehensive report on their findings provided in Hammond *et al*. (2009). An analysis of data from the southern Irish Sea assesses how useful Joint Cetacean Protocol (JCP) data, gathered and integrated from around Europe, may be in detecting changes in the abundance and distribution of cetacean species in UK waters (Thomas 2009, Paxton & Thomas 2010 (In Prep). The study showed that there was a limit to the power of analysis using this data (it is estimated to be able to detect a 15-30% annual decline in abundance), although there is scope for further development of methods of analysis.

Scotland

Our understanding of harbour porpoise in the Greater Minch area has improved since OESEA. Marubini *et al*. (2009) looked at habitat preferences and interannual variability in harbour porpoise occurrence. Key findings included: a preference for waters within 15km of the shore and between 50 and 150m depth; a relationship between tidal variables and porpoise distribution, with more sightings predicted for areas with high tidal stream velocities, as well as during times of high tide. These findings further support the evidence for the importance of strong tidal current areas to this species.

The information presented in OESEA relating to the distribution and abundance of cetaceans, particularly bottlenose dolphins and harbour porpoise, in the inner Moray Firth remains up-to-date and subsequent studies (e.g. Bailey & Thompson 2009, Bailey *et al*. 2009b) describing movements of bottlenose dolphins and harbour porpoise in the inner Moray Firth accord with previous descriptions.

The outer Moray Firth is less well documented and throughout 2008 the Whale and Dolphin Conservation Society coordinated marine mammal surveys of this area, culminating in a project report for the BBC Wildlife Fund in 2009. The key findings of the project were: minke whales were more usually observed in deeper waters further from shore; both visual and acoustic data indicate that harbour porpoises are widespread in the survey area throughout the year though usually more abundant in deeper waters further from shore; common dolphins were recorded in May and August. Due to the volume and temporal brevity of the data available from these surveys, indications of seasonal trends in density and distribution should be used with care. Robinson *et al*. (2009a) has also identified evidence of translocational movements of animals between the Moray Firth and the Inner Hebrides.

In May 2009, DECC with various co-funders, contracted the University of Aberdeen to carry out a three year study to assess the potential impact of oil and gas operations on cetaceans in the Moray Firth. The study focuses on the central area of the Moray Firth adjacent to the Special Area of Conservation. A report by Thompson *et al*. (2010) presents the results of work carried out during the first year of the study, where the key objectives were to review existing cetacean survey data for the area, to carry out surveys to assess the relative abundance of bottlenose dolphins and other cetaceans during the summer months (May-October) of 2009, and develop procedures for measuring ambient and seismic noise levels. The key findings of the acoustic and visual surveys relating to abundance and distribution of bottlenose dolphins, harbour porpoise and minke whales accord with information presented previously in OESEA.

The distribution of minke whales is documented in the OESEA with reference to SCANS-II 2008, which suggested relatively high numbers were observed in the Moray Firth. A recent study indicates that minke whales in the southern outer Moray Firth, display a strong spatial preference for water depths between 20 and 50m, steep shelf slopes with a northerly-facing aspect and sandy-gravel sediment type (Robinson *et al*. 2009b).

Information relating to the predation of seals around major UK colonies (particularly in Scottish waters) by killer whales as documented in OESEA has been augmented by Bolt *et al.* (2009) who suggest a possible, though speculative link between harbour seal decline and predation by killer whales.

England and Wales

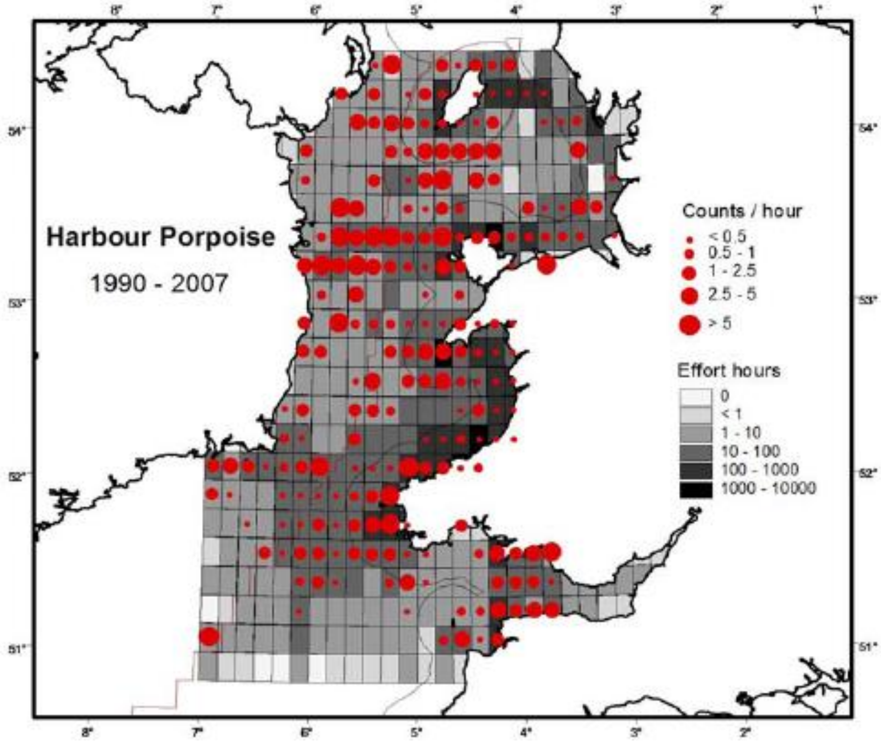
The previous findings by Northridge *et al*. (2004) presented in the OESEA with respect to the winter movements of common dolphins into the western English Channel have been partly updated by an analysis of sightings from 1996-2006 by Macleod *et al*. (2009). The study suggests that the winter occurrence of common dolphins in the English Channel has increased although the trend is not regarded as significant.

Population trends and abundance estimates of bottlenose dolphins off the coast of south west England are not well documented compared to those populations occurring in Cardigan Bay and the Moray Firth. Doyle *et al*. (2007a) suggest there has been a significant decrease (93%) in sighting numbers and average group sizes (70%) around the coastline of Devon and Cornwall since 1990. Bycatch is one possible explanation for such a decline (see A3a.8.2.2 below). SeaWatch SW is currently monitoring cetacean distribution in this region (Wynn & Brereton 2009).

Marine mammal distribution in Welsh waters has been investigated by Baines & Evans (2009) who have produced an atlas covering the majority of the Irish Sea. The atlas presents distribution data from effort-related sightings between 1990 and 2007, and presents occurrence trends for relatively common species; harbour porpoise, bottlenose dolphin, short-beaked common dolphin, Risso's dolphin and minke whale. Maps of rare species such as killer whale, fin whale and white-beaked dolphin are also included. The atlas indicates that harbour porpoise are the commonest and most widespread species (Figure A3a.8.1).

The distribution of relatively common species presented in the atlas accords with those previously described in OESEA. Baines & Evans (2009) noted seasonal differences were found to exist in dispersion and group size of harbour porpoise, with smaller groups occurring mainly near the coast, concentrated within Cardigan Bay in summer and the formation of larger groups dispersing more widely and generally northwards in winter.

Figure A3a.8.1 – Harbour porpoise sightings in the Irish Sea



Source: Baines & Evans (2009)

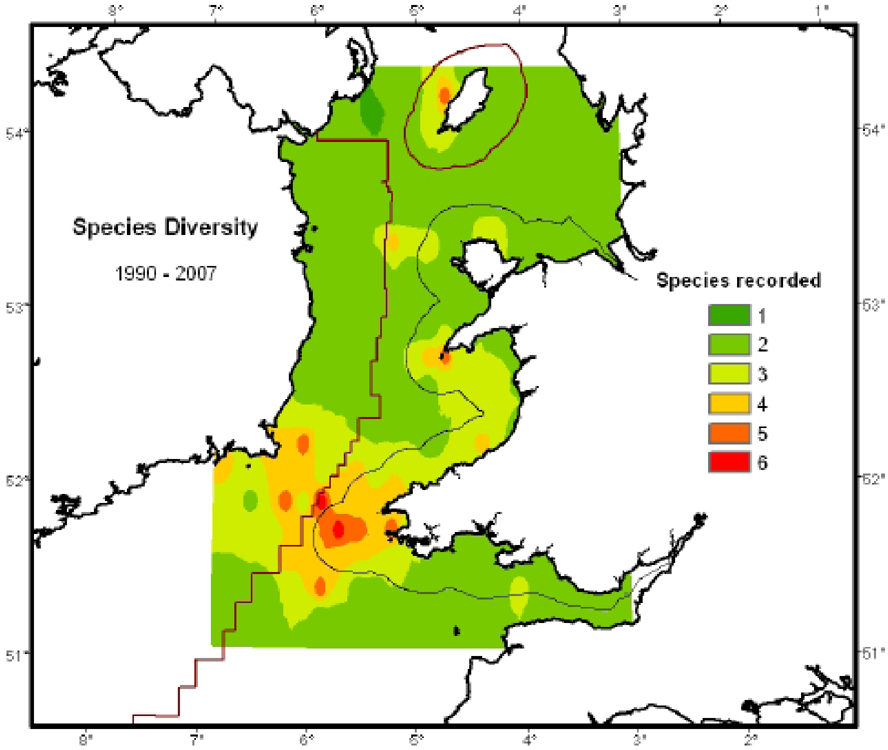
Baines & Evans (2009) suggested cetacean species diversity is highest around the Celtic Deep and in coastal areas, west Pembrokeshire, the western end of the Llyn Peninsula, and west of Anglesey (Figure A3a.8.2).

Other supporting publications include: Pierpoint *et al*. (2009), Fiengold *et al*. (2010) and Simon *et al*. (2010), the latter revealing the importance of Cardigan Bay to harbour porpoise during winter. The north coast of Anglesey was identified in the OESEA as important for harbour porpoise, and this was further confirmed by a study of the abundance and distribution of this species (Schucksmith *et al.* 2009).

Northern Ireland

Since the installation of a tidal energy device (SeaGen) in Strangford Lough in 2008 by Marine Current Turbines (MCT), an environmental monitoring programme has been implemented to monitor the impact of the device on marine mammal behaviour and abundance. The biannual report provides a comparative analysis of all environmental data collected during the baseline period (pre-installation), installation, commissioning and initial operation of the SeaGen turbine. Of the total 426 marine mammal sightings made throughout the duration of pile-based marine mammal observation there are clear peaks in the number of sightings at slack water particularly high water slack. Following analysis of T-POD data, no significant difference between porpoise detections during baseline and post-installation has been recorded in the inner Lough. A decline in the overall detections within the Narrows was recorded, and it is possible that this may indicate that the porpoise now pass through the Narrows more quickly and/or quietly (Royal Haskoning Ltd 2010).

Figure A3a.8.2 – Number of cetacean species recorded per study cell



Source: Baines and Evans (2009)

A review of recent research relating to cetaceans in Irish waters (O'Brien *et al*. 2009) suggested that the habitat requirements of most cetacean species are not fully understood, though some important areas in southern Ireland have been identified, such as the Shannon estuary. In November 2008 the Northern Ireland Environment Agency (NIEA) implemented a systematic cetacean monitoring programme involving monthly shore-based watches conducted from 12 key sites using standard monitoring methodology. This will hopefully improve the baseline information that exists for Northern Irish waters.

Seal distribution and abundance

Grey seals

The overall estimate for the grey seal population associated with annually monitored colonies in 2008 was 183,000 (SCOS 2009). The pattern of grey seal pup production estimates for the main colonies surveyed has not changed since the publication of the OESEA (see OESEA Table A3a.7.7). The average annual percentage change in pup production from 2003-2008 for the main colonies surveyed was positive apart from colonies in the Outer Hebrides which showed no change, and the Inner Hebrides which showed a negative change.

Harbour seals

Each year SMRU carries out surveys of harbour seals during the moult in August. Observed declines around the UK have prompted survey effort to be increased and an attempt was made to survey the entire Scottish and the English east coast populations during 2007, completed in 2008. Recent survey counts and overall estimates are summarised in a briefing paper (09/3) for the SCOS (2009) report. The distribution pattern of harbour seals presented in the OESEA remains valid, with the most recent counts (2006-2008) indicating that the vast majority of seals (82%) are still found in Scotland. There has also been no change in the minimum estimated UK population presented in the OESEA, approximately 28,000 animals. The SMRU survey counts provide minimum population estimates, as they are believed to record between 60-70% of actual numbers. SMRU are currently undertaking a telemetry study of haul out behaviour to estimate the proportion of the population hauled out during the moult surveys

Scotland

The Moray Firth is an important foraging area for both grey and harbour seals. Using habitat modelling, Bailey & Thompson (2009) found that harbour and grey seals were widely dispersed throughout the Moray Firth SAC and their distribution at a larger scale (4 × 4km grid cells) was significantly related to depth, seabed slope, distance to shore and mean sea surface salinity, with sediment type also important at the smallest scale (1 × 1km grid cells). A range of studies (Cunningham *et al*. 2009, Sharples *et al*. 2009a) have described harbour seal movements, haul out patterns and abundance in western and south east Scotland and these accord with those previously described in OESEA.

A greater understanding of seals as marine predators and predator prey interactions in coastal waters and estuaries is important when assessing the impacts of tidal and wave devices. The diet of harbour seals in the Firth of Tay estuary was dominated by sandeels in winter, and salmonids for the rest of the year: salmon comprised 64% of the diet in summer and sea trout comprised 40% of the diet in autumn (Sharples *et al*. 2009b).

England and Wales

The distribution of grey seal haul out sites in Welsh waters presented by Baines & Evans (2009) is in accordance with Hammond *et al*. (2005) which provided the basis of the information presented for this area in the OESEA. Information from telemetry studies indicates that seals may make foraging trips to very localised areas, with animals from a particular locality tending to remain in that region (Baines & Evans 2009).

Northern Ireland

Aerial surveys of seal numbers undertaken as part of the MCT project in Strangford Lough have shown no significant changes in seal use of haul out sites since the installation of SeaGen (Royal Haskoning Ltd 2010). The 2009 counts of harbour seals in Strangford Narrows were similar to those recorded in 2006, though higher numbers were recorded in 2008. This contrasts with the wider survey area (Carlingford Lough to Belfast Lough) for which an overall decline in seal numbers was observed. Smaller numbers of grey seals were recorded in Strangford Narrows compared to harbour seals.

A3a.8.2 Evolution of the Baseline and Environmental Issues

A3a.8.2.1 Evolution of the Baseline

Cetaceans

Defra (2010c) indicates that in general, cetaceans as a group are considered to be in good condition in both the northern and southern North Sea; poor condition in the Eastern Channel due to historical bycatch, and in moderate condition in the Western Channel and Celtic Sea, the Irish Sea, the Minches and western Scottish waters. Cetacean status is unknown over the Scottish continental shelf area and offshore waters north and west of Scotland.

SCANS survey data from 1994 and 2005 presented in the OESEA suggested a southerly shift in harbour porpoise distribution within the North Sea which is further supported by a monitoring study reported by Jung *et al*. (2009).

Seals

In the UK, grey seals are considerably more numerous than harbour seals. After decades of increase, total grey seal pup production appears to be levelling off and is now increasing at only a small number of colonies. Longer term pup production averages suggest that the growth of pup production in the Inner and Outer Hebrides has effectively stopped while in Orkney it has levelled off (SCOS 2009). Even if this trend in pup production continues, the UK grey seal population as a whole is likely to continue to increase for some years because there is a time lag between changes in pup production and subsequent changes in population size.

Counts of the harbour seal population along the east coast of England and in the Wash have failed to demonstrate any recovery since the phocine distemper virus (PDV) epidemic. These declines are in contrast to the adjacent European colonies which have experienced rapid growth since 2002. Major declines have now been documented in harbour seal populations around Scotland with reductions of up to 50% since 2000 in Orkney, Shetland, the Moray Firth and the Firth of Tay (SCOS 2009). There has been a smaller decline in the Outer Hebrides but numbers on the west coast of Scotland have remained relatively stable. The causes of these declines are still not known and further studies are needed.

A3a.8.2.2 Environmental Issues

Environmental issues relating to cetaceans and seals have been presented in detail in the OESEA and other SEA supporting technical reports and remain largely unchanged. A summary of new information relating to these issues is presented below.

Cetaceans

Defra (2010c) summarises relevant threats and pressures to cetaceans (Table A3a.8.1).

Table A3a.8.1 – Summary of relevant threats and pressures to cetaceans

Regional Sea	Summary of relevant threats and pressures	Overall status	Confidence
1	Areas of the northern North Sea provide the focus for much of the oil and gas industry operations. Additionally, the renewable industry is expanding. As a result it is likely that there has been an increase in noise disturbance which may affect cetaceans.	Good	Moderate
2	Oil and gas industry operations occur in the southern North Sea. Additionally, the renewable industry is expanding. As a result it is likely that there has been an increase in noise disturbance which may affect cetaceans.	Good	Moderate
3	There are relatively few cetaceans in the eastern English Channel. This area has one of the highest densities of shipping in the world and its margins have a high density of fixed net fishing. There is some evidence that it was once more important for harbour porpoises and that fixed net fishing in the area may have lead to their decline.	Poor	Low

Regional Sea	Summary of relevant threats and pressures	Overall status	Confidence
4	The bycatch of short-beaked common dolphins and harbour porpoises is probably the main anthropogenic impact on cetaceans in the Celtic Sea area. Approximately 65% of common dolphin strandings for which a post mortem is undertaken have been identified as bycatch. However, the most recent international assessment of this bycatch indicated that it was, nevertheless, likely to be sustainable in population terms (ICES 2008).	Moderate	Low
6	The renewable industry is expanding in the Irish Sea and is likely to increase noise disturbance. There has been an increase in whale and dolphin watching operations in the Cardigan Bay area (Wales). Associated with this there is the possibility of an increased risk of noise disturbance and also collision with vessels.	Moderate	Low
7	The waters around the Hebrides, in particular the Minches, are important for minke whales and also have a high incidence of entanglement in ropes and nets. Concern regarding this led to the Scottish Government funding research to examine the issue with findings presented in an SMRU report (Northridge *et al*. 2010).	Moderate	Low
8	In recent years, oil and gas exploration has expanded in the Atlantic Frontier. As a result of these activities, it is likely that there has been an increase in noise disturbance.	Unknown	

Source: Defra (2010c)

Underwater noise

Previous SEAs have examined the potential sources of underwater noise and the associated impacts. Thompson *et al*. (2010) has developed procedures for measuring ambient and seismic noise levels. A prototype device has been tested for measuring higher frequency components of seismic noise and results indicate that this device will be suitable for undertaking the noise recording work should a seismic survey go ahead. Identifying the impacts of noise from renewable energy sources and associated activities, and the levels of sound which may induce them has been the subject of research by Tougaard *et al.* (2009a, 2009b) and Kastelein *et al*. (2010). Information on the characteristics of underwater noises and their potential effects on marine mammals are provided in Section 5.3 of the Environmental Report.

Bycatch

Bycatch and entanglement in fishing gear (including discarded gear) are the main anthropogenic causes of cetacean death in UK waters (Defra 2010c). The issue is of greatest concern in the western channel, Celtic Sea, Irish Sea, the Minches and western Scotland. The OESEA report described this issue and there is ongoing research funded by Defra and carried out by the Sea Mammal Research Unit to monitor bycatch in the limited UK bass pair-trawl fishery outside of 12nm. The Scottish Government has funded research to investigate the entanglement of minke whales in Scottish waters. Approximately 11 or 12 baleen whales strand every year in Scotland and about half of them appear to have died due to entanglement (Northridge *et al.* 2010).

Strandings

In 2008, 583 cetaceans were reported to the UK Cetacean Strandings Investigation. The most common stranded species was the harbour porpoise and the short-beaked common dolphin which is consistent with previous years. There have been two unprecedented mass stranding events, both of which occurred in 2008. The first event involved the stranding of 56 deep-diving whales (18 Cuvier's beaked whales, 4 Sowerby's beaked whales, 5 unidentified beaked whales and 29 long-finned pilot whales) along the UK and Irish coast between January and April 2008. The cause of the event was not established, predominantly due to the degree of carcass decomposition (Dolman *et al.* 2010). The second event involved the stranding of common dolphins, first discovered in the Fal estuary, Cornwall in June 2008. Defra funded an investigation to determine the cause of the event but despite post mortems on all the individuals, no obvious cause of death could be established (Jepson & Deaville 2009, Deaville *et al*. 2009).

Climate change

Simmonds & Eliott (2009) provide an up-to-date synthesis of new information relating to concerns and recent developments associated with cetaceans and climate change.

The North East Cetacean Project was established at the beginning of 2010 to study white-beaked dolphin abundance in the Farne Deeps off the Northumberland coast. This species is vulnerable to the effects of global warming as it lives in the cold waters of the northern Atlantic and its available habitat is thought to be shrinking

Other issues

The installation of wave and tidal energy devices creates a potential collision risk for cetaceans with Marubini *et al*. (2009) describing harbour porpoise preference for high tidal stream areas in the Greater Minch area. The Scottish Association for Marine Science (SAMS) is looking at the risk of collision of harbour porpoises with tidal stream renewable devices in the Sound of Islay and surrounding waters, with a report of the project findings is expected soon.

A study of the spatial distribution of cetacean species from a variety of sources was conducted by the Whale and Dolphin Conservation Society (WDCS) in order to identify critical habitats for consideration in the designation of Marine Protected Areas. They suggested that the waters of the Hebrides, the coast of northeast Scotland, southwest England and Cardigan Bay were all areas of critical habitat for species including harbour porpoise, bottlenose dolphins, white-beaked dolphins, Risso's dolphins, minke whales and common dolphins (Clark *et al*. 2010).

Seals

Defra (2010c) presents the key pressures that are thought to impact on grey and harbour seals, these are summarised below.

Climate change

The effect of climate change on seals is difficult to determine and will depend on the nature of the change. The primary impact is thought to be a change in sea temperature which may change the distribution and abundance of main prey species and thus have an impact on seal populations and their distribution. A rise in sea levels may also impact seals by removing certain haul out and breeding locations, however it is likely that other sites may be made available.

Contamination

Contamination of seals by hazardous substances can include hydrocarbon spills, the threat of disease from pathogens introduced from sewage and the accumulation of pollutants such as heavy metals. These pressures have been described previously in OESEA.

Habitat damage

Fishing practices such as trawling and scallop dredging around the UK coast result in damage to the sea bed which in turn reduces habitat and therefore the availability of various prey species.

Energy production

Turbines are located in strong tidal current areas, which are also where seal foraging activities occur. The impact of tidal turbines is not known at present but the risk of collision is thought to be greatest in the northern North Sea, Irish Sea, the Minches and west Scotland where tidal energy devices are likely to be concentrated.

Disturbance

A number of pressures are associated with human disturbance, these include removal of target and non-target species by fisheries, bycatch, legitimate and illegitimate killing and disturbance at haulout and/or breeding sites.

Defra (2010c) suggests there is little information to inform on the impact of these pressures and the extent and magnitude of most impacts has not been quantified. Pressures such as climate change, contamination by hazardous substances and marine litter are presented as impacting seals across all regional sea areas.

APPENDIX 3B – GEOLOGY, SUBSTRATES AND COASTAL GEOMORPHOLOGY

The following sections provide an update to information presented in Appendix 3b of the OESEA Environmental Report (DECC 2009b).

A3b.1 UPDATE TO BASELINE INFORMATION

A3b.1.1 Relevant Initiatives

Since the OESEA, there have been a number of updates/revisions to initiatives of relevance to geology, substrates and coastal geomorphology. A full list of relevant initiatives is presented below, with those which are new, updated, or now of relevance due to the new elements of the plan, distinguished below those previously considered in OESEA. Note that only those new items are discussed below. A full narrative relating to these initiatives is given in Appendix 4.

Level	Geology, Substrates & Coastal Processes	OESEA / OESEA2
International	The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (the London Convention) and 1996 Protocol Thereto (amendment on the storage of CO2 in geological formations came into force 10 February 2007).	OESEA2
Regional	OSPAR Recommendation 2003/3 on a Network of Marine Protected Areas OSPAR Agreement 2005-6 on the Agreement on Background Concentrations for Contaminants in Seawater, Biota and Sediment OSPAR Recommendation 2006/5 on a management regime for offshore cuttings piles	OESEA
Regional	OSPAR Decision 2007/2 on the Storage of Carbon Dioxide Streams in Geological Formations	OESEA2
EU	Directive 2007/60/EC on the assessment and management of flood risks (2007) EC Habitats Directive 92/43/EEC (1992) Water Framework Directive (2000/60/EC) Marine Strategy Framework Directive 2008/56/EC Communication from the Commission Report to the European Parliament and the Council: An evaluation of Integrated Coastal Zone Management (ICZM) in Europe 2007. COM(2007)308 final	OESEA
EU	Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide	OESEA2
UK	Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended) The Wildlife and Countryside Act 1981 Geological Conservation Review (GCR)	OESEA
UK	The Conservation of Habitats and Species Regulations 2010 Flood and Water Management Act 2010 Marine and Coastal Access Act 2009 Marine Conservation Zones (and equivalent designations under the devolved administrations) Defra's Consultation on Coastal Change Policy (2009) Making Space for Water: National Coastal Erosion Risk Mapping Project (ongoing) The Framework for the Development of Clean Coal (FDCC) The Government Response to the Consultation on the Proposed Offshore Carbon Dioxide Storage Licensing Regime and Draft Regulations (2010) The Energy Act 2008 (Consequential Modifications) (Offshore Environmental Protection) Order 2010	OESEA2

Local

Cleaner Coasts Healthier Seas, Working for a better marine environment, Our strategy for 2005-2011 (Environment Agency)
Local Coastal Partnerships and the Scottish Coastal Forum
A Follow up to Seas the Opportunity: A Strategy for the Long Term Sustainability of Scotland's Coasts and Seas 2007
Marine Strategy for Scotland's Coast and Marine Environment
Making the Most of Wales' Coast. The Integrated Coastal Zone Management Strategy for Wales
Earth Science Conservation Review (Northern Ireland)
An Integrated Coastal Zone Management Strategy for Northern Ireland 2006-2026
Planning Policy Statement 9: Biodiversity and Geological Conservation (England)
Minerals Policy Statement 1: Planning and Minerals (England)
Marine Mineral Guidance Note 1: Guidance on the Extraction of Sand, Gravel and Other Minerals from the English Seabed
Technical Advice Note 14: Coastal Planning (Wales)
Technical Advice Note 15: Development and Flood Risk (Wales)
Interim Marine Aggregates Dredging Policy (Wales)
Planning Policy Statement 15: Planning and Flood Risk (Northern Ireland)

Environment Agency Shoreline Management Plans - currently under review (SMP2) (England and Wales)
A Strategy for Promoting an Integrated Approach to the Management of Coastal Areas in England
Making space for water: Taking forward a new Government strategy for flood and coastal erosion risk management in England
Planning Policy Statement 5: Planning for the Historic Environment (England)
Consultation paper on a new Planning Policy Statement: Planning for a Natural and Healthy Environment - consolidates *inter alia* PPS9: Biodiversity and Geological Conservation
Planning Policy Statement 25: Development and Flood Risk and supplement Development and Coastal Change (England)
Planning Policy Guidance 20: Coastal Planning (England) - note that PPS25 supplement replaces the policy on managing the impacts of coastal erosion to development set out in PPG20, which is cancelled with the exception of paragraphs 2.9, 2.10 and 3.9. PPG20 will be cancelled following introduction of the new Planning Policy Statement: Planning for a Natural and Healthy Environment (above).
Technical Advice Note 5: Nature Conservation and Planning (Wales)
Scottish Planning Policy
CRoW Act 2000 (England and Wales)
Flood Risk Management (Scotland) Act 2009
Coast Protection Act 1949 (England and Wales)

The Marine and Coastal Access Act (MCAA) and Marine (Scotland) Act provide a means for the conservation of specific "features of geological and geomorphological interest" through the designation of Marine Conservation Zones (MCZs) and Marine Protected Areas (MPAs) respectively. It may be reasonably anticipated that a similar designation may emerge from a Northern Ireland Bill. In addition, the Marine and Coastal Access Act amends the Wildlife and Countryside Act 1981 in such a way that SSSI notifications can be made in England and Wales below the Mean Low Water Mark (MLWM) under certain statutory conditions, set out in the Act (e.g. the flora, fauna or features leading to the notification of the SSSI are also present in the subtidal area to which SSSI protection is to extend). The Act also provides powers to remove SSSI notifications where they coincide with new MCZs in England and Wales.

Geological Conservation Review (GCR) sites previously considered in Appendix 3j of OESEA are in the process of being designated as SSSIs. Many of these sites, which may be designated for earth science conservation on the basis of their geology, palaeontology, mineralogy or geomorphology, are coastal features or within close proximity to the coast and may be of both national and international importance. Attention is drawn to the guidance provided in Prosser *et al.* (2006) in relation to best practice with regard to geological conservation sites.

At the coast, natural denudation processes are leading to shoreline retreat and increased flood risk in many cases, which may be accentuated by projected climate and associated environmental change, which may includes increased storminess and sea-level rise (e.g.

Lowe *et al*. 2009). Integrated Coastal Zone Management and appropriate planning policy aims to help manage and mitigate the problems associated with *inter alia* coastal erosion and flood risk. The Flood and Water Management Act 2010 (England and Wales) and the Flood Risk Management (Scotland) Act 2009 make provisions for the creation of flood risk (and in the case of England and Wales, coastal erosion) management strategies/plans. In addition to these, planning policy for England and the devolved administrations provides policy and guidance for developers and authorities on how to manage development at the coast, incorporating aspects relating to climate change (such as increased sea-levels) and the prohibition of unnecessary development in areas subject to erosion and coastal flooding. Shoreline Management Plans (SMP) (in England and Wales)already take a longer term view by identifying sustainable management approaches of relevance for up to the next 100 years. Each SMP (or revised SMP2) provides policy recommendations for coastal areas which may advise *Holding the Line* (HTL), through the maintenance of present defences or where monitoring and assessment provide evidence that new defences would be beneficial; *No Active Intervention* (NAI), where defences are not maintained and *Managed Realignment* (MR) or *Retreat* (R), where defences are removed and/or moved inland to allow for natural coastal denudation. Policies are provided in each SMP over three ‘epochs’, 2009-2025, 2025-2055 and 2055-2105.

The Water Framework Directive (WFD) seeks to achieve good ecological status for coastal and estuarine water bodies. River Basin Management Plans (RBMPs) now completed for England and the devolved administrations are one of the principal means that the WFD has been implemented in the UK and will be used in combination with other plans including SMPs to achieve a fully integrated approach to coastal management. RBMPs identify relevant morphological and hydrodynamic issues (discussed in A3b.1.2.2 below) and the measures to manage such issues. Similarly, the Marine Strategy Framework Directive (MSFD) seeks to achieve good environmental status, which incorporates geological conditions, in the marine environment. These objectives, aligned with the upcoming Marine Plans associated with the MCAA should provide a holistic consideration of the geological aspects of the marine and terrestrial environment across the intertidal and coastal areas of the UK.

The storage of carbon dioxide in geological formations is likely to take place in the UK within the next 10 years at least at a demonstrator level. Suitable formations may consist of saline aquifers, halite deposits or depleted hydrocarbon reservoirs (see A3b.1.1.2 below). The UK Government will partly fund by incentive (e.g. through the electricity supply levy, see: Energy Act 2010) 4 CCS demonstrator projects by 2020, and it is expected that after that date the technology will be economically and technologically feasible. In preparation for this, all new fossil fuel power stations must be designed so as to be Carbon Capture Ready (initially for ~25% of their capacity or 400MW), and all coal plants must be retrofitted within five years of CCS being proven. CCS demonstrator projects are likely to be located in areas of high CO_2 emissions (e.g. Thames Estuary, Humberside, Merseyside, the Firth of Forth, Teesside and Tyneside), and the UK Government plans to promote their co-location.

Internationally, the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (the London Convention) and 1996 protocol provide environmental law for the permanent storage of carbon dioxide in geological formations. The amendments to the 1996 protocol, which entered into force on 10 February 2007, state that, “carbon dioxide streams may only be considered for dumping, if: disposal is into a sub-seabed geological formation; they consist overwhelmingly of carbon dioxide (they may contain incidental associated substances derived from the source material and the capture and sequestration processes used); and no wastes or other matter are added for the purpose of disposing of them.” OSPAR Decision 2007/02 on the Storage of Carbon Dioxide Streams in Geological Formations, states that all contracting parties should not allow storage of carbon dioxide in geological formations without authorisation or regulation from their competent authorities. The decision also indicates what any permit or approval should, at least, contain. Directive 2009/31/EC establishes a European level legal framework for the environmentally safe storage of carbon dioxide by member states in their EEZ and Continental Shelf. The basis for this Directive is that CCS can provide a bridging technology whereby carbon emissions can be attenuated while renewable technologies and associated technologies provide a more sustainable energy source. The Directive also sets out a number of requirements of member states in the selection of geological stores and a permitting and monitoring regime. At the UK level, the Energy Act 2008 provides a legislative basis permitting carbon storage on the UKCS, implemented by the Secretary of State for Energy and Climate Change, or Scottish Ministers in their Territorial Waters. In August 2010 the UK Government set out a response to the proposed licensing regime for offshore carbon dioxide storage forming part of the transposition of EU Directive 2009/31/EC (see above). Regulations implementing this decision are due to come into effect in October 2010.

A3b.1.1 Changes in UK Context

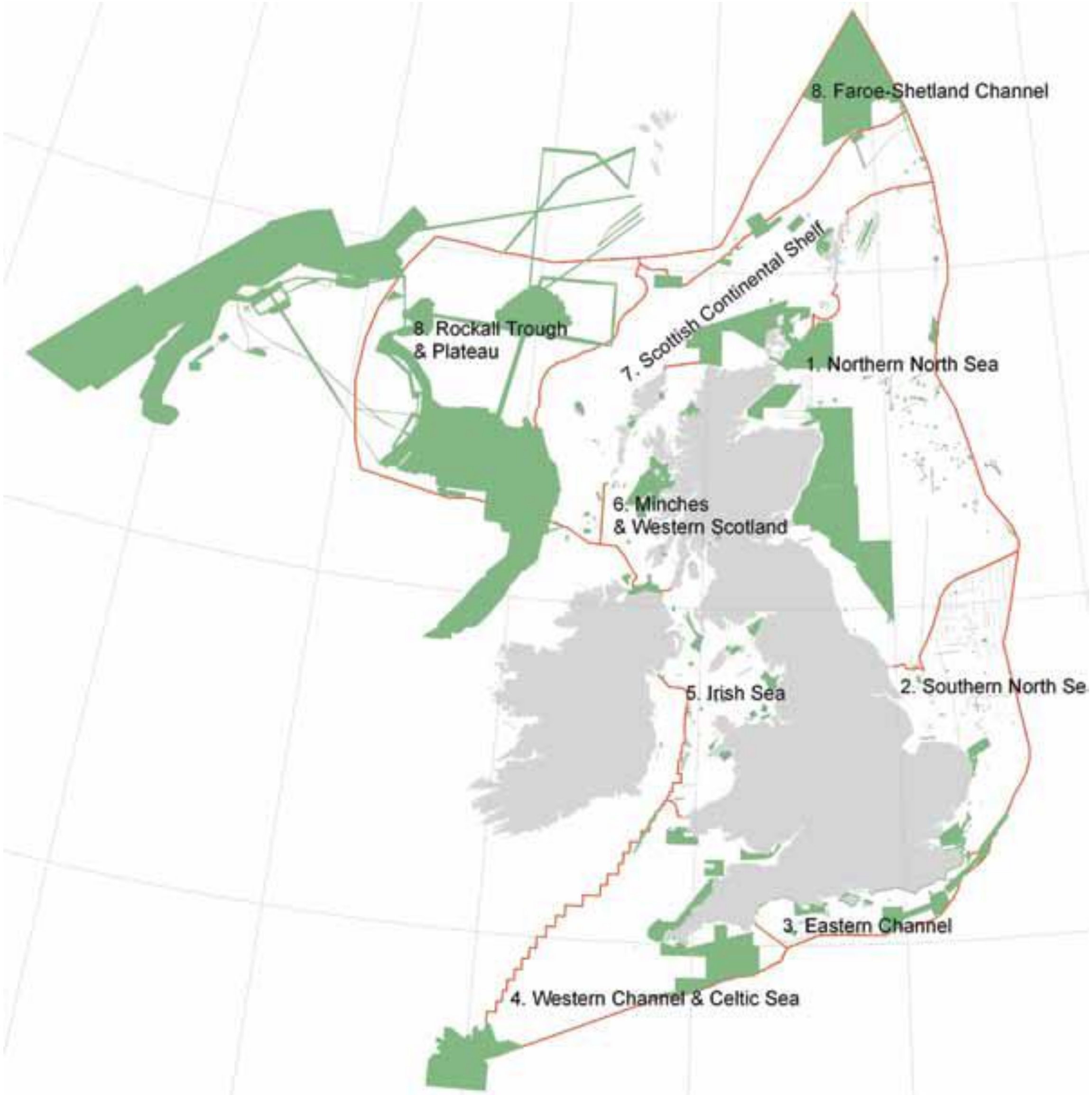
The broadscale characterisation of the UKCS geology, substrates and coastal geomorphology presented in the OESEA remains unchanged. The BGS sediment map, a subset of which was presented in OESEA, is highlighted in Charting Progress 2 as being of insufficient detail to define the UK's marine resources and habitats, evidenced by the level of detail provided by new multibeam, Olex data and digital single-beam bathymetry studies which presently only cover a limited extend of the UKCS (Figure A3b.1, Defra 2010b). BGS are presently working on a revised seabed map for the UKCS, though coverage is limited at present, and bathymetry studies such as the UK Civil Hydrography Programme continue to add to the increasing multibeam dataset for the UKCS. Commercial programmes also collect data which may be of wider use, but the lack of coordination in efforts in this area means that separate studies are not contributing to a single national dataset.

A number of new aspects of the geology and coastal geomorphology of the UK are presented here which provide baseline information relevant to the additional areas of the draft plan/programme in OESEA2, namely tidal range, CCS and gas storage.

A3b.1.1.1 Estuarine environments

The following text describes the geomorphological type and distribution of estuaries in England and Wales (i.e. the area of the plan/programme applicable to tidal range energy) and highlights their present morphological condition as evaluated by the Environment Agency under the Water Framework Directive. Since 1998 the joint Defra/Environment Agency Estuaries Research Programme has facilitated study in UK estuary morphology and process, including the modelling and simulation of estuarine processes and morphological change for the purposes of estuarine management. The studies provide models suitable for use in order to determine the morphological characteristics and processes and predict change based on a number of natural and anthropogenic variables. The reports and models are largely disseminated through the Defra Research Programme webpages and the estuary-guide.net website. Some elements of this programme are still ongoing.

Figure A3b.1 – Present multibeam coverage of the UKCS



Source: Defra (2010b); Reproduced in Defra (2010b) with the permission of the British Geological Survey© NERC. All rights reserved.

The JNCC (Davidson & Buck 1997) lists 107 estuaries in the area covered by the draft plan/programme for tidal range technologies (Figure A3b.2). These estuaries have evolved as a function of antecedent geology, topography, past glacial processes, sea-level change and ongoing local fluvial and oceanographic processes. The estuaries of the UK range from meso- (<4m) to macro-tidal (>4m) (see Appendix A3d), and those in the territorial waters of England and Wales fall into eight broad geomorphological categories described in Table A3b.1 (after Davidson & Buck 1997, Masselink & Hughes 2003 and Woodroffe 2003).

Figure A3b.2 – Principal etuaries in England and Wales as classified by JNCC

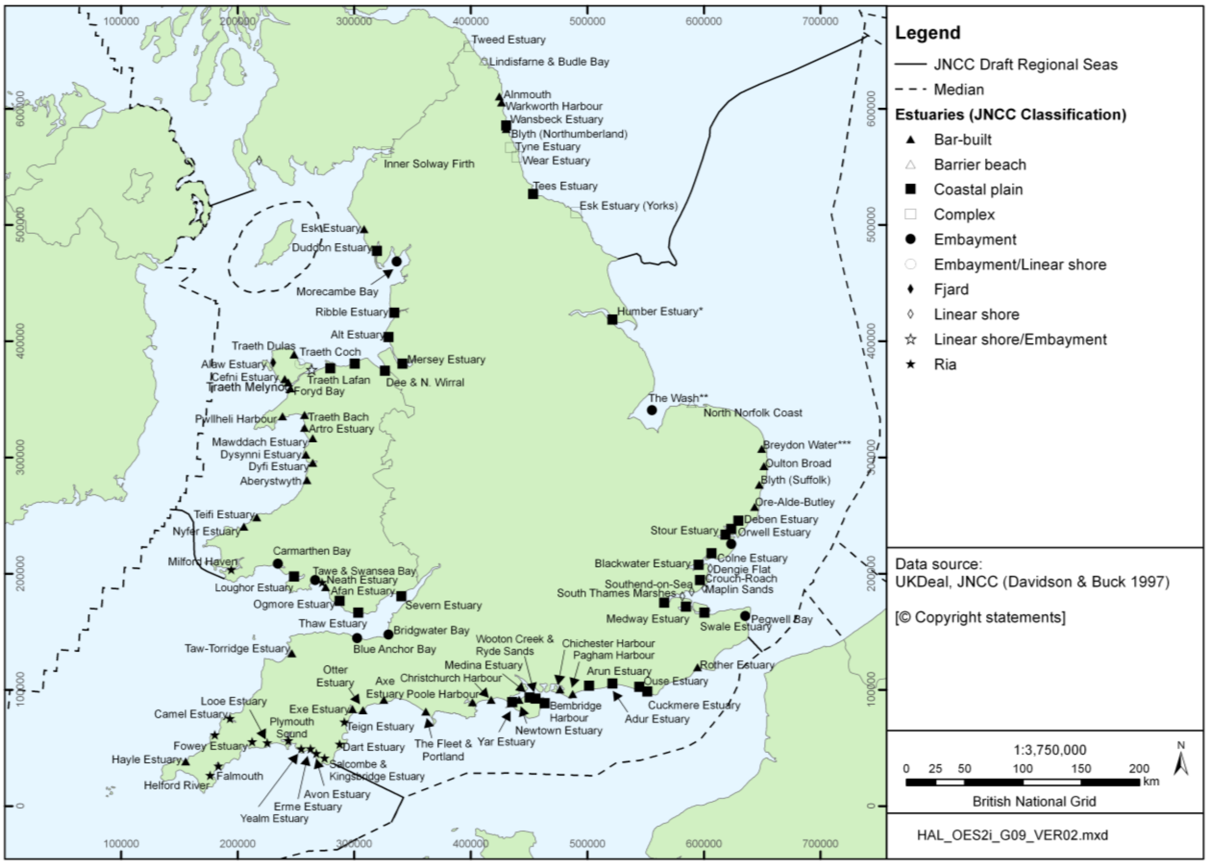


Table A3b.1 – Types of estuary in England and Wales

Estuarine type	Description and examples
Fjords and fjards	Drowned river valleys resulting from Holocene eustatic sea-level change, in some instances augmented by negative isostatic adjustment, with form largely controlled by bedrock geology. Archetypal fjords do not feature along UK coastlines with the exception of western Scotland where they are termed lochs, or sea lochs and are therefore not discussed further. Fjards are typical of formerly glaciated lowlands, although with a more open and complex morphology than fjords, are more exposed to wave action, and often have no main tidal channel (Davidson & Buck 1997). Alaw Estuary, Anglesey, is the only Fjard in England and Wales (Regional Sea 6).

Estuarine type	Description and examples
Rias	High-relief topography, largely defined by bedrock. Primarily occur in Devon and Cornwall (e.g. Teign, Dart and Tamar, Portsmouth, Langstane, Chichester – Regional Seas 3 and 4) flooded by eustatic changes in sea-level compounded by negative isostatic adjustment (see A3b.1.2 below). A few other examples are isolated to the Welsh estuaries of Milford Haven and Neath Estuary. Sediments accrete as sea-level rises, though infill has not kept pace with inundation, so rias take the form of drowned river valleys (Davidson & Buck 1997). Since the stabilisation of sea-levels ~6000 BP, there has been a general tendency towards estuarine infilling (Masselink & Hughes 2003). Many European rias (including those in Devon) contain sediment sequences reflecting Quaternary sea-level fluctuations, though the extent to which such material has been removed in lowstands will vary greatly between individual estuaries (Woodroffe 2003). Sediment accumulation rates are controlled by fluvial sediment inputs and wave-energy characteristics, and infill eventually leads to these estuaries consisting of an incised river channel.
Bar-built estuaries	Partly drowned river valleys which have sufficient sediment supply such that they are infilled and have a bar or spit across their entrance (Davidson & Buck 1997). The barrier is a wave-induced depositional bar generated from the landward movement of sediment from the shelf or from longshore transport of material. As the bar progrades, the estuary may become enclosed most or all of the time, forming coastal lagoons which decrease in area and depth due to infill from both seaward and fluvial sources of sediment (Woodroffe 2003). The relative balance of wave, fluvial and tidal influences, and the geology and topography, control the morphology and evolution of such estuarine environments. Such estuaries are variously distributed throughout the UK, occurring in all Regional Seas in England and Wales (e.g. Alnmouth, Deben, Newtown, Taw Torridge, Dyfi).
Barrier beaches	Open coast systems with abundant sediments present in the coastal system. Soft shores develop in shallow water where bars form due to the dissipation of wave and current energy offshore (Davidson & Buck 1997). Such systems are isolated to the North Norfolk coast and Lindisfarne (Regional Sea 1).
Complex estuaries	Some estuaries do not easily conform to any form of strict characterisation, being formed through a combination of glacial and fluvial action, sea-level change and geological influence (Davison & Buck 1997). Outside of Scotland such estuaries tend to be narrow and incised into relatively hard geology. In England such estuaries are largely isolated to the North East (Regional Sea 1).
Linear shore	Linear shore estuarine types form in low energy environments where broad areas of soft sediments have been deposited in shallow seas. There is little indentation at the coast and most form part of wider estuaries such as the Thames (Davidson & Buck 1997), for instance the South Thames Marshes, Southend-on-Sea and Maplin Sands (Regional Sea 2).
Embayments	Form between rocky headlands where soft sediments accumulate, often having one or more rivers discharging into them (Davidson & Buck 1997). These components often exhibit characteristics of coastal plain estuaries. Such estuaries are limited in extent in the UK, the largest being the Wash (Regional Sea 2).
Coastal plain estuaries	Formed by the flooding of pre-existing valleys during the Holocene transgression, depths of these inlets tend to be less than 30m often with a sinuous central channel (Davidson & Buck 1997). The cross-section of these estuaries tends to be aligned more with unglaciated terrestrial valleys rather than that observed in over-deepened or widened relict valley channels found in Rias or Fjord systems. Unlike these systems, coastal plain estuaries have extensive mudflat, sandflat and saltmarsh deposits. River flow in these estuaries tends to be low and therefore the water has a high salinity.

A3b.1.1.2 Geological formations or deposits suitable for gas storage/CCS

An increase in the capacity of gas storage in the UK has been highlighted by Wicks (2009) as necessary to provide secure supplies of natural gas to the UK throughout the year, an assertion also made in the DECC Low Carbon Transition Plan. Additionally, the Framework for the Development of Clean Coal (see above) makes provisions for the creation of 4 CCS demonstrator projects to 2020. In the longer term, other industrial processes responsible for substantial emissions of CO_2 (e.g. iron and steel, cement) may also adopt CCS technologies. Capacity for the storage of gas and CO_2 may be found in a number of offshore geological formations which are discussed below.

Hydrocarbon reservoirs

Hydrocarbon reservoirs have geological characteristics advantageous to trapping gas (albeit natural gas or CO_2) over long timescales (e.g. a suitable porosity/permeability and cap rock). The mature stage of hydrocarbon exploration and production on the UKCS means that the location and size of these reservoirs is relatively well known, having a primarily eastern distribution extending from the Faroe-Shetland Channel and northern North Sea to the southern North Sea, with some in the east Irish Sea Basin. A review of storage potential for CCS in DECC (2010i) concluded that storage in depleted gas fields in the southern North Sea (Regional Sea 2) provides the greatest prospects having suitable capacity and presenting relatively low risks (e.g. risks associated with site integrity (geological and well), regulatory risks and investment risks). Storage in the central and northern North Seas would primarily be in depleted oil reservoirs and therefore presents opportunities for Enhanced Oil Recovery (EOR) which could prove to be economically viable depending on the scale of any modification to infrastructure required (Holloway *et al.* 2006). Holloway *et al.* (2006) estimated the combined realistic[3] storage capacity of oil and gas fields on the UKCS to be ~7.5Gt, mainly from storage in gas (southern North Sea and east Irish Sea Basin) rather than oil fields.

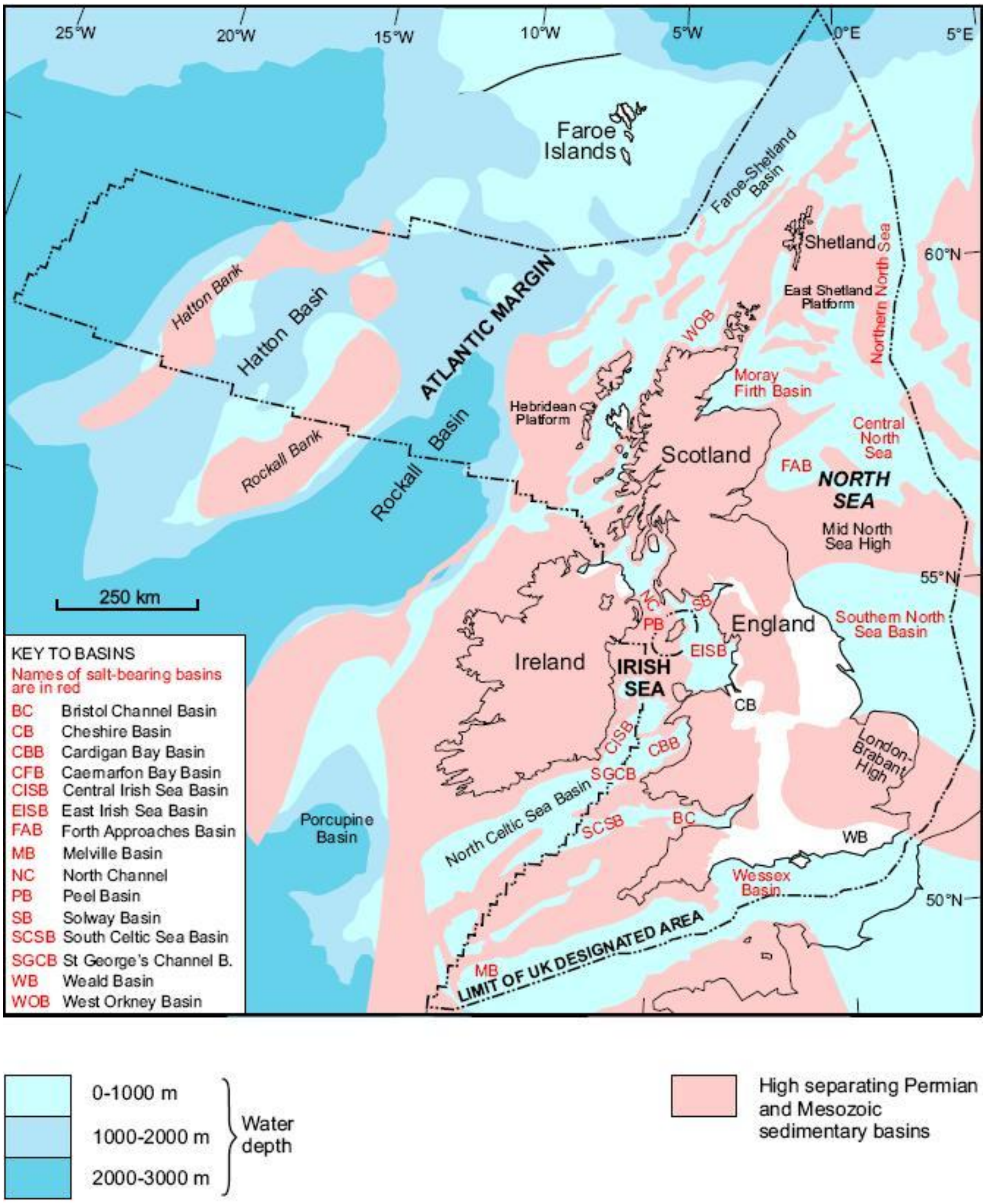
Halite deposits

Smith *et al.* (2005) studied the distribution (Figure A3b.3) and morphology of halite deposits in the UKCS that might be used as a storage medium for gas through the construction of salt caverns (i.e. the solution and discharge of salt to allow space for gas storage). Criteria used to isolate the most prospective areas, which also included economic considerations, were:

- A formation thickness of ~1000ft.
- Burial depth of not more than ~3000ft to avoid salt creep (plastic movement when the salt is under stress), or less than 1000ft to avoid gas outbursts.
- Water depths of 15-40m.
- Dykes, faults and areas potentially prospective for oil and gas (e.g. discovery wells) should be avoided.
- Proximity to abandoned offshore facilities if they are to be used, and the distance from the coast.

[3] *Realistic*: applies geological and engineering cut-offs to basin data to produce pragmatic storage capacity estimates (after Bradshaw *et al.* 2006).

Figure A3b.3 –Salt bearing basins on the UKCS



Source: Smith et al. (2005)

The most favourable location was found to be the Triassic Preesall Halite Formation in the southern east Irish Sea Basin (Regional Sea 6), having a thickness of 300-1800ft and a depth of burial of 1,000-1,500ft (Smith *et al.* 2005). A number of other locations were considered to have good potential, but may have units that are too small or have insufficient data on which to make an assessment. These other locations include the Triassic Mercia Mudstone Group with deposits in the Solway Firth and St. George's Channel highlighted, undifferentiated deposits of the central Irish Sea, the Late Permian Z2 (Stassfurt) formation of the southern North Sea and the Zechstein Group of the Forth Approaches Basin (Smith *et al.* 2005).

Most other deposits in the UKCS are too thin or buried at too great a depth to be viable, though some salt diapers that rise to shallow depths may be prospective in the central (Regional Seas 1 and 2) and southern North Seas (Regional Sea 2).

Saline aquifers

Saline aquifers could provide commercial scale storage of CO_2 in the UK having been technologically proven at a number of sites internationally (see Michael *et al.* 2010), however estimates of the storage capacity of suitable formations on the UKCS are not well developed and vary widely depending on assumptions about the storage efficiency of deposits (Element Energy 2010).

The Lower Triassic Bunter Formation is located in the southern North Sea Basin (Regional Sea 2) and is the most prospective deposit in this area for storage in saline aquifers. The formation consists of fine to locally medium or coarse sandstone and generally thickens in a south and easterly direction, reaching a maximum thickness of 350m (Cameron *et al.* 1992). A study of part of this formation was made by Smith *et al.* (2010) and the area is presumed to be isolated from the wider southern North Sea Basin by various permeability barriers. A storage capacity for the area of between 2,200 and 4,900 Mt CO_2 was calculated depending on assumptions about aquifer boundary conditions (i.e. controls on the extent to which fluids and pressure may be transferred between adjacent formations). Holloway *et al.* (2006) placed the realistic capacity of the Bunter Formation at up to 14.25Gt, though raised some uncertainty over the integrity of parts of the formation. Though not well defined, Holloway *et al.* (2006) tentatively put a further figure of 3Gt on the early Cenozoic sandstones of the central and northern North Sea, which with further research may prove to be productive formations for CO_2 storage.

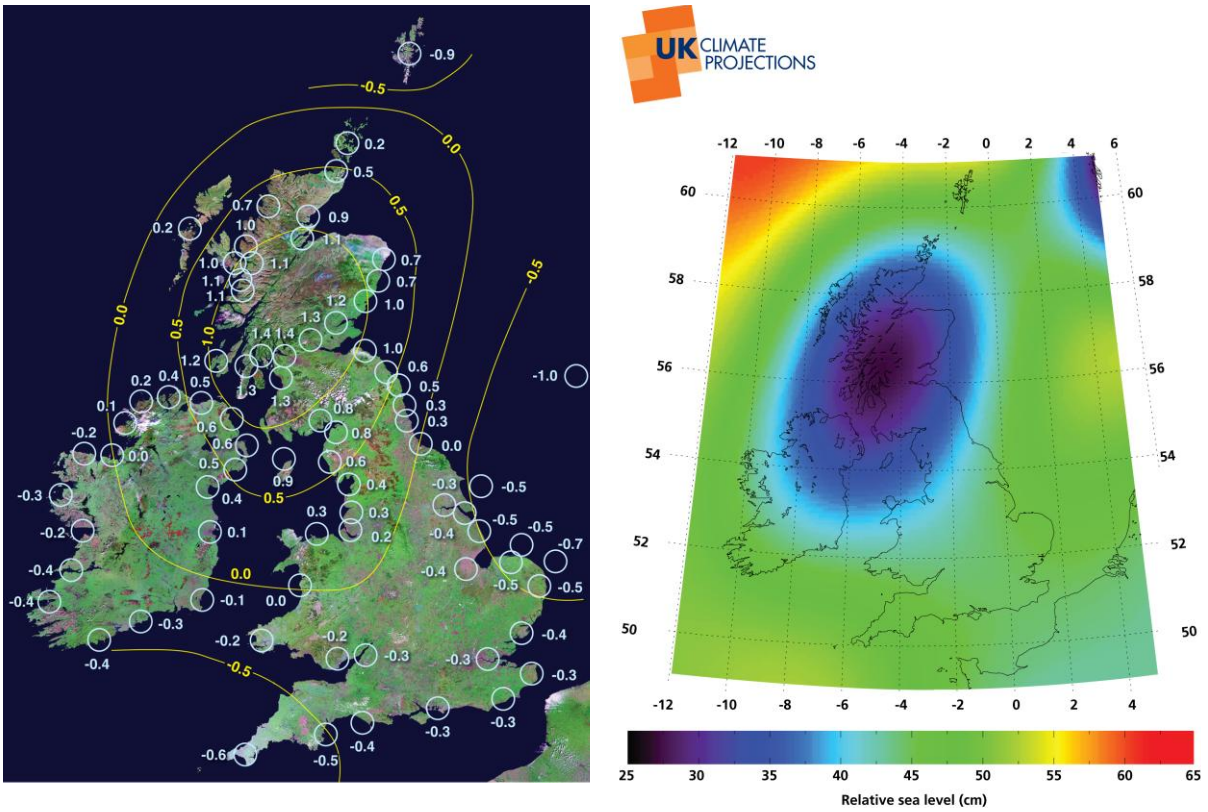
A3b.1.2 Evolution of the Baseline and Environmental Issues

A3b.1.2.1 Sea-level change

Holocene sea-level change was discussed previously in the OESEA. Since its publication, several updates of both Holocene sea-level change and projections for future movement based on a number of modelled climate projections have been made. Shennan *et al.* (2009) update some of the previous work in Shennan & Horton (2002) on the relative sea-level change across the UK, considering both eustatic changes (i.e. that associated with changes in ocean water volume due to melting ice sheets), and isostatic changes (i.e. land uplift or subsidence due to glacial unloading). The broadscale character of change remains the same – generally positive adjustment over much of the Highlands, central and western Scotland, and negative adjustment in south west England, the southern North Sea coast and Shetland (Figure A3b.4), though the 2002 model showed greater uplift in Scotland, and greater relative subsidence in southwest England.

Anthropogenically augmented climate change has been linked to a global eustatic change in sea-levels in the order of 3.1mm yr^{-1} between 1993 and 2003 (IPCC 2007), primarily through freshwater input from the reduction in the size of valley glaciers and ice caps, and the thermal expansion of the ocean associated with increased global temperatures. Sea-level is predicted to increase (in absolute terms) by 12-76cm over the next 100 years (Lowe *et al.* 2009), outpacing even the highest positive isostatic uplift figures for the UK. The resulting relative sea-level rise (Figure A3b.4; e.g. 21-68cm for London and 7-54cm for Edinburgh) will lead to a greater risk of coastal flooding and erosion, which may be exacerbated by an increased frequency and severity of storms. Lowe *et al.* (2009) discuss the possible range of climate-driven changes in surge levels that may occur around the UK. The significance of these is considered small though is more significant when combined with predictions for relative sea-level rise indicated above.

Figure A3b.4 – Isostatic adjustment (mm/yr) and relative sea-level rise (cm) for 2095



Source: Shennan et al. (2009), UKCP09, after Bradley et al. (2009)
Note: Relative sea-level rise based on a central estimate of the medium emissions scenario (see Appendix 3f for details).

A3b.1.2.2 Coasts and estuaries

Coastal change was broadly covered in relevant sections of the OESEA, though some additional information is presented below. Coastal erosion is a widespread though spatially local phenomenon, and any general prediction of UK coastal response to variables such as relative sea-level rise or wave conditions (i.e. those associated with climate change), are likely to be of low confidence (Masselink & Russell 2010). A general estimate is that 17% of UK coasts are eroding (Defra 2010b). The coasts of England (30%), Wales (23%) and Northern Ireland (20%) are worst affected, with just 12% of Scotland's coast considered to be retreating. In addition, intertidal steepening, or coastal squeeze, has been linked to recent sea-level rise and restrictions placed on coastline migration by engineered structures, many of which were erected to prevent further coastline retreat, or for the purposes of land reclamation. Structures in their various forms are present along 44% of England's coastline and just 6% of those in Scotland. Though controversial, in many instances managed realignment is recommended as the course of action for some eroding coasts, particularly where this is both economically and environmentally justified, and where erosion may actually lead to improved defence against coastal flooding (Dawson *et al.* 2009, in Masselink & Russell 2010). Erosion may be undesirable due to the loss of land and associated property or infrastructure, but in some cases can be essential in providing sediment to the nearshore area which may be redistributed in the longshore direction. Many coastal features are dependent upon such a process (e.g. Spurn Point is dependent upon sediment supply from the rapidly eroding Holderness coast).

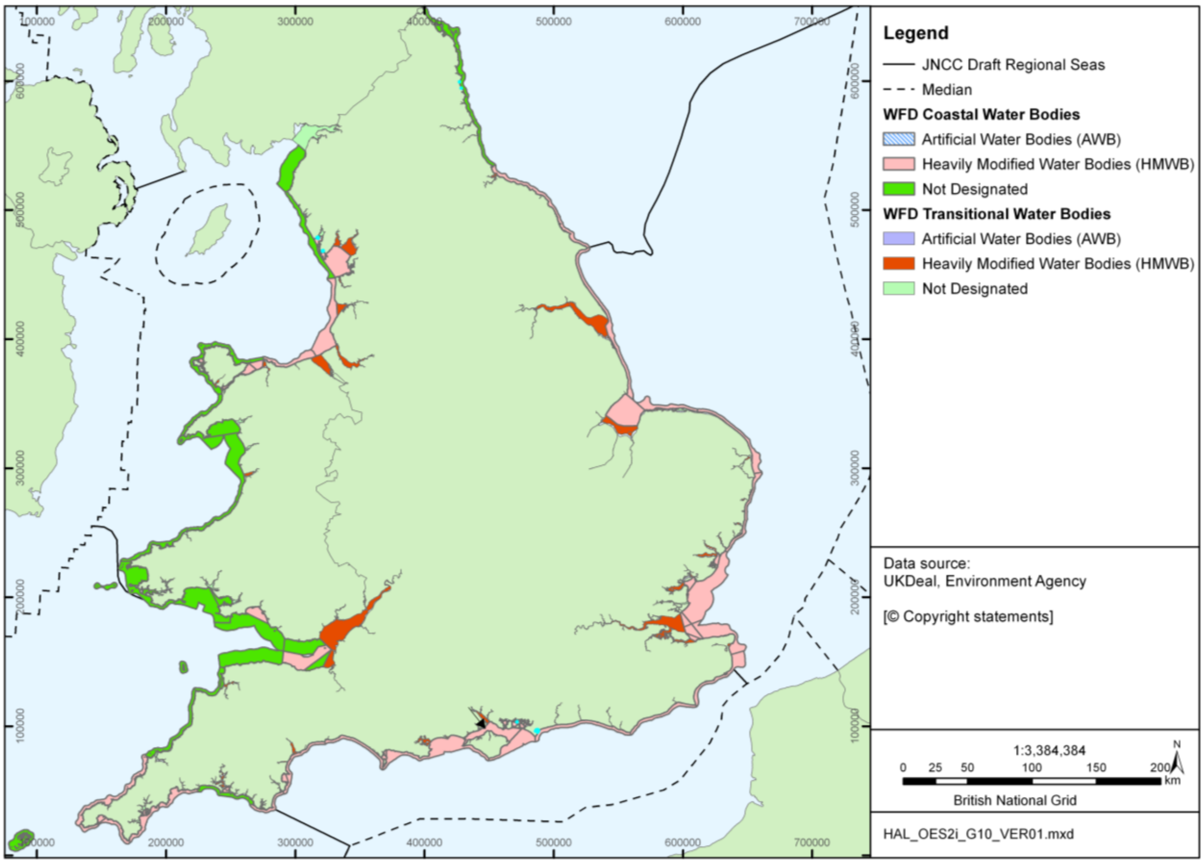
Shoreline Management Plans (SMPs) include policy recommendations for a number of local coastal sub-cells based on a consideration of local geomorphological issues and anthropogenic use of the coast considered over the timescale of the next ~100 years. Though a high level of confidence in the recent MCCIP report card (Masselink & Russell 2010) is attached to the current knowledge with regard to coastal processes and erosion, a low level of confidence is applied to what could happen, mainly due to uncertainties about the effect of climate change, rate of sea-level rise and changes in the wave climate, and their interactions with a complex coastal system. Many of the coastal and estuarine environments around the UK are defined as heavily modified due to the incidence of land reclamation, coastal and flooding defences, aggregate extraction, use for marine fisheries, and navigation and port activity (see Appendix 3h for details relating to many of these activities). Work is underway in order to try and achieve "good ecological potential" (GEP) in such areas – i.e. encouraging those elements of the natural environment in these areas recognising the physical changes and restrictions applied through the current conditions of use (e.g. navigation). In order to achieve GEP, mitigation measures set out for each water body by the EA need to be put in place. The WFD set the objective that modified/artificial water bodies should aim to achieve GES by 2015.

Coastal and transitional (estuarine) water bodies are classified as artificial if they constitute 'a surface water body which has been created in a location where no water body existed before and which has not been created by the direct physical alteration or movement or realignment of an existing water body' (Paragraph 3.1.2 of the WFD Common Implementation Strategy guidance). Of the 180 transitional waters and 145 coastal waters in England and Wales, 36 and 7 of these are considered to be Artificial Water Bodies (AWB) respectively (Figure A3b.5). These are generally associated with natural features and have a limited areal extent. An additional 84 transitional waters and 73 coastal waters are considered to be Heavily Modified Water Bodies (HMWB) (Figure A3b.5). This latter category of site includes those which have had their character or physical form greatly altered by anthropogenic activities, or which are designated as such under Article 4(3) of the WFD.

A3b.1.2.3 Renewable energy development

The wave and tidal screening conducted by AEA & Hartley Anderson (2010) identified and mapped a number of estuaries in which commercial interest in tidal range energy generation had been expressed in England and Wales. These estuaries have a primarily western distribution with those of greatest interest (excluding the Severn) being: the Solway Firth, Wyre Estuary, Mersey, Colwyn Bay, Swansea Bay, Bridgewater Bay and the River Thames. Potential technologies included barrages and lagoons with generation capacities ranging from 60MW (Swansea Bay) to 5,680MW (Bridgewater Bay). A feasibility study has also been carried out on the Severn Estuary for a number of different development scenarios based around either barrage or tidal lagoon technologies. Numerous wave and tidal devices have been deployed as demonstration projects consisting of a few, or more often, isolated devices (e.g. at the EMEC in waters off Orkney). Deployment of these is likely to increase as the best designs become commercially and technically viable.

Figure A3b.5 – WFD morphological status of transitional (estuarine) and coastal water bodies



Note: Correct at date of printing (October 2010). Some UK estuaries classified by the JNCC (Davidson & Buck 1997, above) form part of larger estuarine complexes, for instance Morecambe Bay contains the Wyre, Lune, Leven and Kent Estuaries. As such, a lesser number of estuaries are classified by JNCC compared to those categorised as 'transitional waters' (i.e. estuaries) under the Water Framework Directive for the UK.

A recent report (ABPMer Ltd. *et al.* 2010) details a review of sediment monitoring data from offshore wind farms either built or under construction. In most cases the main effects of construction and operation on sediments is restricted to changes in bedform associated with scour and wake patterns. These may propagate away from the immediate surrounds of the turbine foundation, controlled by the prevailing sediment type, including shallow sediment layers, and the wave energy environment. UK experience to date is restricted to relatively shallow depths and monopile style foundations (with the exception of the Beatrice demonstrator), with further research required to assess the impacts of larger turbine types and associated foundations.

A3b.2 EXISTING CONTAMINATION

A3b.2.1 Changes in UK Context

Appendix 3b Geology, substrates and coastal geomorphology of OESEA described existing contamination on the UKCS. The following provides an update of relevant information.

Charting Progress 2 provides a useful summary of existing contamination in coastal and marine waters and sediments (Defra 2010d). Key points include:

- The open seas are still little affected by pollution and levels of monitored contaminants continue to fall, albeit slowly in many cases. This reflects reductions in riverine inputs of a range of contaminants and in atmospheric deposition of some heavy metals and polycyclic aromatic hydrocarbons (PAHs) to UK seas. However, a range of persistent chemicals appear in deep-sea fish and marine mammals off UK coasts, and litter has been found at a depth of 1000m.
- Some ‘legacy’ contaminants are present at high concentrations in estuaries historically contaminated by industrial processes. For example, in the northeast of England, PAHs are present in sediments at concentrations which may be toxic to organisms living in or on the seabed, and may take many tens to hundreds of years to degrade.
- There have been no major marine oil or chemical spills in UK waters since the publication of Charting Progress in 2004. Levels of oil in produced water discharged by the offshore oil and gas industry are falling in response to regulatory controls. Doses of radioactivity received by people and wildlife continue to be well within regulatory limits.

A3b.2.1.1 Sources of contamination from the oil and gas industry

Produced Water

As indicated above, the levels of oil in produced water discharged by the UK offshore oil and gas industry have continued to fall. Table A3b.2 below presents produced water discharge data for UK offshore installations between 2006 and 2008.

Table A3b.2 - Oil discharged with produced water 2006-2008

	2006	2007	2008
Number of installations discharging oil in produced water	105	101	96
Total produced water discharged (million m^3)	219	203	198
Total dispersed oil in produced water discharged (tonnes)	4,356	2,960	3,160
Oil content (mg/l)	19.9	14.6	16
Number of installations re-injecting oil in produced water	20	23	24
Produced water re-injected (million m^3)	30.7	40.5	39.6

Source: DECC oil and gas website - Oil discharged with produced water 2005-2008

In general over the OSPAR area recent trends in produced water and chemical discharges from the oil and gas industry are as follows (OSPAR 2009a):

- The total quantity of dispersed oil (aliphatic oil) discharged to the sea (from produced water, displacement water and accidental spillage) show a decreasing trend over the last few years, but increased to 9,025 tonnes in 2007 compared to 8,756 tonnes in 2005. The main reason for this increase was a large oil spill of 3,815 tonnes offshore Norway in 2007.
- Produced water and displacement water are the main contributors to the oil discharges from offshore oil and gas activities, representing 98% of the total amount of oil discharged to the sea in 2006, but due to the large oil spill, only 57% in 2007. Flaring is a minor source of oil discharges.
- The annual average dispersed oil content in produced water was 17.8mg/l in 2006 and 12.5mg/l in 2007, well below the current performance standard for dispersed oil of 30mg/l for produced water discharged into the sea. The drop in 2007 is to some extent due to a change in method of analysis.

- The total quantity of chemicals used offshore in 2007 was nearly 900,000 tonnes. Only 2.5 weight % of the chemicals used contain either substances on the OSPAR List of Chemicals for Priority Action (LCPA) or substances which are candidates for substitution.
- The total quantity of chemicals discharged into the sea in 2007 was roughly 250,000 tonnes, almost 87% of this were chemicals on the OSPAR list of substances/preparations used and discharged offshore which are considered to pose little or no risk to the environment (PLONOR). Discharge to the sea of chemicals on the LCPA was 70kg in 2007.

Regional contamination surveys

In addition to field and well specific studies, the UK has undertaken regional surveys of contaminant and ecological status in areas of oil industry activity (see Figure A3b.6 below). A summary of the results of these surveys (BERR 2008a) was produced for the OSPAR Joint Assessment and Monitoring Group and concluded that:

- Since the cessation of Oil Based Mud (OBM) discharges, the regional trends in sediment hydrocarbon concentrations in developed areas have been significant reductions and a return to background or near background concentrations. Mean hydrocarbon concentration in the Fladen Ground had reduced to 19.3µg/g in 2001. In the East Shetland Basin, the mean oil concentration reduced from 74.4µg/g in 1994 to 26.1µg/g in 2002.
- Regional scale benthic ecological perturbation attributed to oil industry activities has not been detected. In contrast to previous studies in the Norwegian section (Olsgard & Gray 1995) - which appeared to indicate that stations 2 to 6km away from platforms showed measurable faunal effects after a period of 6 to 9 years development – available data from the Fladen Ground (2005) and East Shetland Basin (2007, analysis ongoing) showed no indications of ecological disturbance. This may be associated with the observed recovery in terms of contaminant concentrations and absence of anthropogenic changes to sediment size distribution in sediments (i.e. benthic community structure may have shown some degree of broadscale disturbance during the earlier period following development).
- Evidence from long term studies of single OBM wells indicates that a variety of degradation, redistribution and recovery processes are involved and that after 25 years recovery is almost complete at both diesel and low-toxicity OBM sites. Broadly similar processes and timescales were observed in the Fladen Ground and central North Sea (2004); in several cases a period of opportunist species colonisation is believed to have occurred as evidenced by the presence of numerous dead shells of the bivalve *Thyasira sarsi* in sediments from within 200m of the well.
- Relatively long monitoring time series (from the mid-1980s) have been established for multiwell production platforms in the east Shetland Basin and central North Sea. In several cases the data suggest little change over the period when there was active OBM drilling and appreciable declines in THC contamination (considered as peak concentration at 500m from the platform and as the spatial extent over which 50µg/g concentration is exceeded) and also in far field concentrations by 2006.
- In deep water areas to the west of the UK conditions are sufficiently energetic and dispersive that North Sea monitoring approaches and strategies are of limited applicability. A managed programme of regional survey coverage and targeted investigation of specific habitat features has been conducted over a ten-year period, using a combination of seabed mapping and imaging followed by sampling the seabed sediments using a range of equipment to suit the sediment types identified.

A preliminary fieldwork report of a central North Sea regional survey carried out in 2009 on behalf of Oil and Gas UK and the UK Government/Industry Environmental Monitoring Committee (Hartley Anderson Ltd 2009) indicated that no drill cuttings or other evidence of oil industry operations were observed in any samples. A final report is currently in preparation.

Radioactive material

Concentrations of TNORM (Technologically-enhanced naturally occurring radioactive material) are discharged into UK waters from offshore oil and gas platforms as a constituent of produced water and insoluble scale. Radionuclides found in these discharges include ^{226}Ra (radium) and ^{228}Ra, and their decay products such as ^{210}Pb (lead) and ^{210}Po (polonium).

Estimates of the total radioactivity discharged per annum into UK waters from offshore platforms vary considerably. The MARINA II project (van Weers 2003) calculated that as much as 4.6TBq of both α- and β-emitting activity was discharged during the late 1990s, while more recent assessments (DEFRA 2008), put the annual discharge at around 0.75TBq of ^{226}Ra (an α-emitter) and 0.25TBq of ^{228}Ra (a β-emitter) over the period 2004–2005, with future projections of an increase in discharges due to operational and decommissioning sources (Defra 2010d).

The OSPAR (2009e) report on discharges of radioactive substances from the non-nuclear sectors indicated that the UK offshore oil and gas industry discharged approximately 0.027TBq of ^{210}Pb, 0.24TBq of ^{226}Ra and 0.2TBq of ^{228}Ra, in produced water primarily to the Greater North Sea area in 2007. In terms of total alpha and total beta discharges this represents approximately 2TBq alpha and 1.3TBq beta discharges (OSPAR 2009b).

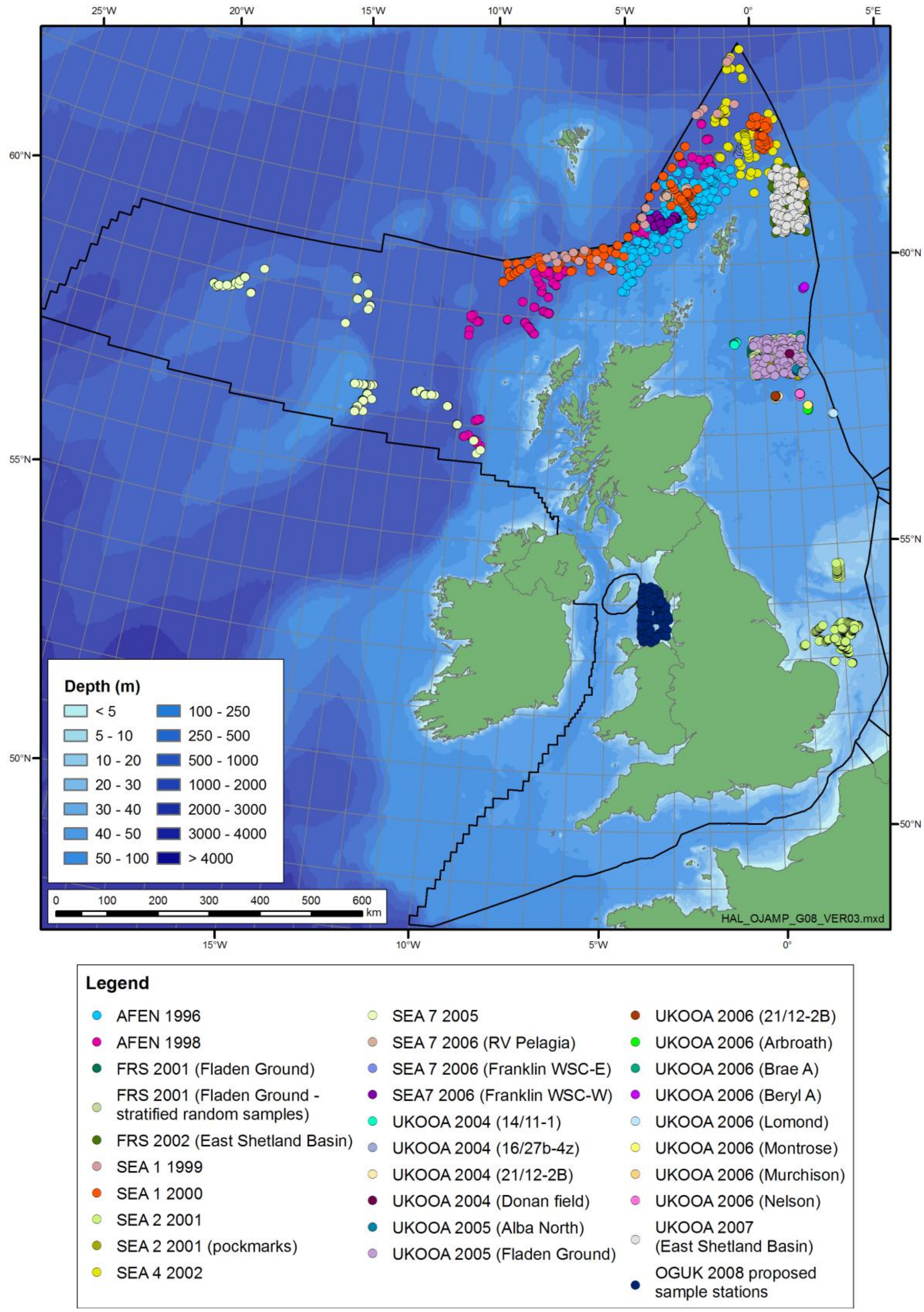
The enhancement of radium in the local zone around an oil platform has been considered as part of the MARINA II project. Sazykina & Kryshev (2003) estimated that concentrations of each of the radionuclides ^{226}Ra and ^{228}Ra, due to the discharge of produced water, would be between 0.005 and 0.01Bq/l. This compares with a typical concentration of ^{226}Ra in seawater of ~0.002Bq/l (Defra 2010d).

A3b.2.2 Evolution of the Baseline and Environmental Issues

A3b.2.2.1 Evolution of the Baseline

The aim of the Marine Strategy Framework Directive (adopted in June 2008) is to protect more effectively the marine environment across Europe. It aims to achieve good environmental status of the EU's marine waters (out to 200 nautical miles) by 2021. One of the overarching descriptors of good environmental status is that *"concentrations of contaminants are at levels not giving rise to pollution effects"*. The implementation of the Marine Strategy Framework Directive and the Water Framework Directive through River Basin Management Plans will likely reduce further existing contamination in estuarine, coastal and marine waters and sediments.

Figure A3b.6 – UK regional and other seabed monitoring stations



A3b.2.2.2 Environmental Issues

Accidental oil and chemical discharges

The latest ACOPS annual survey of reported discharges from vessels and offshore oil and gas installations operating in the UK pollution control zone (Dixon 2009) indicates a 6.5% reduction in the total number of accidental discharges attributed to offshore oil and gas installations during 2008, reversing the underlying upward trend in the annual totals recorded over the previous 4 years. The reported total of 272 accidental oil discharges from offshore oil & gas installations during 2008 was 8 fewer than the mean annual total of 280 oil discharges reported between 2000 and 2007. The total of 163 accidental discharges of chemical substances was 21 less than the total recorded during the previous year.

The overall geographical pattern for vessel-source oil discharges in the survey area during 2008 showed the highest density of reported open-sea incidents occurring in the vicinity of oil & gas installations and in the English Channel (Figure A3b.7).

Crude oils accounted for 22% of the identified types of mineral oil discharges (primarily from offshore oil and gas installations) and this figure was 5% higher than the previous year's. The largest ongoing crude release incident of 4.73 tonnes was from an offshore installation between 1 January 2008 and 4 August 2008. A leaking section of subsea water injection flowline was subsequently replaced – see Dixon (2009) for summary details of discharges of 2 tonnes or more.

The largest reported chemical incident of 120,259kg of methanol was an ongoing release from a subsea umbilical tied back to an installation from 21 June 2008 to 31 December 2008 - see Dixon (2009) for summary details of discharges of 2 tonnes or more.

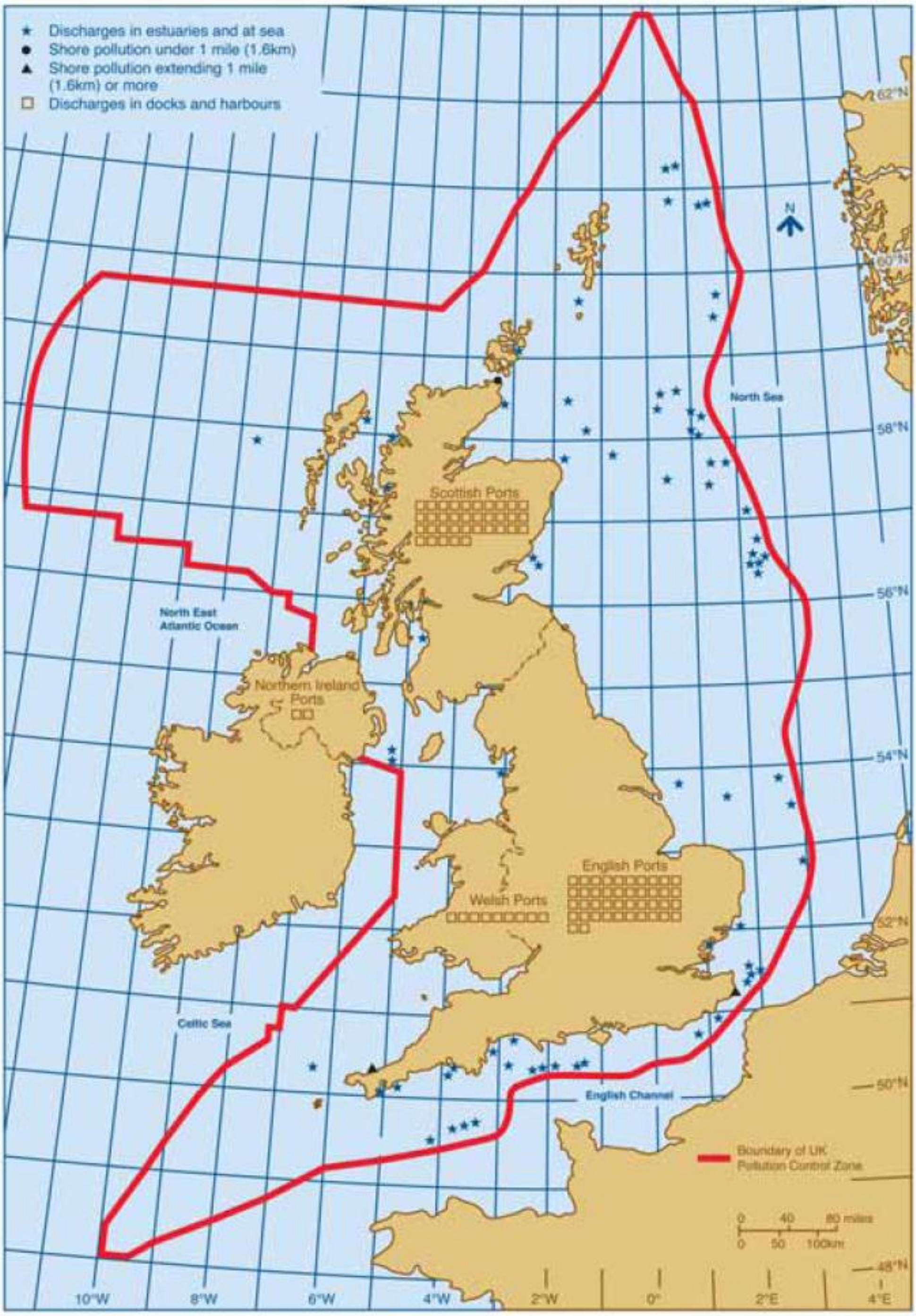
Spills of bunker, diesel, fuel and gas oils were reported in varying quantities from vessels or oil and gas installations on 175 occasions, 21 fewer than the previous year's total. The spills occurred most frequently during bunkering operations in the UKCS, south west England and eastern Scotland areas. Seventy one spills of lubrication oil or hydraulic oil were attributed to offshore oil & gas installations in 2008 (Dixon 2009).

OSPAR have developed an Ecological Quality Objective of relevance to accidental oil discharges – EcoQO: *The average proportion of oiled common guillemots in all winter months (November to April) should be 20% or less by 2020 and 10% or less by 2030 of the total found dead or dying in each of 15 areas of the North Sea over a period of at least 5 years* (OSPAR 2010b). Current oiling rates for stranded guillemots in the North Sea vary between 4% and >50% with the highest values in the southern North Sea (the Netherlands, Belgium and south east England) and the lowest oil rates in Orkney (4%) and Shetland (14%) (OSPAR 2010b).

Marine litter

The importance of tackling marine litter has been highlighted in the EU Marine Strategy Framework Directive (MSFD), which includes the quantity of marine litter as one of eleven high level descriptors of good environmental status (GES). All Member States, including the UK, must put in place a programme of measures by 2016 to ensure that "*Properties and quantities of marine litter do not cause harm to the coastal and marine environment*".

Figure A3b.7 – Locations of reported oil discharges attributed to vessels



Source: Dixon (2009)

Beach litter surveys indicate that, in general, quantities of litter on UK beaches have shown no appreciable decrease over the period 2003 to 2007. Average litter densities on UK beaches remain high, at over 2,000 litter items/km surveyed, compared to around 1,000 items/km surveyed when monitoring began in 1994 (Defra 2010d).

Throughout all regions most litter continues to come from the general public either through direct littering on beaches or through litter being swept or blown onto beaches. Fishing is consistently the second major identified source of beach litter, followed by sewage-related debris, shipping, fly tipping and medical uses. Plastic items remain the highest material source of litter in all regions with on average over 1,500 such items found per kilometre of beach surveyed.

Offshore, the spatial distribution of litter varies widely from year to year. Data indicate that there is generally a low abundance of litter on the seabed, though significantly higher densities of litter found at Carmarthen Bay, North Cardigan Bay, Celtic Deep and Rye Bay, suggest that these are areas of accumulation (Defra 2010d).

One of the emerging issues for marine litter in the Greater North Sea is the discovery of microscopic plastic particles in the µm to mm size range at concentrations of 150-2,400 particles per m^3. These have been shown to be widespread and based on plankton records have been increasing in line with the production of synthetic fibres. The impact of this type of pollution on marine organisms is not yet known although several organisms have been shown to ingest the particles, which could potentially cause physical damage or the transportation of hazardous substances (OSPAR 2009, 2010). An ecological quality objective (EcoQO) study (2002-2006) based on plastic particles found in seabird's stomachs in the North Sea found that 90% of northern fulmars had plastic in their stomach and between 45–60% had >0.1g, more than the objective set by OSPAR (EcoQO: *There should be less than 10% of fulmars having more than 0.1 g plastic particles in the stomach in samples of 50 to 100 beach-washed fulmars found from each of 4 to 5 areas of the North Sea over a period of at least five years*, OSPAR 2010b).

APPENDIX 3c – LANDSCAPE/SEASCAPE

The following sections provide an update to information presented in Appendix 3c of the OESEA Environmental Report (DECC 2009b).

A3c.1 UPDATE TO BASELINE INFORMATION

A3c.1.1 Relevant Initiatives

Since the publication of the OESEA, there have been a number of updates/revisions to initiatives of relevance to landscape and seascape. A full list of relevant initiatives is presented below, with those which are new, updated, or now of relevance due to the new elements of the plan distinguished below those previously considered in the OESEA. Note that only those new items are discussed below. A full narrative relating to these initiatives is given in Appendix 4.

	Landscape/Seascape (OESEA / OESEA2)
Regional	World Heritage Convention 1972
Europe	Council of Europe European Landscape Convention 2000
UK	Draft Overarching National Policy Statement for Energy (EN-1) Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) Draft National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4)
Local	The National Character Areas of England English Heritage Historic Landscape and Seascape Characterisation Programmes Seascape Assessment for Wales Natural Heritage Zones: A National Assessment of Scotland's Landscapes Landscape Character Areas of Northern Ireland LANDMAP Wales programme Cadw/ICOMOS Register of Landscapes of Outstanding Historic Interest or Special Historic Interest Natural England's Landscape Policy 2008 and detailed policies on designated landscapes, future landscapes and historic landscapes Natural England's European Landscape Convention A: Framework for Implementation (2007) SNH's Landscape policy framework (2006) Planning Policy Statement 1: Delivering Sustainable Development (England) Planning Policy Statement 7: Sustainable Development in Rural Areas (England) Technical Advice Note 12: Design (Wales) Planning Policy Statement 1: General Principles (Northern Ireland) The Nature Conservation and Amenity Lands (Northern Ireland) Order 1985

Local

Severn Tidal Feasibility Study Phase 1 Consultation (2009)
The European Landscape Convention – The English Heritage Action Plan for Implementation (2009)
Coastal Access: An audit of coastal paths in England (2008-09)
Coastal Access: Natural England's Scheme: consultation version (2009)
English Heritage Historic Landscape and Seascape Characterisation (ongoing)
Planning Policy Statement 5: Planning and the Historic Environment (England)
Scottish Planning Policy (2010)
The National Planning Framework for Scotland 2 (2010)
Strategic Environmental Assessment of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters (Scotland) (2010)
Pentland Firth and Orkney Waters Marine Spatial Plan Framework & Regional Locational Guidance for Marine Energy (2010)
Planning Policy Wales (2010)
Technical Advice Note 12: Design (Wales) (2009)
Landscape Character Map for Wales (2009)
Planning Policy Statement 18: Renewable Energy and Wind Energy Development in Northern Ireland's Landscapes (Northern Ireland) (2009)
Offshore Renewable Energy Strategic Action Plan 2009-2020 and Offshore Wind and Marine Renewables Energy SEA Environmental Report (Northern Ireland) (2010)

The OESEA provided an introduction to the Council of Europe European Landscape Convention (ELC), one of the main tenets of which is that within planning, all landscapes should be considered, i.e. not just those designated for particular natural or semi-natural characteristics, but also those which are not designated, degraded or urban, and such studies go some way to charactering landscapes and seascapes so that they might be considered more widely. This principle is starting to filter through into planning policy and is also endorsed by the main statutory conservation bodies of England and the devolved administrations. The statutory conservation bodies are at present working on frameworks to implement the principles of the ELC, for instance both English Heritage and Natural England have a "Framework for Implementation". The Scottish Landscape Forum (2007) also made a number of recommendations for changes in landscape policy in Scotland, some of which derive from the content of the ELC.

In addition to the plan/programme of the OESEA, and that presented within this SEA, a number of other national and devolved energy infrastructure plans or initiatives have been consulted on. The Framework for the Development of Clean Coal, which seeks to see 4 CCS demonstrators in operation by 2020, interlinks with this plan/programme and is considered in Appendix 3b. The devolved plans of Scotland and Northern Ireland for the development of offshore renewables in territorial waters, particularly those areas in Scotland, are in some cases within close proximity of Round 3 wind leasing areas.

The consideration of landscape and seascape has been included in the draft National Policy Statements (NPS) for Energy Developments arising from the Planning Act 2008. The principles outlined in the energy NPSs are largely in alignment with those presented elsewhere in terrestrial policy statements, e.g. PPS7: Sustainable Development in Rural Areas, which highlights statutory sites (National Parks, AONBs) and their immediate surrounds as requiring the highest level of protection, but these do not propose that development should be precluded within such areas where project design would not conflict with the interests and features for which the sites are designated. More generally, they state that all developments should be well designed and in keeping with the scale and character (modern and historic) of the local area (e.g. Technical Advice Note (TAN) 12: Design, Welsh Assembly Government).

The draft Marine Policy Statement (MPS) arising from the Marine and Coastal Access Act 2009 was released for consultation in July 2010. The MPS states that all coastal landscapes should be considered in the preparation of the next phase of marine spatial planning (Marine Plans), not just those which are protected through designations, which is broadly complementary to the tenets of the ELC. A recent publication (Europarc Atlantic Islands 2010) indicated that the Marine Management Organisation, created under the Marine and Coastal Access Act, expressed the desire to work with Natural England and others in order to ensure that a suitable seascape character assessment methodology is developed and piloted. The creation of such a methodology would then promote the proper consideration of coastal protected landscapes, and seascape more generally, during the Marine Plan process. The timetable for the production of such guidance will be quite restricted, with the first of the Marine Plans due to get underway in England in 2011.

In addition to direct considerations of landscape, the MPS and the Marine and Coastal Access Act provide a legal and policy framework for the construction of a new national coastal trail in England and amenity land associated with this route which the public is free to use. The scheme for the implementation of this part of the Act in England and its methodology has been drawn up by Natural England (2010). The Marine (Scotland) Act 2010 makes no similar provisions though both Scotland and Wales are planning their own equivalent trails, with the Welsh route planned to be open in 2012. A number of existing routes were detailed in Appendix 3h of OESEA. Though this may not in itself have a significant impact on seascape, it is likely that it will encourage more people to visit the coast for recreation and hence enhance the number of visitors (visual receptors) there.

In addition to those types of landscape designations listed in the OESEA, the register of historic landscapes of Wales should also be noted. There are 58 landscapes on the register which are of particular historic interest and are regarded as a material consideration in planning decisions in Wales. These are complemented by the Historic Landscape Character Assessment and Historic Seascape Character Assessment programmes previously mentioned in the OESEA, which are still ongoing in England, with 60% of the project now completed (as of January 2011). Reports relating to the currently completed characterisations adjoining the coast of England, and the seascape studies, are available via the English Heritage website and Archaeological Data Service websites respectively. Methodological statements are also available from these sources.

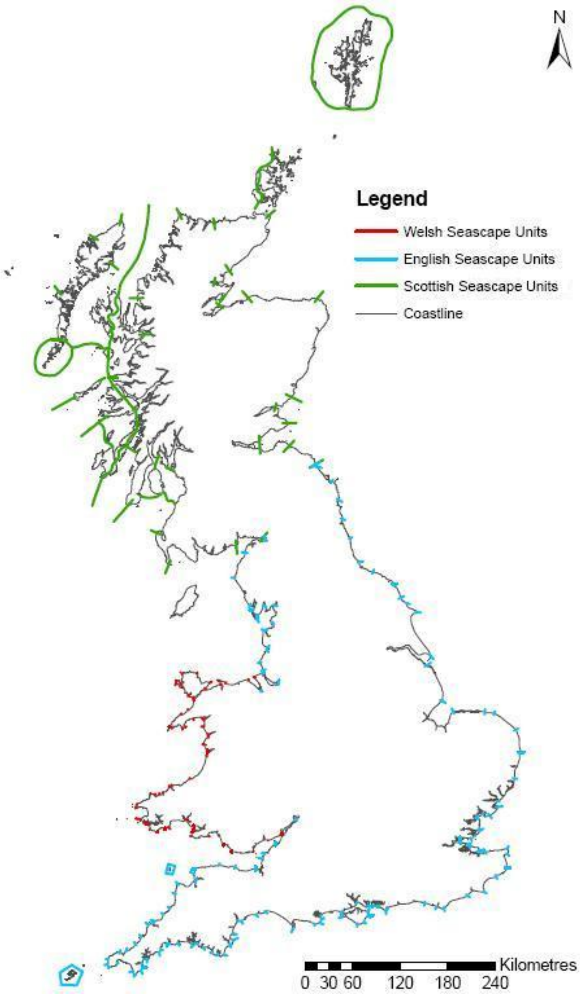
A3c.1.2 Changes in UK Context

The definition of seascape given in OESEA was, 'a discrete area within which there is shared inter-visibility between land and sea', which can be separated into areas of sea, land and intervening coastline, as provided by DTI (2005c) in their seascape and visual assessment guidance for wind farms. Since then, the ELC definition, 'an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors', has been become more widely used and implies a deeper meaning to landscape and seascape. This is central to the idea that the character of landscapes in all their forms should be a consideration in planning (see above) and the public participation elements of the convention.

A3c.1.2.1 Landscape/seascape background

As part of the process of assessing the impacts on seascape from marine activities, a number of guidance documents and some methodological background were previously provided or signposted in the OESEA. In addition to these, the Landscape Character Assessment guidance (formerly Countryside Agency and Scottish Natural Heritage 2002) is at an advanced stage of revision and will be published later in 2010. The regional seascape studies which identified seascape units and their sensitivity to development for Scotland (Scott *et al*. 2005) and Wales (CCW 2008b), are now complemented by 125 further units identified by White Consultants (2009) for the English coast (Figure A3c.1). The individual characteristics or sensitivity of the English regional units to any particular technology or development scenario has not yet been assessed. More generally, the generic interests of coastal landscapes with regard to their interaction with the marine environment have been described in the Europarc Atlantic Isles (2009) publication, *Connecting Land and Sea: the place of coastal protected landscapes in the marine environment.*

Figure A3c.1 – Regional seascape units defined for the UK (excluding Northern Ireland)



Source: White Consultants (2009)

A3c.1.2.2 Overview of designations

In addition to the landscape site designations presented in the OESEA, extensions have been proposed for the Lake District, Yorkshire Dales and Cairngorms National Parks and the extension to the South Downs National Park was confirmed in November 2009. No further relevant statutory or non-statutory designations (Heritage Coast, National Scenic Area, World Heritage Site) within 10km of the coast have been confirmed since January 2009. Since the OESEA, it should be noted that in Scotland Special Landscape Areas (SLAs) replace the former Local Landscape Designations and Areas of Great Landscape Value.

A3c.1.3 Evolution of the Baseline and Environmental Issues

A3c.1.3.1 Marine renewables

There are presently 5 offshore wind farms in planning and a further 7 which have been consented, adding to the 17 which are either operational or under construction in England and Wales. In addition to these there are now exclusivity agreements for the 9 Round 3 areas within which turbines with a total capacity of up to 32GW may be installed. With the exception of the Dogger Bank site, all of the Round 3 areas may be visible from coastal locations, and future leasing rounds for this technology are also possible. Though the scope of this SEA does not include renewable energy in Scottish territorial waters, it is noted that agreements for 10 wind leasing areas have been made within 12nm of the Scottish coast, a number of which are closely associated with the Moray Firth and Firth of Forth Round 3 zones. Marine Scotland (2010a) carried out a Strategic Environmental Assessment (SEA) of the draft plan for offshore wind energy in Scottish territorial waters which included an assessment of potential effects on landscape and visual amenity. Areas to the west of Scotland, particularly Islay, Kintyre, Argyll Array, Solway Firth and Wigtown Bay, were thought to be the most sensitive to developments arising from the plan as their seascapes were of medium to high sensitivity (see Scott *et al.* 2005) and included National Scenic Area designations.

The draft plan/programme considered in this SEA would allow for the progression of leasing/licensing of areas of the seabed for wave, tidal stream and tidal range technologies that will introduce a number of new visual components into seascapes. Scotland has already completed a leasing round for commercial-scale wave and tidal devices in their territorial waters around Orkney and the Pentland Firth, with a further round proposed for locations around Shetland and the Inner and Outer Hebrides. Seascape studies currently available for such technologies include that for the Severn tidal barrage and lagoons and those contained within the SEAs for marine renewables in Scotland (Faber Maunsell & Metoc 2007) and Northern Ireland (AECOM & Metoc 2009).

The magnitude of visual impacts will be device specific and depend on the sensitivity of individual seascapes to these devices which is defined by a range of characteristics described in OESEA. The present demonstration phase of wave and tidal devices has led to a wide range of contrasting designs, the impacts of which will become more apparent as they progress towards commercial viability and are deployed in larger arrays. Very little work has yet been completed studying the impacts that wave and tidal devices may have on seascape. The Wales regional seascape study (CCW 2008b) did consider the possible impacts from tidal current and wave devices of a scale and form thought probable in the next 10 years, with tidal stream represented by vertical columns projecting from the sea surface (10 x 3m), and wave by broad, flat objects (400 x 3m) – e.g. similar in form to the Seagen tidal and Pelamis wave devices. Seascapes generally displayed less sensitivity to the wave scenario than to the tidal one, though in both cases headlands and areas with restricted or focussed views, e.g. along estuaries, recorded high sensitivities. It should be noted that this exercise only looked at a single scenario for each technology (which were not well defined) and seascape unit, and the impacts of particular wave and tidal designs may differ significantly from these. Some devices such as the Openhydro open centre turbine are designed so that they have no surface component, and therefore visual impacts would be largely restricted to those occurring during deployment, monitoring and maintenance, and subsequent decommissioning.

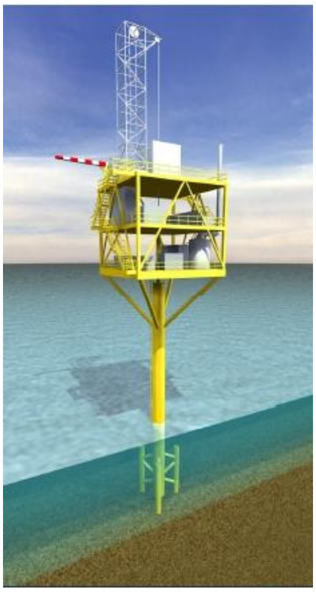
AECOM & Metoc (2009) and Faber Maunsell & Metoc (2007) similarly assessed two broad design classes (e.g. surface point structures and surface linear structures) recognising that surface point structures may also be wave devices, (e.g. the Aquamarine clam). Like the CCW (2008b) study, they found greater sensitivity in seascapes for point structures than linear ones for all seascape types, primarily as linear structures may follow the natural movement of the sea and be partially hidden by wave motion.

The Seagen tidal stream device in Strangford Lough, Northern Ireland, is an individual demonstrator project which is visible as a point surface structure. The Environmental Report for this development (Royal Haskoning 2005) indicated that the device would be visually obvious at all stages of development, which would affect views from land, particularly Portaferry, and would affect the open seascape offered during ferry crossings. The requirements to use paints providing suitable contrast and lighting for navigation were highlighted as restrictions in making the device less visible though these are health and safety requirements. Visual impacts were considered most significant during maintenance as the turbine blades would be exposed above the water surface, though this is a temporary activity. Similar tidal stream devices are therefore likely to pose a transient visual impact proportional to the amount of time required for maintenance. Visual impacts present for the life of many submerged developments are therefore likely to be restricted to any local substation that may be required above water and associated landfall.

A seascape study was undertaken as part of the SEA for the Severn Tidal Feasibility Study (DECC 2008d, 2010r) in addition to that already completed for a hypothetical inner barrage between Lavernock Point and Brean Down by Land Use Consultants (2007a). Specific impacts (e.g. on individual AONBs, National Character Areas and viewing locations) for the Severn are presented in these reports, though only generic impacts are considered here as these may be more widely applicable to other estuaries considered for tidal range technologies in the UK, and the Severn is also subject to its own SEA at this time. Barrages would alter the character of a given estuary due to land-use change associated with new infrastructure, for instance power cables and onshore development associated with the barrage (access roads and buildings). The barrage would be visible at all points in the tidal cycle and would also feature navigation lighting at night. There would be some visual effects during the construction phase at both onshore and offshore locations that would influence views across and down the estuary. Secondary effects include the loss of intertidal habitat (and also associated fauna and flora), a reduction in the extent of intertidal areas at low tide, changes to water clarity and also shipping routes. Similar effects may be generated by lagoons, though some of these may be exacerbated at low tide as, depending on specifics of development design, more of the embankment structure would be exposed.

A3c.1.3.2 Carbon capture and storage, gas storage and traditional oil and gas

Figure A3c.2 – Gas storage topside



Source: Gateway Gas Storage (2007)

Carbon Capture and Storage (CCS) facilities may have few visual components in the marine environment visible from coastal locations, and any structures associated with CCS may be restricted to the landfall of pipelines or increased, or new, port facilities at the coast and any associated tanker traffic. It is likely that up to 4 demonstration projects will become operational towards 2020, though transportation infrastructure may be shared or clustered (DECC 2009e). Gas storage operations may have similar impacts, having both onshore and offshore facilities. A proposed facility in the east Irish Sea (Gateway Gas Storage) is the first development in the UK to use artificial salt cavern construction to provide gas storage capacity, in this case ~1.136 billion cubic metres (BCM). The offshore facilities will lie 24km from the coast and comprise 20 wells, each with a monopod topside facility (Figure A3c.2) of dimensions 14x14m, reaching 50m above the seabed. It is uncertain whether this will be typical of the size, design and orientation of future developments of this type, and the results of the seascape study for this development (see Gateway Gas Storage 2007) may not generally be applicable to other locations. It does however provide an indication of how such facilities and offshore wind farms visually interact.

Though typically at some distance from the coast, and with minimal visual impact, a number of oil and gas facilities (or activities) may occur in coastal areas in the near future. In the last (26^{th}) seaward oil and gas licensing round, a number of blocks were awarded in the North Channel, east Irish Sea, English Channel, southern North Sea and Moray Firth, which are located either directly adjacent to, or are within visual range of the coast. Moreover, some of these occur within close proximity to wind farm leasing zones. Many new oil and gas activities require only temporary surface infrastructure, as on completion many wells are tied-back to existing facilities. When this is not the case, longer term visual impacts may come in the form of jacket, semi-submersible or jack-up rig facilities, FPSOs, and transient support vessel and aviation traffic. At night, any flaring and lighting from support vessels and rigs may also be visible from shore.

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APPENDIX 3d – WATER ENVIRONMENT

The following sections provide an update to information presented in Appendix 3d of the OESEA Environmental Report (DECC 2009b).

A3d.1 UPDATE TO BASELINE INFORMATION

There have been a number of updates/revisions to initiatives of relevance to the water environment since OESEA. A full list of initiatives and an explanation of their content is provided in Appendix 4 – note that only initiatives arising or updated since OESEA, or those which are not relevant to OESEA2 are discussed here.

A3d.1.1 Relevant Initiatives

Water Environment — OESEA | OESEA2

International

IMO International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 (MARPOL 73/78)
International Convention for the Control and Management of Ships' Ballast Water and Sediments (adopted 2004, still to enter into force)
International Convention on Oil Pollution Preparedness, Response and Co-operation (1990)
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (1972, as amended) 1996 protocol - revision to convention (2006) and amendments to 1996 protocol

Regional

Convention for the Protection of the Marine Environment of the North East Atlantic (the OSPAR Convention 1992)
OSPAR Recommendation 2003/1 on the Strategy for the Joint Assessment and Monitoring Programme
OSPAR Decision 2000/3 on the use of organic-phase drilling fluids (OPF) and the discharge of OPF-contaminated cuttings
OSPAR Decision 2000/2 on a harmonised mandatory control system for the use and reduction of the discharge of offshore chemicals (as amended by decision 2005/1)
OSPAR Decision 2007/1 to Prohibit the Storage of Carbon Dioxide Streams in the Water Column or on the Sea-bed
OSPAR Decision 2007/2 on the Storage of Carbon Dioxide Streams in Geological Formations
OSPAR Recommendation 2000/5 on a Harmonised Offshore Chemical Notification Format (HOCNF), as amended by OSPAR Recommendation 2005/3 and 2008/2
OSPAR Recommendation 2005/2 on Environmental Goals for the Discharge by the Offshore Industry of Chemicals that are, or Contain Added Substances, Listed in the OSPAR 2004 List of Chemicals for Priority Action
OSPAR Recommendation 2006/3 on Environmental Goals for the Discharge by the Offshore Industry of Chemicals that are, or which Contain Substances Identified as Candidates for Substitution
OSPAR Recommendation 2001/1 for the Management of Produced Water from Offshore Installations as amended by Recommendation 2006/4
OSPAR Strategy to Combat Eutrophication
OSPAR Biological Diversity and Ecosystems Strategy
OSPAR Hazardous Substances Strategy
OSPAR Offshore Oil and Gas Strategy
OSPAR Radioactive Substances Strategy
OSPAR Co-ordinated Environmental Monitoring Programme (CEMP)

OSPAR (2010) Quality Status Reports (QSRs) of the North Atlantic and its sub-regions

EU

Water Framework Directive (2000/60/EC) and daughter directives: the Groundwater Directive (2006/118/EC) and Priority Substances Directive (2008/105/EC)
Bathing Waters Directive (2006/7/EC)
Shellfish Waters Directive (2006/44/EC)
Urban Wastewater Treatment Directive (91/217/EC)
Priority Substances Directive (2008/105/EC)
Marine Strategy Framework Directive (June 2008)
Nitrates Directive (91/676/EC)
Integrated Pollution Prevention Control Directive (2008/1/EC)
Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)
Directive 2004/35/EC on environmental liability with regard to the prevention and remedying of environmental damage
Environmental Impact Assessment Directive 85/337/EEC

Directive 2009/28/EC on the promotion of the use of energy from renewable sources

UK

Safeguarding our seas: A strategy for the conservation and sustainable development of our marine environment (Defra 2002)
Water Resources Act 1991

UK Marine and Coastal Access Act 2009 and Bills proposed by devolved administrations
Our Seas – a shared resource. High level marine objectives (2009)
Draft Marine Policy Statement
Draft National Policy Statement for Ports (DfT, 2009)
Draft Overarching National Policy Statement for Energy (EN-1) (DECC, 2009)
Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) (DECC, 2009)
River Basin Management Plans for respective administrations, including those which are cross-border
Defra's Charting Progress II (2010)
Marine Strategy Framework Directive - putting in place the legal framework for implementation
The Marine Strategy Regulations 2010

Local

A Strategy for the Long Term Sustainability of Scotland's Coasts and Seas (2007)
An Integrated Coastal Zone Strategy for Northern Ireland 2006-2026
Making the Most of Wales' Coast: Integrated Coastal Zone Management Strategy
Cleaner Coasts Healthier Seas, Working for a better marine environment, Our strategy for 2005-2011 (Environment Agency, England and Wales)
A strategy for promoting an integrated approach to the management of coastal areas in England (2008)
The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003
The Water Environment (Controlled Activities) (Scotland) Regulations 2005
Water Environment and Water Services (Scotland) Act 2003

Flooding in England: A National Assessment of Flood Risk
Environment Agency Shoreline Management Plans (SMP2) (England and Wales)

This year (2010) saw the culmination of a number of information gathering and assessment initiatives which will provide significant information on the current state of the UK and neighbouring seas, and the activities which affect them. The OSPAR Quality Status Report (QSR) published in September 2010 evaluated the implementation of the OSPAR strategies and their effectiveness in improving the quality of the marine environment. Key aspects of the QSR cover biodiversity, eutrophication, hazardous substances, offshore oil and gas industry and radioactive substances (OSPAR 2010a). Similarly Charting Progress 2 (Defra 2010a) provided an updated assessment of the state of UK seas since Charting Progress was published in 2005. Supporting technical reports on healthy and biologically diverse seas, ocean processes, clean and safe seas, and productive seas (Defra 2010b,c,d,e) provide relevant information on the current baseline and issues affecting the water environment (see A3d.1.3 below).

Consultation on the UK legal framework for implementation of the EU Marine Strategy Framework Directive (MSFD) (Defra 2009a) has progressed since OESEA. The Marine Strategy Regulations 2010 transposes the Directive into UK law and requires the development of the five elements of the marine strategy: (1) the assessment of marine waters; (2) the determination of the characteristics of good environmental status for those waters; (3) the establishment of environmental targets and indicators; (4) the establishment of a monitoring programme; (5) the publication of a programme of measures. Qualitative descriptors for determining good environmental status are listed in Annex I of the MSFD and those of relevance to the water environment include:

- Human-induced eutrophication is minimised, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms and oxygen deficiency in bottom waters.
- Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.
- Properties and quantities of marine litter do not cause harm to the coastal and marine environment.
- Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

Work has also progressed on the Marine Policy Statement (MPS) which will underpin marine spatial planning as part of the Marine and Coastal Access Act 2009. Consultation on a draft MPS (UK Government 2010a) and associated Appraisal of Sustainability (UK Government 2010b) closed in October 2010 with water quality and resources, and noise identified as high level considerations for marine plan authorities (e.g. Marine Management Organisation). The draft MPS also indicates that marine plan authorities must contribute to or align with delivery of the policies and objectives of relevant River Basin Management Plans and the Marine Strategy Framework Directive.

Since the OESEA, River Basin Management Plans (RBMP) have been finalised for all UK River Basin Districts (RBD). These plans describe the RBDs, the pressures that the water environment faces and the measures that will be taken to protect and improve rivers, lakes, estuaries, coastal waters (out to 3nm in Scotland and Solway Tweed RBD and 1nm in rest of UK) and groundwater. The Water Framework Directive sets a target of aiming to achieve at least 'good ecological status' in all water bodies by 2015. However, provided that certain conditions are satisfied, in some cases the achievement of good status may be delayed until 2021 or 2027. The current status of relevant RBDs is described below in A3d.1.2.1 below.

Similarly, the second tranche of Shoreline Management Plans (SMP2) are being consulted on or have been finalised for England and Wales. These are non-statutory policy documents for coastal flood and erosion risk management planning (see Appendix 3b Geology, substrates and coastal geomorphology).

Climate change is likely to have a pervasive effect on all aspects of the coastal and marine environment including flooding, coastal erosion, water quality and resources. The Defra UKCIP initiative reflects current understanding of how the climate system operates, how it might change in the future, and allows a measure of the uncertainty in future climate projections to be included (see Appendix 3f Climate and Meteorology). UKCP09 has significantly enhanced its consideration of marine and coastal environments from previous assessments and a specific marine and coastal projections report (co-authored by the Marine Climate Change Impacts Partnership (MCCIP)) includes projections of changes in air-temperature over the sea, projected future sea-level rise, sea temperature, salinity, stratification and circulation, as well as surges and waves (Lowe *et al.* 2009, see A3d.1.3 below).

A3d.1.2 Changes in UK Context

In general, the information on UK water masses and circulation; stratification and frontal zones; coastal tidal flows; temperature and salinity, wave climate and ambient noise presented in OESEA remains unchanged.

The Ocean Processes feeder report (Defra 2010b) completed as part of Charting Progress 2 provides the most recent comprehensive review of the UK's physical marine environment. A summary of the CP2 assessment of ocean processes is presented below (Table A3d.1).

Table A3d.1 – CP2 ocean processes assessment summary

Variable assessed	Status in UK seas	Influencing factors and significance for UK seas
Sea temperature	**Rising in all regions** Sea-surface temperature risen by between 0.5 and 1 °C from 1870 to 2007. Warming since the mid-1980s has been more pronounced in the Southern North Sea, Irish Sea, Minches and Western Scotland.	**Influencing factors** Air temperature **Significance** Reduces the ability of the oceans to take up CO_2, affects certain species, e.g. forcing them to move or adapt, and contributes to rising sea level. Shifts in plankton populations on which most marine animals feed are associated with temperature rise
Sea level	**Rising in all regions** Mean sea level around the UK coast rose by about 1.4 mm per year during the 20th century	**Influencing factors** Temperature (the greater effect to date) and melting land-based ice (potentially more important in future) **Significance** Intertidal habitats and groundwater regimes are affected, and the flooding risk for vulnerable coastal populations will increase, notably in the southern North Sea, if upward trends continue
Carbon dioxide and ocean acidification	**Acidification in all regions** Oceans are acidifying (pH decreasing) as CO_2 is absorbed. In UK waters, no baseline measurements of pH against which changes can be judged, and it will be some time before accurate judgements about the rate of acidification relative to natural annual and interannual cycles of pH can be made.	**Influencing factors** CO_2 which is present naturally and released from anthropogenic sources (e.g. combustion of fossil fuel). Various climatic factors influence its concentration in the sea **Significance** There are potential threats to marine species and ecosystems if acidification continues

Variable assessed	Status in UK seas	Influencing factors and significance for UK seas
Circulation, suspended particulate matter, turbidity, salinity and waves	**Variable** These processes vary on daily to interannual timescales but show no significant trend over the past decade, except for a slight salinity decrease in the southern North Sea and a slight increase in salinity in northern areas	**Influencing factors** *Circulation*: tides and weather, especially winds *Salinity*: rainfall near the surface and near river outflows; adjacent Atlantic salinity **Significance** *Suspended particles*: can reduce light availability and inhibit plant growth *Waves*: the main cause of damage to offshore and coastal structures

Source: Defra (2010b)

A3d.1.2.1 Status of coastal and estuarine water bodies

The general objective of the Water Framework Directive is to achieve 'good ecological status' for all surface waters by 2015, including coastal and transitional (estuarine) water bodies.

The WFD classification scheme for water quality includes five status classes: high, good, moderate, poor and bad. Annex V of the WFD provides a general definition of good status for rivers, lakes, transitional waters and coastal waters: *"The values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions."* More specific definitions including of chemical and biological quality elements are also detailed in Annex V.

Details of relevant RBDs and the extent and status of estuarine and coastal waters are provided in Table A3d.2 below. Relevant issues impacting on the quality of estuarine and coastal water bodies within each RBD are highlighted in A3d.1.3.4 below.

Table A3d.2 – Current extent and status of estuarine and coastal water bodies

River Basin District	Number of water bodies in the RBD		Percentage of water bodies at good overall status	
	Estuarine	Coastal	Estuarine	Coastal
Scotland	40	449	85%[1]	94%[1]
Solway Tweed	10	8	91%[1]	88%[1]
Northumbria	7	7	14%	86%
Humber	8	1	14%	86%
Anglian	18	11	0%	27%
Thames	11	1	0%	0%
South East	20	17	0%	12%
South West	23	25	26%	44%
Severn	6	0	17%	-
Western Wales	27	24	30%	67%
Dee	1	0	0%	-
North West	12	8	8%	38%
North Western IRBD	22	23	28%[1,2]	26%[1,2]
Neagh-Bann IRBD	9	5	0%[1]	20%[1,3]

River Basin District	Number of water bodies in the RBD		Percentage of water bodies at good overall status	
	Estuarine	Coastal	Estuarine	Coastal
North Eastern	4	15	25%[1]	33%[1]

Notes:

1. *Includes water bodies at good or better overall status.*
2. *36% of estuaries and 44% of coastal waters are yet to have status assigned*
3. *20% coastal waters are yet to have status assigned.*

Sources:

Scottish Environment Protection Agency website – http://www.sepa.org.uk/water/river_basin_planning.aspx
Environment Agency website – http://www.environment-agency.gov.uk/research/planning/33106.aspx
Northern Ireland Environment Agency – http://www.ni-environment.gov.uk/water-home/wfd.htm

A3d.1.2.2 Tidal range

The annual mean significant wave height and peak flow for mean spring tide were presented and described in Appendix 3d of OESEA, and remain relevant to the leasing of areas for wave and tidal stream developments which form part of the draft plan considered by this SEA. In addition to these, details of the mean spring tidal range around the UK is presented in Figure A3d.1, being relevant to tidal range technologies.

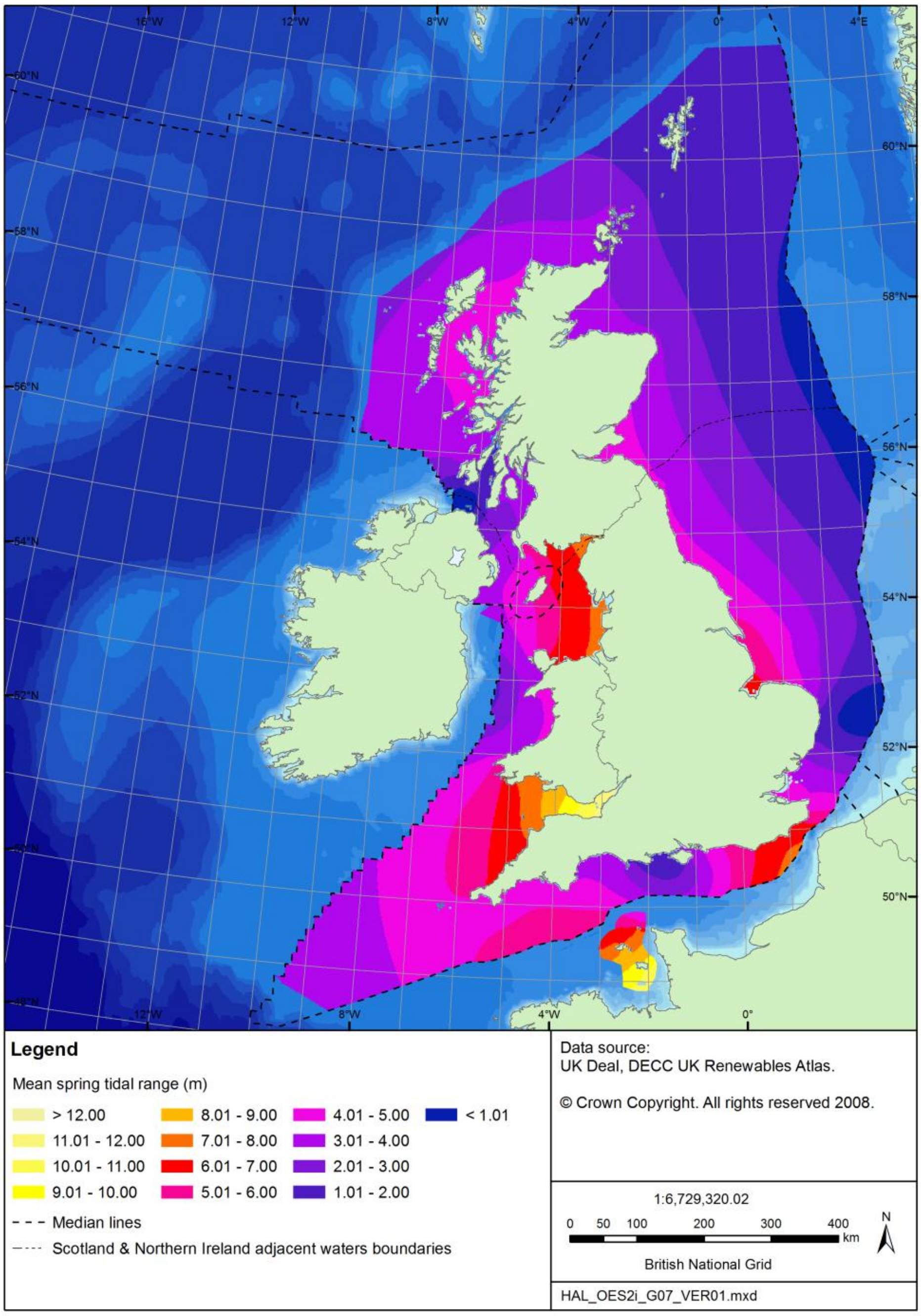
Tidal range devices operate on the principal of converting energy from a rising and falling tide. Standard tidal typology would class the tidal range into the following terms:

Tidal range (m)	Typology
<2	Micro-tidal
2 to 4	Meso-tidal
4 to 8	Macro-tidal
>8	Mega-tidal

Source: ABPmer et al. (2008)

ABPmer *et al.* (2008) indicate that mega-tidal range conditions and above are of particular interest to tidal impoundment devices. From Figure A3d.1 these conditions are restricted to the Irish Sea and Bristol Channel. Potential scenarios developed for the current SEA propose a minimum tidal range of 6m for potential tidal range projects (Section 2.5.4 of the Environmental Report) which includes other areas such as parts of the English Channel and the east coast. As a result Table A3d.3 provides details of those estuaries for which the tidal range is considered mega-tidal (i.e. >8m) and those with a range of 6m or above in England and Wales (The Estuary Guide website).

Figure A3d.1 – Mean spring tidal range around the UK



Source: ABPmer et al. (2008)

Table A3d.3 – Tidal range of estuaries considered mega-tidal (>8m) and those with a tidal range of 6m or above in England and Wales

Estuary	Regional Sea	Tidal range
Severn Estuary	4	12.3
Bridgwater Bay	4	11.1
Thaw Estuary	4	10.5
Blue Anchor Bay	4	9.7
Ogmore Estuary	4	8.9

Estuary	Regional Sea	Tidal range
Mersey Estuary	6	8.9
Afan Estuary	4	8.6
Neath Estuary	4	8.6
Tawe & Swansea Bay	4	8.6
Morecambe Bay	6	8.4
Inner Solway Firth	6	8.4
Duddon Estuary	6	8.1
Alt Estuary	6	8
Ribble Estuary	6	7.9
Esk Estuary	6	7.7
Dee & N. Wirral	6	7.6
Carmarthen Bay	4	7.5
Taw-Torridge Estuary	4	7.3
Loughor Estuary	4	7.1
Conwy Estuary	6	7.1
Traeth Lafan	6	6.9
Clwyd Estuary	6	6.7
Dee Estuary	6	6.7
The Wash	2	6.5
Inner Thames Estuary	2	6.5
Cuckmere Estuary	3	6.5
Gannel Estuary	4	6.4
Traeth Dulas	6	6.4
Traeth Coch	6	6.4
Milford Haven	6	6.3
Ouse Estuary	3	6.1
Humber Estuary	2	6

Source: The Estuary Guide website - http://www.estuary-guide.net/

A3d.1.3 Evolution of the Baseline and Environmental Issues

The following provides an update where necessary of the information presented in Appendix 3d of OESEA as well as new information relevant to the OESEA 2 draft Plan.

A3d.1.3.1 Evolution of the Baseline

The environmental baseline is likely to be affected by large scale climatic and oceanographic processes. Variations have been observed in North Atlantic and North Sea circulation patterns in the past few decades which are likely to influence sea surface temperatures. Increased wave heights have been observed in the western and northern UK waters and wave heights in the north-east Atlantic and northern North Sea are known to respond strongly and systematically to the North Atlantic Oscillation. Around the UK, sea temperatures and seasonal stratification strengths are predicted to increase, while salinity is projected to decrease over the 21st Century.

At a local level, topography often interacts with these principal forces, focusing currents and leading to the generation of amplified current flow or eddies. At present there are no local anthropogenic activities within the UKCS area that are likely to change significantly the physical properties of the water environment, though the pH of the world's oceans has been declining due to CO_2 uptake from anthropogenic sources. It can be expected that in the wider environment, global sea-levels may rise by *c.* 1-2mm per annum. Coastal and marine waters around the UK are generally thought to be non-problem areas with respect to eutrophication.

A3d.1.3.2 Environmental Issues

Climate change

The UK Climate Projections (UKCP09) provide probabilistic climate information for the UK up to the end of this century and supersede the scenarios described in UKCIP02. Projections of future changes to the UK climate are provided, based on simulations from climate models. The projections show three different outcomes representing high, medium and low greenhouse gas emissions scenarios (see Appendix 3f).

Lowe *et al.* (2009) provides information on future marine and coastal projections (for sea level rise, storm surge, sea surface and sub-surface temperature, salinity, currents, and waves). Key messages from Lowe *et al.* (2009) of relevance to OESEA2 are highlighted below. These should be read in conjunction with the wider suite of results presented by Lowe *et al.* (2009) and the UKCP09 website.

- Around the UK the size of storm surge expected to occur on average about once in 50 years is projected to increase by less than 0.9mm per year (not including relative mean sea level change) over the 21st century. In most locations this trend cannot be distinguished clearly from natural variability. This suggests that this component of extreme sea level will be much less important than was implied by UKCIP02, where corresponding values exceeded 5 mm per year in places.
- Seasonal mean and extreme waves are generally expected to increase slightly to the SW of the UK, reduce to the north of the UK and experience little change in the North Sea. There are large uncertainties especially with the projected extreme values.
- Changes in the winter mean wave height are projected to be between –35cm and +5cm. Changes in the annual maxima are projected to be between –1.5m and +1m.
- Seasonal stratification strength (layering of the water column which limits 'mixing' between surface and deeper waters) is projected to increase everywhere but substantially more in the deep seas than the shelf sea regions. It is projected to start ~5 days earlier across the whole of the UK shelf seas and breakdown ~5–10 days later across much of the region each year, hence extending the 'stratified' period.
- The seas around the UK are projected to be 1.5-4ºC warmer, depending on location with warming most pronounced in the Celtic, Irish and southern North Sea areas. The seas are also projected to become slightly fresher (less saline) by the end of the 21st century, particularly in the North Sea areas. The change in salinity is particularly dependent on the projected change in the storm tracks (which is not well understood) owing to the latter's effect on precipitation.
- Table A3d.4 shows central estimate projections (a projected change that has equal probability of being exceeded and not being exceeded) for each decade of relative sea level changes (cm) with respect to 1990 levels, for each of the three emissions scenarios.

Table A3d.4 – Central estimates of relative sea level changes around the UK

	London			Cardiff			Edinburgh			Belfast		
	High	**Med**	**Low**	**High**	**Med**	**Low**	**High**	**Med**	**Low**	**High**	**Med**	**Low**
2000	3.5	3.0	2.5	3.5	2.9	2.5	2.2	1.6	1.2	2.3	1.7	1.3
2010	7.3	6.2	5.3	7.3	6.2	5.3	4.7	3.5	2.6	4.9	3.8	2.8
2020	11.5	9.7	8.2	11.5	9.7	8.2	7.5	5.7	4.3	7.8	6.0	4.6
2030	16.0	13.5	11.4	15.9	13.4	11.4	10.7	8.2	6.1	11.1	8.6	6.6
2040	20.8	17.5	14.8	20.8	17.5	14.8	14.2	10.9	8.2	14.7	11.4	8.7
2050	25.8	21.8	18.4	25.9	21.8	18.4	18.0	13.9	10.5	18.6	14.5	11.1

Note: a wider range of projections for these scenarios (5th to 95th percentile range) are given in Lowe et al. (2009)
Source: Lowe et al. (2009)

Acidification

Since the OESEA, the MCCIP has provided further briefings on the uptake of CO_2 (Hardman-Mountford *et al.* 2009), ocean acidification and the potential impacts on marine ecosystems and goods and services (Turley *et al*. 2009). The MCCIP Ecosystem Linkages Report Card 2009 (Turley *et al*. 2009) provides a summary of key linkages between CO_2 and ocean acidification with an assigned level of confidence (based on author's assessment of 'level of agreement/consensus' and the 'amount of evidence available', see relevant section of MCCIP annual report card 2010-2011 for further details).

CO_2 flux into the ocean [very high confidence] causes oceanic pH and carbonate ion concentration to decrease [very high confidence] this links to impacts on organisms through changes in physiology [medium confidence], calcification/dissolution [medium confidence] and changes in nutrient chemistry and speciation [low confidence]. All marine organisms face the potential risk of physiological impacts [medium confidence] and early-life stages are particularly vulnerable [medium confidence]. Short-term acidification events cause benthic shell-forming organisms such as shellfish to have reduced growth [medium confidence] and reduced survival [medium confidence] while important planktonic organisms (e.g. coccolithophores) have reduced growth [low confidence]. These impacts may harm economical valuable species [low confidence], with potential impacts [low confidence] on the provision of ecosystem goods and services, and human wellbeing. Any changes in plankton will alter the carbon and nutrient cycles [medium confidence] and impact up the food web [low confidence] (Turley *et al*. 2009).

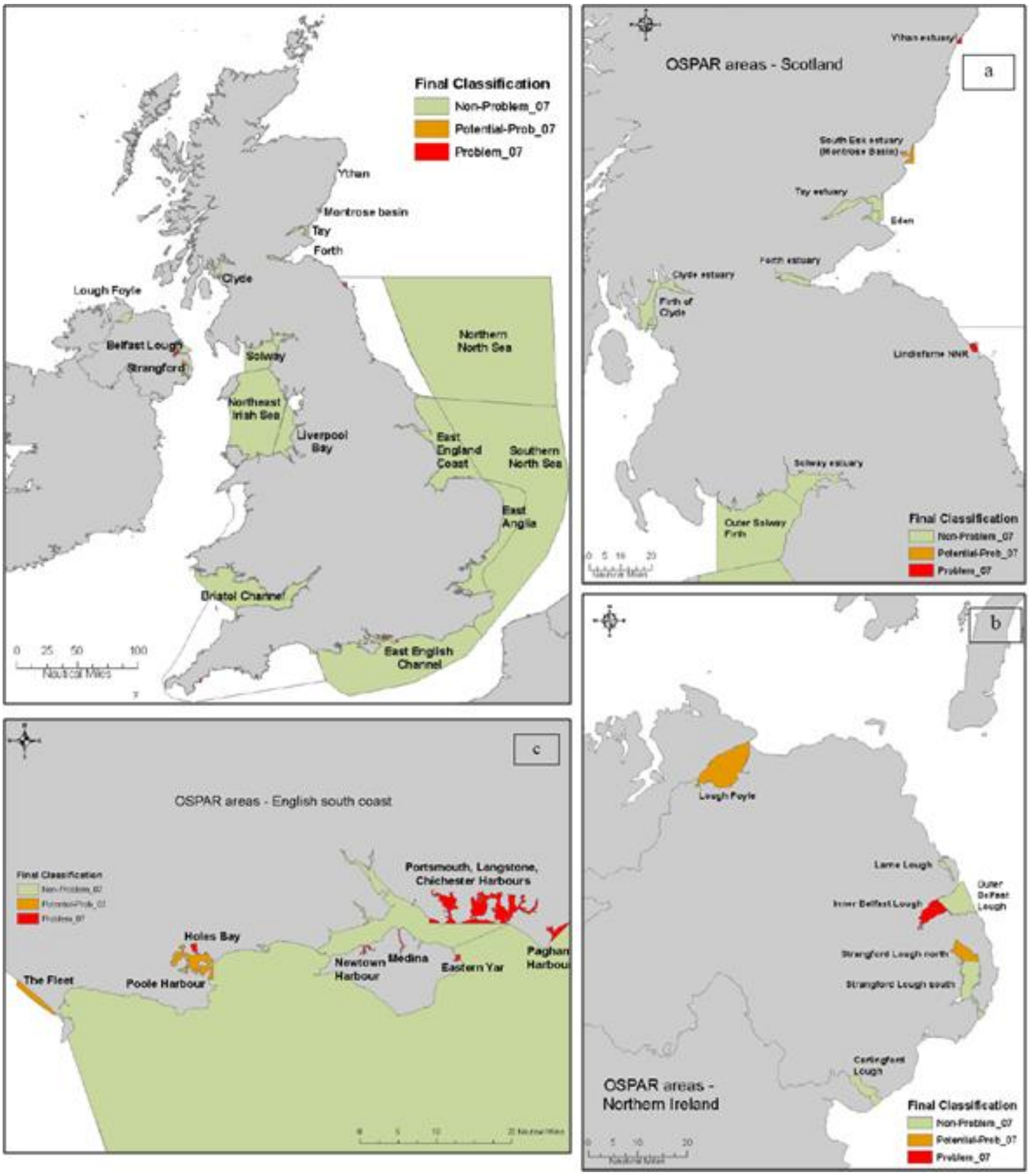
Eutrophication

The results of the latest, more robust, application of the OSPAR Comprehensive Procedure which assesses the eutrophication status of UK seas, generally confirms those of the first application in 2002. The evidence revealed by the monitoring programmes clearly shows, with a good degree of confidence, that the coastal and marine waters around the UK are non problem areas (assessed against 10 parameters and associated elevated levels, see OSPAR 2009i) with respect to eutrophication and show no signs of undesirable disturbance. However, there are a number of small estuaries, loughs and harbours which are problem areas with respect to eutrophication, or are at risk due to factors such as restricted circulation (Figure A3d.2) (OSPAR 2009i).

The overall results for the UK were: 19 areas classified as non-problem areas (green shading), 17 areas classified as problem areas (red shading) and 5 areas classified as potential problem areas (amber shading), with respect to eutrophication.

The major pressures occur in the east, south and north-west of England where input of nutrients of anthropogenic origin (notably nitrate and phosphate from agriculture and urban waste water sources) has resulted in nutrient enrichment. The designation of Nitrate Vulnerable zones covering 69% of the land in England, 14% of Scotland, 4% of Wales and the whole of Northern Ireland is likely to lead to a reduction in nutrient inputs from agriculture, as is the effective implementation of the Urban Waste Water Treatment Directive which will reduce nutrient inputs from waste water (Defra 2010d).

Figure A3d.2 – Final classification for UK assessment areas - (a) Scotland, (b) Northern Ireland, and (c) English south coast



Source: Anonymous (2008)

Pressures on coastal and estuarine waters

In addition to the potential issue of eutrophication discussed above, coastal and estuarine waters may be subject to a range of other pressures. The recently finalised River Basin Management Plans provide details of the main pressures facing coastal and estuarine water bodies within each River Basin District (Table A3d.5).

Table A3d.5 – Main pressures affecting coastal and estuarine water bodies

River Basin District	Main pressures
Scotland	Inputs of nutrients and other point and diffuse sources from agriculture and sewage disposal, engineering modifications for flood protection and navigation
Solway Tweed	Pollution, modification of beds, banks and shores
Northumbria	Pollution from industrial discharges, nutrient and microbiological contamination from run-off, sewage, non-native species and encroachment.
Humber	Pollution from industrial discharges, nutrient and microbiological contamination from run-off and sewage.
Anglian	Potential impact of offshore wind power on benthic fauna, fish and birds, flooding, pollution from urban and agricultural sources.
Thames	Sewage, physical modification, flooding, pollution from industrial discharges and elevated nutrient levels.
South East	Physical modification for flood and coastal erosion risk management, physical impacts of commercial fishing, ports and harbours, point source pollution from sewage works and diffuse pollution from agriculture.
South West	Pollution from industrial discharges, nutrient and microbiological contamination from run-off and sewage, sea level rise leading to coastal squeeze and potential over-exploitation of fisheries.
Severn	Modifications for flood protection and navigation.
Western Wales	Morphological alterations, nutrient and microbiological contamination from run-off and sewage, chemical contamination and potential over-exploitation of fisheries.
Dee	Morphological alterations, nutrients from sewage and potential over-exploitation of fisheries.
North West	Diffuse pollution from rural and urban areas, point source pollution from sewerage systems and industry, physical modification.
North Western IRBD	Wastewater and industrial discharges, physical modifications and damage, aquaculture, invasive alien species
Neagh-Bann IRBD	Wastewater and industrial discharges, physical modifications and damage, dangerous substances, aquaculture, invasive alien species, recreation.
North Eastern	Wastewater and industrial discharges, agriculture, physical modifications, invasive alien species.

Sources:
Scottish Environment Protection Agency website –
http://www.sepa.org.uk/water/river_basin_planning.aspx
Environment Agency website –
http://www.environment-agency.gov.uk/research/planning/33106.aspx
Northern Ireland Environment Agency –
http://www.ni-environment.gov.uk/water-home/wfd.htm

APPENDIX 3e – AIR QUALITY

The following sections provide an update to information presented in Appendix 3e of the OESEA Environmental Report (DECC 2009b).

A3e.1 UPDATE TO BASELINE INFORMATION

A3e.1.1 Relevant Initiatives

Since the OESEA, there have been a number of updates/revisions to initiatives of relevance to air quality. A full list of relevant initiatives is presented below, with those which are new, updated, or now of relevance due to the new elements of the plan, distinguished below those previously considered in OESEA. Note that only those new items are discussed below. A full narrative relating to these initiatives is given in Appendix 4.

Air Quality — OESEA | OESEA2

International

OESEA:

Marine Pollution Convention, MARPOL 73/78 (the International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978)
Geneva Convention on Long Range Transboundary Air Pollution (1979)
Vienna Convention for the protection of the ozone layer (1985)
Montreal Protocol on substances that deplete the ozone layer (1987) and subsequent updates and adjustments
Stockholm Convention on Persistent Organic Pollutants (2001)

OESEA2:

UNEP Global Mercury Partnership and Proposed Treaty
2008 amendment of MARPOL on a revised Annex VI dealing with the reduction in the emission of sulphur from shipping, enacted in 2010 .

Regional

OESEA:

The Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR) 1998

EU

OESEA:

EU Sixth Environmental Action Plan (2002-2012)
Air Quality Framework Directives (96/62/EC) and Daughter Directives (1999/30/EC), (2000/69/EC), (2002/3/EC), (2004/107/EC)
National Emissions Ceiling Directive (2001/81/EC)
Clean Air for Europe Programme: Towards a Thematic Strategy for Air Quality (2001)
EU Thematic Strategy on Air Quality (2005)
Directive 2008/50/EC on Ambient Air Quality and Cleaner Air for Europe
Directive on Integrated Pollution Prevention and Control (96/61/EC)
Ozone Depleting Substances Regulation 2037/2000/EC
Directive 2005/33/EC of the European Parliament and of the Council of 6 July 2005 amending Directive 1999/32/EC as regards the sulphur content of marine fuels
Directive 2004/35/EC on environmental liability with regard to the prevention and remedying of environmental damage
The Proposal for a Directive of the European Parliament and of the Council on industrial emissions (integrated pollution prevention and control) (Recast)

UK

OESEA:

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2007)
Consultations on the European Commission's proposed Directive on Industrial Emissions (Integrated Pollution Prevention and Control) (Recast)

OESEA2:

Air Pollution: Action in a Changing Climate (Defra 2010)

Local

Environment Strategy for Wales (2006)
Scottish Environment Protection Agency Policy Priorities Relevant to the Scottish Environment Protection Agency (Paper 2004/13)
Planning Policy Statement 1 Delivering Sustainable Development (England)
Planning Policy Statement 23: Planning and Pollution Control (England)

Air Quality Standards Regulations 2010
Air Quality Standards (Scotland) Regulations 2010
Air Quality Standards (Wales) Regulations 2010
The Air Quality Standards Regulations (Northern Ireland) 2010
The National Planning Framework for Scotland 2
Planning Policy Wales (2010)

As an addendum to the Air Quality Strategy for England, Wales, Scotland and Northern Ireland (2007), Defra and the devolved administrations have published, Air Pollution: Action in a Changing Climate (Defra 2010f), which outlines how further health benefits may be drawn from the integration of air quality and climate change policies. The core messages in this publication are:

- Activities which generate air pollution are often also those which create emissions of gases associated with climate change, and it would therefore be conducive to consider the linkages between climate change and air quality policy areas.
- Connected with the above point, the UK's commitment to build a 'Low Carbon Economy' by 2050 will reduce air pollution, though by varying degrees depending on choices relating to achieving this goal (e.g. energy use and generation mix, and any carbon abatement technology). Optimizing climate policy decisions to account for air pollution could yield economic benefits of approximately £24 billion by 2050, for instance through the improvement of life expectancy from the use of low carbon transport and energy technologies.
- The promotion of low-carbon vehicles and renewable sources of energy that do not involve combustion will contribute to both climate change and air quality targets. At the same time, actions that tackle climate change but damage air quality must be avoided.
- Action will be needed at international, EU, national, regional and local levels to ensure air quality and climate change policies are efficiently integrated and to ensure ambitious but realistic air quality targets are set for the future.

Defra (2010f) updates the current Air Quality Strategy based on the climate change policy and legislation which has developed since 2007 (e.g. the Climate Change Act 2009, The Low Carbon Transition Plan; see Appendix 3f). Directive 2008/50/EC on ambient air quality and cleaner air for Europe was discussed previously in the OESEA, though since then its transposition into UK law has taken place through the Air Quality Standards Regulations 2010, and those equivalent Regulations of the Devolved Administrations.

Shipping emissions are becoming a greater concern both in relation to the environmental and health implications they pose, but also their contribution to climate change. The Marine Environment Protection Committee of the International Maritime Organization (IMO) agreed amendments to the Annex VI regulations of MARPOL to further reduce harmful emissions from ships, comprising a progressive reduction in sulphur oxide (SO_x) emissions. Progressive reductions in nitrogen oxide (NO_x) emissions were also agreed, with the most stringent controls being placed on those engines installed on ships constructed on or after 1st January 2016. On 1st July 2010, the amendments to MARPOL came into effect such that ships operating in the North Sea and English Channel will need to use fuel not exceeding 1% sulphur, reducing to 0.1% in 2015. Shipping emissions are also of concern in relation to climate change (see Appendix 3f), with the amount of CO_2 emitted from ships in the EU being greater than that for aviation (Entec UK Ltd 2005). Gilbert *et al.* (2010) state that in the context of carbon reduction commitments in the UK, international shipping emissions should be accounted for despite their exclusion from national emission inventories or reduction targets in the Kyoto Protocol, and that unilateral action by the UK to adopt mitigation measures could potentially drive the shipping industry to adopt lower carbon intensive practices. The CCC (2008) state that there is significant uncertainty in trying to apportion the UK component of global shipping emissions and that a global emissions cap would be one way to overcome the issue, with the IMO open to cap-and-trade methods. Emissions from ships are currently in the order of ~3% total global CO_2 (national and international shipping), projected to increase to ~15-30% in 2050.

A3e.1.2 Changes in UK Context

A3e.1.2.1 Atmospheric emissions and deposition

Since the publication of the OESEA there have been some minor changes to the number/type of coastal Air Quality Management Areas (AQMAs) and details relating to pollutants for which they were declared that were not available or presented previously. The list of Local Authorities which have declared AQMAs, and for which emissions, is available on the Defra website. Faulkner & Russell (2010) reviewed the use of Local Air Quality Management (LAQM) for Defra and the devolved Administrations in order to make recommendations which would improve their outcomes. The report states that of the 58% of Local Authorities declaring an AQMA, very few have successfully reduced emissions in these areas to a level which has resulted in this designation being removed, and that these are contributing little to reducing emissions. The scale of AQMAs as outlined in OESEA may be small, perhaps just a street, and Faulkner & Russell (2010) indicate that concentrating on such 'hot-spots' may detract from the wider land-use and transport issues in urban areas which are contributing to the inability of Local Authorities to meet air quality objectives. More widely, the UK is failing to meet its emissions targets for PM_{10} and NO_2, having submitted a notification to the EC in April 2009 to secure additional time to meet the limit values with regard to these emissions for eight areas across the UK[4], in accordance with Article 22 of the Ambient Air Quality and Cleaner Air for Europe Directive (Defra 2009b). The UK now has until 2011 to apply the required limit values to these areas.

Offshore oil and gas installation emissions are reported annually to OSPAR. The latest OSPAR report for 2007 emissions suggests: SO_2 emissions decreased about 29% between 2005 and 2007; emissions of CO_2 have remained more or less stable and emissions of NO_x went down about 9% between 2005 and 2007 (OSPAR 2009b). A significant decrease in emissions of SO_2 in the UK was due to cessation of flaring H_2S containing gas at an offshore installation in 2007. Most offshore emissions are generated by shipping, and offshore emissions in relation to oil and gas E&P are dominated by these sources rather than flaring or other routine platform operations. Carbon dioxide accounts for the greatest proportion of emissions to air from offshore installations with around 32 million tonnes emitted in the OSPAR area in 2007. Emissions of carbon dioxide and nitrogen oxides have been relatively stable since 1999, while sulphur dioxide and methane emissions have been substantially reduced. Emissions of non-methane volatile organic compounds have halved. Measures taken by operators to reduce fugitive emissions and the use of vapour recovery systems at off-loading facilities have helped reduce emissions of methane and other volatile organic compounds (OSPAR 2010a).

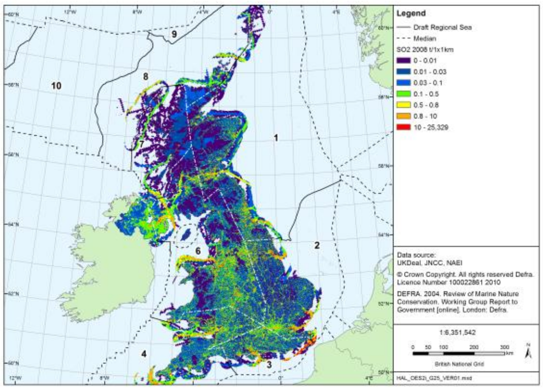
[4] Greater London, West Midlands urban area, West Yorkshire urban area, Glasgow urban area, Swansea urban area, Eastern England zone, Yorkshire and Humberside zone, Brighton/Worthing/Littlehampton.

Mapped emissions estimates

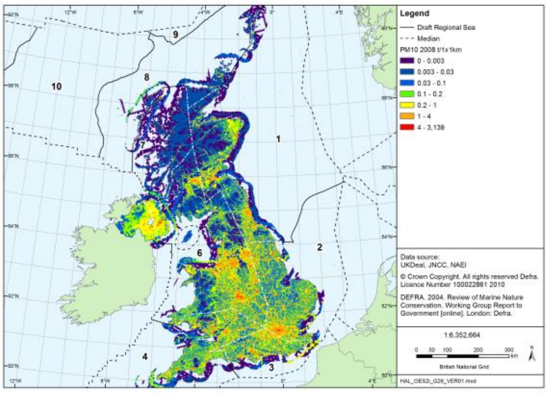
Since the OESEA was published, the National Atmospheric Inventory has been updated and now holds data on the estimated amounts and types of pollutants emitted to the air for 2008. The details of sulphur dioxide, particulate matter, nitrogen oxides and carbon monoxide were described in A3e.3 of the OESEA. There is not a significant difference in the data (magnitude and distribution) estimated for these pollutants in 2008 compared to those presented in the OESEA for 2006. The reporting methodology for shipping emissions has been modified since OESEA to include the development of a 1km^2 gridded ship emissions inventory for UK waters (to 12nm) which uses information on ship movements, vessel engine characteristics and emissions factors based on the 2006 EMEP/CORINAIR Atmospheric Emission Inventory Guidebook (AEA Personal communication). Figure A3e.1 provides an example of emissions of a number of pollutants.

Figure A3e.1 – Emissions in 2008

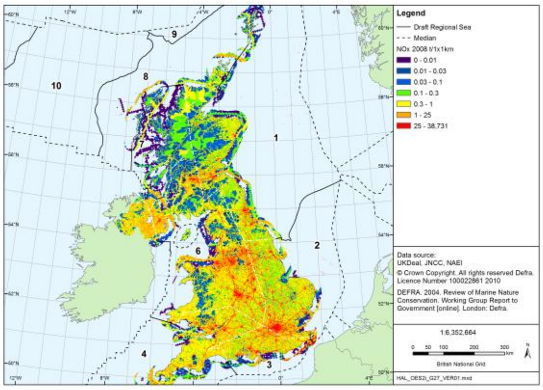
Sulphur Dioxide (SO_2)



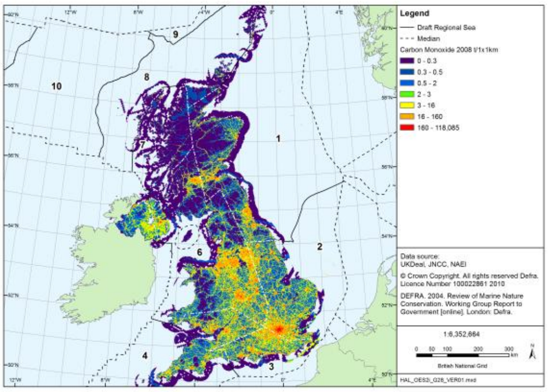
Particulate Matter (PM_{10})



Nitrogen Oxides (NOx)



Carbon Monoxide (CO)



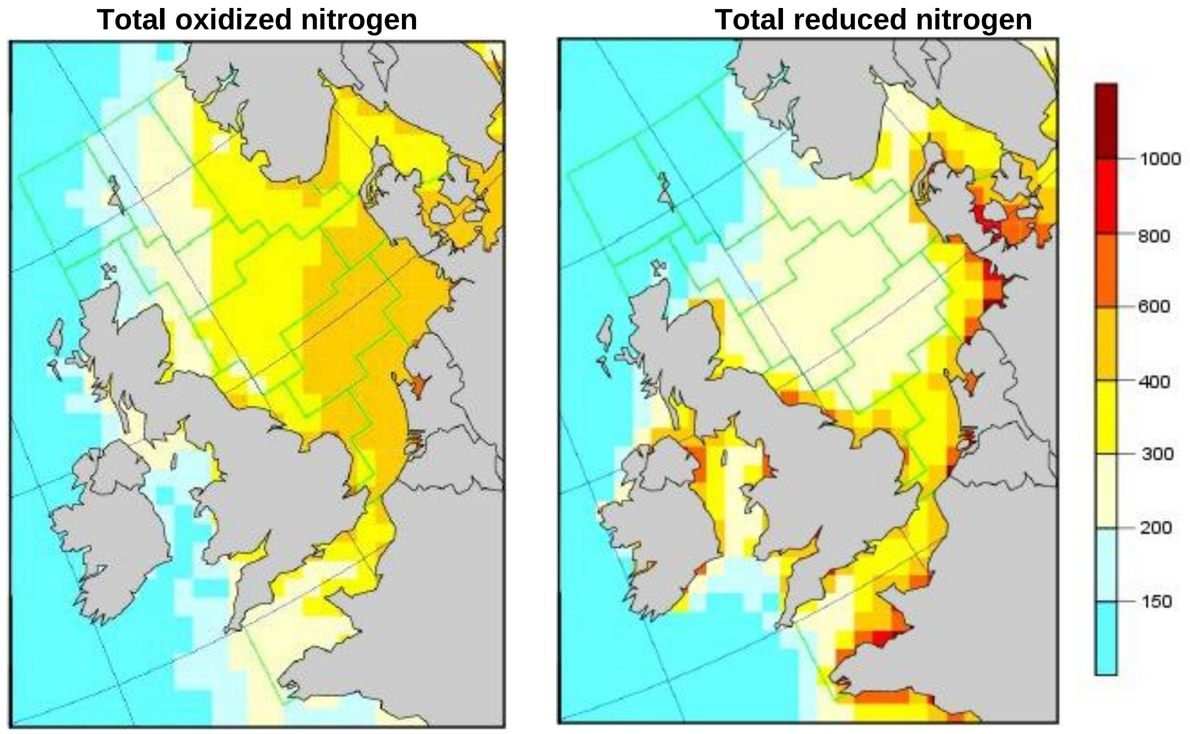
Metals

Figures relating to the emissions of metals to the Greater North Sea are presented in Appendix 3e of the OESEA baseline, and remain current. Maps of both metal emissions from OSPAR countries, and deposition of these to each marine area are provided in OSPAR (2008a), and the emission of metals from the UK is also modelled as part of the NAEI initiative, for which gases are mapped above. The general deposition trends for each Regional Sea presented in the OESEA remain unchanged. OSPAR (2009a) provides an update of deposition trends of relevance (Greater North Sea and Celtic Seas) for a number of heavy metals (cadmium, lead, mercury). Since OESEA, the creation of an international mercury partnership to raise awareness of the risks and help reduce the use of mercury has been promoted by the United Nations Environment Programme (UNEP) while a treaty is being drafted. It is hoped that negotiations on such a treaty can be completed by 2013.

Nitrogen

The regional deposition of nitrogen on the UK mainland for 2006 was presented graphically in the OESEA displaying a prominent southeast maximum and northwest minimum. This pattern still exists for the most recent data on the European Monitoring and Evaluation Programme (EMEP) website. The deposition of nitrogen to the Greater North Sea has reduced between 1990 and 2004 by 22% and 8% for oxidised and reduced nitrogen respectively (OSPAR 2007). The deposition of nitrogen to the Greater North Sea, not previously presented in the OESEA, can be observed in Figure A3e 2.

Figure A3e.2 – Estimated atmospheric deposition of nitrogen to the greater North Sea (OSPAR Region II), 2004 (mg/m^2/p.a.)



Source: OSPAR (2007)

A3d.1.4 Evolution of the Baseline and Environmental Issues

The environmental issues presented in OESEA for this topic remain unchanged. The reduction in emissions of heavy metals and other substances which may lead to deleterious environmental and health effects is likely to continue as present and upcoming initiatives and legislation, either handed down from or implemented, at the International, European and National level take effect. The UK Government targets to produce ~15% of energy from renewable sources by 2020, and to cut carbon emissions by ~34% over the same period (e.g. through greater efficiency, renewables deployment and CCS) are likely to not only contribute to climate change targets (see Appendix 3f), but also help to reduce air quality issues at a national scale. The alignment of a number of policy areas relating to air quality (e.g. health, transport, climate change) has been realised in the addendum to the 2007 Air Quality Strategy, Air Pollution: Action in a Changing Climate, outlined above.

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APPENDIX 3f – CLIMATE AND METEOROLOGY

The following sections provide an update to information presented in Appendix 3f of the OESEA Environmental Report (DECC 2009b).

A3f.1 UPDATE TO BASELINE INFORMATION

A3f.1.1 Relevant Initiatives

Level	Climate & Meteorology	OESEA / OESEA2
International	The United Nations Framework Convention on Climate Change Kyoto Protocol to the UN Framework Convention on Climate Change	OESEA
International	The Copenhagen Accord Intergovernmental Panel on Climate Change Fifth Assessment Report (AR5)	OESEA2
EU	EU Sixth Environmental Action Plan (2002-2012) European Climate Change Programme (I and II) EU Green Paper 'adaptation to climate change in Europe – options for EU action' (2007) Directive 2003/87/EC on establishing a scheme for greenhouse gas emission allowance trading within the Community EU Emission Trading Scheme (linked to Directive 2003/87/EC) Communication on: 2020 by 2020 Europe's climate change opportunity. COM(2008)30	OESEA
EU	Directive 2009/28/EC on the promotion of the use of energy from renewable sources	OESEA2
UK	Climate Change – The UK Programme 2006: Tomorrow's Climate Today's Challenge UK Climate Change Act (2008) The Energy Act (2008) and the current Energy Bill (2009-10) Sustainable Development Strategy (2006) Stern Review of the Economics of Climate Change Energy White Paper: Meeting the Energy Challenge (2007) Health Effects of Climate Change in the UK 2008 – An update of the Department of Health Report 2001/2002	OESEA
UK	UK Low Carbon Transition Plan – National Strategy for Climate Change and Energy (2009) Framework for the Development of Clean Coal (FDCC) (2009) The Road to Copenhagen: The UK Government's Case for an Ambitious Agreement on Climate Change (2009) Committee on Climate Change: Building a Low-Carbon Economy - the UK's contribution to tackling climate change (2008), Meeting carbon budgets - ensuring a low-carbon recovery (2010) UK Climate Impacts Programme (UKCIP) update 2009 (UKCP09) The Energy Act 2010 The Climate Change Act 2008 (2020 Target, Credit Limit and Definitions) Order 2009	OESEA2
Local	Environment Strategy for Wales (2006) Wales Changing Climate: Challenging Choices: the Impact of Climate Changes in Wales 2020-2080 Changing Our Ways – Scotland's Climate Change Programme (2006) Preparing for Climate Change in Northern Ireland (2007) Planning Policy Statement 1 Delivering Sustainable Development (England) Planning and Climate Change: Supplement to Planning Policy Statement 1 (England)	OESEA
Local	A Low Carbon Revolution: Wales' Energy Policy Statement (2010) Climate Change Strategy for Wales (2010) Climate Change Delivery Plan: Meeting Scotland's Statutory Climate Change Plans (2009) Climate Change (Scotland) Act 2009 Scotland's Climate Change Adaptation Framework (2009) Committee on Climate Change: Scotland's Path to a Low-Carbon Economy (2010) Scottish Planning Policy (2010) The Climate Change (Scotland) Act 2009 The National Planning Framework for Scotland 2 (2010) Adapting to Climate Change in England (2008) A Low Carbon Economic Strategy for Scotland (2010) Low Carbon Scotland: The Draft Report on Proposals and Policies (2010)	OESEA2

Since the OESEA, there have been a number of updates/revisions to initiatives of relevance to climate and meteorology. A full list of relevant initiatives is presented above, with those which are new, updated, or now of relevance due to the new elements of the plan distinguished below those previously considered in OESEA. Note that only those new items are discussed below. A full narrative relating to these initiatives is given in Appendix 4.

The Climate Change Act 2008 was discussed in the OESEA, though a subsequent 2009 Order has amended the previous target for carbon equivalent emissions reductions to 34% below 1990 levels for 2020. The target of an 80% reduction on 1990 levels by 2050 remains the same. The Act aims to meet this target through a range of measures, but principally through both the establishment and work of the Committee on Climate Change (see first and second annual reports: CCC 2008, 2010), a system of carbon budgeting and trading, activities that reduce or remove greenhouse gases from the atmosphere, promotion of such activities through financial incentive, the production of less waste and more recycling. The fourth and most recent carbon budget report of the CCC covers the period 2023-2027 and makes the recommendation that carbon equivalent emissions are reduced by 60% on 1990 levels by 2030 (to ~310MtCO_2e). Draft legislation for this budget is expected in spring 2011, after which this target will become legally binding. Moreover, the report advises that international aviation and shipping are included in the carbon budget, though it is accepted that further analysis is required to develop a suitable methodology for inclusion. A number of initiatives have stemmed from these reduction targets and other provisions of the Act, for instance the establishment of a National Adaptation Programme based on the Climate Change Risk Assessment (due in 2011), which forms part of Defra's *Adapting to Climate Change in England*[5].

Similarly, in Scotland the Climate Change (Scotland) Act 2009 sets an interim 42% reduction target for greenhouse gases by 2020, increasing to 80% by 2050 on 1990 levels. Scottish ministers are to set annual targets through secondary legislation from 2010-2050. These targets will be set with advice from the CCC (as above) or by an equivalent Scottish body should one be set up, and duties are placed on ministers to report on progress to the Scottish Parliament. The Act sets out duties of public bodies in relation to climate change, and other climate provisions including adaptation (see Scotland's Climate Change Adaptation Framework), land use, energy efficiency and waste reduction.

In July 2009, the UK Government published the *Low Carbon Transition Plan*, which outlines how the challenges of reducing greenhouse gas emissions for each sector will be met while ensuring clean, affordable and secure energy supplies. These broad principles are in line with those of the 2007 Energy White Paper (also see The Energy Act 2008 and 2010). Another important element of this plan is the Framework for the Development of Clean Coal (FDCC) which initiates a programme of Carbon Capture and Storage (CCS) demonstration with the ambition of seeing CCS ready for wider deployment from 2020. All new coal power stations built in the UK will have to be "CCS ready" and operators of any new and existing plants will have to retrofit CCS technology once it is considered ready for wider deployment.

CCS and renewables deployment could contribute to a significant reduction in carbon emissions during the currency of this SEA. At an international level, the UK has a legally binding target to generate 15% of energy from renewable sources by 2020, stemming from the EU Renewable Energy Directive. The UK Government *Renewable Energy Strategy* (2009) outlines scenarios for achieving this goal. Wales' Energy Policy, *A Low Carbon Revolution* (2010), aims to (amongst other carbon reduction measures) produce twice as

5 Note also Scotland's Climate Change Adaptation Framework (2010). The administrations of Wales and Northern Ireland are in the process of producing similar adaptation frameworks.

much electricity by 2025 from renewables as at present, and by 2050 to produce almost all energy (heat, electricity, transport) from low carbon sources.

The evidence base for climate change in the UK has been updated with the publication of UKCP09, which includes reports detailing recent trends and future changes for the terrestrial and marine environment (see Section A3f.1.3). At an international level, the IPCC are presently in the early stages of compiling their Fifth Assessment Report (AR5) which is due to be completed between 2013 and 2014, with the synthesis report being published in 2014.

A3f.1.2 Changes in UK Context

The average meteorological conditions for the terrestrial and marine environment presented in the OESEA remain unchanged.

A3f.1.3 Evolution of the Baseline and Environmental Issues

Anthropogenically augmented climate change is likely to have an effect on a number of meteorological (e.g. rainfall and temperature) and oceanographic (e.g. sea-level rise, alteration in wave conditions and circulation) parameters in the coming decades, and it is these projections (e.g. IPCC 2007, Lowe *et al.* 2009) that are the basis for the carbon emissions reductions and adaptation initiatives listed above, and the wider consideration of this topic in policy and legislation. The principal GHG of concern is CO_2, as it constituted 85% of UK weighted GHGs[6] emitted in 2008 (534.7 Mt, ~10% fall since 1990 [MacCarthy *et al.* 2010]), and also due to its longevity in the atmosphere, for which figures vary widely. Houghton *et al.* (2001) suggest a range of 5-200 years, with a pertinent figure of ~1000 years suggested by Archer (2005), though the author indicates that the 'tail' of greenhouse gas emissions from fossil fuel sources may take ~30,000 years to completely dissipate. This compares with ~12 years for CH_4, which is short by comparison, though this gas has a Global Warming Potential (GWP) 72 times that of CO_2 over a 20 year time horizon (see Forster *et al.* 2007). The residence time of CO_2 therefore means that today's policy implications are further reaching than immediate, decadal scales, but could significantly influence climate for at least a century to come. In order to stabilise atmospheric CO_2 concentration and avoid the worst effects of climate change, emission reductions of ~80% CO_2 by 2050 may be required (NAS 2010, CCC 2008), which is the target that is sought by the UK's Climate Change legislation (see above).

Hughes *et al.* (2010) details recent changes in UK marine air temperature over the relatively short time period of 1984-2008. Using data from the NOCS2.0 dataset (Berry & Kent 2009), the greatest warming was reported in the southern North Sea (0.6°C/decade), with lower rates of 0.2-0.4°C off North East Scotland and Southwest Approaches, with all other areas around the UK displaying rates in the range 0.4-0.6°C.

UKCP09 details climate change projections based on a number of emissions scenarios (low, medium and high) and for various timescales leading up to 2100. The scenarios reflect alternative views of future emissions and are based on three 'storylines' developed for the IPCC Special Report on Emission Scenarios (see: Nakićenović *et al.* 2000). The high emissions scenario has the highest global total emissions of carbon (summed over the 21st century at 2,189 billion tonnes of carbon), more than twice the mass of the low emissions scenario (983 billion tonnes). For context, about 7 billion tonnes of CO_2 are presently

[6] GHGs here refer to the 'Kyoto basket', CO_2, CH_4, N_2O, HFCs, PFCs and SF_6. The emissions referred to have been weighted against their GWP to assess the contribution of each gas to global warming. See MacCarthy *et al.* (2010) for more information.

emitted globally into the atmosphere each year, with an additional 1.6 billion tonnes emitted by land-use change (Wicks 2009). UKCP09 details projections for:

- Terrestrial modelled climate projections (e.g. air temperature, precipitation) – see Murphy *et al.* (2009)
- Marine and coastal projections (e.g. air temperature, sea level pressure and precipitation rate. Changes in mean sea-level, surges and extreme water levels, waves, and hydrography and circulation are also modelled) – see Lowe *et al.* (2009) and Hughes *et al.* (2010)
- Observed present and recent terrestrial UK climate trends – see Jenkins *et al.* (2009)

Key differences between UKCIP02 and UKCP09 based purely on comparisons of central probability estimates[7] include:

- Projected mean temperatures are generally greater than in UKCIP02
- Projected summer rainfall reduction is less in UKCP09 than UKCIP02
- There is some geographical variation in the predicted changes in winter rainfall
- There is some change in the projected winter cloud cover

These differences may also be partly explained by a number of factors taken into account in the UKCP09 projections previously unaccounted for in UKCIP02:

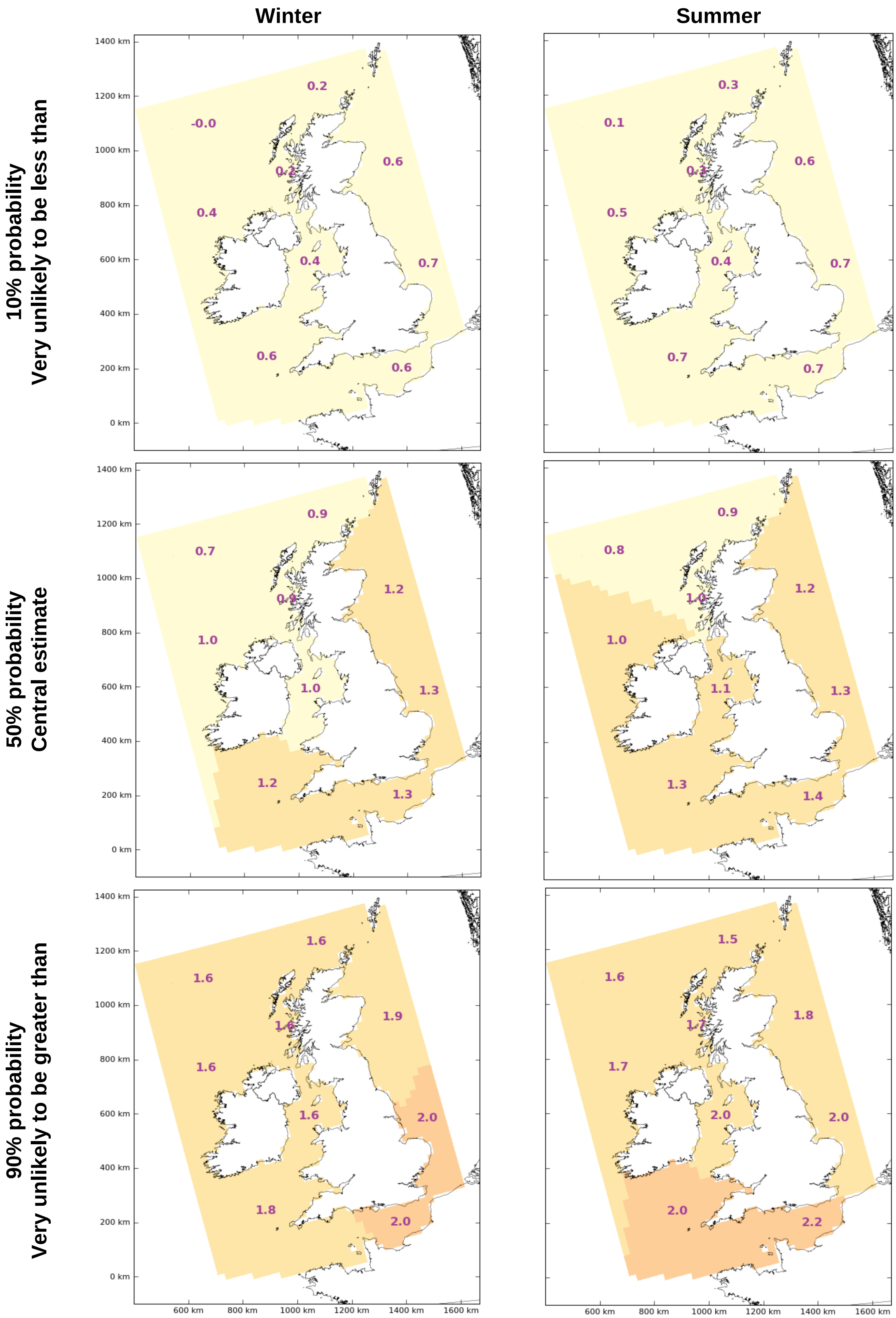
- The explicit effects of land and ocean carbon cycle feedbacks and the uncertainty in land carbon cycle feedback
- Uncertainty due to natural variability, modelling methods and statistical processing

Figure A3f.1 shows the projected changes in marine air temperature for the 2020s (2010-2039) for the medium emissions scenario. The 10, 50 and 90% probability projections are shown to reflect the uncertainty for this time period. In all cases temperature increases are projected to be greatest in the North Sea, English Channel and Western Approaches (Regional Seas 1, 2, 3 and 4). For the 50% probability projections, the magnitude of temperature increases in winter and summer are broadly similar, ranging from 0.7°C in Regional Sea 10 to 1.4°C in Regional Sea 3. Projected changes in precipitation for the same time period with different emission scenarios are shown in Figure A3f.2. A similar north-south gradient of generally increasing values is also present in this dataset.

The figures given here should be read in conjunction with the wider suite of results presented in the UKCP09 reports and technical website. Only updated meteorological components of climate change for the marine environment are presented here. The implications of climate change on other SEA topic areas (e.g. the water environment, biodiversity, habitats, flora and fauna) are dealt with in their respective appendices.

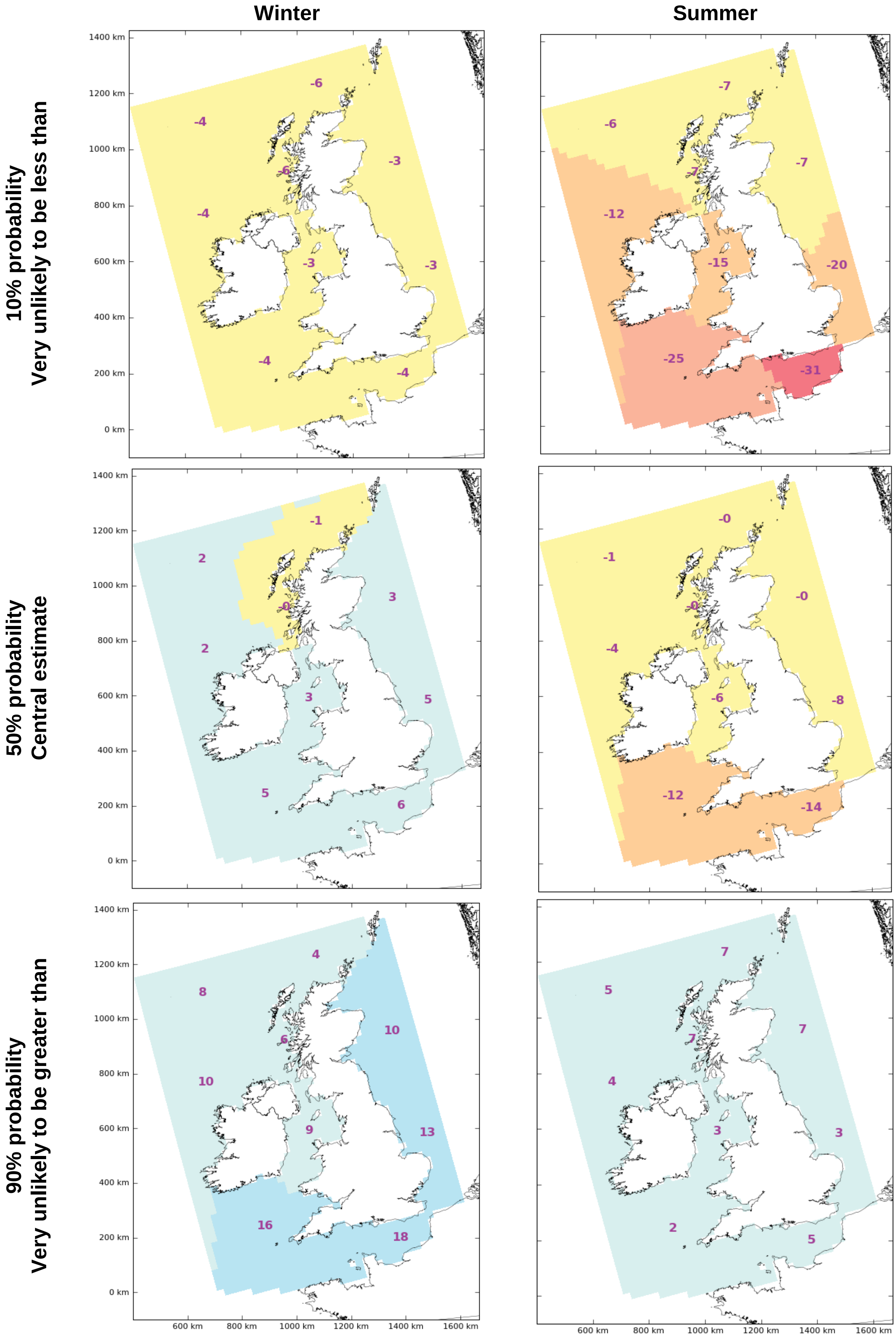
[7] These are estimates at the 50% probability level, i.e. climate change at the 50% probability level is that which is as likely as not to be exceeded; it is properly known as the *median*.

Figure A3f.1 – Probabilistic change in marine air temperature (°C) for the 2020s (2010-2039)



Note: Crown Copyright 2009. Maps produced through the UKCP09 User Interface (http://ukclimateprojections-ui.defra.gov.uk/ui/)

Figure A3f.2 – Probabilistic change (%) in marine precipitation for the 2020s (2010-2039)



Note: Crown Copyright 2009. Maps produced through the UKCP09 User Interface (http://ukclimateprojections-ui.defra.gov.uk/)

APPENDIX 3g – POPULATION AND HUMAN HEALTH

The following sections provide an update to information presented in Appendix 3g of the OESEA Environmental Report (DECC 2009b).

A3g.1 UPDATE TO BASELINE INFORMATION

A3g.1.1 Relevant Initiatives

Level	Population & Human Health (OESEA / OESEA2)
International	World Summit on Sustainable Development, Johannesburg, 2002 Aarhus Convention (Convention on Access to Information, Public Participation in Decision Making and Access to Justice in Environmental Matters) (1998) Espoo Convention on Environmental impact Assessment in a Transboundary Context (1991) Commission on Social Determinants of Health (2008), 'Closing the gap in a generation: health equity through action on the social determinants of health.
Regional	Children's Environment and Health Action Plan for Europe 2004
EU	Together for Health: A Strategic Approach for the EU 2008-2013 The European Environment and Health Action Plan 2004-2010 EU Sustainable Development Strategy (EU SDS) First issued 2001, Revised 2006
UK	UK Government Sustainable Development Strategy: Securing the Future (2005) and the UK's Shared Framework for Sustainable Development, One Future – Different Paths (2005) Saving Lives: Our Healthier Nation White Paper (July 1999) Tackling Health Inequalities: A programme for Action (2003) Securing Good Health for the Whole Population Report to the Treasury (Wanless, 2004) Choosing Health: Making Healthier Choices Easier (November 2004) Our Health, Our Care, Our Say White Paper (2006) Strong and Prosperous Communities Local Government White Paper (2006) Health Effects of Climate Change in the UK (2008) Strategy for Workplace Health and Safety in Great Britain to 2010 and Beyond UK High Level Marine Objectives relevant to population and human health Health & Safety Executive (HSE) regulations for CCS projects
UK (OESEA2)	Health & Safety Executive (HSE) regulations for CCS projects

Local

Sustainable Communities: Building for the Future (2003)
People, Places, Futures: Wales Spatial Plan 2004 (updated in 2008)
Wales: A Better Country. The Strategic Agenda of the Welsh Assembly Government (2003)
Starting To Live Differently: The Sustainable Development Scheme of the National Assembly for Wales (2004-2007)
Well Being in Wales (2002)
Ministerial Interim Planning Policy Statement (Draft) – Planning, Health and Well Being (Wales)
Choosing Our Future: Scotland's Sustainable Development Strategy (2005)
Meeting the Needs… Priorities, Actions and Targets for Sustainable Development in Scotland (2002)
Partnership for Care: Scotland's Health White Paper (2003)
Scottish Executive (2003) Improving Health in Scotland: The Challenge
The Northern Ireland Sustainable Development Strategy (2006)
Planning Policy Statement 1: Delivering Sustainable Development (2005)
Planning Policy Guidance 17: Planning for Open Space, Sport and Recreation (England)
PPS 8: Open Space, Sport and Outdoor Recreation (Northern Ireland)

One Wales, One Planet: A New Sustainable Development Strategy for Wales (2009)
Investing in Health: A Public Health Strategy for Northern Ireland (2002). Reviewed in 2009.
DECC: Meeting the Low Carbon Skills Challenge – Consultation (2010)
Technical Advice Note 16: Sport, Recreation and Open Space (Wales)
Scottish Planning Policy (2010)
The National Planning Framework for Scotland 2 (2010)

Since the OESEA, there have been a number of updates/revisions to initiatives of relevance to population and human health. A full list of relevant initiatives is presented belowabove, with those which are new, updated, or now of relevance due to the new elements of the plan, distinguished below those previously considered in OESEA. Note that only those new items are discussed below. A full narrative relating to these initiatives is given in Appendix 4.

The European Environment and Health Action Plan acknowledges that there are potential health implications from environmental impacts, and seeks to make the connection between health and environmental conditions. The plan also has the aim of maximising the economic benefits of good health, recognising that these often outweigh the cost of remedial action. At the UK and UK constituent country level, health is considered in the context of sustainable development and initiatives attempt to address health inequalities, for instance the gap in infant mortality across social groups, and the difference in life expectancy in disadvantaged areas compared with those that are more prosperous.

A3g.1.2 Changes in UK Context

There have been no information updates for aspects of this topic covered in Appendix 3g of the OESEA, such as employment structure and health indicators, as these were generated from 2001 Census data which is due to be updated in 2011.

A3g.1.2.1 Population

Mid-year population estimates for the UK are calculated annually, and 2009 data for the UK and its constituent countries is provided below (Table A3g.1) along with the mid-2006 data used in the OESEA for means of a comparison.

Table A3g.1 – Population estimates for mid-2009 and mid-2006

Country	Mid-2009 Population (000's)	% change from 2006	Area (km^2)	Density (persons/km^2)
England	51,809.7	+2.1%	130,279	398
Wales	2,999.3	+1.1%	20,733	145
Scotland	5,194	+1.5%	77,925	67
Northern Ireland	1,788.9	+2.7%	13,573*	131.8
United Kingdom	61,792	+2%	242,495	255

*Note: *Calculated from published population estimates and density.*
Source: Office for National Statistics website - Population estimates for UK, England and Wales, Scotland and Northern Ireland

Figure A3g.1 shows the population density for each administrative region of the UK for 2009. General trends observed are similar to those detailed in OESEA, with lower densities in coastal areas around much of the southwest of England, west and north Wales, the far north of England, and much of Scotland excluding the central belt. The highest densities in coastal areas are found around much of southeast England, part of northeast England, the Firths of Forth and Clyde, part of northwest England, south Wales and around the Severn Estuary.

Figure A3g.1 – Population density in the UK, mid-2009

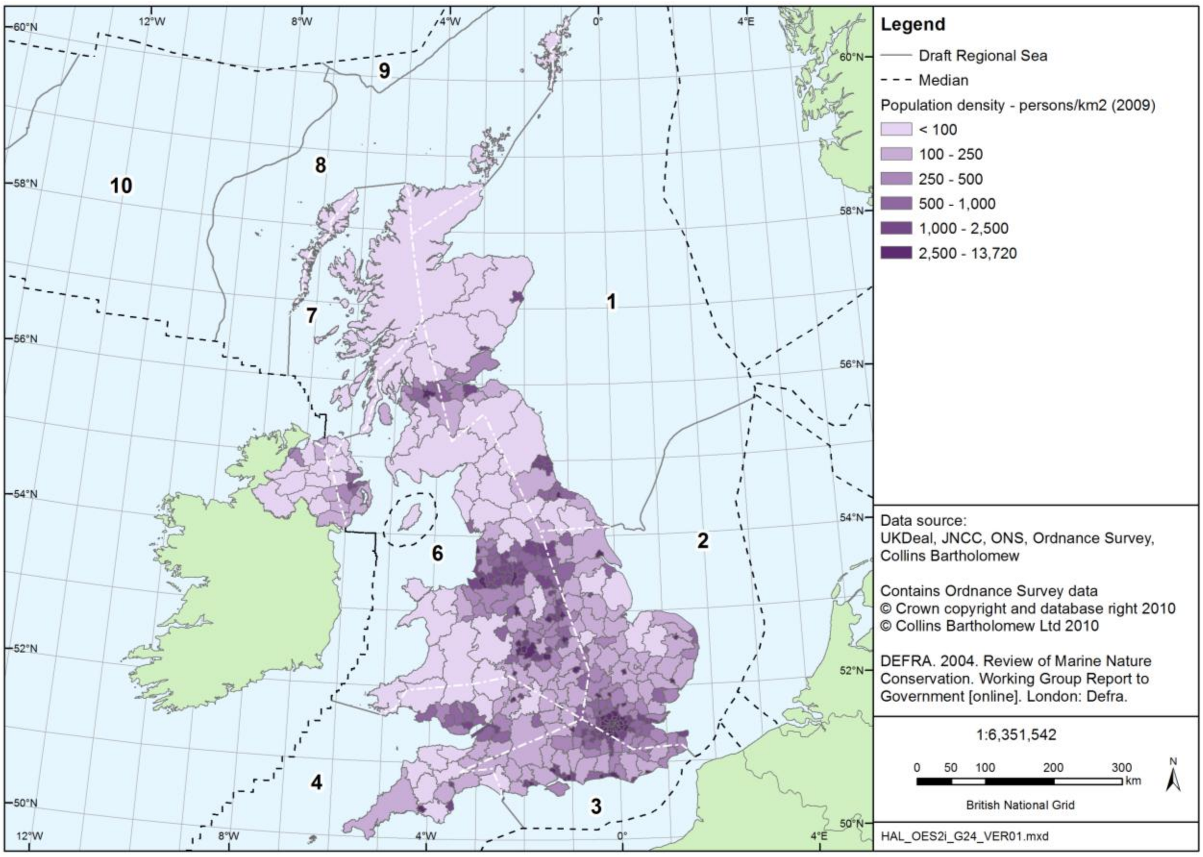


Table A3g.2 provides details of population estimates for coastal administrative areas by Regional Sea. This clearly indicates that southern parts of the UK (Regional Seas 2, 3 and 4) support the highest population densities.

Table A3g.2 – Mid-2009 population estimates for coastal administrative areas

Regional Sea	Local Authorities[1]	Area (km^2)[1]	Population (000's)	Density (persons/km^2)
1	Shetland, Orkney, Highland, Moray, Aberdeenshire, Aberdeen, Angus, Dundee, Perth & Kinross, Fife, Falkirk, West Lothian, Edinburgh, East Lothian, Scottish Borders, Northumberland, North Tyneside, South Tyneside, Sunderland, County Durham, Hartlepool, Redcar & Cleveland, Scarborough	56,495	4,367	79
2	East Riding of Yorkshire, Kingston-upon-Hull, North Lincolnshire, North-East Lincolnshire, East Lindsey, Boston, South Holland, King's Lynn & West Norfolk, North Norfolk, Great Yarmouth, Waveney, Suffolk Coastal, Babergh, Tendring, Colchester, Maldon, Rochford, Southend-on-Sea, Castle Point, Thurrock, Medway, Swale, Canterbury, Thanet, Dover	13,640	3,400	249
3	Weymouth & Portland, West Dorset, Purbeck, Poole, Bournemouth, Christchurch, New Forest, Isle of Wight, Southampton, Eastleigh, Fareham, Gosport, Portsmouth, Havant, Chichester, Arun, Worthing, Adur, Brighton & Hove, Lewes, Wealden, Eastbourne, Rother, Hastings, Shepway, Dover	6,689	3,145	470
4	Pembrokeshire, Carmarthenshire, Swansea, Neath Port Talbot, Bridgend, Vale of Glamorgan, Cardiff, Newport, Monmouthshire, South Gloucestershire, Bristol, North Somerset, Sedgemoor, West Somerset, North Devon, Torridge, Cornwall, Isles of Scilly, Plymouth, South Hams, Torbay, Teignbridge, Exeter, East Devon, West Dorset, Weymouth & Portland	18,152	4,245	234
6	Argyll & Bute, West Dumbartonshire, Renfrewshire, Inverclyde, North Ayrshire, South Ayrshire, Dumfries & Galloway, Moyle, Larne, Carrickfergus, Newtonabbey, Belfast, North Down, Ards, Down, Newry & Morne, Carlisle, Allerdale, Copeland, South Lakeland, Barrow-in-Furness, Lancaster, Wyre, Blackpool, Fylde, West Lancashire, Sefton, Liverpool, Halton, Cheshire West, Wirral, Flintshire, Denbighshire, Conwy, Gwynedd, Anglesey, Ceredigion, Pembrokeshire	35,232	4,823	137
7	Highland, Eilian Siar, Argyll & Bute, Limavady, Coleraine, Moyle	30,071	445	15
8	Shetland, Orkney, Highland, Eilian Siar	31,186	289	9

Note: [1]Local Authorities and Areas are those identified by the Draft Marine Policy Statement Appraisal of Sustainability (UK Government (2010b).
Source: Office for National Statistics website - Population estimates for UK, England and Wales, Scotland and Northern Ireland

A3g.1.2.2 Human health

The health indicators used in OESEA were from Census 2001 data which is due to be updated in 2011. Therefore the OESEA information remains valid. Patterns of life expectancy are unlikely to have changed significantly since those described in OESEA. Life expectancy is likely to continue to increase for males and females across the UK although there will likely be distinct regional and local variations in statistical trends which can often be linked to levels of deprivation.

A3g.1.3 Evolution of the Baseline and Environmental Issues

A3g.1.3.1 Evolution of the Baseline

The UK population (based on 2008 population figures) is projected to increase by more than 4 million to 65.6 million by 2018 and to exceed 67 million by 2023 (Table A3g.3). Population growth to 2023 is predicted to be smallest in Scotland (4%), Northern Ireland (5.6%) and Wales (6.7%), with growth in England (11%) similar to the UK as a whole (10.4%) (Office for National Statistics 2009a).

Table A3g.3 – Estimated and projected population of the UK and constituent countries, 2008-2023

County	Estimated and projected population (millions)			
	2008	**2013**	**2018**	**2023**
England	51.5	53.3	55.3	57.2
Wales	3	3.1	3.1	3.2
Scotland	5.2	5.3	5.4	5.4
Northern Ireland	1.8	1.8	1.9	1.9
United Kingdom	61.4	63.5	65.6	67.8

Source: Office for National Statistics (2009a)

A3g.1.3.2 Environmental Issues

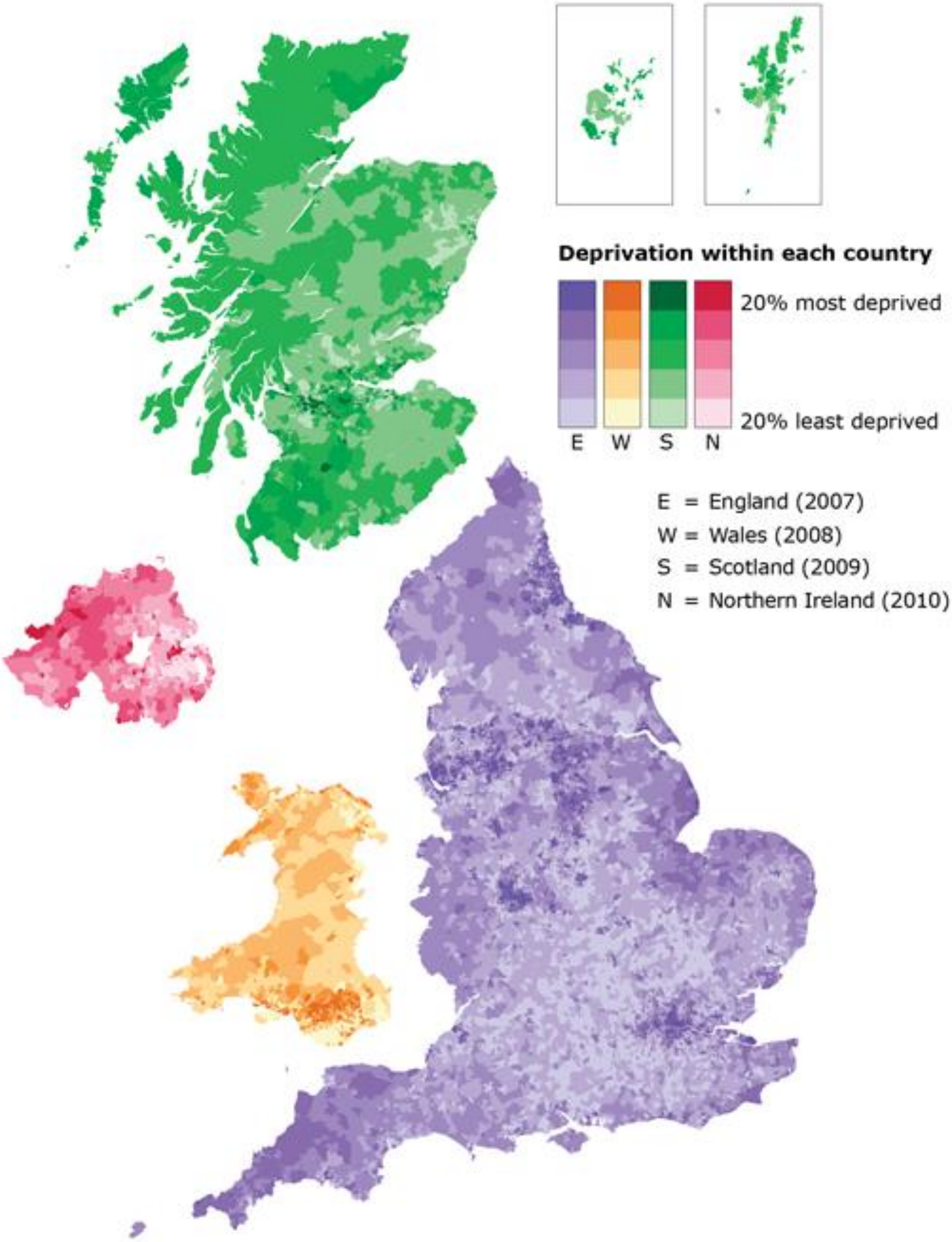
Deprivation

Many coastal settlements have been affected by industrial decline which has resulted in significant and complex health and deprivation issues (UK Government 2010b).

Separate indices of deprivation have been constructed for England, Northern Ireland, Scotland and Wales (Figure A3g.2). Though not directly comparable, each index is based on the concept that distinct dimensions of deprivation such as income, employment, education and health can be identified and measured separately. These dimensions, sometimes referred to as 'domains' are then aggregated to provide an overall measure of multiple deprivation and each area is allocated a deprivation rank and score (Office for National Statistics website - Indices of deprivation across the UK).

Figure A3g.2 indicates that some coastal areas of England, Wales, and Northern Ireland support some of the most deprived areas, although these are localised (e.g. north east England and south east Wales).

Figure A3g.2 – Within country indices of multiple deprivation (rank) for each country in the UK



Source: Office for National Statistics website - Indices of deprivation across the UK

Air pollution

Air pollution associated with marine and coastal transport and industry has been linked to adverse human health effects (UK Government 2010b). Further information is presented in Appendix 3e Air Quality.

Water quality

Effects on marine water quality as a result of marine pollution incidences, which may have their source both in the terrestrial and marine environment, can influence human health, for example, through the pollution of bathing waters or other recreational areas through unintentional oil or chemical spillages (UK Government 2010b). However, Defra (2010d) indicate that in general the microbiological quality of bathing waters and shellfish growing waters does not appear to be a significant issue throughout the UK.

Coastal erosion and flooding

Many coastal areas are at risk of flooding, sea-level rise and erosion, which may be exacerbated by climate change. Shoreline Management Plans (SMPs) have been developed for England and Wales which provide an assessment of the risks associated with coastal erosion and flooding at the coast. They also present policies to help manage these risks to people and to the developed, historic and natural environment in a sustainable manner. Appendix 3b Geology, Substrates and Coastal Geomorphology provides further details of SMPs and possible environmental effects from increased coastal defences and sand extraction for beach nourishment.

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APPENDIX 3h – OTHER USERS AND MATERIAL ASSETS (INFRASTRUCTURE, OTHER NATURAL RESOURCES)

The following sections provide an update to information presented in Appendix 3h of the OESEA Environmental Report (DECC 2009b).

A3h.1 UPDATE TO BASELINE INFORMATION

A3h.1.1 Relevant Initiatives

Since the OESEA, there have been a number of updates/revisions to initiatives of relevance to other users and material assets (infrastructure, other natural resources). A full list of relevant initiatives is presented below, with those which are new, updated, or now of relevance due to the new elements of the plan, distinguished below those previously considered in the OESEA. Note that only those new items are discussed below. A full narrative relating to these initiatives is given in Appendix 4.

Level	Other Users & Material Assets (OESEA / OESEA2)
International	United Nations Convention on the Law of the Sea (1982) The London Convention (1972) UN Fish Stocks Agreement (2001) FAO Code of Conduct for Responsible Fisheries Marine Pollution Convention, MARPOL 73/78 (the International Convention for the Prevention of Pollution From Ships, 1973 as modified by the Protocol of 1978) Basel Convention of the control of transboundary movements of hazardous waste and their disposal (1992) Convention on International Civil Aviation (Chicago Convention) 1944 Nairobi International Convention on the Removal of Wrecks 2007
International (OESEA2)	IMO draft Convention for the Safe and Environmentally Sound Recycling of Ships (2009)
Regional	European Transport Policy for 2010: A Time to Decide (2001) Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) (1992) Convention on the Future Multilateral Cooperation in North-East Atlantic Fisheries (NEAFC) (1982) Freight logistics in Europe - the key to sustainable mobility (2006) OSPAR Decision 98/3 on the disposal of disused offshore installations OSPAR Guidance on Environmental Considerations for Offshore Wind Farm Development (2008)
EU	Sulphur Content of Marine Fuels Directive 2005/33/EC (2005) Directive on Waste (2006/12/EC) and Revised Directive on Waste 2008/98/EC (2008) EC Directive on Port Reception Facilities 2000/59/EC (2000) EU Integrated Maritime Policy (2007) EC Shellfish Waters Directive 2006/113/EC (2006) EC Roadmap on Maritime Spatial Planning: Achieving Common Principles in the EU A European Strategy for Sustainable, Competitive and Secure Energy. European Commission Green Paper, 2006. COM(2006)105 An Energy Policy for Europe. Communication from the Commission to the European Council and the European Parliament. COM(2007)1 EU Energy Security and Solidarity Action Plan: Second Strategic Energy Review - Securing our Energy Future

EU

Green Paper: Towards a Secure, Sustainable and Competitive European Energy Network. COM(2008)782
Communication on Offshore Wind Energy: Action needed to deliver on the Energy Policy Objectives for 2020 and beyond. COM(2008)768
Communication on the Directive 2004/67/EC concerning measures to safeguard security of natural gas supply. COM(2008)769
European Commission White Paper - European transport policy for 2010: time to decide (2001)
Regulation (EC) No 1692/2006 of the European Parliament and of the Council of 24 October 2006 establishing the second Marco Polo programme for the granting of Community financial assistance to improve the environmental performance of the freight transport system (Marco Polo II) and repealing Regulation (EC) No 1382/2003
Decision No 884/2004/EC amending Decision No 1692/96/EC on community guidelines for the development of the trans-European transport network
European Council Directive 91/689/EEC (the Hazardous Waste Directive as amended)
Council Directive 2001/77/EC on the Promotion of Electricity from Renewable Energy Sources in the Internal Electricity Market (Renewables Directive) (2001)
Commission Regulation (EC) No 1013/2006 on shipments of waste
Commission Regulation (EC) No 1418/2007 concerning the export for recovery of certain waste listed in Annex III or IIIA to Regulation (EC) No 1013/2006 to certain countries to which the OECD Decision on the control of transboundary movements of wastes does not apply
Commission Regulation (EC) No 669/2008 on completing Annex 1C of Regulation (EC) No 1013/2006

UK

National Fisheries Policy: Fisheries 2027 (Defra 2007)
British Shipping: Charting a new course. (DfT, 1998)
A project appraisal framework for ports (DfT, 2002)
Delivering a Sustainable Transport System (DfT, 2008)
UK Ship Recycling Strategy (2007)
The Energy White Paper: Meeting the Energy Challenge (2007)
The Renewables Obligation (introduced 2002)

Our Seas - A Shared Resource. High Level Marine Objectives (2009)
The UK Low Carbon Transition Plan (2009)
Framework for the Development of Clean Coal (FDCC) (2009)
Marine and Coastal Access Act 2009
Draft National Policy Statement for Ports (DfT, 2009)
Draft Overarching National Policy Statement for Energy (EN-1) and those for Fossil Fuels, Renewables, Gas Supply and Gas and Oil Pipelines, and Electricity Networks (EN 2-5) (2009)
Marine Energy Action Plan (2010)
Clean Coal Industrial Strategy (2010)
Wreck Removal Convention Bill
The Energy Act 2008 (Consequential Modifications) (Offshore Environmental Protection) Order 2010
The Renewable Energy Strategy (2009)
The Sea Fishing (Illegal, Unreported and Unregulated Fishing) Order 2009

Local

Sea Fishery Committee bylaws (England & Wales) - these will transfer to the Inshore Fisheries and Conservation Authorities on 1st April 2011.
Technical Advice Note 8: Renewable Energy (Wales) - does not cover offshore elements of a development, but makes mention of any associated infrastructure that takes place on land
Coastal Tourism Strategy for Wales (2008)
Strategic Framework for Inshore Fisheries in Scotland (2005)
Technical Advice Note 13: Tourism (Wales)
The Wales Freight Strategy (2008)
The Wales Transport Strategy (2008)
Wales Fisheries Strategy (2008)
Draft framework for the development and deployment of renewables in Scotland (2008)
Renewable Energy Route Map for Wales (2008)
Waste Strategy for England (2007)
The National Waste Strategy and the National Waste Plan 2003 (Scotland)
Wise about Waste, The National Waste Strategy for Wales (2006)

Local	
	The Northern Ireland Waste Management Strategy 2006-2020 (2010) Offshore Renewable Energy Strategic Action Plan 2009-2020 and Offshore Wind and Marine Renewables Energy SEA Environmental Report (Northern Ireland) (2010) Northern Ireland Strategic Energy Framework (2010) Scottish Enterprise and Highlands and Islands Enterprise National Renewables Infrastructure Plan (2010) National Transport Plan for Wales (2010) A Fresh Start: The Renewed Strategic Framework for Scottish Aquaculture (2009) Welsh Assembly Government's Energy Policy Statement (2010) WAG Marine Renewable Energy Strategic Framework (2007) Scottish Government: The Carbon Capture and Storage Roadmap (2010) Draft Plan for Offshore Wind Energy in Scottish Territorial Waters (2010) Draft framework for the development and deployment of renewables in Scotland (2010) The Marine (Scotland) Act 2010

The High Level Marine Objectives (HLMOs) provide an overarching context agreed between the UK Government and devolved administrations within which the full range of marine policies can be reflected. Both environmental and socio-economic aspects of the marine environment are considered, including the intrinsic link between the healthy function of the marine environment and the resources which may be extracted from it. The objectives are based around the five principles of sustainable development, and those which are most pertinent to Appendix 3h fall within the category, *Achieving a sustainable marine economy*, and are:

- Infrastructure is in place to support and promote safe, profitable and efficient marine businesses
- The marine environment and its resources are used to maximise sustainable activity, prosperity and opportunities for all, now and in the future
- Marine businesses are taking long-term strategic decisions and managing risks effectively. They are competitive and operating efficiently
- Marine businesses are acting in a way which respects environmental limits and is socially responsible. This is rewarded in the marketplace

The HLOs have already helped to underpin the preparation of a draft Marine Policy Statement and will also be used to guide the development of Marine Plans, both of which are statutory requirements under the Marine and Coastal Access Act 2009.

The marine licensing regime for a number of activities is to undergo changes resulting from the Marine and Coastal Access Act 2009. The Act combines the regimes under FEPA, the Coast Protection Act 1949 and Telecommunications Act 1984 (Schedule 2 Electronic Communications Code). Activities (in England and Wales) will be regulated by the Marine Management Organisation (MMO) which will control the environmental, navigational, human health and other impacts of constructions, deposits and removals in the marine environment for matters that are not devolved; an exception being major (or nationally significant) infrastructure projects (e.g. offshore marine renewable energy projects of greater than 100MW capacity) for which decisions are considered separately as indicated in the Planning Act 2008. In Scotland, Marine Scotland has been established as the relevant authority with marine planning and policy responsibilities, and in Northern Ireland, the Northern Ireland Environment Agency (NIEA) will be the licensing and enforcement authority (as part of the Department of the Environment).

A significant fraction of renewable energy generation in the next 10 years will come from offshore wind and other marine renewables as they become technically and economically feasible, and the UK has a legally binding target to produce 15% of its energy from renewable sources by 2020. These will help deliver part of the government targets to reduce carbon dioxide equivalent emissions (34% on 1990 levels by 2020) and increase renewable energy deployment (30% of electricity by 2020) as outlined in the UK Low Carbon Transition Plan and 2007 Energy White Paper. Devolved Governments have also released a number of documents outlining their commitment to the low carbon transition, such as the Welsh Assembly Government Energy Policy Statement, Scotland's Draft Framework for the Development and Deployment of Renewables, and the Northern Ireland Strategic Energy Framework. The UK Government Renewable Energy Strategy sets out what is required to achieve the desired (and legally binding) renewables targets, including the role of government, individuals and businesses. A commitment set out in the strategy was the development of a Marine Action Plan, which considers wave, tidal stream and tidal range technologies, the potential resource which may be utilised by these, the economic benefits of their development and the challenges faced in their deployment. The Action Plan also makes a comprehensive list of recommendations covering a range of economic, environmental and permitting aspects of marine renewables development. These are too numerous to list here but may be viewed on the DECC website.

The Framework for the Development of Clean Coal (FDCC) forms part of the wider plan to reduce carbon emissions connected with anthropogenically augmented climate change and other undesirable environmental effects including ocean acidification. The key elements of the FDCC are:

- all new coal-fired power stations must demonstrate CCS at commercial-scale (around 400MW of output)
- a programme of 4 commercial-scale demonstration projects on coal-fired power stations (funded by the proposed CCS incentive) and an expectation that these power stations will retrofit CCS to their full capacity by 2025 – note that only 1 demonstrator will now be funded, and that the competition for the selection of this project has also been opened to gas fired power stations. Further demonstrators may be funded through a levy on electricity as permitted under the Energy Act 2008
- a rolling review of progress in the development of CCS technology to culminate in a report, by 2018, that will consider the case for new regulatory and financial measures to drive the move to clean coal

The Office of Carbon Capture and Storage (OCCS) has been formed within DECC and is responsible for helping to deliver the initial demonstration projects and for setting the longer term strategy for wider deployment to 2030 through its UK CCS roadmap, which is yet to be compiled. This office also holds responsibility for the regulatory framework for CCS in the UK which will include a consultation on implementing the EU Directive on the geological storage of CO_2. A consultation on proposals for transposing the EU Directive into the Environmental Permitting (England and Wales) Regulations 2010 is at the time of writing being conducted by Defra. The OCCS is also responsible for increasing awareness with regards to CCS, including access to finance such as the EU New Entrant Reserve (NER).

Since the accident involving the Deepwater Horizon semi-submersible in the Gulf of Mexico and subsequent problems both in stemming the flow of oil from the open well and adverse environmental and socio-economic impacts, the UK Government instigated a review to put into context the present regulatory and safety procedures which ensure that the UK oil and gas sector operates appropriately. A number of steps were initiated including the recruitment of additional inspectors with a view to doubling the number of annual inspections on drilling rigs, a review of the indemnity insurance requirements of operating on the UKCS, and the establishment of an industry trade association (The Oil Spill Prevention and Response Advisory Group) by Oil and Gas UK to assess the strengths and weaknesses in how the UK would respond to such an incident in its waters. This body includes representatives from both industry and the regulators.

In order to implement the same environmental regulations which apply to the oil and gas industry to the storage and offloading of combustible gas, and the storage of CO_2 (i.e. those activities licensed under the Energy Act 2008), the Energy Act (Consequential Modifications) (Offshore Environmental Protection) Order 2010 has been drafted. This instrument ensures that regulations including the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended), the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended), the Offshore Combustion Installations (Prevention and Control of Pollution) Regulations 2001 (as amended) and the Offshore Marine Conservation (Natural Habitats, &c) Regulations 2007 (as amended) apply to these new developments.

Shipping and port activity has expanded considerably in recent years, particularly since the introduction of the tonnage tax in 2000, and will remain the principal means by which the UK exchanges goods. Ships, though emitting less CO_2 per tonne of goods transported than other methods of bulk transport, represent a significant source of anthropogenic gaseous and particulate emissions (see Appendix 3e, Air Quality). These emissions are presently unregulated (though MARPOL provides a method through which the sulphur content of fuel will be reduced), though a cap and trade scheme may soon emerge from an international agreement.

UK fisheries have reduced in recent years in part due to declining fish stocks and resulting management techniques including catch and effort management. The UK National Fisheries Policy: Fisheries 2027 aims to help reach a balance between economic, social and environmental priorities and impacts, with a view to developing sustainable fisheries. The Marine and Coastal Access Act aims to strengthen fisheries and environmental management protection. Inshore fisheries management will be handled by new authorities, the Inshore Fisheries and Conservation Authorities (IFCAs), replacing the current Sea Fisheries Committees. IFCAs will be responsible for activities out to 6nm from the coast and in estuaries, where they will be responsible for sea fisheries management. In Scotland, prior to the Marine (Scotland) Act 2010, Marine Scotland was set up to take control of a number of a number of functions from existing bodies such as the Scottish Government Marine Directorate, Fisheries Research Services and the Scottish Fisheries Protection Agency, as well as the core marine policy and regulatory functions of the Scottish Government.

A3h.2 PORTS AND SHIPPING

The following sections provide an update to information presented in Appendix A3h.2 of the OESEA Environmental Report (DECC 2009b).

A3h.2.1 Changes in UK Context

A3h.2.1.1 Ports

The 2009 maritime statistics published by the Department for Transport (DfT 2010) provide updated figures on UK port activity. In 2009 UK ports handled 501 million tonnes (Mt) of freight traffic, 61 million tonnes (11%) less than in 2008 (DfT 2010). Table A3h.1 indicates the top five UK ports in 2009 in terms of tonnage.

Table A3h.1 – Top 5 UK ports in 2009 in terms of tonnage

Port	Million Tonnes	
	2009	2008
Grimsby & Immingham	54.7	65.3
London	45.4	53.0
Milford Haven	39.3	35.9
Tees & Hartlepool	39.2	45.4
Southampton	37.2	41.0

Source: Maritime Statistics 2009 (DfT 2010)

The UK's busiest port, Grimsby & Immingham, handled 11% of the UK's traffic, London 9% and both Milford Haven and Tees & Hartlepool 8%. Dover, the leading Ro-Ro port, handled 2.3 million road goods vehicles and unaccompanied trailer units (marginally down on 2008), whilst Felixstowe, the leading container port, handled 1.86 million containers, a 4% decrease on 2008. Milford Haven (38 million tonnes) and Forth (31 million tonnes) were the leading ports for oil and gas traffic in 2009 and together with Tees & Hartlepool and Southampton, handled more than half of all such traffic. In total the top 52 ports within the UK handled 98% of all freight traffic.

Compared with 2008, inward traffic fell 12% (to 304 Mt) and outward traffic fell 9% (to 197Mt). Foreign imports and exports, and domestic traffic all fell, by 14%, 11% and 6% respectively. Ports in each of the countries of the UK handled less traffic in 2009 than in 2008 with falls of 4% in Wales, 11% in Scotland, and 12% in both Northern Ireland and England.

A3h.2.1.2 Commercial shipping and ferry routes

The commercial shipping industry had a turnover of £10,235m in 2008 (DfT 2009), with 501Mt of freight passing though UK ports in 2009 (DfT 2010). The industry also employed 26,700 UK nationals offshore and 58,100 people at associated port facilities in 2009 (DfT 2010). The routes taken by commercial shipping and oil and gas support vessels remain unchanged from the OESEA (with higher resolution data ($1km^2$) presented in Figures A3h.1-A3h.4), with anchorages and places of refuge also remaining valid.

A report compiled by DECC into ship navigation around existing wind farms (DECC 2010p) presents AIS data of before and after construction for 3 operational wind farms (Barrow, Thanet and Greater Gabbard), passing distances of shipping from 3 OWF (Burbo Banks, Scroby Sands and Kentish flats) and baseline shipping information at the proposed Tees, London Array, Humber Gateway and Gwynt y Mor sites. The change in patterns of routes taken by shipping in response to wind farm construction is discussed further in Assessment Section 5.7 but the data presented in the DECC report shows that the proximity of passing shipping to constructed OWF depends on a number of factors:

- Vessel characteristics (physical characteristics, dynamics, manoeuvrability and human factors)
- Environmental characteristics (hydrodynamics, meteorology and area characteristics

Figure A3h.1 – IMO routing and ship AIS tracking, January 1-7 2008

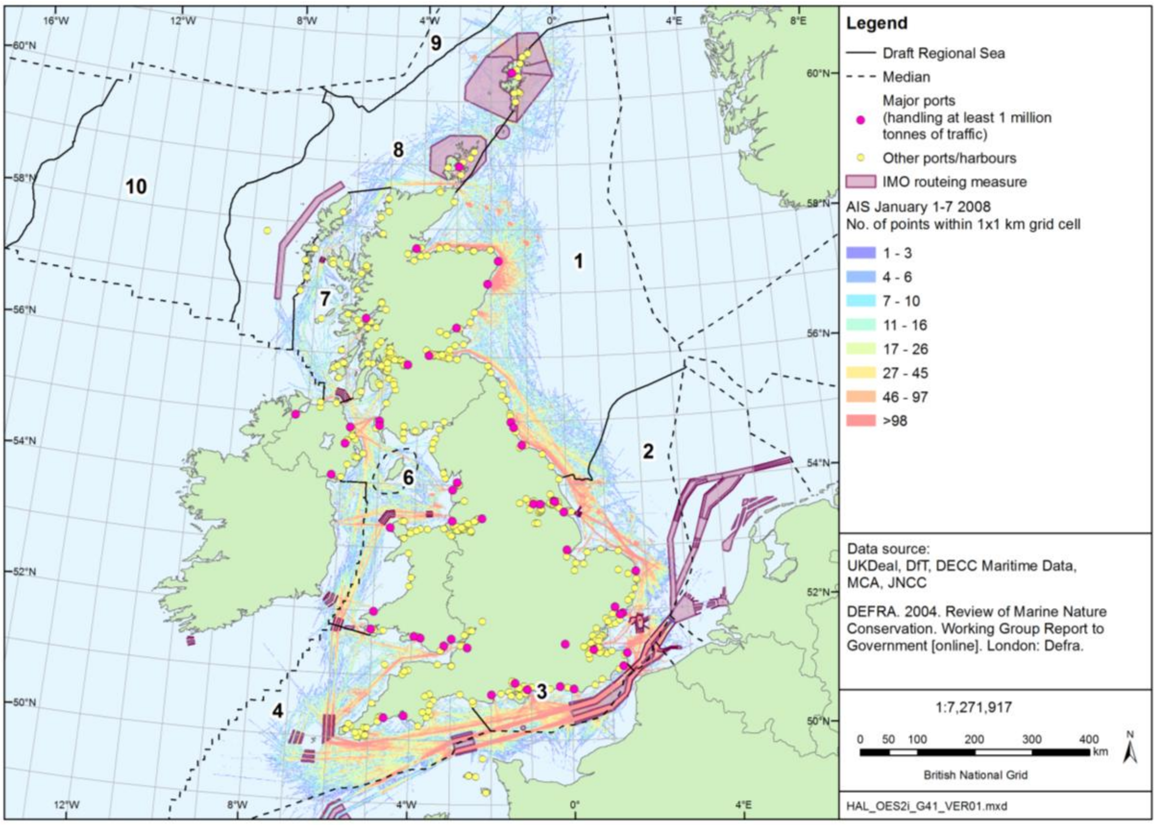


Figure A3h.2 – IMO routing and ship AIS tracking, March 1-7 2008

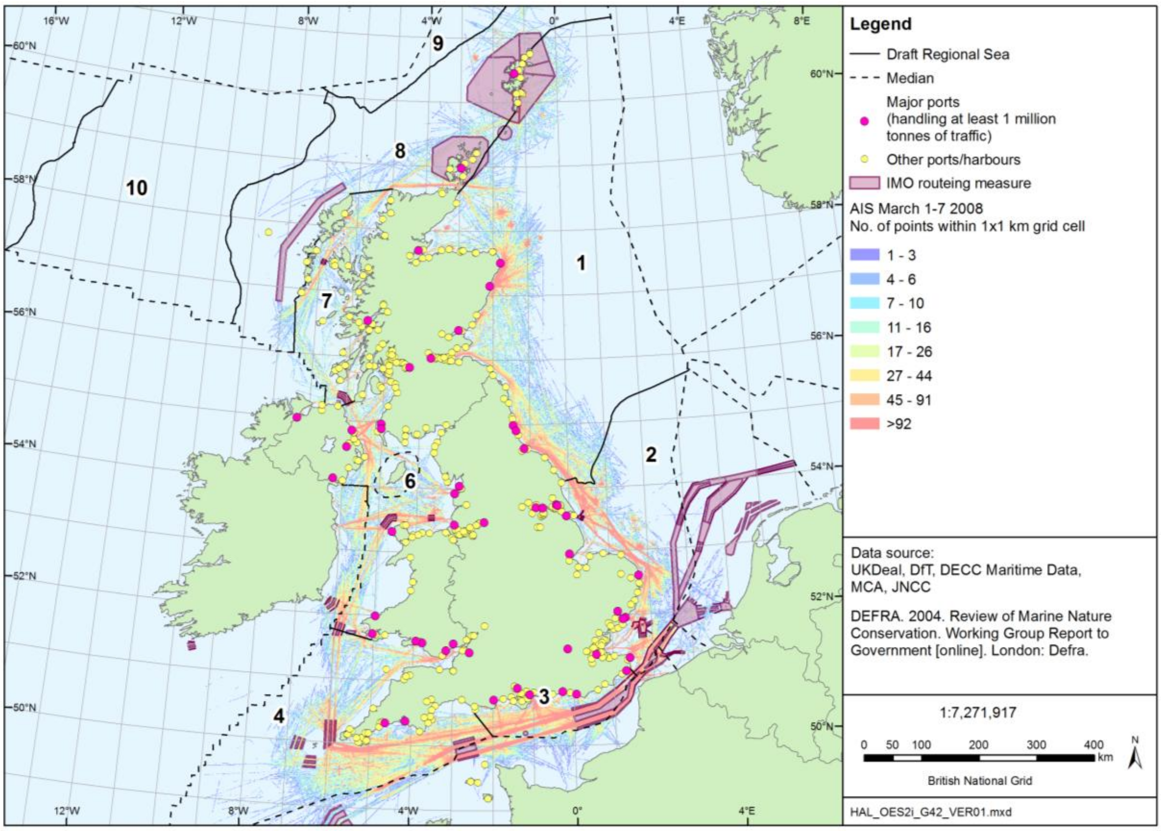


Figure A3h.3 – IMO routing and ship AIS tracking, June 1-7 2008

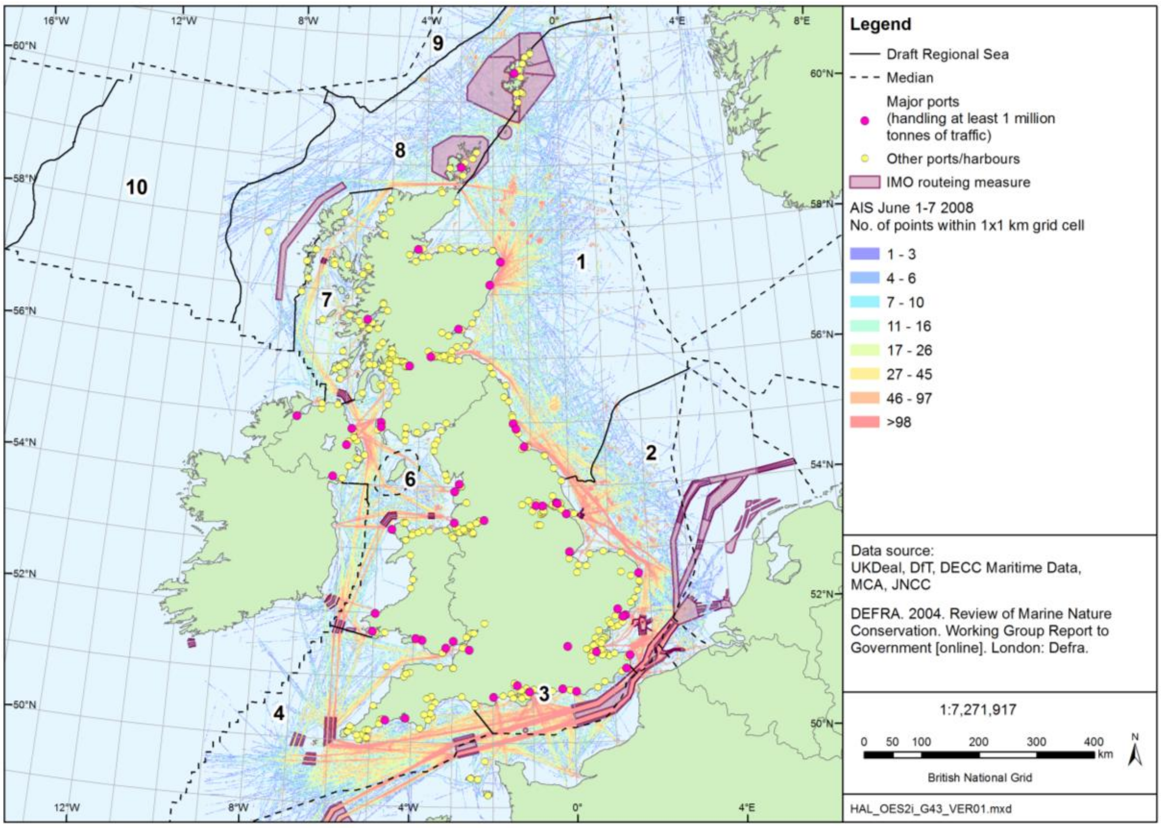
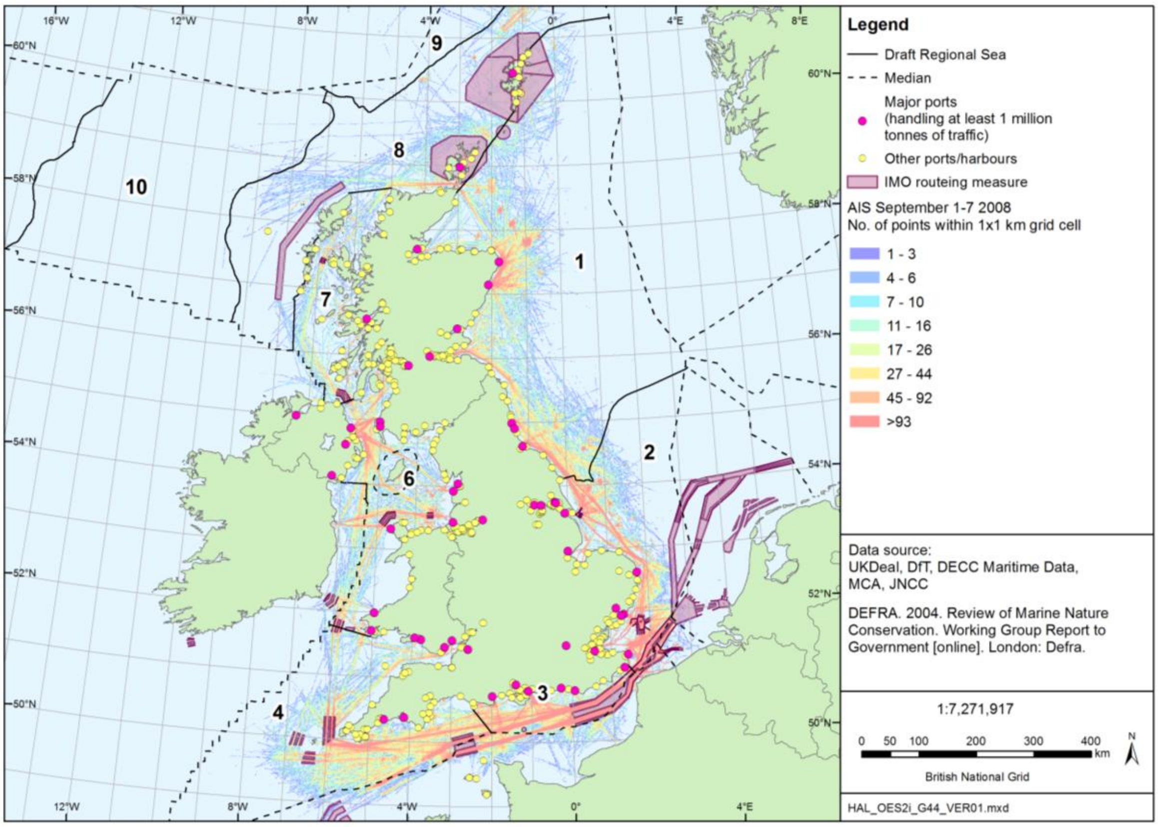
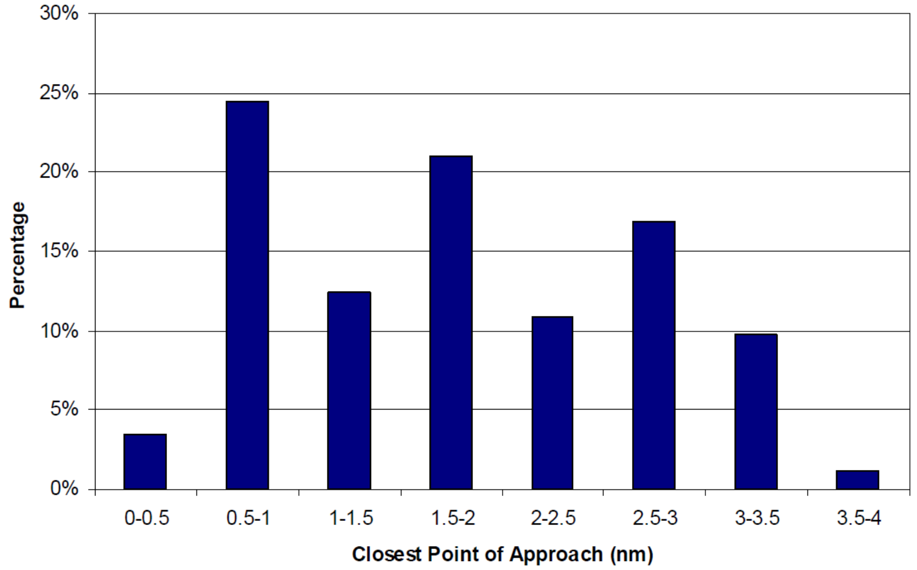


Figure A3h.4 – IMO routing and ship AIS tracking, September 1-7 2008



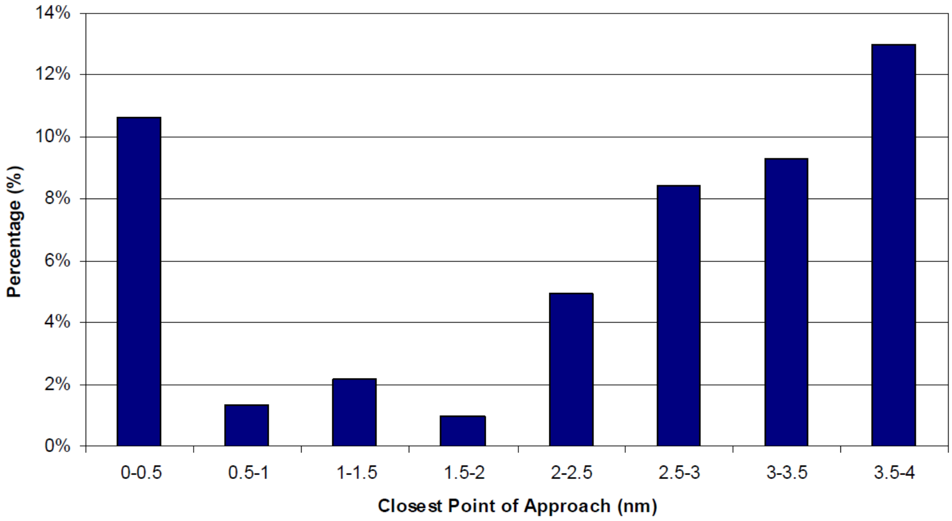
The report suggests that in general the closest point of approach for different vessels and different conditions to OWF ranges from 0.5-2nm. Data for the Barrow wind farm (Figure A3h.5) shows that on average 11 vessels per day pass within 2nm of the OWF boundaries, 4 vessels per day pass within 1 nm and less than 1 vessel per day passes within 0.5nm (excluding harbour control, direct OWF related vessels and lifeboats). However data for the Scroby Sands development (Figure A3h.6) shows far greater numbers of vessels within 1nm of the OWF (8 per day within 1 nm and 7 per day within 0.5nm). This difference in proximity of avoidance is related to the local topography of the region, with the Scroby Sands site located very close to the Caister Road channel, used by vessels travelling to/from Great Yarmouth and Lowestoft to avoid the shallow water (below 10m LAT) at Caister Shoal and Great Scroby.

Figure A3h.5 – CPA distribution data for vessels within 4nm of Barrow wind farm



Source: DECC (2010p)

Figure A3h.6 – CPA distribution data for vessels within 4nm of Scroby Sands wind farm



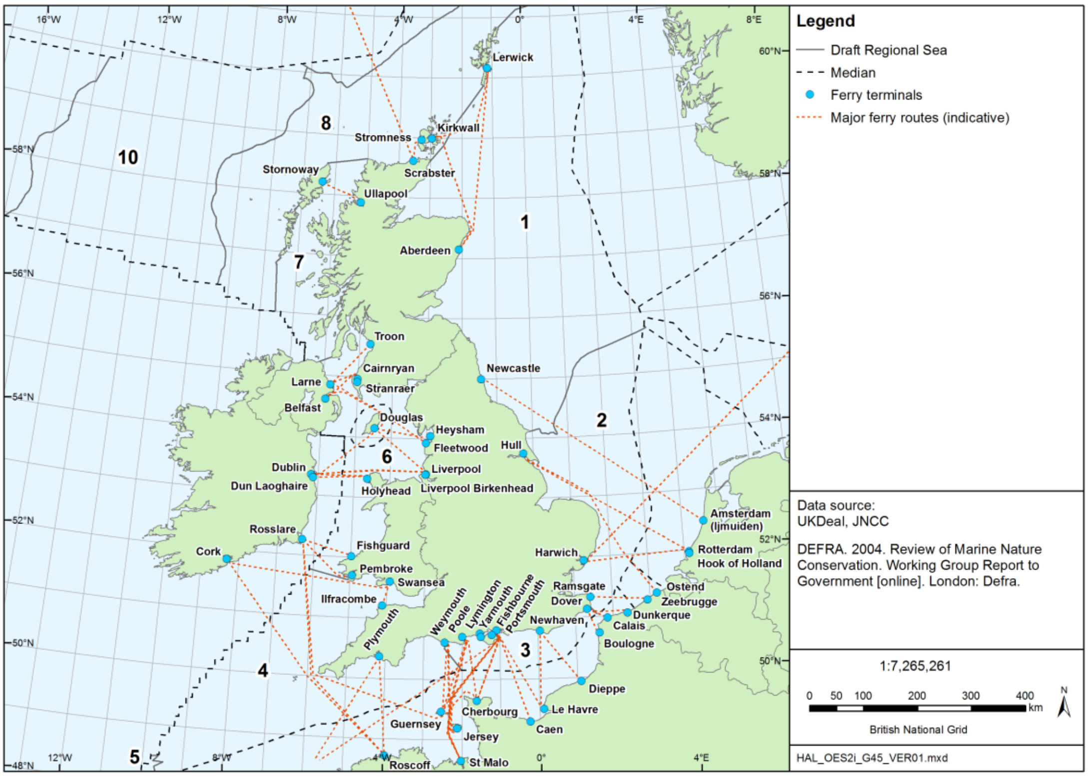
Source: DECC (2010p)

The number of vessels recorded within the boundaries of the OWF over the survey periods ranged from 1 at Burbo Bank (Liverpool harbour pilot vessel) or 2 at Scroby Sands (lifeboat on 2 occasions) and Kentish Flats (1 fishing vessel and 1 passenger/inland waterways vessel), to 16 for Greater Gabbard, composed of fishing vessels and recreational craft. For all of these sites the vessels tracked as inside the OWF are all of a small size, with the only exception being the Thanet OWF site where of the recorded 13 tracks intersecting with the development over the 27 day survey period a small number were actually cargo ships cutting the edge of the construction site (the rest being fishing vessels and recreational craft).

There have been a number of updates with respect to UK ferry routes (see Figure A3h.7):

- The Rosyth to Zebrugge passenger ferry crossing will be permanently cancelled from 15th December 2010.
- A petition has been launched to re-instate a ferry link between the Shetland Isles and Norway (DF news: http://www.directferries.co.uk/news/2010august.htm).
- A new ferry route linking Swansea to Illfracombe is due to start in 2011.

Figure A3h.7 – Ferry terminals and indicative ferry routes



The HMS coastguard responded to 18,759 incidents in 2008 (DfT 2009), with the RNLI recording 9,223 launches in 2009 (RNLI 2010) broken down by Regional Sea in Table A3h.2. Whilst these emergency services do not have a set pattern of routes, the RNLI operate out of 235 lifeboat stations spread around the UK and Republic of Ireland coastline (see Figure A3h.8) and cover all UK waters.

Table A3h.2 – Number of incidents to which RNLI lifeboats responded in 2009

RNLI Area	Regional Sea	Number of Incidents
East	2*, 3	2933
Ireland	6*, 7* (plus ROI waters)	990
North	1*, 2*	1288
Scotland	1*, 7, 8, 9,10,11	1122
South	4	1671
West	6	1206
No Division		13

*Notes: * denotes part of a regional sea only: ROI = Republic of Ireland; RNLI areas are shown in Figure A3h.8*
Source: RNLI (2010)

Figure A3h.8 – Map of UK lifeboat stations and regional areas

Source: RNLI (2010)

A3h.2.1.3 Renewable energy and port facilities

The possible lack of UK port availability and capacity is seen by European wind turbine manufacturers and offshore wind developers as a disincentive to invest in UK projects. DECC commissioned an independent study (DECC 2009d) to consider: the requirements of the offshore industry for ports; current UK port capabilities; the opportunity for UK ports and potential port expansion or development to meet the needs for the offshore wind sector.

In terms of meeting the obligations of Rounds 1-3 of offshore wind farm development by 2020 and the anticipated number of turbines required; 6,440 turbines are expected to be installed in UK waters (excluding Scottish and Northern Ireland territorial waters) by 2020; the study outlined the requirements for both manufacturing and construction.

Requirements for manufacturing sites are:

- Located on North Sea or English Channel to enable export to continental projects as well as supplying UK offshore projects;
- Up to 500ha of flat area for factory and product storage;
- Direct access to dedicated high load bearing deep water quayside (minimum 500m length);
- Ease of landside logistics and access to skilled workforce.

Typical construction port requirements in order to handle 100 wind turbines a year include:

- At least 8ha suitable for lay down and pre assembly of product;
- 200-300m length of quayside with high load bearing capacity and adjacent access;
- Water access to accommodate vessels up to 140m length, 45m beam and 6m draft with no tidal or other access restrictions;
- Overhead clearance to sea of 100m minimum (to allow vertical shipment of towers);
- Sites with greater weather restrictions on construction may require an additional lay-down area, up to 30ha.

Table A3h.3 outlines the numbers of ports by region required to meet the Rounds 1-3 production targets (based on a typical installation capacity of 100 turbines per port per year).

Table A3h.3 – Number of ports per region required to meet production targets

Coastal region	**Years (2009-2020)**											
	'09	**'10**	**'11**	**'12**	**'13**	**'14**	**'15**	**'16**	**'17**	**'18**	**'19**	**'20**
Southern North Sea	2	2	2	3	2	2	2	3	4	5	6	6
North East	0	0	1	0	0	0	1	1	2	2	3	3
Scotland East	0	0	0	1	1	1	1	1	2	2	2	2
Scotland West	0	0	0	0	0	0	0	0	0	0	0	0
Irish Sea	2	1	1	1	2	2	1	1	1	2	2	2
Bristol Channel & Wales West Coast	0	0	1	1	0	1	1	1	2	2	1	1
South Coast	0	0	0	0	0	0	1	1	1	1	1	1
Total	**4**	**3**	**5**	**6**	**5**	**6**	**7**	**8**	**12**	**14**	**15**	**15**

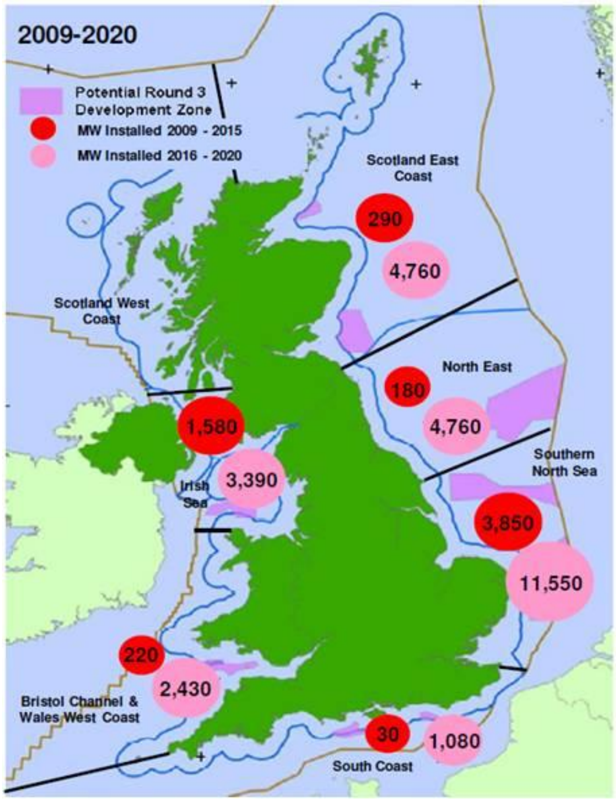
Source: DECC (2009d)

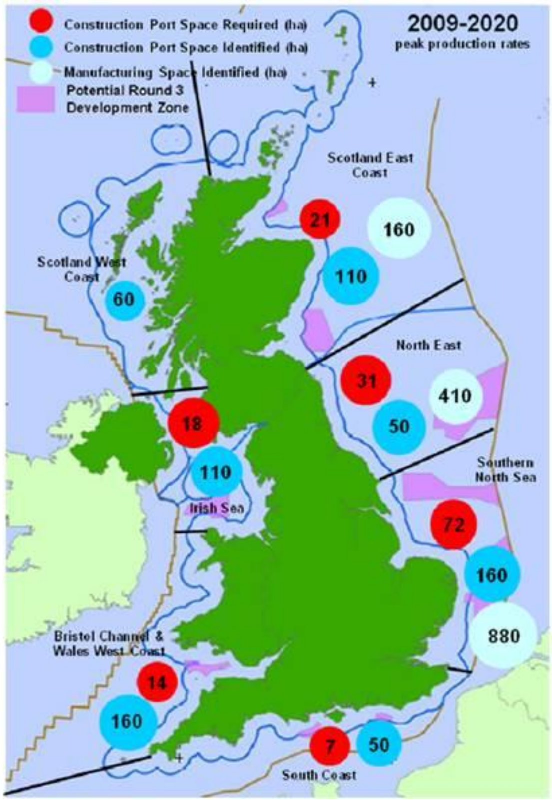
The most significant issue identified in the report is the problem of finding sufficient port capacity for construction of projects, due mainly to a lack of additional land of the scale required. Figure A3h.9a details the expected geographical distribution of offshore wind capacity to be installed and the port space required for its construction (Figure A3h.9b).

The report suggests that to meet the 2020 renewable energy target at least six locations distributed around the UK need to be available for use from 2014 onwards. These locations will need to be offered to developers by 2011 at the latest, to be factored into project plans (DECC 2009d).

Figure A3h.9 – Expected offshore wind capacity to be installed and port space required

a) Expected capacity to be installed[1] b) Space required for construction[2]





Note:

1. *Offshore wind capacity (MW) expected to be Installed off UK (split by coastal region), excluding projects in Scottish and Northern Irish territorial waters.*
2. *Based on 25 ports that have been identified as having the capacity to support the expected offshore wind capacity to be installed. These ports and their facilities are detailed further in the UK Offshore Wind Ports Prospectus (DECC 2009f).*

Source: DECC (2009d)

Scottish Enterprise and Highlands and Islands Enterprise (2010) have produced a National Renewable Infrastructure Plan Stage 2 which indicates that an investment of £223 million would create a set of 11 clustered port sites which could support the manufacturing of 750 complete offshore wind units a year. The plan states that in order to secure industry use, sites would have to be ready by 2013/14 and earlier for some users, in time for Round 3 and Scottish territorial waters wind farm installation to begin.

In terms of infrastructure requirements for wave and tidal installations, which are still evolving, the Crown Estate has commissioned a report on the 'Build Out' of the Pentland Firth and Orkney Waters leasing programme, due in November 2010, in partnership with Scottish Government, Highland and Islands Enterprise and Local Authorities. The plan acknowledges that the delivery of the Pentland Firth and Orkney Waters commercial scale leasing programme from 2016 will require development of port infrastructure proposals alongside development of the technology and deployment techniques (Scottish Enterprise and Highlands and Islands Enterprise 2010).

A3h.2.1.4 Recreational shipping/sailing

The information presented in the OESEA on recreational cruising routes and use of UK waters, as derived from the RYA atlas of recreational boating remains unchanged, though 2009 mapping updates of the atlas of recreational boating are presented in Figures A3h.10-A3h.13. An update on recreational use of UK waters is provided in Section A3h.11 Tourism and Recreation.

Figure A3h.10 – Recreational sailing, north east coast and Northern Isles

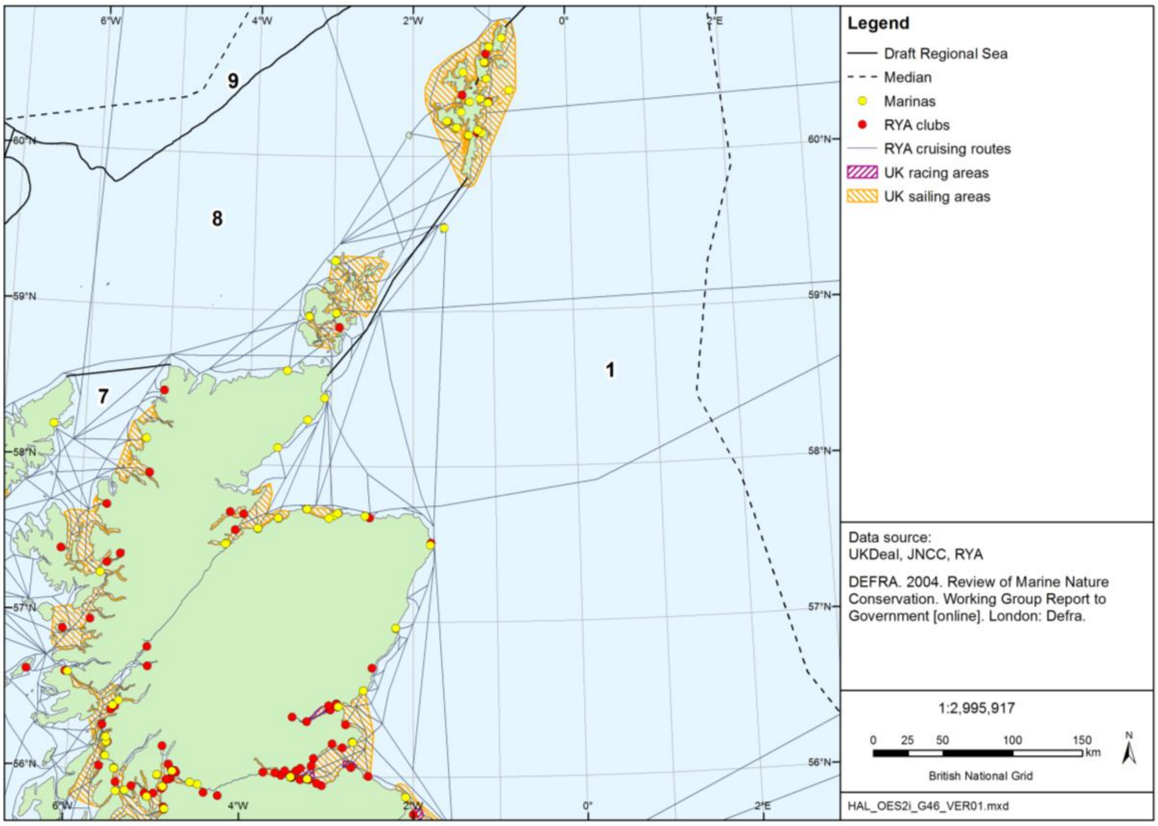


Figure A3h.11 – Recreational sailing, north west coast

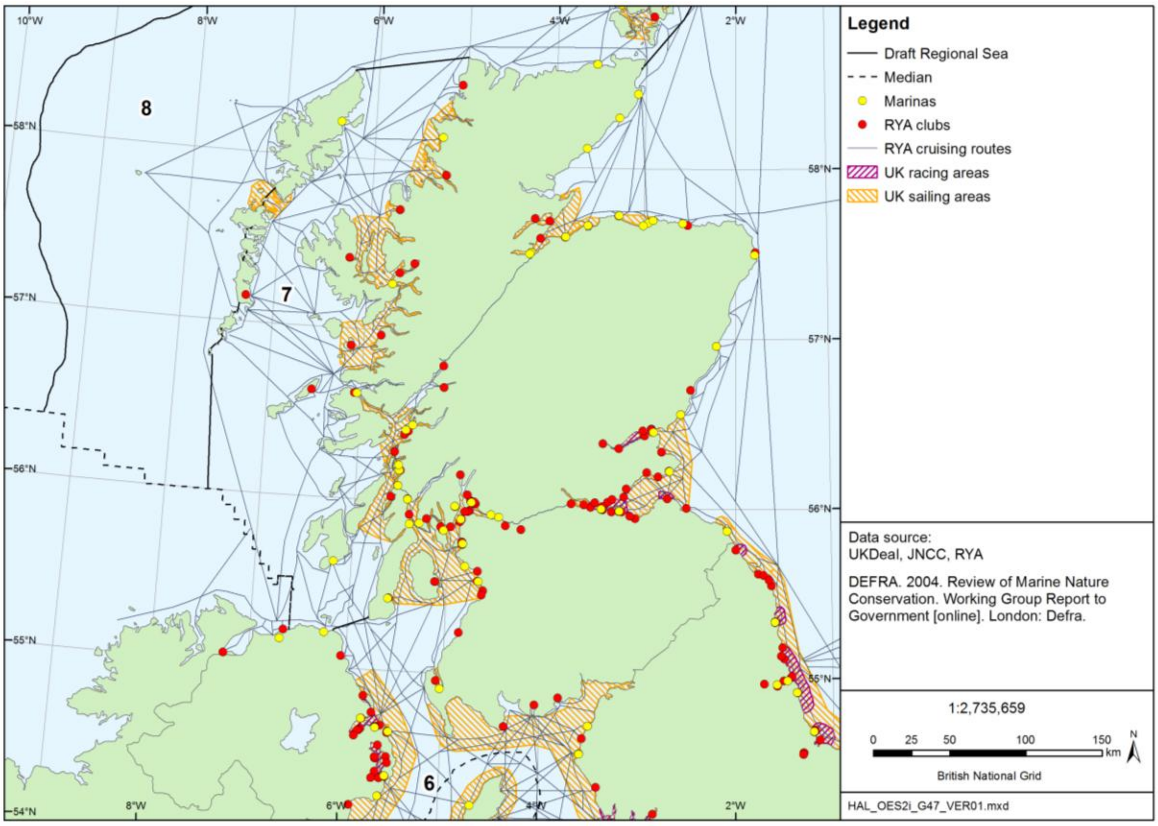


Figure A3h.12 – Recreational sailing, Southern Irish Sea, south west coast and Channel

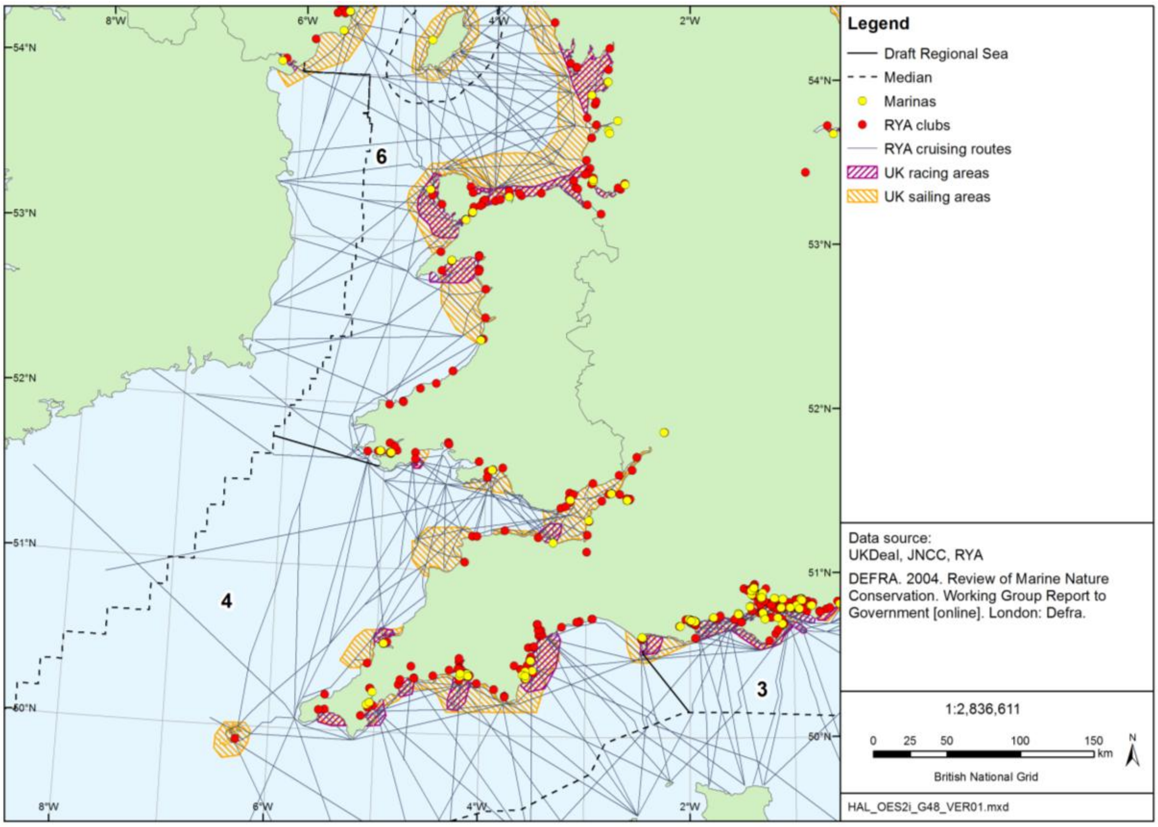
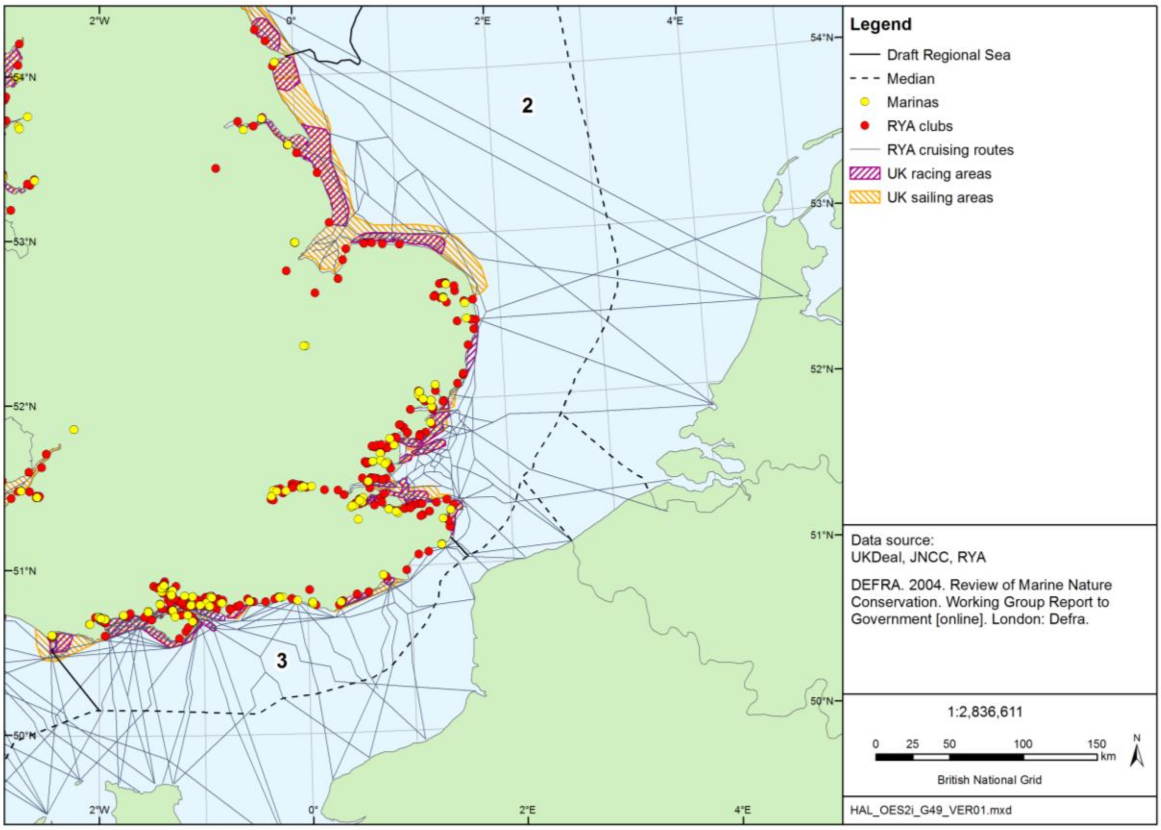


Figure A3h.13 – Recreational sailing, east coast and Channel



The number of people taking part in motor boating / cruising and yacht cruising / racing totalled 954,897 in 2009 (British Marine Federation *et al.* 2009), with 3.5 million people participating in all boating activities in the same year. The RYA has published guidance on the stance of the association in relation to offshore energy developments (RYA 2009), outlining general concerns including navigational safety, location and decommissioning and dereliction. The report recommends a minimum rotor height clearance above mean spring high water level of 22 metres and a minimum underwater clearance of 3.5m below mean low water springs to minimize the collision risk of recreational vessels (defined as those <24m in length) with renewable energy devices. It also outlines the potential exemption of small craft from safety zones around installations, minimum burial depth of cables required within arrays to allow for emergency anchoring and low level lighting that allows turbine numbers to be read from a safe distance, with corners and navigation routes through installations clearly lit. The issue of interference of especially OWF with navigational instruments is detailed further in Section A3h.3. In terms of locations for energy installations the concerns outlined by the RYA report focus on the loss of cruising routes, the subsequent squeeze of recreational vessels into commercial routes and the interference of OWF on wind speed and turbulence in areas used for racing.

A3h.2.2 Evolution of the Baseline and Environmental Issues

A3h.2.2.1 Evolution of the Baseline

Although 2009 saw a fall in traffic through ports compared to 2008, total traffic has increased since 1989 by 28Mt (6%). Whilst imports have also grown by 13% since 1999, exports have fallen by 25% and domestic traffic has fallen by 26%. This negative trend is seen across the

UK with falls in traffic through ports in Northern Ireland (2%), England and Wales (both 5%) and Scotland (34%) (DfT 2010).

The longer term trend however shows an increase in the number of freight units through UK ports from 2 million in 1970 to 11.7 million in 2009, road goods vehicles and unaccompanied trailers has also risen from less than 0.4 million in 1970 to 6.5 million in 2009 and container traffic rose from 1.5 million units in 1970 to 4.5 million in 2009 (DfT 2010).

Through-traffic in the wider North Sea region, especially by oil tankers, is expected to increase by 2020 with associated higher environmental risks especially in the busy shipping lanes (OSPAR 2010a). Growing ship traffic and ship size will also potentially impact on the dredging and dumping of sediments from shipping lanes, land reclamation and the construction of port facilities, especially in coastal areas.

Data on the alterations to navigation patterns as a result of OWF construction (DECC 2010p; discussed further in Section 5.7) suggest that depending on location, changes at proposed OWF locations will range from none to significant. At the planned Tees OWF site currently 3 vessels per day pass through the site itself (predominantly tankers and cargo vessels going to/from the Tees), with 41 vessels passing within 2nm per day, 31 within 1nm and 11 within 0.5nm. It is expected that with the construction on the OWF these vessels will be displaced to 0.5-2nm from the boundaries of the site. However at the planned London array the shipping currently using the Black Deep to the west of the site are already constrained by water depth (Long Sand on which the London array will be partially constructed) and therefore are not expected to be affected by the wind farm when operational. Similarly traffic separation schemes have been set up at the Humber Gateway and Gwynt y Mor OWF sites (DECC 2010p) in advance of the construction of the sites (see Section 5.7). These have been done to aid port traffic management and safety but have also worked to divert vessels away from the proposed sites.

Participation in recreational boat activities has remained at a reasonably stable level since 2002 with an increase in small sail boat activities in 2009 after a significant decrease in 2008 (Watersport and Leisure Omnibus 2009). The South East of England still dominates the spatial distribution of revenue generated by these activities (36%), with the South West (24%) and East of England (12%) following (Defra 2010a).

A3h.2.2.2 Environmental Issues

Construction of port facilities

The expected changes to port facilities and the increase in number of ports required for offshore marine energy manufacturing, construction and installation will have some environmental impacts. These could include acquiring land (loss of possible habitat and reclamation), noise impacts, changes in sediment regime through dredging, increased road and marine traffic, waste discharges and the construction of coastal defences to protect the ports and surrounding vulnerable areas (OSPAR 2010a).

Shipping

Defra (2010e) and OSPAR (2010a) summarise key environmental issues and impacts associated with maritime transport (Table A3h.4).

Table A3h.4 – Key environmental issues and impacts associated with maritime transport

Issue	Summary of impact
Habitat damage	• Infrastructure associated with shipping activity such as ports replaces natural coastline with man-made structures. • Capital and maintenance dredging associated with shipping can damage marine benthic habitats • Boat wash can damage habitats.
Noise impact	• Noise can arise from construction, ship movements and other operations. Background noise from commercial shipping thought to have doubled (3dB increase) every decade since the 1950's in busy shipping regions in OSPAR waters.
Death or injury by collision with vessels	
Introduction or spread of non-native species	Non-native species may be translocated or spread through the UK in ballast water and as fouling organisms on ships' hulls.
Release of anti-fouling substances	Release of chemicals may result in contamination of water and sediments and biological impacts on biota.
Waste discharges	Litter and sewage from ships • Risk of harm/death to marine wildlife through ingestion of, or entanglement in, marine litter. • Release of sewage introduces pathogens and nutrients into the water, affecting water quality and potentially passing on diseases to humans through contact with contaminated water or consumption of contaminated shellfish. • Release of oil, noxious substances and cargos • Accidental and incidental discharge of these substances may result in contamination of water and sediments and ecological impacts on wildlife, mariculture and tourism. • Discharge from port facilities, ship building and ship repair yards
Atmospheric pollution	Release of nitrogen oxides (NO_x), sulphur oxides (SO_x) and particulate matter into the atmosphere. Stringent emission standards (MARPOL, Annex VI) are in place to reduce air pollution especially in areas of high shipping density such as the North Sea.

Sources: Defra (2010e), OSPAR (2010a)

Accidental oil and chemical discharges from vessels and oil and gas installations are described in Appendix 3b Existing Contamination.

Introduction of non-native species

Introduction of non-native species via ship ballast water and hulls is a major concern for shipping, with figures suggesting that 55% of all non-native species introduced to UK waters are done so through shipping (Defra 2010e). Charting Progress 2 details several non-native species of concern, while the qualitative descriptors for determining good environmental status relating to non indigenous species in Annex 1 of the Marine Strategy Framework Directive states, "*Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem.*"

A3h.3 AVIATION

The following sections provide an update to information presented in Appendix A3h.3 of the OESEA Environmental Report (DECC 2009b).

A3h.3.1 Changes in UK Context

The information presented in the OESEA in relation to aviation remains unchanged, though a number of developments have taken place since its publication which are progressing the resolution of problems caused by offshore wind farms for civilian and military radar. Research into the effects of wind turbines on military and civilian radar continues with coordination provided by the Aviation Management Board (AMB) and Aviation Advisory Panel (AAP). Since the OESEA, one of the main research reports on the effects of wind turbines on radar is that conducted by the Ministry of Defence (MoD 2009) on the effects of wind farms on Precision Approach Radar (PAR) using the Rothes onshore wind farm site near its Lossiemouth RAF base. The results indicate a reduction in the performance of the PAR system, with a loss of radar coverage above and around the turbines. The coverage of this PAR system was an arc with a radius of ~20nm which, depending on the location of any offshore wind farm, may cause localised interference with the system.

Mitigation of such impacts may come not only in the form of appropriate siting to ensure the safeguarding of aerodromes, but also through the use of Radar Absorbing Materials (RAM), one such system having been developed between QinetiQ and Vestas with funding from UK Government and tested at North Pickenham, Norfolk. This technology significantly reduces radar return, though will not completely remove wind farms from military and civilian radar systems (DECC 2008a). A Raytheon sub-group of the DECC Aviation Management Board (AMB) is working with stakeholders to understand the cost and possible solutions of mitigating the impact of turbines on on-route radar sites. RenewableUK (formerly BWEA) is working with stakeholders to investigate solutions for each en-route radar site. Similarly, RenewableUK are working with the MoD to develop a better understanding of the impacts of wind on their systems and mitigate possible impacts. Those wind farms planned for the greater Wash provide a good example of how mitigation can lead to development of offshore wind in areas where objections by the MoD were raised due to possible effects on military radar systems (RenewableUK website).

A number of Civil Aviation Authority (CAA) guidance documents have received updates since the publication of OESEA, which include:

- CAA (2010a) Policy and Guidelines on Wind Turbines (CAP 764) – first released in 2006, this policy document has been subject to several revisions. The first in 2009 was to provide an update on Government renewable energy policy and the interaction of interested aviation parties. The scope of the document was widened to include all aspects of aviation that may be affected by wind turbines, and the methods used for determining radar line of sight have been simplified. The latest revision in 2010 updates references to the Air Navigation Order, which provides for the CAA to ensure that licensed aerodromes are safe for use.
- CAA (2010b) Air Traffic Services Safety Requirements (CAP 670) – provides guidance which air traffic service providers can use in order to safeguard against possible impacts arising from wind farm development and other activities.

A3h.3.2 Evolution of the Baseline and Environmental Issues

Exclusivity agreements are now in place for all of the nine Round 3 offshore wind sites (see A3h.6). These agreements, allied with the UK Government's carbon reduction and renewable deployment targets, will lead to a greater number of turbines of a larger size than those currently deployed, which may have implications for radar in certain circumstances, and up to the completion of the work-streams currently under way as part of the DECC Aviation Plan.

A3h.4 MILITARY ACTIVITY

The following sections provide an update to information presented in Appendix A3h.4 of the OESEA Environmental Report (DECC 2009b).

A3h.4.1 Changes in UK Context

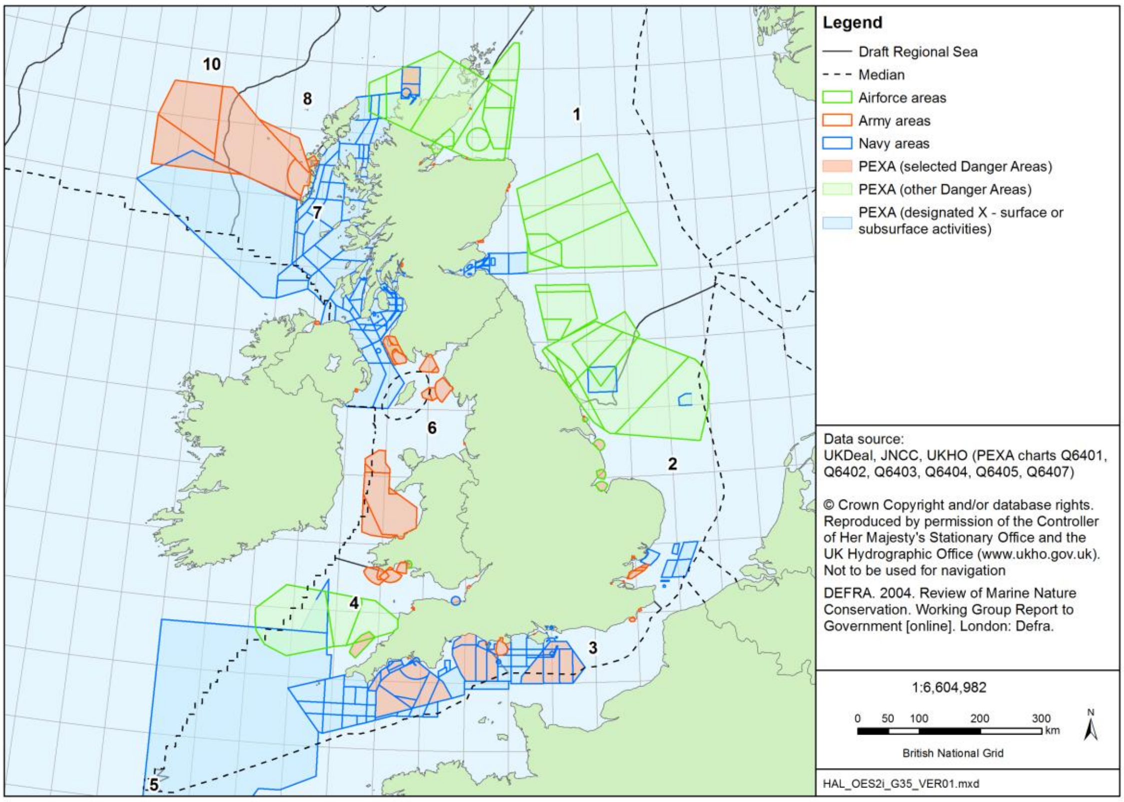
The number and geographical extent of most military practice and exercise areas (PEXAs) presented in OESEA remains unchanged, with the exception of a few modifications in Regional Seas 1, 2, 4 and 6 (Table A3h.5, Figure A3h.14).

Table A3h.5 – Changes to PEXAs since OESEA

RS	Serial #	Name	Nature of amendment	Amendment to activities
		Navy Areas		
4	X5010	Cawsand	Area deleted	-
4	X5016	Bexington	Area deleted	-
6	X5560	Arran	New area	AIR, HMS, Sub
		Army Areas		
1	X5405	Whitburn	Area deleted	-
4	**D113A**	Castlemartin	Area D113 subdivided	F, MF, PTA
	D113B	Castlemartin		F, MF, PTA
6	**D201**	Aberporth	Limits amended	F, B, PTA
	D201C	Aberporth	Area established	PTA
	D201D	Aberporth	Area established	PTA
	D411	Portpatrock (Wigtownshire)	Area deleted	-
		Air Force Areas		
4	**D064A**	South West MDA	New site	ACT, HEM
	D064B	South West MDA	New site	ACT, HEM
	D064C	South West MDA	New site	ACT, HEM

Notes: Danger areas are indicated in ***bold*** *type.*
Key: AIR=Air General, ACT=Air Combat Training, B=Bombing, F=Firing, HEM=High Energy Manoeuvres, HMS=HM Ships (non firing), MI=Missile Firing, PTA=Pilotless Target Aircraft, Sub=Submarine General (non firing).
Source: Notices to Mariners issued since OESEA2 publication

Figure A3h.14 – Location of PEXAs



A3h.4.2 Evolution of the Baseline and Environmental Issues

Owing to the confidential nature of military defence activities it is difficult to assess future plans. However, it is likely that training, surveillance and monitoring will continue at a similar level. Furthermore, a number of strategies are planned for implementation in relation to sustainable development and this may change the way that activities are carried out, resulting in reduced pressure on the marine environment and climate (Defra 2010e).

The EU Marine Strategy Framework Directive adopted in 2008 requires that measures are put in place to achieve Good Environmental Status (GES) in all UK marine waters by 2020. The indicators and targets for the eleven descriptors of GES have not yet been defined and agreed. As a result it is not yet possible to assess whether measures under existing legislation in relation to these descriptors are sufficient to achieve GES and whether the military defence sector will need to manage further its activities. For example, GES descriptor 11 states that “Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment”. However, it is likely that research to describe further the spatial and temporal extent of some pressures will be required in order to assist the assessment of GES (Defra 2010e).

A3h.5 OIL AND GAS ACTIVITY

The following sections provide an update to information presented in Appendix 3h.5 of the OESEA Environmental Report (DECC 2009b).

A3h.5.1 Changes in UK Context

In general the baseline information on the nature, extent and location of oil and gas activities on the UKCS presented in OESEA remains valid. Figures A3h.15 and A3h.16 provide details of the location of oil and gas infrastructure.

Since the OESEA, a number of offshore exploration, appraisal and development wells have been drilled (Table A3h.6). The majority of wells drilled in 2009 and 2010 (Quarters 1 and 2) have been development wells, primarily in the central and northern North Sea.

In 2009, about 77% of the UK's total energy consumption (excluding non-energy use) was provided by oil and gas (DECC 2010a). Offshore production figures for 2009 indicate that the UKCS produced almost 62 million m^3 of oil and 62.8 billion m^3 of gas (DECC oil and gas website).

Figure A3h.15 – Location of existing oil and gas infrastructure (north)

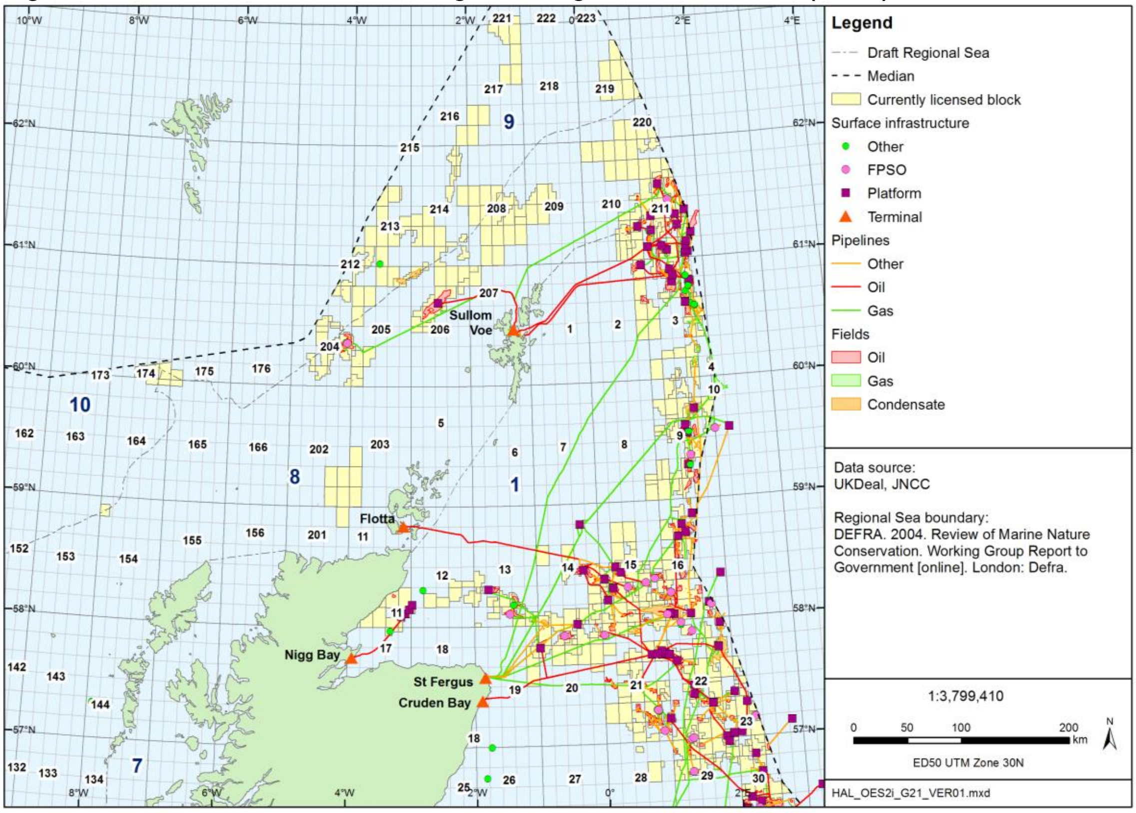


Figure A3h.16 – Location of existing oil and gas infrastructure (south)

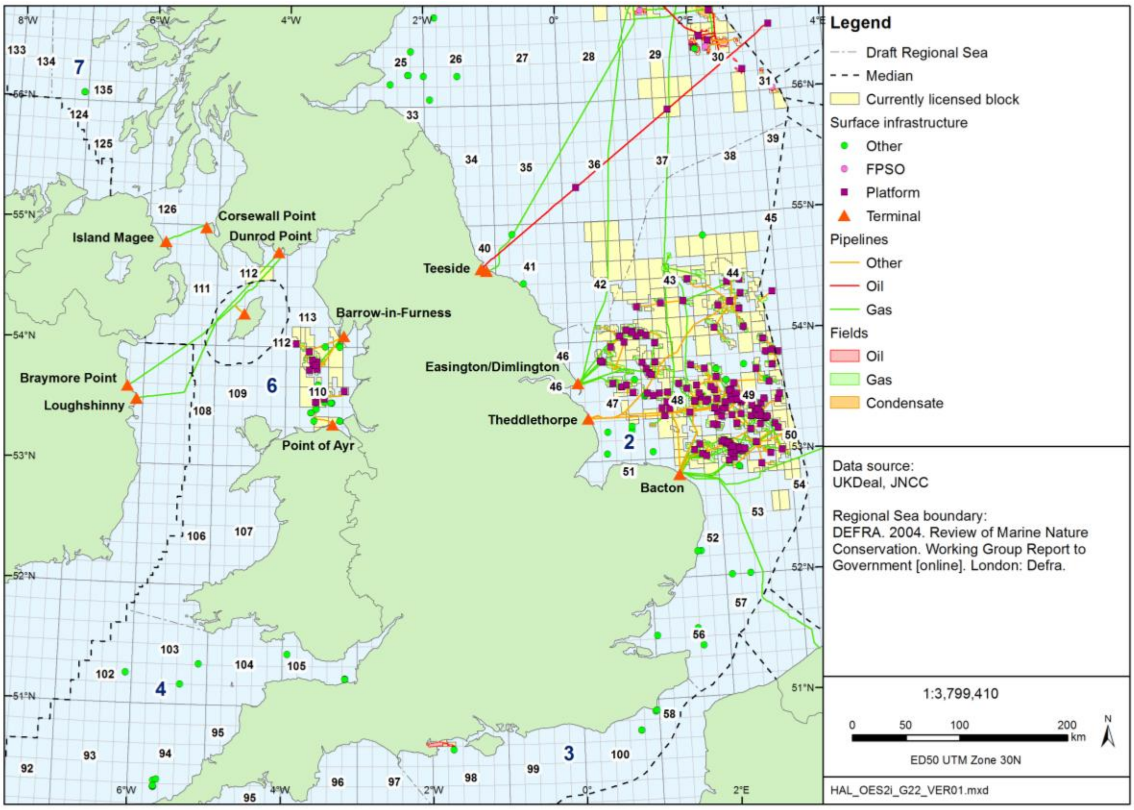


Table A3h.6 – Drilling activity on the UKCS in 2009 and 2010 (Q1 - Q3)

Area	Exploration wells started[1]		Number of appraisal wells started[1]		Number of development wells started[1]	
	2009	2010 (Q1-Q3)	2009	2010 (Q1-Q3)	2009	2010 (Q1-Q3)
Southern North Sea	3	6	3	6 (1)	17 (5)	6 (4)
Central North Sea[3]	9 (1)	9 (1)	24 (15)	15 (4)	67 (27)	57 (28)
Northern North Sea	2	3	4 (3)	7 (5)	33 (13)	31 (9)
West of England/Wales	5	4	1	-	3 (3)	-
West of Shetland[2]	4	2	10 (6)	1 (1)	10 (5)	4 (1)
Total	**23 (1)**	**24 (1)**	**42 (24)**	**29 (11)**	**130 (53)**	**98 (42)**

Notes:

1. *Sidetracked wells are shown in brackets. Sidetrack wells are only counted where the intent was to acquire new geological data (sidetracks drilled due to mechanical problems with the original well are not counted)*
2. *'West of Shetland' includes 'West of Scotland' and the Rockall basin.*
3. *Central North Sea includes inner, most of the outer Moray Firth areas and part of the Mid North Sea High.*

Source: DECC oil and gas website – oil and gas production

A3h.5.2 Evolution of the Baseline and Environmental Issues

A3h.5.2.1 Evolution of the Baseline

As North Sea production matures, the UK will become increasingly dependent on imported energy, meeting about half of the UK's total annual gas demand by 2020. In 2010, 14% of oil and 36% of gas demand was satisfied by imports. Imports are projected to increase to 48% of oil and 53% of gas demand by 2020 (DECC oil and gas website - UKCS Oil and Gas Production Projections). The decommissioning of offshore installations is expected to increase significantly, and it is predicted that around 500 individual structures (including platforms and tie backs) will be decommissioned over the next three decades (Defra 2010e). In the future, it is likely that potential reserves in more challenging areas of the UKCS will be explored, such as the recent start up of a project to develop the Laggan and Tormore fields located 125km north west of the Shetland Islands at a depth of 600m. It is forecast that about 17% of the UK's remaining oil and gas reserves lie under the waters to the west of Shetland (Oil & Gas UK 2010).

The potential to use geological formations (depleted hydrocarbon reservoirs, saline aquifers and halite deposits) for the storage of natural gas and CO_2 produced from power generation and industrial processes is currently being explored, for instance through the UK Government CCS demonstrator competition (see Appendix 3b Geology, Substrates and Coastal Geomorphology). The further potential to utilise existing oil and gas infrastructure for CCS is possible, particularly where this is suitable for the transport of corrosive substances.

The Rough Alpha facility located in block 47/8 (central North Sea) is currently the only offshore gas storage facility in operation in the UK, utilising a depleted gas field. However there are possible gas storage developments undergoing feasibility studies in gas fields in the Irish Sea (e.g. Gateway Storage, using constructed salt caverns) and southern North Sea (e.g. a Gas storage licence has been awarded for ENI's proposed facility at the Deborah field), but some of these have also been proposed for CO_2 storage. The potential for CO_2 storage in depleted UKCS oil and gas fields has been estimated to be within the range 7.4-9.9 billion tonnes of CO_2. Initially, storage sites are likely to focus on relatively well understood and low risk depleted hydrocarbon fields, particularly gas reservoirs.

A3h.5.2.2 Environmental Issues

The potential environmental impacts associated with offshore oil and gas activities have been comprehensively identified and assessed as part of the DECC offshore energy SEA process.

A3h.6 OFFSHORE RENEWABLE ENERGY ACTIVITY

The following sections provide an update to information presented in Appendix 3h.6 of the OESEA Environmental Report (DECC 2009b).

A3h.6.1 Changes in UK Context

A3h.6.1.1 Offshore wind

Table A3h.7 and Figure A3h.17 shows the updated status of the offshore wind developments in UK waters, including Round 3 zones and Scottish wind farm exclusivity zones currently undergoing development and expected to be constructed around 2015.

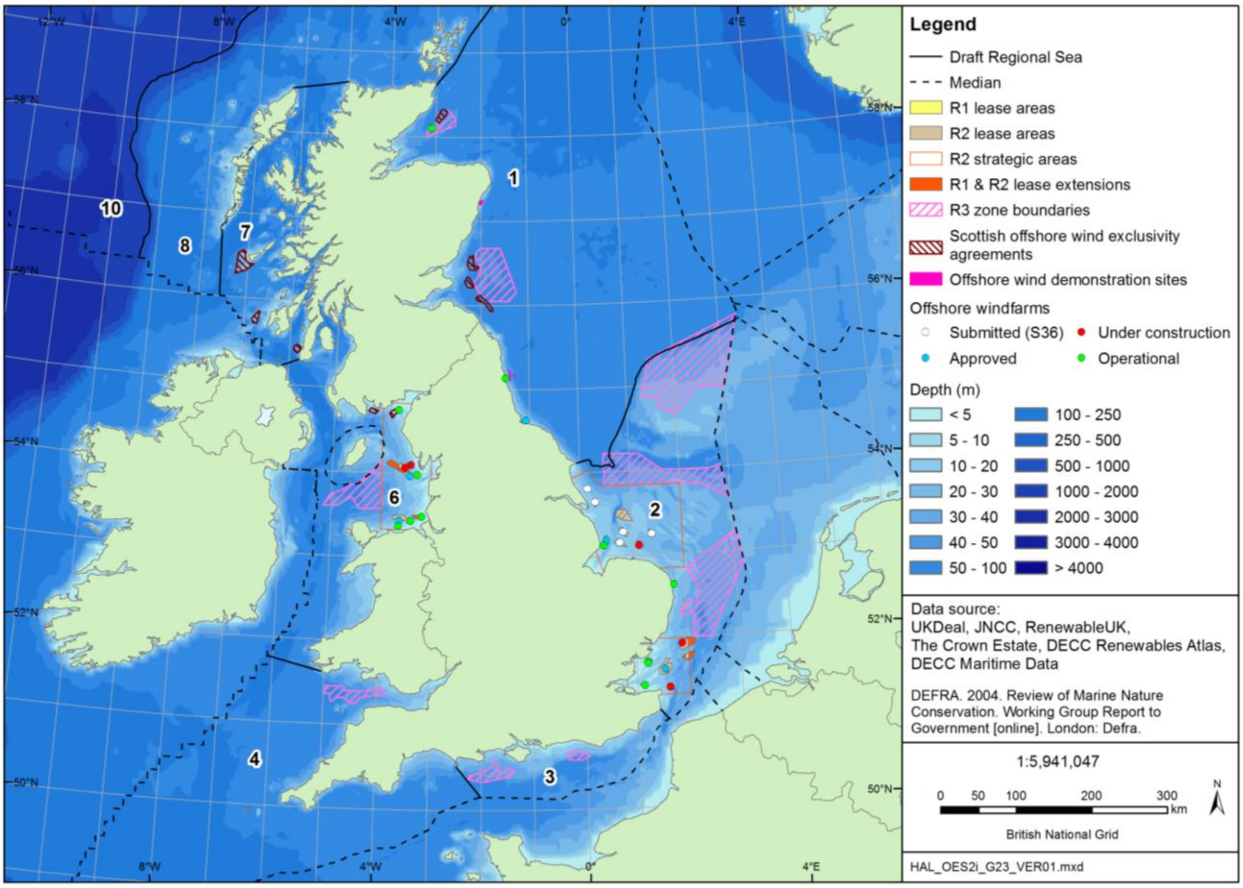
Table A3h.7 – Current status of UK offshore wind developments (September 2010)

Wind Farm	Location	Round	Status
Regional Sea 1			
Beatrice II	Outer Moray Firth	SWEA	Zone awarded
Moray Firth	Outer Moray Firth	3	Zone awarded
Firth of Forth	Outer Firth of Forth	3	Zone awarded
Inch Cape	Outer Firth of Forth	SWEA	Zone awarded
Bell Rock	Firth of Tay	SWEA	Zone awarded
Neart na Gaoithe	Outer Firth of Forth	SWEA	Zone awarded
Forth Array	Outer Firth of Forth	SWEA	Zone awarded
Regional Sea 2			
Kentish Flats II	Thames	1Ex	Awaiting application
Gunfleet Sands I	Thames	1	Operational
Gunfleet Sands II	Thames	2	Operational
Greater Gabbard	Thames	2	Under construction
Galloper Wind Farm	Thames	2Ex	Extension to Greater Gabbard
London Array II	Thames	2	Consented, pre-construction
Thanet I	Thames	2	Operational
Thanet II	Thames	2Ex	Presently on hold
Sheringham Shoal	Greater Wash	2	Under construction
Lincs	Greater Wash	2	Under construction
Race Bank	Greater Wash	2	Application submitted
Triton Knoll	Greater Wash	2	Site awarded
Dudgeon East	Greater Wash	2	Application submitted
Westernmost Rough	Humber (Greater Wash)	2	Application submitted
Hornsea Zone	Central North Sea	3	Zone awarded
Dogger Bank	Central North Sea	3	Zone awarded
Norfolk Bank	Southern North Sea	3	Zone awarded
Regional Sea 3			
Hastings	English Channel	3	Zone awarded
West of Isle of Wight	English Channel	3	Zone awarded
Regional Sea 4			
Scarweather Sands	Bristol Channel	1	Withdrawn
Bristol Channel	Bristol Channel	3	Zone awarded
Regional Sea 6			
Burbo Bank Extension	Easter Irish Sea	1Ex	Awaiting application
Robin Rigg East	Eastern Irish Sea – Solway Firth	1	Operational
Robin Rigg West	Eastern Irish Sea – Solway Firth	1	Operational
Rhyl Flats	Eastern Irish Sea	1	Operational
Walney I	Eastern Irish Sea	2	Under construction
Walney II	Eastern Irish Sea	2	Consented, pre-construction
Walney Extension	Eastern Irish Sea	2Ex	Awaiting application
Ormonde	Eastern Irish Sea	n/a*	Under construction

Wind Farm	Location	Round	Status
Irish Sea	Central Irish Sea	3	Zone awarded
Solway Firth	Inner Solway Firth	SWEA	Zone awarded
Wigtown Bay	Solway Firth	SWEA	Zone awarded
Regional Sea 7			
Kintyre	North Channel	SWEA	Zone awarded
Islay	North Channel	SWEA	Zone awarded
Argyle Array	Sea of Hebrides	SWEA	Zone awarded

*Notes: * Ormonde project was consented outside of Rounds 1 and 2: 1Ex and 2Ex relate to extensions to Round 1 and 2 sites: SWEA is the Scottish Wind Farm Exclusivity Award (Scottish Government)*
Source: [RenewableUK] website; [DECC RESTATS] website

Figure A3h.17 – Wind energy activity and leasing areas



A3h.6.1.2 Other marine renewables

Table A3h.8 details updates to other marine renewable energy projects within UK waters and their status in terms of development and deployment.

Table A3h.8 – Other forms of marine renewable energy (as of September 2010)

RS	Name	Type	Status	Capacity	Summary
2	Pulse Tidal Scheme	Tidal	Operational (2009)	0.10MW	Tidal power generation device. 1km from the south bank of the Humber
	Neptune Proteus	Wave	Application under consideration (2010)	0.5MW	River Humber tidal turbine
3	Wooton Bridge	Tidal Stream & Tidal Barrage	Application approved, awaiting construction	2MW	In the village of Wooton Bridge, Isle of Wight
4	Hayle Wave Hub	Wave	Installed and ready for operation	20MW	10 miles offshore Hayle, Cornish coast
	Marine Energy Ltd	Wave	Application under consideration	10MW	A pre-commercial wave energy power park on a site off the Pembrokeshire coast in Wales
6	Delta Stream Tidal Scheme	Tidal Barrage & Tidal Stream	Application approved, awaiting construction	1.20MW	Ramsey Sound, Pembrokeshire
	Skerries SeaGen	Tidal	Application submitted	10.50MW	Anglesey, North Wales
8	Siadar Wave Energy Generation Scheme	Wave	Application approved, awaiting construction	4.00MW	Installation of Wavegen Active breakwater technology at Siadar, on the north coast of Lewis
	European Marine Energy Centre (EMEC)	Wave	Operational (2003)	3.00MW	4 test berths situated off Billia Croo, Stromness on the Orkney mainland (some 2km offshore)
	Shetland Floating Wave Power Project	Wave	Awaiting construction	4.54MW	Off Mu Ness, Dale of Walls, Shetland

Sources: DECC (2010a), EMEC website, DECC RESTATS website, Wavegen website, E.On website, Marine Current Turbines website, Tidal Electric website, SeaGen website, Marine Energy Pembrokeshire website

In March 2010 the Crown Estate announced the successful bidders for the Pentland Firth and Orkney wave and tidal leasing round. The licensing round aims to produce 1.2GW of installed capacity by 2020, 600 MW each from wave and tidal, broken down between the following sites (Table A3h.9).

Table A3h.9 – Outcome of Pentland Firth and Orkney licensing round

Site	Energy Type	Capacity	Operator
Costa Head	Wave	200MW	SSE Renewables Developments
Brough Head	Wave	200MW	Aquamarine Power & SSE Renewables Developments
Marwick Head	Wave	50MW	Scottish Power Renewables UK

Site	Energy Type	Capacity	Operator
West Orkney South	Wave	50MW	E.ON
West Orkney Middle South	Wave	50MW	E.ON
Armadale	Wave	50MW	Pelamis Wave Power Ltd
Westray South	Tidal	200MW	SSE Renewables Developments
Cantick Head	Tidal	200MW	SSE Renewables Holdings & OpenHydro Site Development
Brough Ness	Tidal	100MW	Marine Current Turbines
Duncansby	Tidal	100MW	Scottish Power Renewables

Source: The Crown Estate website

A marine spatial plan for the Pentland Firth and Orkney Waters region has also been produced by Marine Scotland and the Scottish Government aimed at setting out a framework for the future development of the region (Marine Scotland *et al.* 2010a). The plan contains a summary of existing information on different users of the seas, shows how these different users may impact on each other and makes recommendations for future research to ensure that the plan is properly underpinned by relevant and good quality information. It also sets out how the plan will be developed and draft regional locational guidance for the development of wave and tidal resources.

A tidal power study in the eastern Irish Sea area (Regional Sea 6) is currently investigating the potential of a combination of barrages, built across the estuaries of the Dee, Mersey, Ribble, Morecambe Bay and the Solway Firth, together with tidal stream turbine arrays and nearshore tidal lagoon installations (Burrows *et al.* 2009). Early estimates suggest that there is potential to meet at least half of the north west of England's electricity needs. The feasibility study for the Severn tidal power scheme concluded in October 2010 that currently there is no strategic case for proceeding with any of the proposed tidal energy schemes, although the option is to be kept open for future consideration (DECC Severn Tidal Power website).

The Offshore Valuation Group (a combination of government and industry organisations) produced a report in 2010, detailing the valuation of the UK's offshore renewable energy resource. The report suggests that by harnessing 29% of the potential offshore renewable energy by 2050 the UK could produce electricity equivalent to 1 billion barrels of oil a year, making the UK a net exporter of electricity, produce a carbon dioxide reduction of 1.1 billion tonnes and provide 145,000 new jobs within the industry (The Offshore Valuation Group 2010).

A3h.6.1.3 Spatial distribution of renewable energy activity and potential

Defra (2010e) provides a summary of the spatial distribution of wind farm leases and wave and tidal resources in each of the regions in relation to total area available for generation (Table A3h.10). This illustrates that the key areas for offshore wind in terms of existing capacity and licensed areas are the southern North Sea and Irish Sea (Regional Sea 2 and 6). Installed capacity in these areas already provides 98% of the total capacity.

Table A3h.10 – Spatial distribution of activity and resources

Regional Sea	Existing grid-connected capacity (MW)	Round 1 & 2 Wind farm leases, % of total lease area	R3 Wind farm zones, % of total R3 area	Wave resource, % of total UK resource area	Tidal resource, % of total UK resource
1	14	1	15	17	3
2	330	73	69	0	0
3	0	0	4	0	2
4	0	1	4	11	9
6	240	25	8	0	4
7	0	0	0	2	26
8	0	0	0	18	56
9, 10, 11	0	0	0	52	0
Total	**584**	**100**	**100**	**100**	**100**

Source: Defra (2010e)

Much of the UK wave resource is located offshore to the north and west of Scotland (Regional Seas 9, 10 and 11). However, with existing technology and installation costs it is unlikely that developments will proceed in this area in the immediate future. Prototype testing has been focussed on inshore resources in SW England and Celtic Sea (Regional Sea 4) where Wave Hub is being progressed and in Orkney (Regional Sea 8) where EMEC has a testing facility.

Tidal stream resources are greatest around the western and northern Scottish Isles (Regions 7 and 8), particularly focussed around headlands and narrows such as the Pentland Firth. Regional distribution of development is currently restricted due to limitations in the national grid network receiving and transmitting power from remote areas.

In March 2010 the South West Regional Development Agency (RDA) appointed a renewable energy consultancy (PMSS) to examine the potential for offshore wind, wave and tidal installations in the region up to 2030. This study will be used to inform future investment decisions, marine conservation zone discussions and keep the region at the forefront of development of marine renewables. Similarly the UK government agreed to a £5 million investment towards a new marine energy business park in Hayle, Cornwall South West England (South West RDA website).

DECC has completed a screening exercise to identify likely areas for wave and tidal development and potential generation capacity based on a number of development scenarios (AEA & Hartley Anderson 2010).

A3h.6.2 Evolution of the Baseline and Environmental Issues

A3h.6.2.1 Evolution of the Baseline

In January 2010 the Crown Estate awarded exclusivity zone agreements to nine consortia for the Round 3 offshore wind licensing round. The projects have a total generating capacity of 32GW and are likely to be made up of blocks of around 100 turbines, with construction expected to begin in 2015.

In May 2010 the Crown Estate awarded extensions to 5 Round 1 and 2 offshore wind sites, with an additional 2GW of capacity.

In February 2009 the Crown Estate announced 10 development zones for offshore wind in Scottish Territorial Waters. Exclusivity agreements were signed by development partners for sites on both the east and west coasts of Scotland, which are expected to yield a combined generating capacity of 6.4GW. The timescale for construction of Scottish Territorial Water development sites is likely to be similar to that of Round 3.

In addition to the Pentland Firth and Orkney wave and tidal schemes currently being developed, the Inner Sound region is being re-tendered for a further tidal project and the Crown Estate announced plans in September 2010 to offer further leases for wave and tidal energy projects in Scottish waters, in connection with the Scottish Government's Saltire Prize. Companies are invited to propose projects of up to 30MW capacity from October 2010.

Twelve offshore wind farm projects are either in the process of being constructed or have been consented and another 17 are in the planning process. The total capacity from all these wind farms will be over 14GW. This does not include Round 3 wind farms which may add an additional 30GW generating capacity. There are strong targets to increase total capacity to 33GW or more by 2020. Ongoing financial incentives such as the Renewables Obligation Certificates (ROCs), the Scottish Government's Saltire Prize and the Marine Renewables Deployment and Proving Funds will continue to provide support for the industry over this period (Defra 2010e).

In September 2010 the Scottish Government announced an update to their renewable energy target from 50% to 80% of all electricity generation by 2020.

A3h.6.2.2 Environmental Issues

Potential environmental impacts associated with offshore renewable energy activities have been identified and addressed as part of the DECC offshore energy SEA process (offshore wind) and other SEAs, for instance, for offshore wind energy in Scottish territorial waters (Marine Scotland 2010a), for offshore wind and marine renewables in Northern Irish waters (AECOM & Metoc 2009), and for wave and tidal stream in waters west and north of Scotland (Faber Maunsell & Metoc 2007). However, information on potential impacts, particularly of wave and tidal devices remains limited due to the paucity of developments. Defra (2010e) summarises some of the key pressures and impacts associated with marine renewable energy construction, operation and decommissioning (Table A3h.11).

Table A3h.11 – Pressures and impacts associated with marine renewable energy

Pressure	Impact
Noise from construction, operation and decommissioning activities	Potential impacts on noise sensitive species such as cetaceans and some fish species, particularly from pile driving and the use of explosives. Noise impacts from pile driving may result in permanent or temporary threshold shifts for cod, herring, dab and salmon in close proximity to the activity. In shallow waters piling work may generate a noise field that could act as a barrier to movement for some species.
Habitat damage from construction activities	Changes to the marine environment (e.g. increased suspended sediments and turbidity, smothering, disturbance of contaminated sediments and direct disturbance)

Pressure	Impact
Habitat loss	Loss of habitat from the presence of devices
Biological disturbance	The presence and operation of devices may disturb seabed communities, for example, scour around the structure. Potential barrier effects of the placement of turbines, piling and scour protection on marine migratory pathways. Behavioural changes, especially in mobile species from the presence and operation of devices.
Collision risk	The moving blades of turbines (wind and tidal) may strike mobile animals (birds, fish and marine mammals), injuring or killing them.
Habitat introduction	Alteration in substrate type, habitats, hydrodynamics and sediment dynamics. Introduction of hard substrate.
Hydrographic changes due to extraction of energy	Changes in hydrographic patterns may alter levels of exposure to energy with positive or negative impacts for species that are strongly correlated with or dependent on particular wave or tidal energy environments; for example the species characteristic of the BAP (Biodiversity Action Plan) habitat: tideswept channels.
Changes to electromagnetic fields (EMF)	Avoidance or attraction responses in EMF sensitive species resulting in behavioural changes
Spillage of fuel oil and construction materials (e.g. cement, antifoulants etc.)	Adverse effects on sediment or water quality potentially impacting on benthic communities

Source: Defra (2010e)

The OSPAR QSR (OSPAR 2010a) indicates that currently, the location, size and separation of the relatively few operational offshore wind farms in the OSPAR area are such that population-scale impacts on marine organisms have not been found. However, many proposed wind farms are more extensive than those in operation and in some cases several hundred turbines are planned per farm. The potential for cumulative and transboundary effects (particularly on migratory species) will increase as more wind farms are developed (OSPAR 2010a).

A3h.7 ELECTRICITY NETWORK

The following sections provide an update to information presented in Appendix A3h.7 of the OESEA Environmental Report (DECC 2009b).

A3h.7.1 Changes in UK Context

As offshore renewable devices continue to be developed and installed, there will be further requirements for links to be made to the National Grid so that the electricity that is generated can be delivered to consumers. This will involve the building of new infrastructure both offshore and on land, including cables, transformers and substations.

To more effectively support the growth in offshore renewable energy generation and the development of offshore electricity transmission networks, the UK Government has introduced a new regulatory regime for Offshore Electricity Transmission in Great Britain. Under the regime, any offshore transmission network that operates at 132kV or above will be a licensed activity. Through a competitive tender process, companies will bid for a licence to be the Offshore Transmission Network Owner (OFTO) of particular offshore networks. The OFTO will own the transmission assets between the offshore point of connection with the generator and the point of connection with the onshore operator (DECC/Ofgem 2009). The new regime covers all offshore generation projects (operational and future developments); a transitional regime will apply to those projects that have met certain criteria by certain dates and an enduring regime will be used for those that have not. It is expected that the majority of R2 and R3 wind farms sites will fall under the new regime, while in the near future, most wave and tidal devices will connect via low voltage cables (<132kV) and will be exempt (The In-House Lawyer website). The first transitional tender round commenced on 22nd June, 2009 (Ofgem website) with a second round beginning in summer 2010. A further consultation on the enduring regulatory regime began in August 2010 and closes in September 2010.

There are currently 14 operational offshore wind farms (The Crown Estate website) with connections to the National Grid (see Table A3h.12).

Table A3h.12 – Existing grid connections for operational offshore wind farms

RS	Wind farm	Offshore Cable	Onshore Cable	Substation Location
1	Blyth	Single 3 core subsea cable		
2	Gunfleet Sands I	Single 3 core subsea cable, 9.3km long	Three underground single core cables, each 3.8km long	Clacton substation near Clacton-on-Sea
2	Gunfleet Sands II	As above	As above	As above
2	Inner Dowsing	Three subsea cables		Middlemarsh, Skegness
2	Kentish Flats	Up to four buried subsea cables with landfall adjacent to Hampton Pier, west of Herne Bay	Buried onshore cable 2km long	Existing substation (subject to upgrading) south of Herne Bay
2	Lynn	Three subsea cables		Middlemarsh, Skegness
2	Scroby Sands	Three subsea cables	Buried onshore cable approximately 3km long	Existing substation at Admiralty Road, Great Yarmouth
2	Thanet	Two 3 core 132kV subsea cables 23.6km long with landfall at North Foreland Point	Two sets of three underground single core 132kV cables each 2.4km long	Existing Richborough substation near Sandwich
6	Barrow	Single buried 132kV subsea cable approximately 26km long with landfall south of Heysham power station	Buried onshore cable 3km long	Existing substation at Heysham with new small extension
6	Burbo Bank	Three buried subsea cables approximately 7.2km long with landfall at Mockbeggar Wharf, the Wirral	Buried onshore cable 3.5km long	New substation on brownfield site close to Wallasey substation
6	North Hoyle	Three buried subsea	Buried onshore	Existing substation at

RS	Wind farm	Offshore Cable	Onshore Cable	Substation Location
		cables approximately 10km long with landfall at Rhyl	cable approximately 5km long	Manweb complex next to Rhyl Technical College
6	Rhyl Flats		Three 33kV circuits. Each circuit is just under 2km long	New substation at Towyn
6	Robin Rigg East	Two 3 core subsea cables, 12.5km long	Two cables, 1.8km long	Existing substation at Seaton, Cumbria
6	Robin Rigg West	As above	As above	As above

Source: Centrica Energy, E.On website, Global Renewable Energy Partners (2002), NWP Offshore Ltd (2002), Ofgem (2009a, b, c), Seascape Energy Ltd (2002), Warwick Energy Ltd (2002).

The following wave and tidal sites in UK waters also have grid connections:

- The European Marine Energy Centre (EMEC) in Orkney has two test sites, the Fall of Warness tidal site located off the island of Eday and the Billia Croo wave site located outside Stromness on the mainland. The tidal site has five test berths with subsea cables following back to the coast and passing under the beach into an external housing next to the Caldale substation. Eday is linked to Westray and Sanday by subsea cables that form a ring through the Northern Isles and feed into the National Grid. The wave site has four test berths situated along the 50m water depth contour of Billia Croo also with subsea cables following back to the Billia Croo substation (EMEC website).
- The South West RDA Wave Hub is a project to develop an offshore facility to demonstrate the operation of renewable energy device arrays. After device prototypes have been tested elsewhere, the Wave Hub provides an area of sea with grid connection and planning consent where arrays of devices can be operated over several years. The Wave Hub covers an eight square kilometre area off St. Ives on the north Cornish coast. A 17km long subsea cable will bring electricity onshore to a new substation behind existing facilities at Hayle (South West RDA website, Halcrow 2006).
- SeaGen is an experimental 1.2MW tidal turbine installed in Strangford Lough, Northern Ireland, in 2008. Since installation, SeaGen has been regularly generating power into the UK electricity grid (SeaGen website).
- Islay LIMPET (Land Installed Marine Power Energy Transformer) currently generates 0.5MW of power which is fed into the grid in the Island of Islay.

There are also several other initiatives currently ongoing that are researching the feasibility of constructing new offshore transmission networks to store and transport renewable energy offshore to market:

- Irish-Scottish Links on Energy Study (ISLES) – a collaborative project between the Scottish Government, the Northern Ireland Executive and the Government of Ireland to assess the feasibility of an offshore transmission network in the Irish Sea (ISLES Project website).
- European Commission's Strategic Energy Review infrastructure priority to build a North Sea Offshore Grid (Scottish Government website).
- European 'Super-Grid' that would connect European electricity markets with renewable energy sources at the boundaries of the system (e.g. the North Sea) (UK Parliament website, The Offshore Valuation Group 2010).

A3h.7.2 Evolution of the Baseline and Environmental Issues

A3h.7.2.1 Evolution of the Baseline

In the future, as more offshore wind farms become operational and wave and tidal energy devices are developed there will be a requirement for further grid connections and grid reinforcements so that the electricity generated can be transmitted to the consumer. Several reports have been published both prior to and since the OESEA which investigate and propose the likely grid connections and grid reinforcements needed for future offshore renewables developments. These are in addition to the National Grid study carried out for the OESEA (National Grid 2008). Some of the main points from these reports are briefly summarised below.

Following on from the publication of the Government's UK Renewable Energy Strategy in June 2008, the Electricity Networks Strategy Group (ENSG) asked the three GB Transmission Licensees to carry out a study to:

- look at electricity generation and demand scenarios consistent with the EU target of 15% of the UK's energy to be produced from renewable sources by 2020; and
- identify and evaluate a range of potential network solutions to accommodate these scenarios.

The report (ENSG 2009a) found that:

- export of energy from the north of Scotland to the central belt of Scotland places a severe strain on the 275kV elements of the network
- the circuits between Scotland and England are already operating at their maximum capability
- under all the generation scenarios considered, power transfers from England to Scotland will increase. Reinforcements identified to relieve the boundary restrictions across these circuits results in power transfers on the Upper North network of the England and Wales transmission system, exceeding its capability
- increased power transfers across the North to Midlands boundary and/or the increased generation off the East Coast and/or Thames Estuary results in the severe overloading of the transmission circuits north of London

Recommendations made in the report are for grid reinforcements in the following areas:

- North of Scotland
- Western subsea High Voltage Direct Current (HVDC) link between Hunterston and Deeside
- Eastern subsea HVDC link between Peterhead and Hawthorne Pit
- North and Central Wales
- English East coast (Humberside and East Anglia)
- London
- South West

As an addendum, a further report was also published to look at generation and demand scenarios from 2020 to 2030. This was to ensure that the proposed anticipatory reinforcements set out in the 2020 report would remain justifiable against a set of future developments in the electricity generation market, including from offshore wind, nuclear power, carbon capture technology and wave and tidal energy. The report found that the reinforcements outlined in the 2020 report were generally still valid with a few minor amendments (ENSG 2009b).

Prior to the publication of the OESEA in 2009, Senergy Econnect and the National Grid (National Grid/Econnect 2008) investigated and reported on the optimum offshore and onshore electricity transmission network reinforcements required to connect the 25GW of offshore wind energy proposed as part of the Round 3 leasing process. For each of the proposed R3 development zones, the report provided analysis of the options for offshore connections and onshore reinforcements. It was found that significant onshore reinforcements would be needed, particularly for the connection of the Dogger Bank, Hornsea and Norfolk R3 development zones (the English East coast). The assumptions made in the report were subject to both the outcome of the OESEA and further work with project developers; no environmental impact assessments of the required reinforcements were undertaken.

In 2007, Metoc carried out a report for the Sustainable Development Commission (SDC 2007) which considered grid connection issues related to tidal energy development in the UK. Having identified sites potentially suitable for tidal energy development, the report suggested that the grid is currently most able to accept electricity in the Severn, Wash and the Mersey. The grid in the north of Scotland was identified as being most constrained, however, the Beauly to Denny overhead line reinforcement will help to alleviate this. Further reinforcements will also be required north of the Midlands. In the south and south west there is capacity for the connection of generation but reinforcements are required to connect the generation to the backbone of the transmission network.

Moving towards a low carbon economy in the future where nearly all electricity is generated from renewable and clean resources also requires a change in the way in which power transmission on the grid is managed. It is envisaged that smart grid technology (incorporating Information Communications Technology – ICT) will offer the possibility of monitoring and managing the fluctuations of power generated by large-scale intermittent renewable generation, increasing efficiency so that reinforcement and construction costs can be minimised (DECC 2009g).

A3h.7.2.2 Environmental Issues

Environmental impacts from grid construction and reinforcement works, offshore and onshore will increase as further development takes place, more offshore wind farms become operational and wave and tidal devices are installed. These may be offset in the future to some extent by the implementation of smart grid technology, managing flows across the current infrastructure to accommodate power inputs from new generation sources. See relevant section in Appendix 3h.8 Submarine Cables below for relevant environmental issues.

A3h.8 SUBMARINE CABLES

The following sections provide an update to information presented in Appendix A3h.8 of the OESEA Environmental Report (DECC 2009b).

A3h.8.1 Changes in UK Context

Submarine cables include those used for both power transmission (connections and export) and for telecommunications. Power cables use either Alternating Current (AC) or High Voltage Direct Current (HVDC) transmission and may be monopolar, bipolar or three-phase systems. Their diameter can be up to 15cm depending upon design. Modern submarine telecommunications cables are fibre optic using pulses of light to carry information and are only 2-5cm thick. Older coaxial cables use electric current to carry information and have a diameter of up to 10cm. Cables are usually buried on the seafloor to minimise the risk of damage to them by, for example, anchors and fishing gear. Where they cannot be buried (such as in areas of exposed bedrock) they are laid directly on the seabed and may be protected by a rock armour covering (OSPAR 2009k). It is estimated that the existing 2,368km of power cables cover only 0.2km^2 (0.00002%) of the UKCS while the existing 18,000km of telecommunications cables cover 1.6km^2 (0.0002%) of the UKCS (Defra 2010e).

In the future, the deployment of power cables will increase, driven by demand from offshore renewables development and the need for stability in supply. Telecommunications cables will continue to be reinforced and upgraded, extending the global reach of the submarine networks and investing in higher capacity circuits.

Table A3h.13 below lists the interconnectors that are planned for UK waters in the future. These are in addition to those already mentioned in the OESEA.

Table A3h.13 – Future interconnectors planned for UK waters

Name	Owner	Connects to	Capacity	Status
East West 1 East West 2	Imera	Ireland	2 x 350MW	Exemption granted 2009
Channel Cable	Imera	France	800MW	Exemption requested in 2009
Nemo	NG and Elia	Belgium	1,000MW	Feasibility study complete In discussions with regulators
IFA 2	NG and RTE	France	1,000MW	Feasibility stage
Norwegian interconnector	NG and Statnett	Norway	1,000MW	Feasibility study
Belbrit	Imera	Belgium	1,000MW	Licence granted

Notes: Imera is a private company, Elia is the Belgian transmission system operator, RTE is the French transmission system operator, Statnett is the Norwegian transmission system operator. Exempt refers to exemption from conditions 9, 10 and 11 of the Interconnector Licence and Article 6(6) of the Second Package Regulation.
Source: Ofgem (2010)

Recent telecommunications cables development includes:

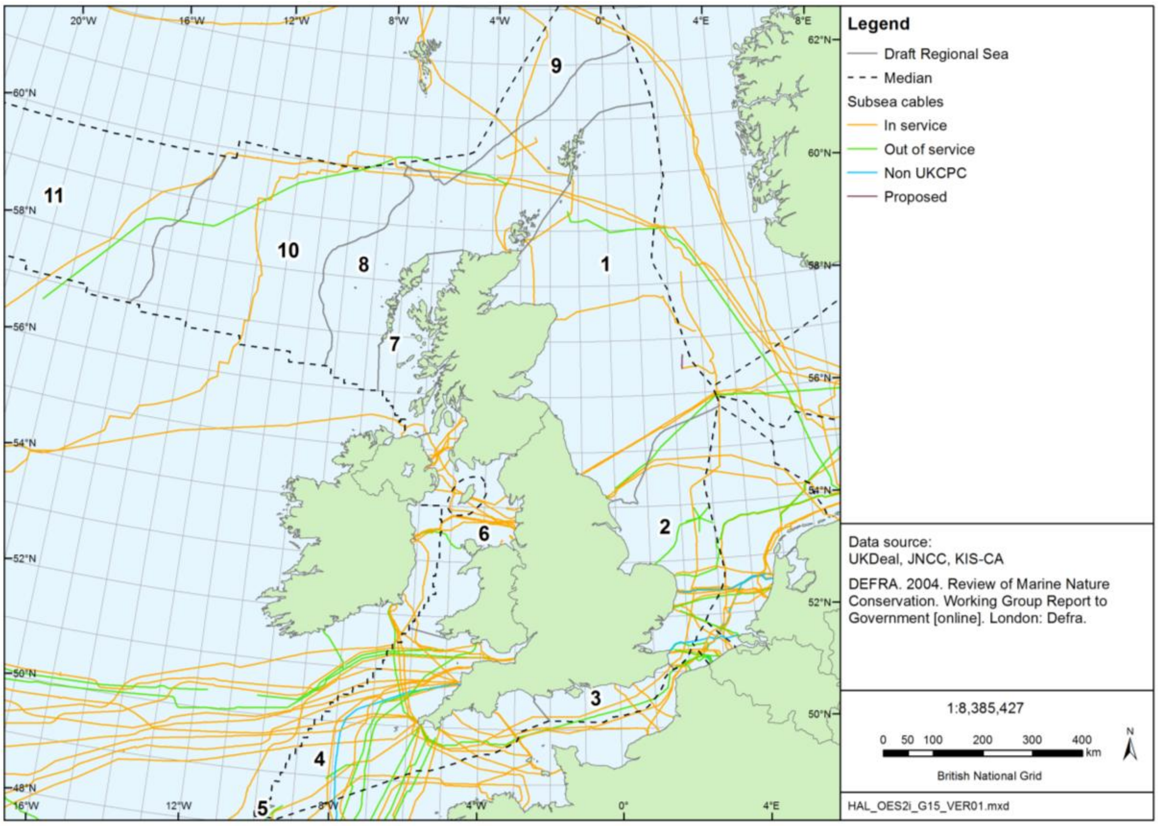
- Project Kelvin – an initiative between Northern Ireland and the Republic of Ireland to build a new connection to an existing trans-Atlantic cable (owned by Hibernia Atlantic), connecting the two countries to North America and Europe. The new cable makes landfall at Portrush in Northern Ireland (Hibernia Atlantic website).
- The Europe India Gateway – a new high-bandwidth, undersea cable linking Europe, Africa and India. In the UK, the cable makes landfall in Bude, Cornwall (Europe India Gateway website).

A3h.8.2 Evolution of the Baseline and Environmental Issues

A3h.8.2.1 Evolution of the Baseline

The Great Britain electricity market currently has up to 2.5GW of interconnection to France and Northern Ireland. By 2020, this will increase to about 4GW with new links to the Netherlands and Ireland. There may be a further increase to about 8GW by 2020, partly reflecting the expected increase in intermittent electricity generation by offshore wind (Ofgem 2010). As R2, R3 and future offshore wind farms and other offshore renewable generation plants are constructed, further subsea connection and export cables will be laid to transport electricity to the onshore National Grid. In 2001 there was a downturn in the telecommunications market for installation companies caused by the bursting of the 'dotcom' bubble. 2008 saw a mini boom in installation activity which continued into 2009. Future growth continues to be driven by market demand with companies developing their own plans to meet capacity (Defra 2010e). Figure A3h.18 shows the current distribution of cables in UK and surrounding waters. At the present these are predominantly telecom with a small number of power cables.

Figure A3h.18 – Location of submarine cables in UK waters



A3h.8.2.2 Environmental Issues

There are a number of potential environmental impacts associated with both the laying and operation of submarine cables. These can differ considerably depending upon the size of the area covered, duration and frequency of operations and the potential for reversibility (OSPAR 2009k).

The issues associated with subsea cables include (OSPAR 2008b & 2009k, Defra 2010e):

- Electromagnetic fields (EMF) which can cause behavioural changes to electro and magneto sensitive species. In general, HVDC cables produce stronger electromagnetic fields than AC cables.
- Thermal radiation of the seabed surrounding the cable as heat is lost when electricity is transported along the cable. Although research is limited, there is an assumption that a permanent rise in seabed temperature could lead to changes in the physiology, reproduction or mortality of certain benthic species and subsequently the alteration of benthic communities. Heat dissipation is generally greater from AC cables than HVDC at equal transmission rates.
- Physical disturbance of the seabed strata during installation which could result in alterations to the local habitat and benthic faunal structure through increased turbidity, the release of contaminants and the alteration of sediments.
- Abrasion of the seabed where telecommunications cables are laid on the surface.
- Visual disturbance, noise and vibration during cable burying, displacing sensitive sea birds and seals, affecting migratory routes and causing damage to hearing mechanisms.

The narrow corridor used for cable laying (up to 10m where the cable has been ploughed into the seabed) means that the spatial extent of these environmental impacts is relatively small.

A3h.9 DREDGING AND AGGREGATES

The following sections provide an update to information presented in Appendix A3h.9 of the OESEA Environmental Report (DECC 2009b).

A3h.9.1 Changes in UK Context

Between 2007 and 2008, marine aggregate production fell from 23.20Mt to 21.24Mt. Likewise the total area of seabed licensed for dredging (Figure A3h.19) also decreased from 1,344km^2 to 1,278km^2. The area of seabed dredged increased from 134.7km^2 to 137.9km^2, while the area of seabed where 90% of dredging occurs fell from 49.95km^2 to 48.22 km^2. There was a reduction in hours dredged of nearly 13% with a corresponding fall in the total kilometres steamed (-17.8%) and CO_2 emissions (tonnes) produced (-14.32%). These trends reflect a combination of responses to the economic downturn during 2008 (BMAPA 2009).

As both the marine aggregates and offshore renewable industries seek to develop, there is potential for increased interaction between them. The immediate sources of potential interaction include the placing of structures and cables, however, dredging vessels also require safe access to licence areas and the flexibility to navigate safely within the licence area once dredging is underway (BMAPA 2009). To help understand the potential for interaction between the two industries, BMAPA has generated GIS data to show the extent of dredger transit routes between licence areas and the ports supplied (Figure A3h.20).

Figure A3h.19 – Licence areas for marine dredging activities

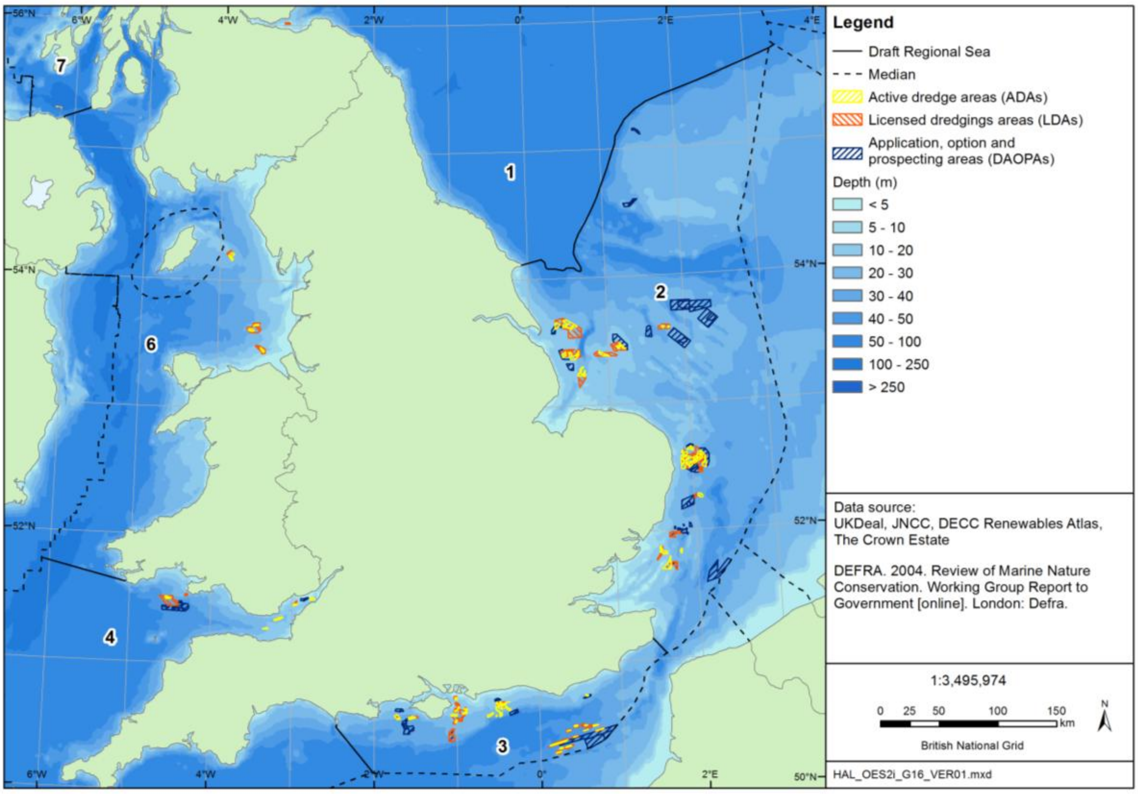
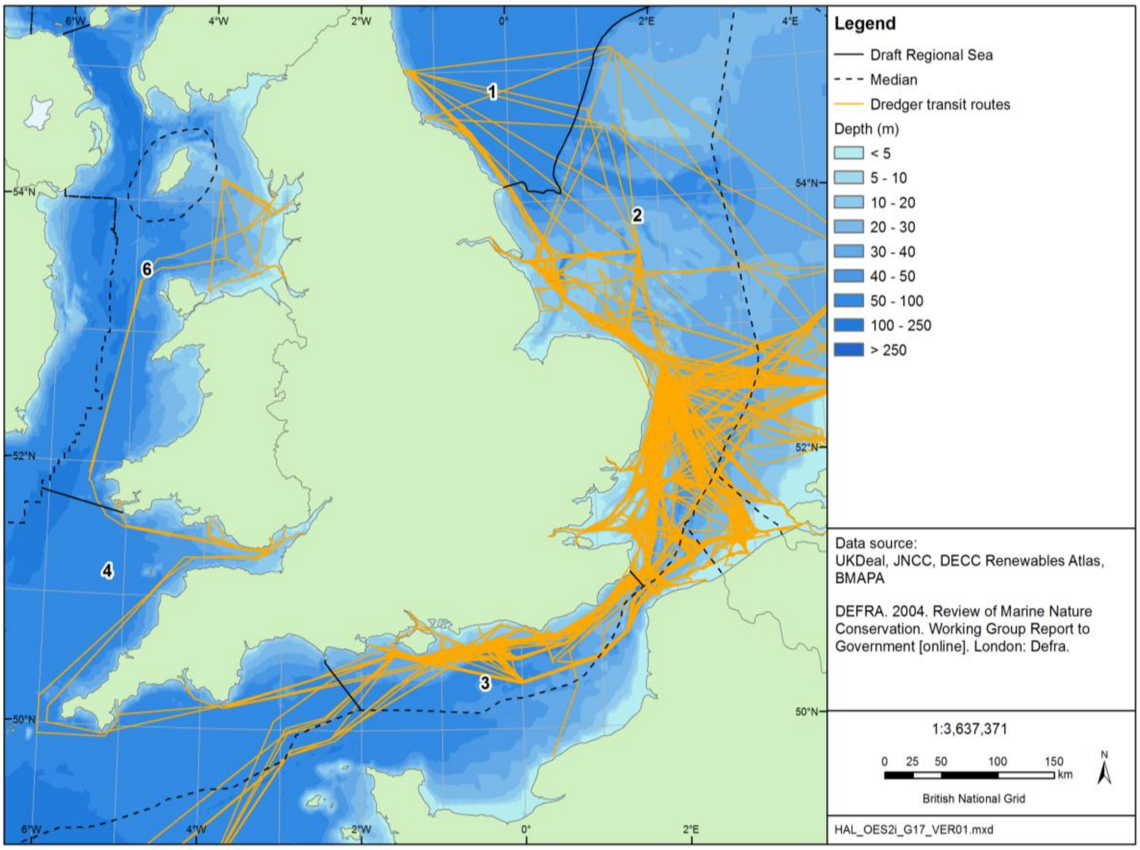


Figure A3h.20 – Dredger transit routes



A3h.9.2 Evolution of the Baseline and Environmental Issues

A3h.9.2.1 Evolution of the Baseline

The marine aggregate industry is a mature industry sector which will remain important into the near future, playing a crucial role in underpinning the UK construction industry. Currently, the east coast and south coast of England dredging areas are the principal sources of supply, however, the recently developed deposits in the East English Channel will become increasingly important.

Demand for marine aggregate materials could significantly increase over the next five to ten years to support large-scale infrastructure projects and coastal defence programmes. Internationally, demand for exports may grow as continental land supplies become exhausted. The marine aggregates industry believes that resources of marine sand and gravel are sufficient for at least 50 years production at the current rates of extraction (Highly *et al*. 2007, Defra 2010e).

A3h.9.2.2 Environmental Issues

The main environmental effects associated with aggregate extraction are changes to the seabed topography, loss and damage to habitats and species (from abrasion, sediment removal and smothering) and noise from exploration and extraction operations which may impact on sensitive species such as cetaceans and some fish species (Defra 2010e).

A3h.10 MARINE WASTE DISPOSAL

The following sections provide an update to information presented in Appendix A3h.10 of the OESEA Environmental Report (DECC 2009b).

A3h.10.1 Changes in UK Context

A3h.10.1.1 Disposal of dredged material

The disposal of wastes to the marine environment is controlled by the Food and Environment Protection Act (FEPA) 1985 (MMO website). In England, licensing is overseen by the Marine Management Organisation (MMO) which replaced the Marine Fisheries Agency (MFA) in April 2010, while the Welsh Assembly Government is responsible for Welsh waters. In Scotland, the Marine Scotland Licensing Operations Team (MS-LOT) is the responsible body (also formed in April 2010) and in Northern Ireland, the Department of the Environment (Northern Ireland Environment Agency) (MMO website). A new Marine Licensing System introduced by the Marine and Coastal Access Act 2009 will be launched in 2011 (Defra website).

In 2007 the United Kingdom was granted 101 permits for the disposal of dredged material and no permits for other types of waste. In 2007, 24,375,099 tonnes (dry weight) of dredged material was licensed for dumping with 17,179,852 tonnes (dry weight) actually dumped (OSPAR 2009c). This represents an increase from figures reported in OESEA for 2006 where 15,349,471 tonnes (dry weight) were dumped. Table A3h.14 and Figure A3h.21 below describe the disposal sites and the approximate quantity of material deposited.

Table A3h.14 – Licensed marine disposal sites around the UK in 2007

Deposit site	Origin water system	Area dredged			Operation type		Total quantity[1]
		Harbour	Estuary	Sea	Capital	Maintenance	
Regional Sea 1							
CR027	Beauly Firth	x				x	24,182
TY022	Coquet River	x				x	0
TY025	Coquet River		x			x	13,071
CR019	Cromarty Firth	x				x	9,570
CR110	Dee River	x				x	94,516
TY130	Durham Coast	x		x		x	12,219
TY180	Esk River	x		x	x	x	40,657
FO036	Firth Of Forth	x				x	2,059
FO038	Firth Of Forth	x				x	11,180
FO041	Firth Of Forth	x				x	8,775
FO042	Firth Of Forth	x				x	10,123
FO043	Firth Of Forth	x				x	10,269
FO044	Firth Of Forth	x			x		3,029
FO044	Firth Of Forth	x				x	52,9467
FO048	Firth Of Forth	x				x	2,856
FO028	Firth of Tay	x				x	37,812
CR050	Grampian Coast	x				x	1,744
CR080	Grampian Coast	x				x	0
FO007	Grampian Coast	x				x	0
CR020	Helmsdale River	x				x	2,934
CR030	Moray Firth	x				x	7,635
TY181	North Yorkshire Coast			x		x	34,492
TY190	North Yorkshire Coast	x			x		0
TY190	North Yorkshire Coast	x				x	1,941
TY042	Northumberland Coast	x			x		0
TY042	Northumberland Coast	x				x	60,202
FO010	South Esk River	x				x	40,435
CR040	Spey Bay/Moray Firth	x				x	7,027
FO020	Tayside Coast	x				x	11,116
TY150	Tees River/Hartlepool Bay	x	x		x		0
TY150	Tees River/Hartlepool Bay	x	x	x		x	0
TY160	Tees River/Hartlepool Bay	x			x		0

Deposit site	Origin water system	Area dredged			Operation type		Total quantity[1]
		Harbour	Estuary	Sea	Capital	Maintenance	
TY160	Tees River/Hartlepool Bay	x	x	x		x	782,114
FO080	Tweed River	x				x	0
TY070	Tyne River		x		x		0
TY070	Tyne River	x				x	74,615
TY081	Tyne River		x		x		0
TY081	Tyne River	x	x			x	40,532
CR010	Wick River		x			x	0
Regional Sea 2							
HU143	Great Ouse River	x	x			x	48,418
HU020	Humber River	x				x	60,550
HU030	Humber River			x		x	627,409
HU040	Humber River	x				x	3,832
HU041	Humber River	x				x	11,670
HU060	Humber River	x			x		29,016
HU060	Humber River	x	x	x		x	3,263,668
HU080	Humber River	x	x			x	0
HU090	Humber River	x	x			x	389,680
HU112	Humber River		x			x	0
HU015	Humberside Coast	x				x	3,637
DV010	Kent Coast	x		x	x	x	0
DV010	Kent Coast	x				x	249,542
DV011	Kent Coast	x				x	0
TH073	Kent Coast	x				x	0
TH140	Kent Coast	x				x	67,759
TH146	Kent Coast	x				x	0
TH147	Kent Coast	x				x	0
HU202	Norfolk Coast			x	x		139,478
XX999	Norfolk Coast			x	x		2478[4]
HU199	Orwell River	x				x	58,596
TH034	Orwell River	x	x		x		598
TH034	Orwell River		x			x	7,043
TH037	Orwell River	x	x			x	13,492
TH053	Orwell River	x	x			x	13,462
TH207	Orwell River	x	x			x	43,858
TH208	Orwell River	x	x			x	46,038
TH209	Orwell River	x	x			x	18,982
TH210	Orwell River	x	x			x	0
TH211	Orwell River	x	x			x	90,967
TH052	Orwell/Stour Rivers + Thames Estuary		x		x		0
TH052	Orwell/Stour	x	x	x		x	1,378,876

Deposit site	Origin water system	Area dredged			Operation type		Total quantity[1]
		Harbour	Estuary	Sea	Capital	Maintenance	
	Rivers + Thames Estuary						
DV040	Rother River and Kent Coast	x				x	39,367
NS100	Suffolk Coast			x	x		0[3]
TH070	Thames Estuary			x	x		0
TH070	Thames Estuary		x	x		x	206,639
TH080	Thames Estuary			x	x		1,044,214
TH005	Waveney River	x				x	41,019
HU170	Witham River	x				x	7,461
HU150	Yare River	x	x			x	21,152
Regional Sea 3							
TH062	Blackwater River		x			x	820
WI045	Chichester Harbour	x	x			x	628
WI046	Chichester Harbour	x				x	0
WI020	East Sussex Coast	x				x	13,866
WI010	Ouse River (E.Sussex)	x		x		x	181,138
WI110	Poole Harbour	x			x		0
WI110	Poole Harbour	x	x	x		x	119,069
WI064	Portsmouth Harbour	x				x	0
WI080	So'ton Water, IoW etc.	x				x	220,284
WI090	So'ton Water, IoW etc.	x				x	0
WI060	So'ton Water, IoW, Portsmouth...	x	x		x		18,362
WI060	So'ton Water, IoW, Portsmouth...	x	x	x		x	316,822
WI031	Sussex Coast	x				x	104,994
WI035	Sussex Coast			x		x	1,118
Regional Sea 4							
LU070	Avon River	x	x			x	76,100
LU080	Avon River	x	x			x	82,684
LU083	Avon River	x	x			x	1,277
LU084	Avon River	x	x			x	2,920
LU085	Avon River	x	x			x	5,440
LU086	Avon River	x	x			x	0
LU010	Camel River	x				x	73
PL075	Falmouth Harbour/Truro		x		x		0

Deposit site	Origin water system	Area dredged			Operation type		Total quantity[1]
		Harbour	Estuary	Sea	Capital	Maintenance	
	River/Mounts Bay						
PL075	Falmouth Harbour/Truro River/Mounts Bay	x				x	0
PL060	Fowey River/Cornwall Coast South	x				x	12,205
LU145	Loughor River	x			x		37,393
PL072	Penrhyn River	x				x	0
LU115	Severn Estuary	x				x	9,004
LU055	Somerset Coast	x				x	1,081
LU110	Taff R./Severn Est.	x				x	208,251
PL031	Tamar River & Kingsbridge Estuary	x	x			x	48,845
LU125	Tawe & Neath Rivers/Swansea Bay	x				x	401
LU130	Tawe & Neath Rivers/Swansea Bay	x		x		x	1,099,199
PO070	Teign River		x		x		0
PO070	Teign River	x				x	0
LU140	Usk River	x				x	48,623
Regional Sea 6							
IS040	Anglesey Coast	x				x	30,137
IS591	Belfast Lough		x		x		229,874
IS591	Belfast Lough		x			x	10,587
IS595	Belfast Lough		x			x	0
IS671	Carlingford Lough	x				x	14,852
DM001	Cumbria Coast	x					518[2]
IS205	Cumbria Coast	x		x		x	432,567
IS231	Cumbria Coast	x				x	0
IS240	Cumbria Coast			x	x		0
IS240	Cumbria Coast	x				x	0
IS241	Cumbria Coast	x				x	102,402
IS251	Cumbria Coast			x		x	0
IS102	Dee River, Wales		x	x		x	140,552
IS620	Down Coast	x				x	0
IS650	Down Coast	x				x	9,762
MA501	Foyle River	x				x	0
MA545	Foyle River	x				x	0
MA010	Loch Ryan	x			x		25,582
MA010	Loch Ryan	x				x	25,882
IS192	Lune River	x				x	1,968

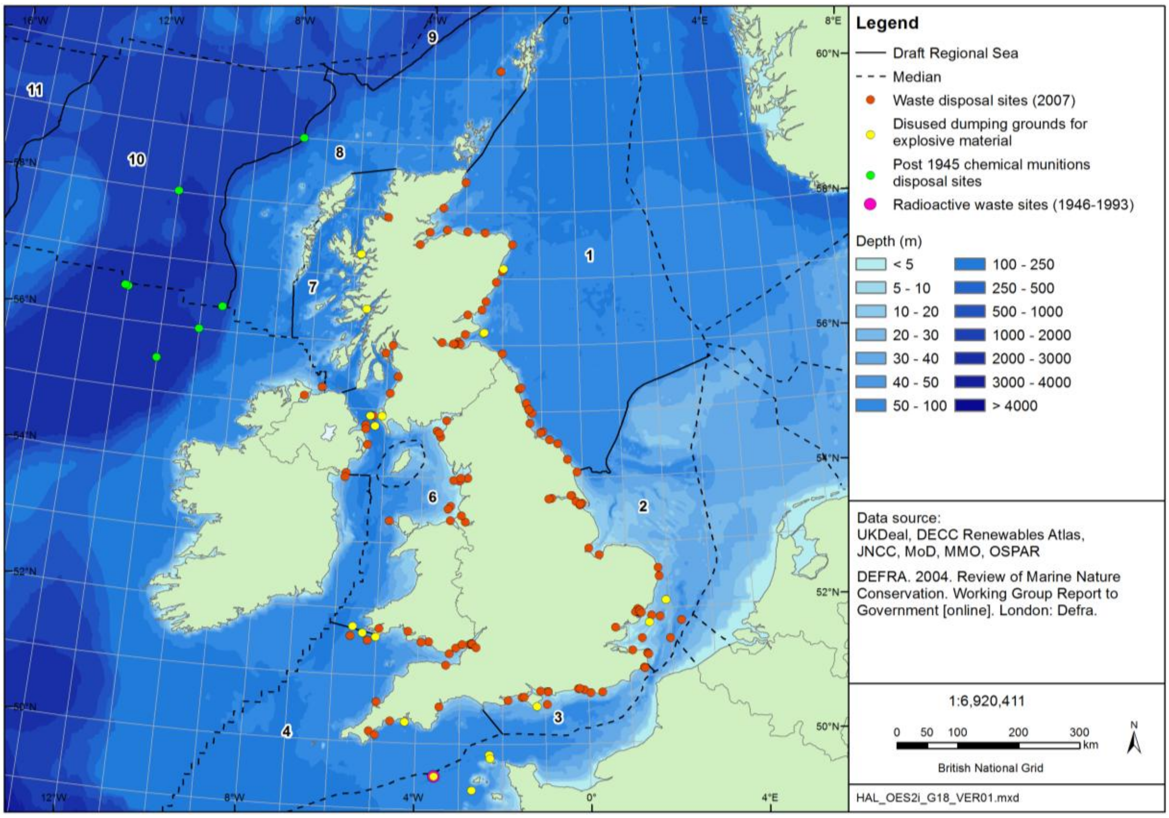
Deposit site	Origin water system	Area dredged			Operation type		Total quantity[1]
		Harbour	Estuary	Sea	Capital	Maintenance	
IS110	Mersey River	x	x			x	162,973
IS128	Mersey River		x			x	259,974
IS140	Mersey River	x	x	x		x	1,663,586
IS120	Mersey River/Liverpool Bay	x		x		x	252,999
IS150	Mersey River/Liverpool Bay	x	x		x		35,247
IS150	Mersey River/Liverpool Bay	x		x		x	0
LU168	Milford Haven	x	x		x		225
LU169	Milford Haven		x		x		0
LU190	Milford Haven		x			x	2,230
IS200	Morecambe Bay	x		x		x	386,051
IS170	Wyre River	x				x	811,555
Regional Sea 7							
MA016	Firth of Clyde	x	x			x	0
MA021	Firth Of Clyde	x	x			x	129,484
MA025	Firth Of Clyde	x				x	0
MA050	Firth Of Clyde	x				x	34,716
HE050	Loch Broom		x			x	2,065
Regional Sea 8							
FI100	Ham Voe	x				x	0

Notes:

1. *Tonnes, dry weight.*
2. *DM001 was a deposit site at Harrington Harbour off the North-West coast of England.*
3. *NS100 was a deposit site in the North Sea disposal of pipeline pre-sweep sediment.*
4. *XX999 was a site for the disposal of sediment/rock from the emplacement of monopiles.*

Source: OSPAR (2009c)

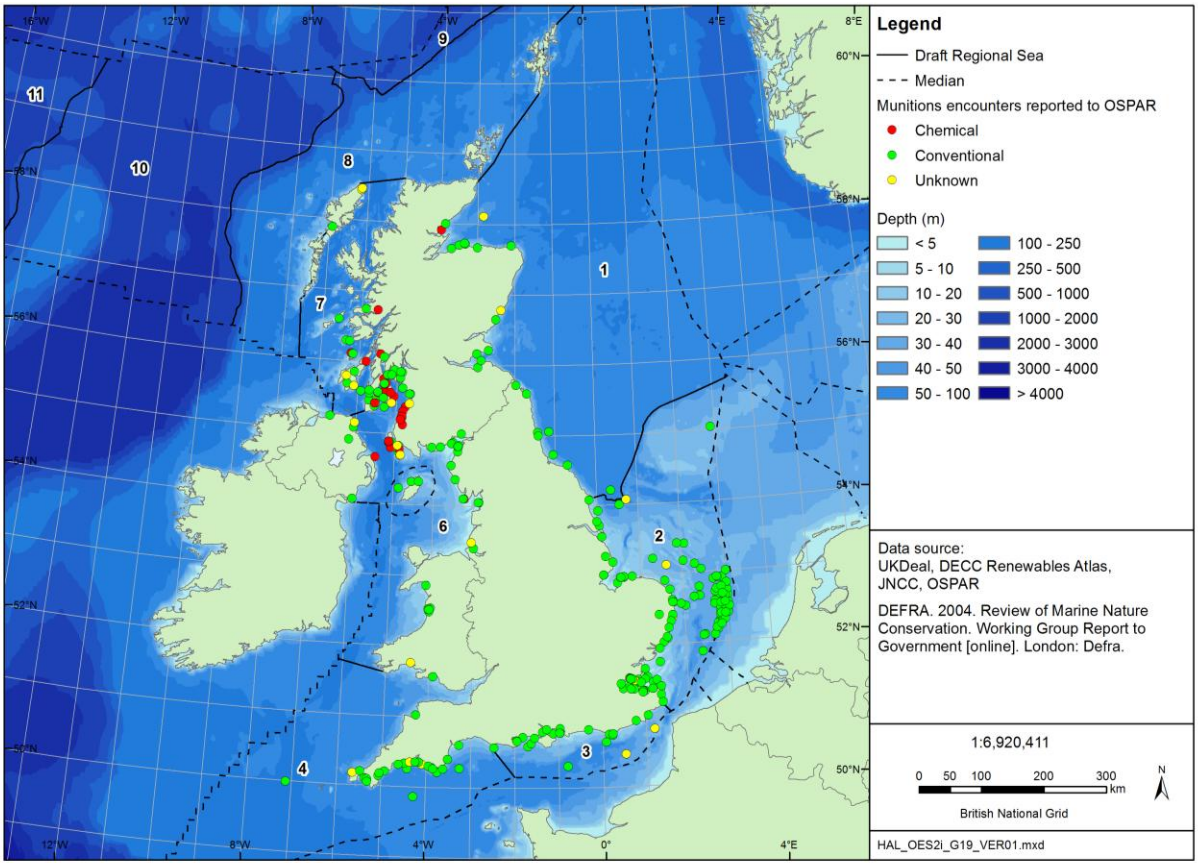
Figure A3h.21 – Known dredged material and munitions disposal sites



A3h.10.1.2 Munitions dumping

On the 2nd July 2004, OSPAR Recommendation 2003/2 on an OSPAR Framework for Reporting Encounters with Marine Dumped Conventional and Chemical Munitions in the OSPAR Convention came into force. Since then, over 1,800 encounters with chemical and conventional munitions have been reported by Contracting Parties (OSPAR 2009f). This has allowed the publication of a detailed assessment to be carried out dealing with encounters reported between 1999 and 2008 (see OSPAR 2009g). The UK has historically had in place a system by which vessels at sea and persons on shore can report munitions encounters to the UK Coastguard through its Maritime Rescue Coordination Centres (MRCC). Instructions for reporting munitions encounters are contained in Marine Guidance Note (MGN) 102 (M+F). Between 2004 and 2008, the United Kingdom reported 703 munitions encounters, some of which were also reported by Belgium and the Netherlands (OSPAR 2009f). OSPAR (2009g) indicated that there was no clear relationship between the locations of known munitions dumpsites and the encounters that emerged from the data submitted. The area with the highest density of encounters reported was the southern North Sea between the UK and the Netherlands. Other areas of medium frequency were the Moray Firth, Firth of Forth, Firth of Tay, Firth of Clyde and along the south and south-east coast of the UK. Shoreline encounters with munitions were the most frequent form of encounter reported.

Figure A3h.22 – Location of munitions encounters



A3h.10.2 Evolution of the Baseline and Environmental Issues

A3h.10.2.1 Evolution of the Baseline

The level of dumping and dredging activities has been relatively stable over the past ten years and is unlikely to fall. The majority of dumped sediments are due to maintenance dredging for navigation channels into major seaports. The need for this may increase in the coming years as ships become larger, requiring deeper and wider navigation channels, or because of a greater frequency and intensity of storm events causing sediment movement by waves and currents (OSPAR 2010a). Other large construction projects (such as the Thames Gateway container terminal on the Thames) will add to the amount of dredged material requiring disposal (Defra 2010e).

A3h.10.2.2 Environmental Issues

One of the main concerns over dumping and dredging is the release of contaminants to the water column such as heavy metals and Tributyltin (TBT). This is associated with temporary increases in turbidity and can lead to the increased availability of contaminants to the food chain. Increased turbidity may also lead to short-term effects on light-dependent organisms. Dumping of sediments on the seabed may smother and crush organisms living on the seafloor and may cause changes in benthic habitats and biological communities, although this is restricted to within 5km of the dump site. Dumping activities also contribute to underwater noise (OSPAR 2009h & 2010a).

The presence of munitions in the UKCS is a historical legacy presenting a remaining risk to users of the marine environment and marine species. The main issues relate to unexploded ordnance posing a risk to those that encounter them. Environmentally, the high pressure sound generated from exploding munitions can injure or kill marine mammals or fish. Harbour porpoises have been reported killed within 4km of explosions and suffering permanent hearing damage up to 30km away.

The available research indicates that there is little or no contamination of fish, shellfish or sediments near munitions dumpsites (OSPAR 2010a).

A3h.11 TOURISM AND RECREATION

The following sections provide an update to information presented in Appendix A3h.11 of the OESEA Environmental Report (DECC 2009b).

A3h.11.1 Changes in UK Context

A3h.11.1.1 Tourism

The OSPAR Quality Status Report (OSPAR 2010a) indicates that the wider North Sea region is the most popular OSPAR region for visiting tourists with numbers approaching 80 million in 2007.

In the UK, 2009 was a positive year for domestic tourism with a reported increase in the number of trips taken. UK residents made an estimated 126 million trips in the UK, representing 399 million bed nights and £22 billion in spending. Of these, a significant number were recorded as being to the seaside (Table A3h.15). This followed a difficult year for the industry in 2008 which was thought to have been affected by the economic recession. The increase in 2009 was due to a rise in demand for domestic holidays (United Kingdom Tourism Survey 2009). Conversely, overseas residents made about 30 million visits to the UK in 2009 (Table A3h.15), down about 6% from the figure of 31.9 million in 2008 (Office for National Statistics 2009b).

Visits to the Welsh seaside accounted for 37% of all overnight trips by UK residents in Wales in 2009; a much higher proportion than in England and Scotland where visits to the seaside only account for 21% and 14% of trips respectively (United Kingdom Tourism Survey 2009).

Beatty *et al.* (2010) estimated that the seaside tourist industry in England and Wales directly supports some 210,000 jobs. The value of the economic output (Gross Value Added) associated with this employment in seaside tourism is estimated to be £3.4bn in 2007 (or £3.6bn in 2009, adjusting for inflation). This is low in relation to the industry's substantial employment because of the prevalence of low-wage, part-time, and seasonal employment in much of the industry. The south east (27%) and south west (25%) regions are the biggest contributors to this gross value added (GVA) figure.

Beatty *et al.* (2010) estimated an increase of 14,000 in seaside tourism employment across England and Wales (41 principal seaside towns) between the late 1990s and the second half of the 2000s, representing an increase of around 10% in the number of tourism jobs. They concluded that far from being in terminal decline as a result of the rise of foreign holidays, the British seaside tourist industry remains alive and well and seems even to have been growing over the last decade.

Table A3h.15 – Number of trips and expenditure by UK residents and overseas visitors in 2009[1], including trips to seaside by UK residents

	UK	England	Scotland	Wales
UK residents				
Total number of trips (millions)	126	103	12.5	9
Total expenditure (£ millions)	21,881	17,281	2,736	1,413
Number of seaside trips (millions)	26.5 (21%)[2]	21.6 (21%)[2]	1.7 (14%)[2]	3.3 (37%)[2]
Expenditure at seaside (£ millions)	5,251 (24%)	4,147 (24%)	356 (13%)	608 (43%)
Overseas visitors[3]				
Total number of trips (millions)	29.9	25.4	2.5	1
Total expenditure (£ millions)	16,592	14,426	1,369	332

Note: [1]Relevant figures for Northern Ireland not included in sources below, [2]Figures in brackets represents figure as % of total, [3]Represent all trips by overseas visitors and not just to seaside (figures not given)
Source: United Kingdom Tourism Survey (2009), Office for National Statistics (2009b).

A3h.11.1.2 Recreation

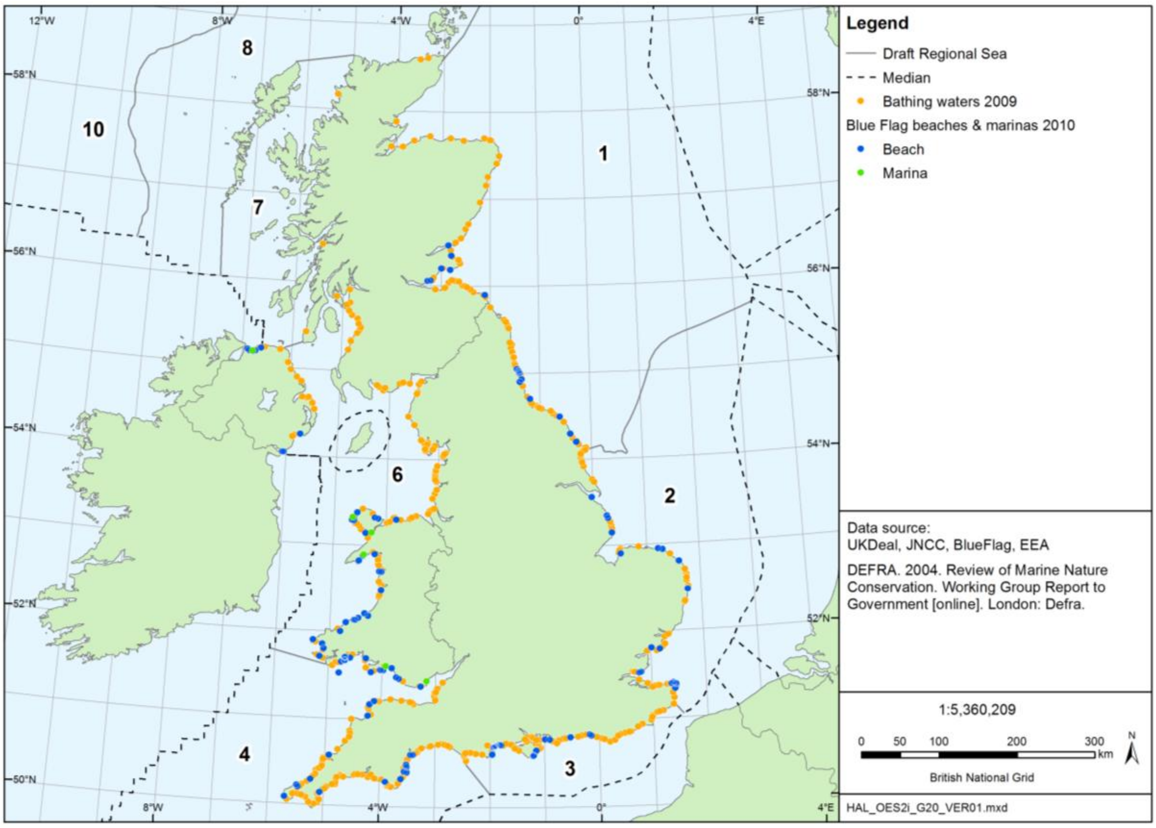
Figure A3h.23 highlights designated bathing waters and Blue Flag beaches/marinas around the UK in 2009-2010.

The microbiological quality of UK bathing waters is summarised in Appendix 3g, Population and Human Health.

The Watersports and Leisure Participation Report (British Marine Federation *et al.* 2009), indicates that up to 13.2 million UK adults participated in watersports and water based leisure activities in 2009. The report indicated no significant change from 2008 in participation in water skiing, using personal watercraft, motor boating/cruising, yacht cruising, small sail boat racing, canal boating, yacht racing, kitesurfing, angling (from a boat), angling (from the shore), cliff climbing, coastal walking, leisure sub-aqua diving (from the shore and boat). However, there were significant increases in people spending general leisure time at the beach and outdoor swimming. In general those living in the south had the highest participation rates in 9 out of the 21 activities, particularly sailing. Motor boating/cruising activities had a higher participation rate amongst people living in the east, whilst Northern Ireland had a very high participation rate for 'spending general leisure time at the beach' (British Marine Federation *et al.* 2009).

Defra (2010e) provides a useful estimation of the regional value of all coastal and marine leisure and recreational activities in the UK. The report estimated a total market turnover due to leisure and recreation of £2.74 billion and £1.29 billion GVA. By allocating the GVA according to the distribution of bathing beaches, dive sites (wrecks and reefs), surf sites, RYA marinas, cruising routes, racing areas and sailing areas, the regional value of all leisure and recreational activities was estimated (albeit with low confidence). Southern and western parts of England and Wales (Regional Seas 3, 4 and 6) appear to support the greatest percentage of leisure activity (approx 20% each), with eastern regions of Scotland and England (Regional Seas 1 and 2) supporting a smaller amount (12-14% each). Western and northern parts of Scotland (Regional Seas 7 and 8) support the smallest amount of leisure activity (approx 7% each).

Figure A3h.23 – Bathing waters and Blue Flag beaches/marinas



A marine and coastal recreation audit for Wales (Land Use Consultants 2009) highlighted four distinct 'hot spots' for coastal recreation in Wales; the Gower and Llyn Peninsulas, Anglesey and Pembrokeshire. Canoeing, cycling, walking and golf were considered key growth markets, whereas sailing has experienced only a slight growth in participation. Wales has also experienced the most significant increase in participation rates in diving compared to other parts of the UK (Land Use Consultants 2009).

A similar review of marine and coastal recreation in Scotland (Land Use Consultants 2007b) indicated that almost the entire coastline and most of the waters around Scotland are of importance for some form of recreation. The quality of the coastal environment was one of the most important factors attracting people to the coast with the most popular areas being; Argyll coast and islands, Firth of Clyde, Lochaber and Skye, Firth of Forth and the East Grampian coast, Solway Firth and inner Moray Firth. The most popular activities were walking, sea fishing, shoreline fishing, sailing (primarily clustered on the Clyde and west coast compared to the north and east coasts; Tourism Resources Company 2010), kayaking and canoeing, and wildlife and bird watching (Land Use Consultants 2007b).

Analysis of the economic impact of wildlife tourism in Scotland (International Centre for Tourism and Hospitality Research 2010) indicated that coastal and marine wildlife tourism had a net economic impact of £39 million with 1,628 additional full time equivalent jobs, and was primarily concentrated in the Highlands and Islands region.

A3h.11.2 Evolution of the Baseline and Environmental Issues

A3h.11.2.1 Evolution of the Baseline

Overall, the participation in most marine leisure and recreation activities has stayed relatively stable or showed an increase in recent years (British Marine Federation *et al*. 2009, Defra 2010e). As the sector is heavily dependent on the general health of the UK economy (so that participants have more disposable income to engage in leisure and recreation activities) it is likely that there may be some short-term decreases in line with the current economic climate.

The coastal access provisions of the Marine and Coastal Access Act 2009 places a duty on the Secretary of State and Natural England to secure a long distance walking route ("the English coastal route"), around the English coast, and to provide public access to a wider margin of coastal land for open-air recreation. A Welsh coastal path is planned to be opened in 2012 (Countryside Council for Wales website) and will likely improve public access to the coast and increase the numbers of people using the coast for recreational activities. Discussions on the proposed development of a Scottish coastal way are also ongoing (Scottish Natural Heritage 2010). The present extent of national trails and long distance routes in the UK is described in section A3h.11.3 of OESEA.

A3h.11.2.2 Environmental Issues

Defra (2010e) highlights a number of relevant environmental pressures and impacts associated with coastal and marine leisure and recreation (Table A3h.16).

Table A3h.16 – Key environmental pressures and impacts

Pressure	Impact	Activities involved
Marine wildlife disturbance (visual and acoustic)	Disturbance can cause animals to stop feeding, resting or travelling and socialising with possible long-term effects of repeated disturbance including loss of weight, condition and a reduction in reproductive success.	Sailing boats, jet skis, powerboats, swimmers and SCUBA divers
Physical disturbance of seabed substrata and alterations to the local benthic habitat	Trampling, clambering, smothering and other physical disturbance of marine benthic habitats.	Coasteering, rockpooling, sea angling, anchoring of dive boats and SCUBA diving, intertidal shellfish collection and bait collection.
Sewage discharge	Sewage discharge from boats causing health problems and nutrient enrichment of coastal areas.	General coastal tourism, leisure-boating.
Erosion and increase in suspended sediments	Increase in the erosion of soft sediment features and an increase in suspended sediments caused by scouring from boats' wake/wash.	Leisure-boating
Litter	Includes plastic, polystyrene, rubber, metals and glass. Litter can impact on marine species through ingestion, entanglement and smothering.	Urban runoff from coastal developments, waste disposal, leisure boating and general beach tourism.

The concept of waves as a resource for surfers and coastal tourism is described in The WAR Report (Surfers Against Sewage 2010). The report describes the principal surfing areas around the UK, the value of the waves to both surfers and non-surfers and the potential impact of coastal and marine development including wave energy converters on this resource. The implications and likely effects of wave devices on the wave resource / climate are further discussed in the Assessment section 5.4.2.

Tourism and recreation at the coast is likely to be affected by direct and indirect impacts of climate change. Direct effects include changing temperature and rainfall while indirect impacts arise from coastal erosion, flooding, habitat change and impacts on cultural heritage (Cooper 2009, Defra 2010e).

A3h.12 RECREATIONAL SEA ANGLING

The following sections provide an update to information presented in Appendix A3h.12 of the OESEA Environmental Report (DECC 2009b).

A3h.12.1 Changes in UK Context

The OESEA (DECC 2009b) and the references therein provide a brief overview of recreational sea angling in the UK, including the value of the activity to the UK economy, key geographical areas for sea angling and the number of charter boats active within each region.

The Angling Trust represents all angling (sea, coarse and game) in England, after a 2009 merger of a number of separate federations, including the National Federation of Sea Angling (NFSA). Prior to the merger, the NFSA comprised 516 member clubs, with most of the English clubs now affiliated with the Angling Trust. The Scottish Anglers National Association (SANA) and the Federation of Welsh Anglers (FWA) are the equivalents in Scotland and Wales. Anglers in Northern Ireland are covered by Sea Angling Ireland. In 2007 the total number involved in angling in the UK was approximately 290,800 from a boat and 480,950 from the shore, with a total annual expenditure by anglers of £686m (Defra 2010e). Of this, approximately 125,000 participants (+23,000 children) were Scottish, with the majority of the remainder coming from England. Key regions for angling include south west England, Northumberland, Pembrokeshire, the Firth of Clyde, Argyll and the Western Isles, the Solway Firth and the East Grampian coast (British Marine Federation et al. 2009; Land Use Consultants 2007b; CCW 2009). It was estimated that sea angling was as significant in Scotland in terms of participant expenditure as freshwater angling (Scottish Government 2009).

Nearly half of all anglers choose bass as their main target species with the bass sport fishery valued in excess of £100m a year (Defra 2010e). Cod, mackerel, rays, shark, conger eels and pollack are also popular target species. Shore anglers catch fewer fish than those angling from boats, and also retain a smaller percentage of those caught (32% for shore anglers, 38-39% for boat anglers) (Pawson *et al*. 2007). There is no licensing scheme for marine recreational fisheries equivalent to those in freshwater angling, making level of participation in, and impact of the activity, difficult to monitor. However, there are many local byelaws prescribing fishing activities in estuaries which protect sensitive diadromous species such as eels, salmon and trout. These byelaws prescribe the types of gear to be used, the time of year (and day) fishing is permitted and the levels of catch permitted (Environment Agency website).

A3h.12.2 Evolution of the Baseline and Environmental Issues

A3h.12.2.1 Evolution of the Baseline

The latest Watersports and Leisure Participation Survey (2009), based on a survey of 12,683 adults, estimated that there were 1,330,044 active sea anglers in the UK, of which 474,110 were boat anglers and 855,934 shore anglers (British Marine Federation *et al*. 2009). These figures are significantly higher than those estimated by Defra (2010e), so it may be that survey responses have resulted in an over-estimation. Based on figures estimated from previous years, the numbers angling from boats has remained fairly stable, while angling from shore has declined since 2007. A marine and recreation land use audit (CCW 2009) reported that angling had declined in recent years due to reductions in fish stocks.

Nevertheless, the survey provides a useful breakdown of the participants. Most of the respondents were infrequent anglers, taking part in the activity 2-5 times a year, although 20.5% of shore anglers participated 25 or more times in the year. The survey also found that approximately 40% of angling trips took place in the summer months (British Marine Federation *et al*. 2009).

A3h.12.2.2 Environmental Issues

Recreational angling from the shore may conflict with other coastal activities, and as with commercial fisheries, albeit to a much lesser extent, there are concerns about the over-exploitation of fish stocks. Digging for lugworms and crabs to use as bait can cause damage from mechanical harvesting, a localized decline in the target invertebrate species, habitat damage and disturbance and the removal of food sources for birds and other predators (Pawson *et al*. 2007). Bait is often collected locally and may be an important secondary industry in an angling region, with estimates of the value ranging from £25m-£90m annually (Defra 2010e).

A3h.13 FISHERIES

The following sections provide an update to information presented in Appendix A3h.13 of the OESEA Environmental Report (DECC 2009b).

A3h.13.1 Changes in UK Context

The OESEA (DECC 2009b) and the references therein provide an overview of fisheries and fishing activity in UK waters and this should be referred to in conjunction with this update. Trends within the industry and patterns in fishing activity and distributions can be seen in the various maps and figures included within the OESEA. The UK fishing industry operates throughout UK waters and as such is a major user of the marine area and is prone to being displaced by other activities.

A3h.13.1.1 Fisheries management

Since the OESEA, there have been significant changes in the structure of fisheries management in the UK. The Marine Management Organisation (MMO) is a new executive non-departmental public body established and given powers under the Marine and Coastal Act 2009 to unify marine decision making and management. It incorporates the role previously fulfilled by the Marine and Fisheries Agency (MFA). In addition to this, the Marine and Coastal Access Act abolished the 12 Sea Fisheries Committees (SFCs) responsible for local inshore fishery management in England and Wales and replaced them with 10 Inshore Fisheries Conservation Authorities (IFCAs) around the coast of England. The boundaries of these IFCAs are approximately the same as those of the SFCs. The new IFCAs are: North Western (takes over the area previously managed by Cumbria SFC and the English coast covered by North Wales and North West SFC), Northumberland, North East, Eastern, Kent & Essex, Sussex, Southern, Devon & Severn, Cornwall and Isles of Scilly. In Wales, the Assembly Government will take on the duties of the SFCs. In Scotland, the management of inshore fisheries is the responsibility of Inshore Fisheries Groups (IFGs), which are currently being established. It is intended that there will be 12 IFGs, although so far only 6 (Outer Hebrides IFG, Clyde IFG, South-East Scotland IFG, North-West IFG, Small Isles and Mull IFG and Moray Firth IFG) have been established.

A3h.13.1.2 Distribution of fishing effort

The broad-scale patterns of fishing effort and distribution around the UK presented in the OESEA (Figures A3h.28-A3h.37) remain valid and provide details of key fishing areas. A recent report (ABPmer 2009a), details the mean value of landings from around the UK, split by gear type. The report describes data obtained both from VMS and non-VMS sources and is a useful complementary source to those figures in the OESEA, highlighting key fishing areas by value of catch, rather than by fishing effort.

A3h.13.1.3 Landings

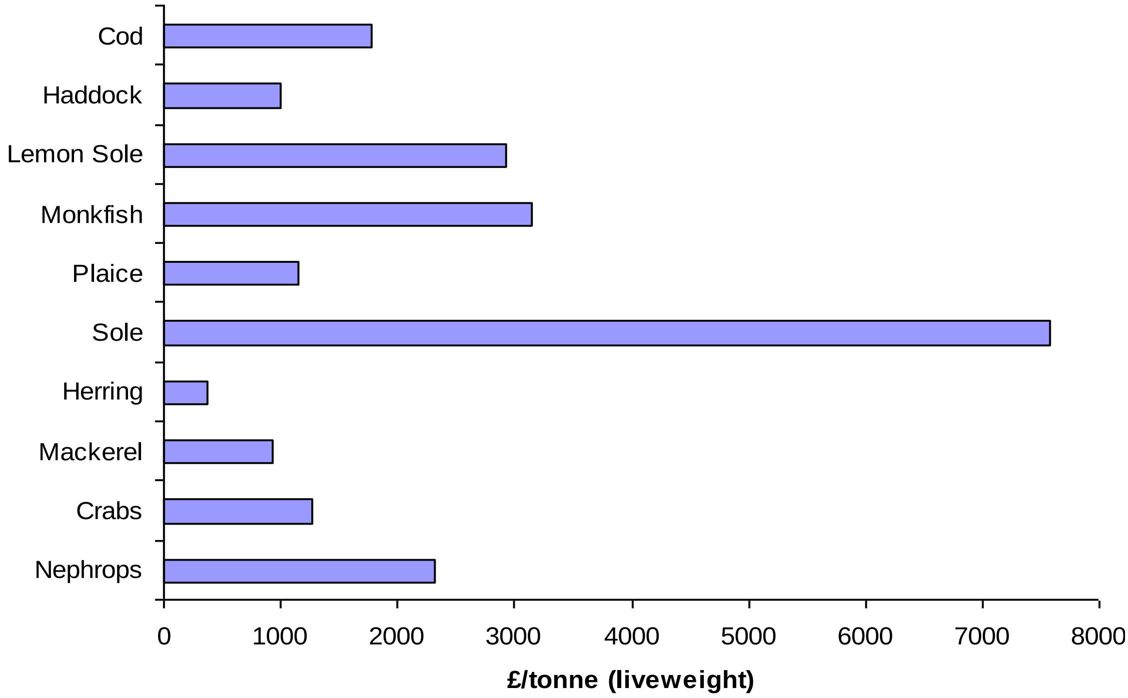
Fisheries may be broken down into the following sectors: demersal, pelagic and shellfish, with the shellfish sector typically the most valuable in the UK, with crabs, lobsters, *Nephrops* and scallops all high value catch. Pelagic fish are usually caught in large numbers but at low values. In 2009 the average annual price per tonne for shellfish species landed in the UK was £1,781, compared with £1,604 for demersal species and £542 for pelagic species (MMO website). Figure A3h.24 shows the average value of selected species landed into the UK. Sole is the highest value catch (£7,584 per tonne), while monkfish (£3,149/tonne) lemon sole (£2,923/tonne) and *Nephrops* (£2,313/tonne) are also valuable species. Since 2007 there has been a slight increase in the value of a number of demersal species, including cod and monkfish.

Figure A3h.25 shows the seasonal pattern of landings in 2009. While demersal and shellfish landings were relatively similar throughout the year, peaking slightly in the summer months, pelagic landings were greatest in late summer and winter months (particularly January, February and October), with increased fishing activity correlated with spawning aggregations of herring and mackerel and migratory passage of mackerel through the Channel and around the north of Scotland.

Demersal

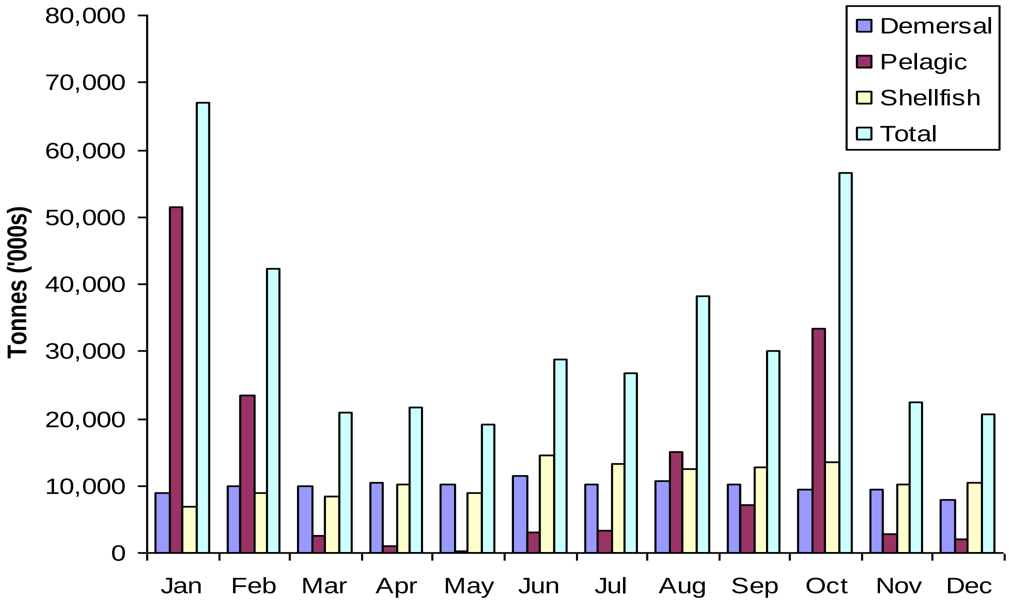
Table A3h.17 shows that landed weights and values of demersal species into the UK by UK vessels in 2009 were broadly similar to the average 2003-2007 values displayed in the previous OESEA. Landings of cod and haddock were slightly lower in 2009 than the average across 2003-2007, while in 2009 monkfish overtook haddock as the most valuable demersal species landed by UK vessels. The total landed value of all demersal species was greater in 2009 (£190.1m) than the average across 2003-2007 (£172.9m), although the landed weight was lower (118,900 tonnes in 2009 compared to an average of 125,200 tonnes across 2003-2007).

Figure A3h.24 – Average value per tonne of selected species landed into the UK in 2009



Source: Data provided by the MMO (MMO website)

Figure A3h.25 – Landings into the UK in 2009 by month and species type



Source: Data provided by the MMO (MMO website)

Table A3h.17– Average annual demersal landings into the UK by UK vessels in 2009

Species	Landed weight ('000 tonnes)	Landed value (£ million)
Cod	11.6	20.7
Dogfish	1.0	0.8
Haddock	34.7	34.2
Hake	6.4	11.8
Lemon sole	2.0	5.3
Monkfish	12.9	40.1
Plaice	3.0	3.4
Saithe	14.4	10.1
Sole	1.9	13.9
Whiting	10.1	9.3
Other demersal	20.8	40.7
Total	**118.9**	**190.1**

Source: Data provided by the MMO (MMO website)

Pelagic

Table A3h.18 shows landings of herring into the UK by UK vessels to be half the weight in 2009 than the average across 2003-2007, although the total value of herring landings remained similar. The landed value of mackerel in 2009 was significantly greater than that of 2003-2007, although the landed weight has remained similar. The landed value of pelagic species was greater in 2009 (£98.1m) than across 2003-2007 (£75.9m), although the landed weight was much lower (145,000 tonnes in 2009 compared to an average of 195,100 tonnes across 2003-2007).

Table A3h.18 – Average annual pelagic landings into the UK by UK vessels in 2009

Species	Landed weight ('000 tonnes)	Landed value (£ million)
Herring	31.6	9.5
Mackerel	100.3	84.5
Other pelagic	13.2	4.0
Total	**145.0**	**98.1**

Source: Data provided by the MMO (MMO website)

Shellfish

Across all shellfish species the total landed weight remained similar to the 2003-2007 average reported in the previous OESEA. However, the value of shellfish landed in 2009 was greater than the 2003-2007 average (£231.5m in 2009 compared to £208.7m across 2003-2007).

Table A3h.19 – Average annual shellfish landings into the UK by UK vessels in 2009

Species	Landed weight ('000 tonnes)	Landed value (£ million)
Crabs	24.4	30.5
Nephrops	42.3	95.8
Other shellfish	63.6	105.1
Total	**130.4**	**231.5**

Source: Data provided by the MMO (MMO website)

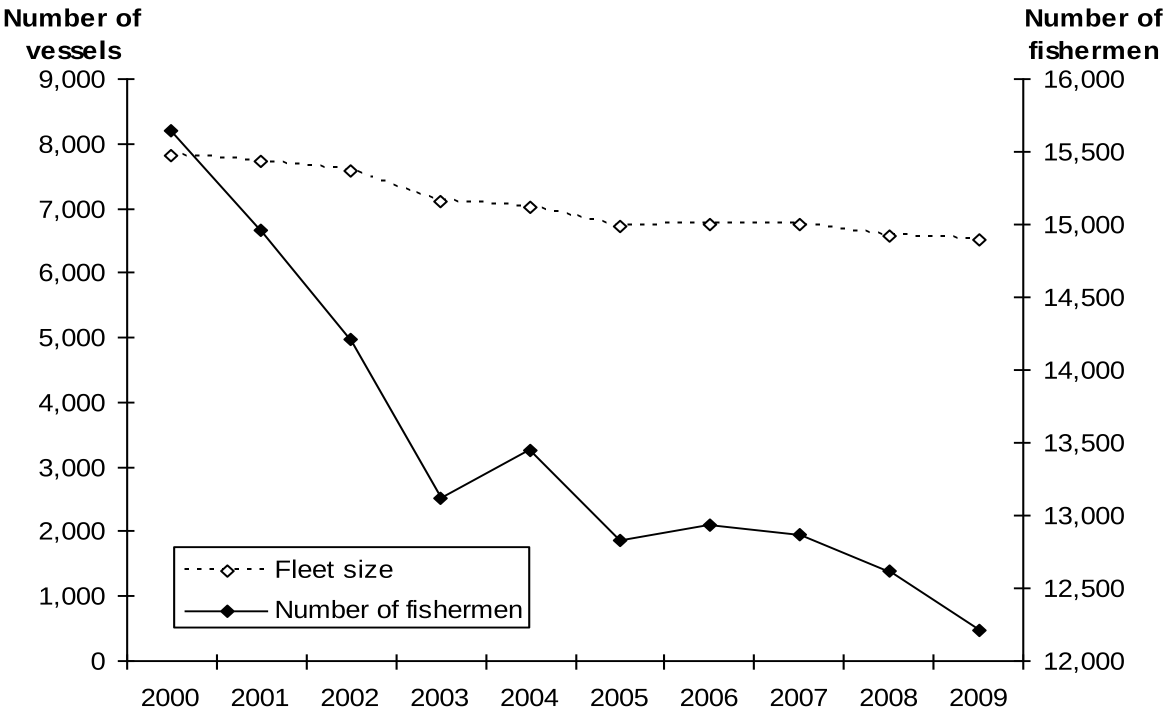
A3h.13.2 Evolution of the Baseline and Environmental Issues

A3h.13.2.1 Evolution of the Baseline

Trends in the fishing industry

The number of registered fishermen in the UK in 2009 was 12,212, a lower number than in 2007 and down 22% since 2000 (Figure A3h.26). Of these, 5,358 were based in England, 5,349 in Scotland, 851 in Wales and 654 in Northern Ireland (MMO 2010). The UK fleet in 2009 comprised 6,500 vessels (down from 6,763 in 2007 and a 17% reduction since 2000) of which 5,021 were under 10m long and 1,479 were above 10m (MMO 2010) (Figure A3h.26).

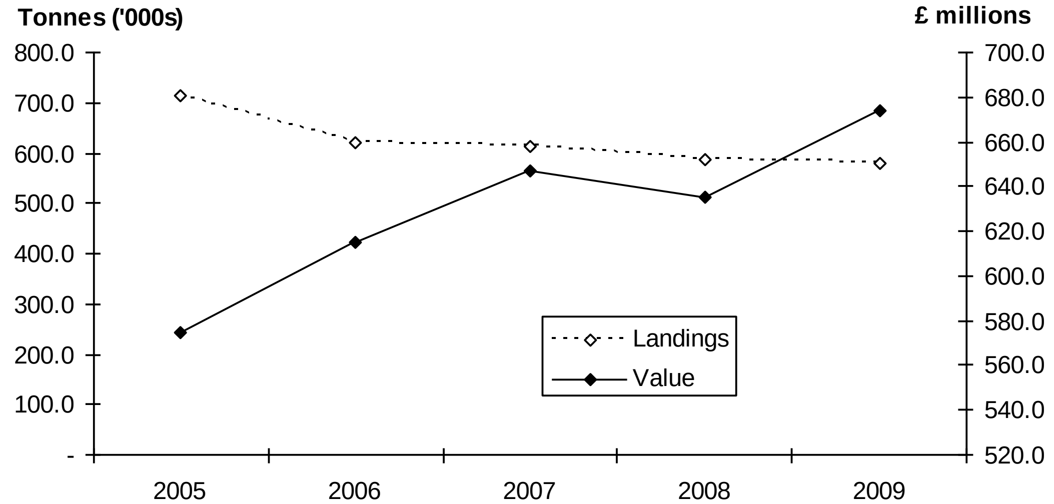
Figure A3h.26 – UK fleet size and numbers of working fishermen, 2000-2009



Source: Data provided by the MMO (MMO website)

Figure A3h.27 shows that the trend of increasing value of landings by UK vessels, as total weight declines, observed in the OESEA, is continuing. In 2009 UK vessels landed 581,000 tonnes of fish and shellfish, with a total value of £674m, a fall of 1% in quantity but a rise of 6% in value since 2008 (MMO 2010).

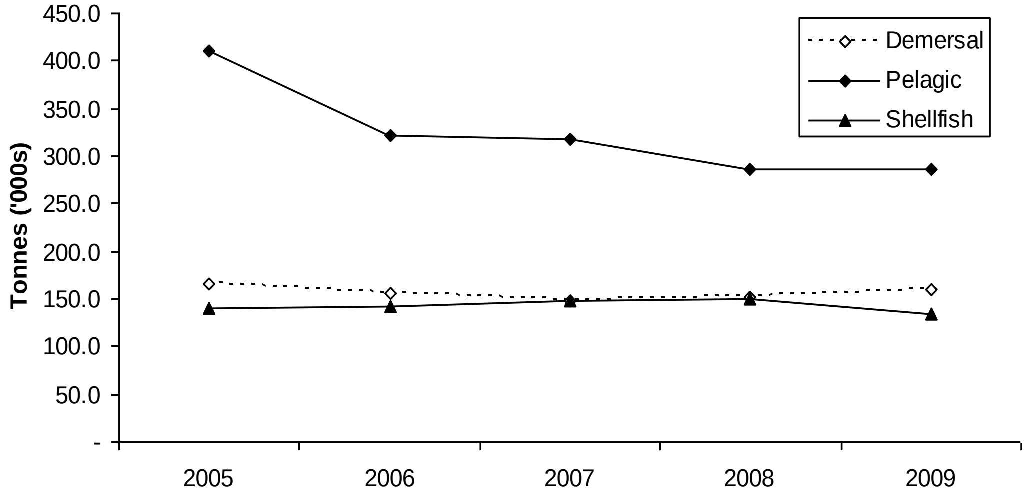
Figure A3h.27 – Total landings UK vessels by weight and value, 2005-2009



Source: Data provided by the MMO (MMO website)

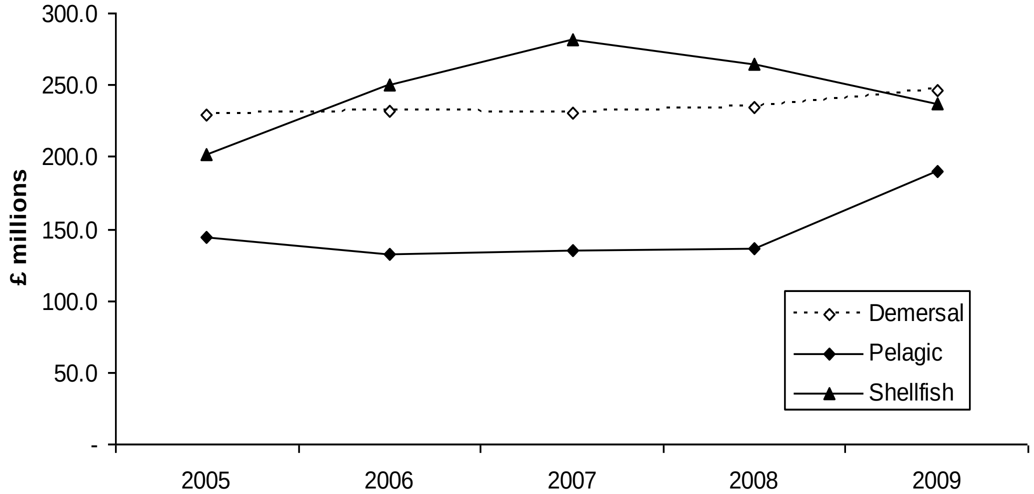
Figures A3h.28 and A3h.29 split weight of UK landings and value by species type. Weight of landings was dominated by pelagic species although shellfish and demersal species are higher value catch, as can be seen in the OESEA. In 2009, the UK fleet landed 160 thousand tonnes of demersal species, 5% greater than in 2008. Over the same period, the value of demersal landings also increased by 5%. There were 287 thousand tonnes of pelagic species landed in 2009, virtually unchanged from 2008 although the value increased by 40% to £190m. The amount of pelagic species landed in 2009 was 30% lower than in 2005 although the value has increased by 32% since 2005. Shellfish landings fell for the first time in five years to 134,000 tonnes, a fall of 11% since 2008. Over the same period the value of shellfish landings decreased by 10% to £237m.

Figure A3h.28 – Total weight of UK landings by species type, 2005-2009



Source: Data provided by the MMO (MMO website)

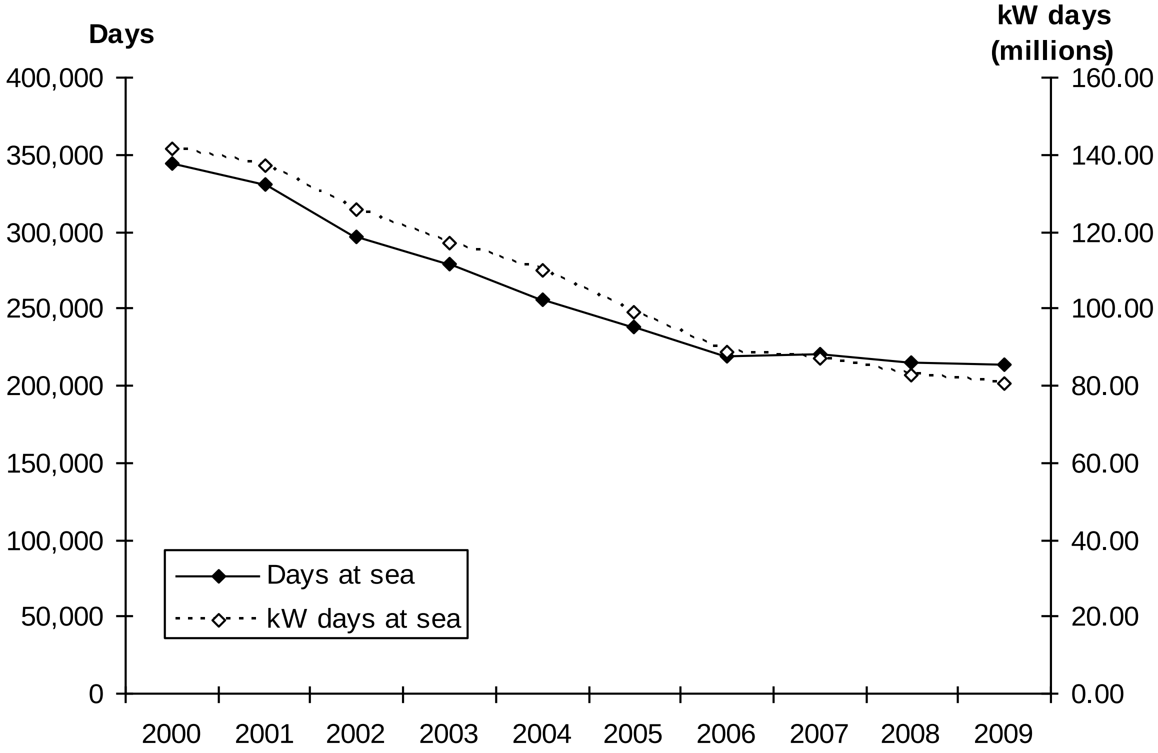
Figure A3h.29 – Total value of UK landings by species type, 2005-2009



Source: Data provided by the MMO (MMO website)

Figure A3h.30 (below) shows that the trend of decreasing effort over the past decade has continued to 2009, although the rate of decline has decreased since 2006. There has been a 43% reduction in kW days at sea since 2000 (8% since 2007). Figure A3h.30 shows days at sea to be a comparable index of fishing effort. This decrease is largely due to a reduction in effort by demersal trawlers and seine netters of 47%, following decommissioning programmes carried out in 2001 and 2003 (MMO 2010).

Figure A3h.30 – UK fishing fleet effort from 2000-2009



Source: Data provided by the MMO (MMO website)

A3h.13.2.2 Environmental Issues

Fishing pressure

The effects of over-fishing on fish stocks were covered in the OESEA as well as in Appendix A3a.4 Fish and Shellfish of this document.

Thurstan *et al*. (2010) showed that over 118 years from 1889-2007, the landings per unit of fishing power in the bottom trawl sector has fallen by 94%, a demonstration of the scale of the decline in demersal fish stocks since the advent of industrial fishing. Anderson *et al*. (2008) and Perry *et al*. (2010) argue that the de-stabilisation of fish stocks caused by heavy fishing leads to increased fluctuations in abundance and therefore increased vulnerability to natural events. This was also illustrated by Lindegren *et al*. (2010) who demonstrate the increased resilience to environmental change of the Atlantic cod in the Sound separating the North and Baltic Seas, where a trawling ban has been in place since 1932, compared to the neighbouring waters.

The latest Charting Progress report (Defra 2010e) states that the majority of UK stocks are still fished well above the levels expected to provide the highest long-term yield, although of 20 indicator stocks, the proportion being harvested sustainably rose from 10% in the early 1990s to about 40% in 2007. Fishing mortality estimates have declined significantly in recent years in 67% of assessed stocks in UK waters, including North Sea haddock and cod. The OSPAR Quality Status Report 2010 (OSPAR 2010a) concludes that too many fish stocks are still outside safe biological limits, although there have been significant improvements in a number of stocks. Recent reductions in fishing effort have been partially offset by a more technologically advanced and efficient fleets (OSPAR 2010a).

Fisheries management

Closed areas

The importance of closed areas as a tool for fisheries management was demonstrated by Wright *et al*. (2010) who conclude that temporary area closures, varying in location in relation to the juvenile settlement concentrations, may be more beneficial for haddock stocks than permanent closures. This system of "live-closures" has been adopted by the MMO with a list of closed areas available from their website and updated monthly (MMO website).

Goni *et al*. (2010) quantified the extent of the benefit of long-term closed areas to the spiny lobster (*Palinurus elephas*) fishery. They show that during an 8-17 year period of protection there was a net annual benefit of 10%, although a concentration of fishing effort along the boundaries of the closed area limits the spatial extent of the spillover.

Spatial planning

Blythe-Skyrme (2010b) reports a survey of fishermen carried out with the aim of identifying potential ways of mitigating the impact of offshore wind farms on the fishing industry. Twenty-six possible mitigation options were identified, including; options to minimize effects on fishing activities; options to enhance stocks of target species and the associated habitats; options to support existing activities; options to develop new fisheries or other activities. Localised studies, including des Clers *et al*. (2008) and Woolmer (2009) have mapped fishing activity as part of efforts to improve knowledge and understanding of the spatial distribution of inshore fishing, which tends to be missed by studies relying on VMS data. des Clers *et al*. (2008) focus on inshore fisheries around the coast of Devon and Cornwall, while Woolmer (2009) produced detailed maps of shellfishery activity in small areas on the south coast of England and the north west coast of Wales. Stelzenmüller *et al*. (2008) present an analysis of fishing pressure in English and Welsh waters and reveal that areas of coarse of mixed sediments with weak or moderate tidal stress are typically heavily fished, while the distribution of fishing activity tends to be patchy.

Bycatch and discards

Since 2007 a new EU policy aimed to reduce the number of discards is being implemented. This included the introduction on 1st January 2009 of a ban on "high-grading" (the practice of retaining on board only the highest value catch while discarding lower value fish). This will be extended to other parts of the Atlantic in 2010 (OSPAR 2010a).

Effect of climate

The effects of climate on fish stocks are well covered in the OESEA as well as in Appendix 3a.4 Fish and Shellfish of this document. The information presented in these sections remains valid. A further review of the effect of climate change may also be found in Brander (2010). MCCIP's Annual Report Card (Pinnegar *et al*. 2010), reports with medium confidence that areas of high cod, haddock, plaice and sole catches have shifted over the past 80-90 years, partially as a result of changes to the climate. Changes in fish distribution are having an effect on the effectiveness of some management schemes, such as fishery closures and the division of resources between countries. This is in addition to effects and predictions reported in the previous OESEA. It is estimated that the economic impact of these changes on fishing dependent communities in the north of Scotland and south west of England will be significant (Pinnegar *et al*. 2010).

Damage to the wider environment

Information on the damage fishing activity may cause to the wider environment is provided in the OESEA. Shifts in the benthic community of the North Sea were described by Robinson & Frid (2008), as well as the losses of entire taxa, apparently through damage from trawling over several decades. Atkinson *et al*. (2010) reported that shellfisheries (predominantly cockle and mussel) conflict with waterbirds in the Norfolk Wash region, by removing prey. In conjunction with nutrient inputs in the area, this has resulted in a decline in species of waterbird, including the knot, shelduck and oystercatcher and a change in the assemblage towards one dominated by species which rely more on less heavily exploited prey items, such as worms.

OSPAR (2010a) conclude that physical disturbance to benthic habitats has decreased in some areas and increased in others. The North Sea has seen a decrease in the number of hours fished, but effort has moved to areas that were previously relatively lightly fished and undisturbed as a result of closed areas (OSPAR 2010a). It is estimated that some areas of the North Sea may take up to 15 years to recover from one pass of a beam trawl, with those areas experiencing low levels of natural disturbance the most sensitive (Hiddink *et al*. 2006). As found by Stelzenmüller *et al*. (2008), fishing pressure is often higher in areas with the least tidal stress.

A3h.14 MARICULTURE

The following sections provide an update to information presented in Appendix A3h.14 of the OESEA (DECC 2009b).

A3h.14.1 Changes in UK Context

The OESEA (DECC 2009b) and the references therein provide a brief overview of mariculture in the UK, including the size and value of the activity in the UK and key geographical areas.

Scotland is responsible for 80% of UK production, with a total output estimated at £367m in 2008. Of this, £336m (128,606 tonnes produced from 257 active marine sites in 2008) is from Atlantic salmon farming and £8m from shellfish production (5,869 tonnes of mussels produced in 2008). Salmon farming in Scotland supports 1,212 full or part time jobs in production as well as 4,674 jobs in processing, with Scottish shellfish production supporting 348 jobs (Scottish Government website). Other important species in Scottish mariculture include rainbow trout, brown trout, halibut, Arctic charr, Pacific oysters, native oysters, queen scallops and scallops. The majority of Scottish mariculture is located in the north and west of the country, with businesses in Shetland accounting for 59% of Scotland's mussel production in 2009 (Marine Scotland 2010b).

There are currently 518 fish and shellfish farms in England and Wales, of which 197 are trout and other finfish fish farms and 128 are shellfish farms (Defra website), although a large proportion of this activity takes place inland in freshwater. A total of 8,127 tonnes of finfish and 15,449 tonnes of shellfish was produced in 2006, with rainbow trout and mussels the main species cultivated. Most production takes place in southern England (Defra website). In Northern Ireland, there are 48 marine shellfish farms and 2 marine finfish sites with the aquaculture sector employing 161 people in 2007, although many of these jobs would have been at inshore sites (DARDNI website).

Table A3h.20 shows the distribution of mariculture around the UK to be heavily concentrated along the coasts of the west and north of Scotland, although distribution of shellfish production is more evenly spread.

Table A3h.20 – The distribution of value of UK mariculture in 2007

Region	Farmed finfish value (£ million)	Farmed shellfish value (£ million)	Total GVA (£ million)
Northern North Sea	46.0	0.7	25.7
Southern North Sea	0.0	1.4	0.8
Eastern Channel	0.0	2.3	1.3
Western Channel and Celtic Sea	0.0	1.0	0.6
Irish Sea	17.9	7.4	13.9
Minches and Western Scotland	153.3	7.5	88.4
Scottish Continental Shelf	109.8	2.6	61.8
Atlantic NW Approaches	0.0	0.0	0.0
Total	**327.0**	**22.9**	**193.0**

Source: Defra (2010e)

A3h.14.2 Evolution of the Baseline and Environmental Issues

A3h.14.2.1 Evolution of the Baseline

Aquaculture and mariculture around the UK is a growing industry. Salmon production in Scotland increased from about 110,000 tonnes in 1998 to 130,000 tonnes in 2007, although there has been a decline in production since 2003 (Defra 2010e). Scottish mussel production increased substantially from 1998-2007 (from approximately 1,300 tonnes to 4,900 tonnes) and rose again by 7% from 2008-2009 (Marine Scotland 2010b). However, there have been decreases in staff employed in salmon production and the number of active shellfish producers in Scotland over the past decade (Marine Scotland, 2010a, b).

A3h.14.2.2 Environmental Issues

Key environmental issues associated with mariculture include the introduction of nutrients or chemicals into the local environment. Accumulations of faecal matter or uneaten feed may de-oxygenate the local seabed and alter the benthic community as well as increase phytoplankton levels, potentially causing eutrophication and harmful algal blooms (Defra 2010e). Disinfectants and antibiotics may have toxic or other harmful effects on benthic fauna and consequently in the UK their use is regulated (Defra 2010e). High concentrations of animals at farms may also lead to outbreaks of disease which may spread to the wild population. For example, increased densities of larval sea lice are associated with salmonid farming, leading to increased incidence of infection among wild fish (Defra 2010e).

Mariculture has been implicated in the introduction of non-native species into the UK. It is believed that up to half of all non-native marine algal species have been introduced through mariculture, for example the brown seaweed *Sargassum muticum* originally from Japan. The escape of farmed fish and consequent interbreeding with wild stocks may lead to a loss of genetic diversity and potentially naturally selected adaptations (for example, the ability of salmon to find a “home river” for spawning), potentially resulting in reduced population fitness (Defra 2010e). In 2008, 56,941 seawater stage Atlantic salmon were reported to have escaped from farms in Scotland (Marine Scotland 2010).

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APPENDIX 3i – CULTURAL HERITAGE

The following sections provide an update to information presented in Appendix 3i of the OESEA Environmental Report (DECC 2009b).

A3i.1 UPDATE TO BASELINE INFORMATION

A3i.1.1 Relevant Initiatives

Since the OESEA, there have been a number of updates/revisions to initiatives of relevance to cultural heritage. A full list of relevant initiatives is presented below, with those which are new, updated, or now of relevance due to the new elements of the plan, distinguished below those previously considered in OESEA. Note that only those new items are discussed below. A full narrative relating to these initiatives is given in Appendix 4.

Cultural Heritage — OESEA | OESEA2

Level	Initiatives
International	UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage 1972, the 'Valetta Convention' Convention on the Protection of Underwater Cultural Heritage (CPUCH) United Nations Convention on the Law of the Sea (UNCLOS)
Europe	Council of Europe, European Convention on the Protection of the Archaeological Heritage 1992 Council of Europe, European Landscape Convention 2000
UK (OESEA)	Treasure Act 1996 (does not extend to Scotland) Protection of Wrecks Act 1973 Protection of Military Remains Act 1986 Ancient Monuments and Archaeological Areas Act 1979 Planning (Listed Buildings and Conservation Areas) Act 1990 Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 The Historic Monuments and Archaeological Objects (NI) Order 1995 National Heritage Act 2002 The Planning (NI) Order 1991
UK (OESEA2)	Draft Heritage Protection Bill (2008) - currently on hold Marine and Coastal Access Act 2009 Marine (Scotland) Act 2010 Draft Northern Ireland Marine Bill Draft Marine Policy Statement Draft Overarching National Policy Statement for Energy (EN-1) Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) Draft National Policy Statement for Gas Supply Infrastructure and Gas and Oil Pipelines (EN-4) The Protection of Military Remains Act 1986 (Designation of Vessels and Controlled Sites) Order 2009

Local

Scotland's Historic Environment Audit (2008)
Planning Policy Statement 5: Planning for the Historic Environment (England)
Planning Policy Statement 6: Planning, Archaeology and the Built Heritage (Northern Ireland)
Planning Advice Note 42 (PAN42): Archaeology in the Planning Process and Scheduled Monument Procedures (Scotland)

English Heritage: Climate Change and the Historic Environment (2008)
English Heritage: Conservation Principles, Policies and Guidance for Sustainable Management of the Historic Environment (2008)
English Heritage: Strategic Environmental Assessment, Sustainability Appraisal and The Historic Environment (2010)
Engligh Heritage National Heritage Protection Plan - Interim version (2010)
HM Government's Statement on the Historic Environment for England (2010)
Circular 07/09: Protection of World Heritage Sites (England) (2009)
Scottish Natural Heritage: Natural Heritage Futures Update (2009)
Scottish Historic Environment Policy (2009)
Marine (Scotland) Act 2010
The Historic Environment (Amendment) Scotland Bill
Strategic Environmental Assessment (SEA) of Draft Plan for Offshore Wind Energy in Scottish Territorial Waters (2010)
Planning Policy Statement 5: Planning for the Historic Environment (England) (2010)
Scottish Planning Policy (2010)
Offshore Wind and Marine Renewables Energy SEA Environmental Report (Northern Ireland) (2010)
Conservation Principles, Policies and Guidance for the sustainable management of the historic environment in Wales: consultation draft (2009)

The reform of heritage protection currently underway in the UK was summarised in the OESEA, although a number of changes have taken place since its publication. The Draft Heritage Protection Bill of the previous Government was not taken forward in parliament in 2009 and its progress is now uncertain, though relevant agencies (e.g. English Heritage, DCMS) are still committed to implementing legislative reform when possible. Though a number of elements of heritage reform in England can be taken forward without this new primary legislation (e.g. Planning Policy Statement 5 and the World Heritage Site Planning Circular), a number of reforms cannot (see below) (English Heritage Website):

- The full transfer of responsibility for designation from the Department for Culture, Media and Sport (DCMS) to English Heritage
- To bring together in one simple list, the separate regimes for listing, scheduling, registration of parks, gardens, battlefields and protected wreck sites
- To introduce interim legal protection for heritage assets being considered for designation
- To give better protection for sites of early human activity which cannot currently be scheduled
- For owners to have a formal right to appeal against a designation decision.
- The unification of Listed Building and Scheduled Monument Consent into a single Historic Asset Consent
- Local authorities to grant Historic Asset Consent including archaeological cases currently handled by the DCMS
- For the pre-determination of Historic Asset Consent via Heritage Partnership Agreements
- To give Historic Environment Records statutory force
- For the merger of Conservation Area Consent with Planning Permission

The Marine and Coastal Access Act 2009 has a number of provisions in relation to the historic environment, including consideration of historic or archaeological sites within the grounds for designating Marine Conservation Zones (MCZs). The Marine (Scotland) Act 2010 allows Scottish Ministers to designate Historic Marine Protected Areas in Scottish territorial waters (i.e. out to 12nm). These designations are to be used instead of the Protection of Wrecks Act 1973 for wreck sites in Scottish waters from 2012 following the repeal of section 1 of the PWA under the Marine (Scotland) Act. Military remains will remain within the remit of the Protection of Military Remains Act 1986. Although Scottish territorial waters are not within the remit of this SEA, landfall locations and offshore developments may take place within close proximity to territorial limits. For the purposes of the Marine (Scotland) Act historic assets may include:

- A vessel, vehicle or aircraft (or a part of a vessel, vehicle or aircraft), or its remains
- An object contained in, or formerly contained in, a vessel, vehicle or aircraft
- A building or other structure (or a part of a building or structure)
- A cave or excavation
- A deposit or artefact (whether or not formerly part of a cargo of a ship) or any other thing which evidences, or groups of things which evidence, previous human activity

English Heritage has recently produced (December 2010) an interim National Heritage Protection Plan due to be finalised by April 2011 which sets out the priorities for which English Heritage will dedicate resources to in the years 2011-2015, for all aspects of national heritage, spanning both the pre-historic and historic periods. The Action Plan embedded in this document sets out what is to be delivered, stating measures and activities to achieve this, with activities consisting of a number of linked projects undertaken by English Heritage. In the context of the marine environment, a number of relevant topics are assigned resources including: marine exploitation impacts, mineral extraction impacts, unknown marine assets and landscapes and submerged heritage assets and landscapes. Plan activities are due to be carried out in a comprehensive and clear manner, involving local communities and with results which are widely disseminated and accessible.

It should also be noted that English Heritage has commissioned the Centre for Maritime Archaeology at the University of Southampton to co-ordinate the development of a Maritime and Marine Historic Environment Research Framework, due for publication in spring 2011. The framework is intended to inform future management, policy and planning for the marine historic environment, and provide research priorities for which funding may be sought.

A3i.1.2 Changes in UK Context

Much of the UK context of the coastal and marine heritage presented in the OESEA remains unchanged. The publication of, *Europe's Lost World: the Rediscovery of Doggerland* (Gaffney *et al.* 2009), summarises much of the work that has taken place with regards to marine archaeology in the North Sea in recent years, particularly Gaffney *et al.* (2008). In the wider context of the timing of the earliest settlement of Britain, and therefore also the shelf area of the North Sea, recent finds near the town of Happisburgh, Norfolk, tentatively push early proto-human occupation back to a maximum age of *ca.* 700-950,000 yr BP (Parfitt *et al.* 2010, Roberts & Grün 2010).

Wrecks

The number of wrecks designated under the Protection of Wrecks Act 1973 remains unchanged. Three additional sites have been designated through the Protection of Military Remains Act 1986 (Designation of Vessels and Controlled Sites) Order 2009, and these are listed below (Table A3i.1). No coordinate information is associated with protected sites.

Table A3i.1 – Designations under the PMRA since the publication of OESEA

Wreck name	Date of sinking	Approximate location
HMS Calgarian	1st March 1918	Northern Ireland – north of Rathlin Island*
HMS Fisgard II	17th September 1914	Portland Bill
HMS Fitzroy	27th May 1942	Great Yarmouth

*Source: The Protection of Military Remains Act 1986 (Designation of Vessels and Controlled Sites) Order 2009, *Canmore database*

Archaeological sites in coastal and estuarine areas

A number of type-areas were identified in the OESEA (after Flemming 2004a, b) in which archaeological material may be advantageously preserved due to site taphonomy (i.e. the processes involved in the entrainment and subsequent preservation of archaeological or biological material), and this included intertidal areas, many of which were described in the Regional Sea sections of marine and coastal archaeology in the OESEA. A number of key sites include not only preserved cultural remains, but also evidence of past environmental conditions and how they have changed, preserved as peat beds or relict forests dating to pre-Holocene times. Such sites are widely distributed in England and Wales, and erosion will continue to expose these former surfaces for instance where aeolian sand dunes retreat (Bell 1997). The relevant Regional Sea sections of the OESEA provide information relating to the distribution of a number of these areas.

A3i.1.3 Evolution of the Baseline and Environmental Issues

A3i.1.3.1 Evolution of the Baseline

The prospects of recovering material of Palaeolithic to Neolithic provenance on the UKCS to the east of the UK (and to a lesser extent to the west) remains unchanged since the OESEA, though revised guidance in prospecting this area prior to renewable energy development has been published by COWRIE (2010), *Offshore geotechnical investigations and historical environment analysis*: *Guidance for the renewable energy sector*. A number of Regional Environment Characterisations (REC) have been carried out by the Marine Aggregate Levy Sustainability Fund, and include regions of the Humber, Thames, East Anglia and Solent. These reports provide a detailed account of, *inter alia*, marine archaeology in these areas (see http://www.marinealsf.org.uk/).

A3i.1.3.2 Environmental Issues

The environmental issues presented in OESEA in relation to cultural heritage on the coast and offshore remain unchanged. Coastal erosion plays an important part in the ongoing denudation of certain sites, particularly on the English east coast, and in the offshore area activities which modify the seafloor (e.g. bottom-trawling, cable laying, aggregate extraction) pose some of the greatest threats to site integrity, although as stated previously interactions with developers can prove fruitful for marine archaeology and the management of marine resources (see Evans *et al.* 2009). The possible environmental impacts on the marine cultural resource as presented in the OESEA (after Flemming 2004b) from the oil and gas industry are still valid, and due to similarities between these activities and those for CCS and gas storage, they may be reasonably transposed to these industries also. Likewise, those environmental issues associated with OWFs (after COWRIE 2008, JNAPC 2006 and Wessex Archaeology 2007) may in some instances be applicable to wave and tidal current devices, though the comparatively small footprint of moorings associated with floating devices present a lower risk to cultural resources than the monopile foundations typical of present OWF deployments.

The sea-level change projections given in the latest UKCIP report (Lowe *et al.* 2009) revise the possible outcome for the UK coast given a range of emissions scenarios and model confidence (see Appendix 3b, OESEA2). Sea-level change, aligned with the possibility of coastal-squeeze and a loss of some intertidal area, may compound the present situation and where managed realignment is the most effective form of coastal management, may lead to the loss of some coastal sites to the sea. It is noted by English Heritage (pers. comm.) that the investigation and cataloguing of such sites are prioritised so that they might add to archaeological knowledge in the long-term before site integrity is lost.

The heritage protection reform outlined in the OESEA has at present been put on hold, with non-legislative elements being carried forward (see above). Despite commitment to the continuation of this reform, no timetable has been set to take it forward. The UK is still not a signatory of the UNESCO Convention on the Protection of the Underwater Cultural Heritage 2001, though this passed into force for the 32 states which ratified or accepted it on 2nd January 2009 (correct at 30th August 2010).

A useful and recent summary of the threats to offshore cultural heritage, interactions with marine developers and marine heritage protection is provided in a special issue (Volume 11, 2009) of the *Conservation and Management of Archaeological Sites* (Flatman 2009).

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APPENDIX 3j – CONSERVATION

The following sections provide an update to information presented in Appendix A3j of the OESEA Environmental Report (DECC 2009).

A3j.1 UPDATE TO BASELINE INFORMATION

A3j.1.1 Relevant Initiatives

Since the OESEA, there have been a number of updates/revisions to initiatives of relevance to conservation. A full list of relevant initiatives is presented below, with those which are new, updated, or now of relevance due to the new elements of the plan, distinguished below those previously considered in OESEA. Note that only those new items are discussed below. A full narrative

Conservation	OESEA	OESEA2
International	Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat (1971, 1982) The International Council for the Exploration of the Sea (ICES) Code of Practice for the Introduction and Transfer of Marine Organisms	
Regional	Agreement on the Conservation of Small Cetaceans of the Baltic North East Atlantic, Irish and North Seas (1994) Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) (1992) OSPAR Agreement 2005-6 on the Agreement on Background Concentrations for Contaminants in Seawater, Biota and Sediment Convention for the Conservation of Salmon in the North Atlantic Ocean (1983) Council of Europe Strategy on Invasive Alien Species (2003)	
EU	EU Biodiversity Communication (2006) Directive 92/43/EEC, on the Conservation of Natural Habitats and of Wild Fauna and Flora Marine Strategy Framework Directive 2008/56/EC	Directive 2009/147/EC, on the Conservation of Wild Birds
UK	UK Marine and Coastal Access Act 2009 and Bills proposed by devolved administrations The Wildlife and Countryside Act (WCA)1981 Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended) National Parks and Access to the Countryside Act 1949	UK Marine and Coastal Access Act 2009 Natural England and JNCC Marine Conservation Zone Project. The Marine Strategy Regulations 2010 The Offshore Marine Conservation (Natural Habitats, &c.) (Amendment) Regulations 2010 The Conservation of Habitats and Species Regulations 2010
Local	Conservation (Natural Habitats, etc.) Regulations (Northern Ireland) 1995 (as amended) Countryside and Rights of Way (CRoW) Act 2000 (England and Wales) Wildlife (Northern Ireland) Order 1985) Nature Conservation (Scotland) Act 2004	Marine (Scotland) Act 2009 Scotland's Marine Survey Programme and Scotland's Priority Marine Features

There is a wide range of international treaties and conventions, European and national legislation and other measures which have application in relation to the protection and conservation of species and habitats in the UK and UK waters, and these were summarised in the OESEA. A number of amendments and additional pieces of legislation have been implemented at the UK level since the production of the OESEA and these are discussed below. Also note that these are discussed in the wider context of international, regional and EU legislation and other relevant initiatives in Appendix 4.

The Marine and Coastal Access Act 2009 (and equivalent Acts/Bills of the devolved administrations) will aid the completion of an ecologically coherent and well-managed network of Marine Protected Areas, suggested as a contributory measure to achieving good environmental status in the Marine Strategy Framework Directive, and as required in similar commitments regarding MPAs under international conventions such as the Convention on Biological Diversity. These sites will be known as Marine Conservation Zones (MCZs) in England and Wales and Marine Protected Areas (MPAs) in Scotland, administered at the local level in each UK constituent country. The Marine Conservation Zone project in England and Wales is delivered through four regional projects administered by Natural England and the JNCC, covering the South-West (Finding Sanctuary), Irish Sea (Irish Sea Conservation Zones), North Sea (Net Gain) and Eastern Channel (Balanced Seas). In UK offshore waters adjacent to Scotland, MPAs will be identified through a Scottish Marine Protected Area Project. Non-Natura MPAs will be established in Scottish Territorial Waters through the Marine (Scotland) Act 2010. In Welsh territorial waters, the Welsh Assembly Government will manage MCZ selection in collaboration with CCW. The Department of Environment (Northern Ireland) consulted (ending July 2010) on policy proposals which form part of the process contributing to the delivery of a Northern Ireland Bill which should provide details of how they are to implement their part of the UK MPA network. Natural England and JNCC have provided draft guidance to be used by the regional MCZ projects, relating to highly protected MCZs or “reference areas”. These reference areas are to be representative of the unimpacted state of at least 1 of each broad-scale habitat or FOCI (features of conservation importance) identified in the four MCZ project areas, and therefore within which all extraction, deposition or human-derived disturbance is removed or prevented. These activities are defined in the guidance with extraction and depositional activities (e.g. commercial fishing, dredging, aquaculture) completely precluded, but with other potentially damaging activities likely to be able to take place with mitigation, unless appropriate mitigation is unlikely to be possible. The location and scale of these areas is not presently known, though the MCZ Ecological Network Guidance states that these sites must be “viable”, defined as following the minimum size guidelines for broad scale habitats (5km minimum dimension), and may be variable for FOCI, though a diameter of <10km is stated as a minimum viable area for all features in this category with the exception of subtidal sands and gravels, though this may also be restricted to sandy substrates.

In addition to this piece of primary legislation, a number of orders and regulations have come into force since the OESEA which help to implement international conservation measures at the national scale, and other pieces of national legislation. The Marine Strategy Regulations 2010 transpose the Marine Strategy Framework Directive into UK law (England, Wales, Scotland and Northern Ireland), setting out deadlines for the achievement of the assessment of marine waters, the determination of the characteristics of good environmental status for those waters, the establishment of environmental targets and indicators, the establishment of a monitoring programme and the publication of a programme of measures, as required by the Directive. The ultimate goal is that of Good Environmental Status in UK waters, and for this to be achieved by 2020.

The Conservation of Species and Habitats Regulations 2010 consolidates the Conservation (Natural Habitats, &c.) Regulations 1994 and also implements certain aspects of the Marine and Coastal Access Act (above). The principal aspects are the transfer of certain licensing functions from Natural England to the Marine Management Organisation, and the recognition that Marine Enforcement Officers are able to use powers under the Marine and Coastal

Access Act 2009 to enforce offences under the Habitats Regulations, within England, Wales and Scotland and their respective territorial seas (though Scotland maintains some devolved functions).

The Offshore Marine Conservation (Natural Habitats, &c.) (Amendment) Regulations 2010 provides for the 2007 offshore regulations to refer to the consolidated Wild Birds Directive (2009/147/EC), which entered into force in February 2010, inserts reference to the Marine and Coastal Access Act 2009 and Planning Act 2008 as enactments to which competent authorities have a duty, and makes provision for Scottish Ministers to carry out certain new conservation functions in offshore waters which were previously the function of the Secretary of State (e.g. the selection, notification and classification, with agreement of the Secretary of State of SPAs and SACs). Certain marine licensing activities and enforcement carried out by Marine Scotland for the Secretary of State are also executively devolved.

A3j.1.2 Changes in UK Context

A3j.1.2.1 International sites

An overview of the background relating to international designations relevant to the UK marine area was provided in the OESEA and this information remains current.

Since the production of the OESEA, a number of new sites of international importance (specifically SPAs and SACs, there have been no changes to the UK Ramsar site list) have been designated, are in the process of being designated, or have been modified (e.g. the Scottish SPA boundary extensions).

Special Protection Areas (SPAs)

Figure A3j.1 shows the national distribution of SPAs and distinguishes those which are new, or which have been updated since January 2009. These new sites are also listed in Table A3j.1 along with a list of their qualifying species or assemblages. Seaward extensions to 31 SPAs in Scotland notable for their colonies of breeding seabirds were classified in September 2009. These sites, listed previously in the OESEA, continue to be notable for their internationally important aggregations of breeding seabirds, and the qualifying features for these sites remain unchanged. The new boundaries cover an area radiating seawards from the previous site boundary by between 1km (recommended for guillemot, razorbill and Atlantic puffin) and 2km (recommended for breeding northern gannet and northern fulmar) and are distinguished on Figure A3j.1 below.

The qualifying species listed for SPA designations in Table A3j.1 are those from the 2001 SPA review publication, as advised by JNCC or from the Natura 2000 standard data sheet for new sites since this publication.

Figure A3j.1 – UK coastal SPAs

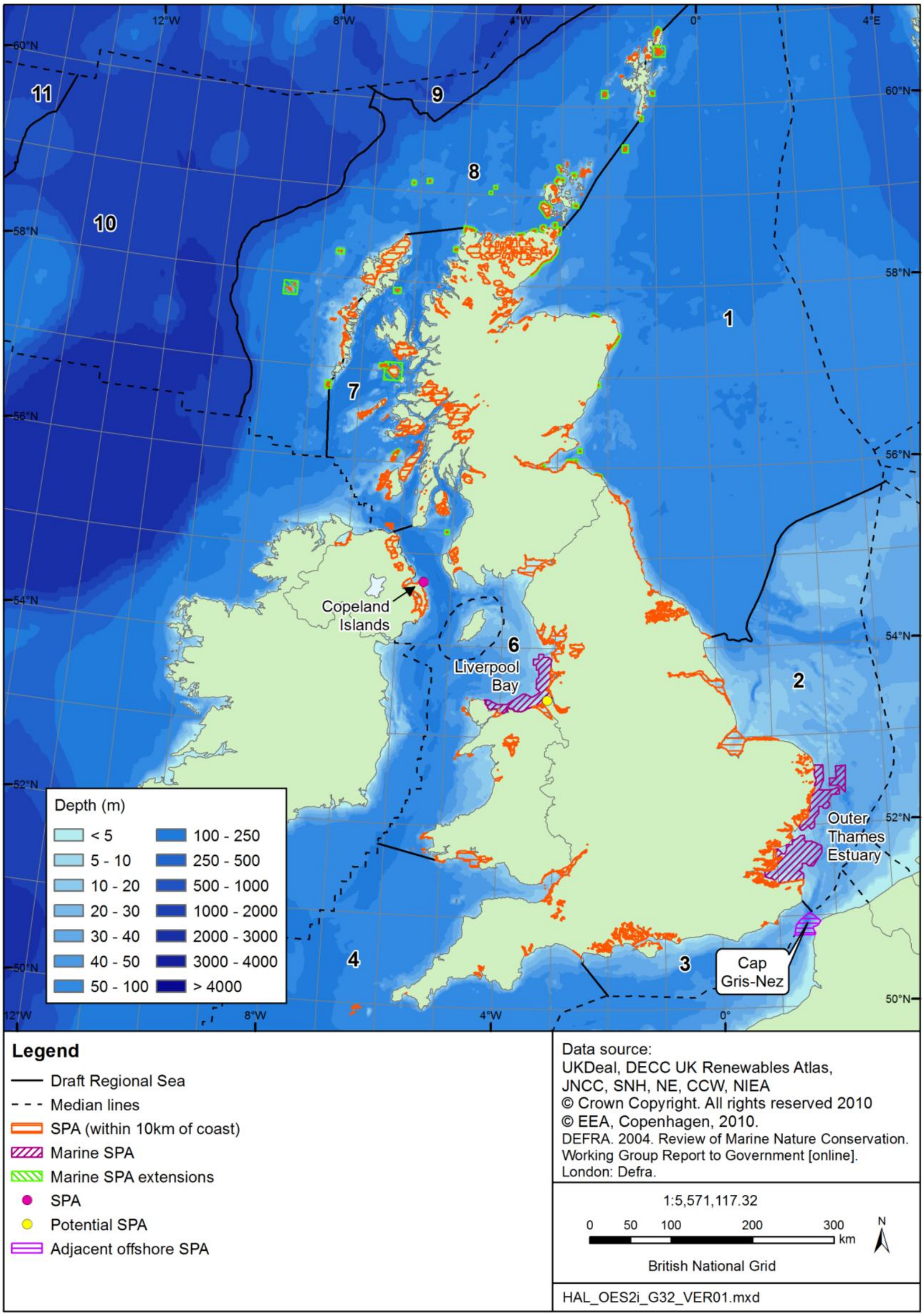


Table A3j.1 – SPAs and their qualifying features

Site Name	Area (ha)	Article 4.1 Species	Article 4.2 Migratory species	Article 4.2 Assemblages[8]
Regional Sea 2				
Outer Thames Estuary	379,268.14	**Over winter**: red-throated diver	N/A	N/A
Liverpool Bay/Bae Lerpwl	170,292.94	**Over winter**: red-throated diver	**Over winter**: common scoter	**Non-Breeding**: 55,597 waterfowl (5 year peak mean 2001/02 - 2006/07) including: red-throated diver, common scoter
Regional Sea 6				
Copeland Islands	201.52	**Breeding**: Arctic tern	**Breeding**: Manx shearwater	N/A

Special Areas of Conservation (SACs)

Since the publication of the OESEA, a number of changes to the list of UK SAC sites have been made, for instance Pevensey Levels in Sussex has been identified as a possible SAC, due to the presence of the lesser whirlpool ram's-horn snail, *Anisus vorticulus*.

A number of areas of search for inshore marine SACs were highlighted in the OESEA. Since then, Natural England, JNCC and CCW have consulted on a number of such areas which are listed in Table A3j.2 and displayed on Figure A3j.2. These sites have been submitted to the European Commission for approval and are legally protected as Candidate sites (cSAC). Natural England started a further consultation on 2 sites, Lune Deep pSAC and Prawle Point to Start Point pSAC. Lune Deep pSAC formed part of the former Shell Flat and Lune Deep pSAC, though evidence suggested that a boundary change was required which necessitated further consultation. Similarly, a change in the boundary extending Prawle Point eastwards to form part of a Prawle Point to Plymouth Sound and Eddystone pSAC, was significant enough to merit further consultation on this site. East Mingulay has been designated a draft SAC, while consideration of a proposal for a Sound of Barra SAC is ongoing.

Natural England has also recommended that a formal consultation be carried out (with a view to consultation beginning January 2011) on a new boundary for the Studland to Portland dSAC which previously formed part of the Poole Bay to Lyme Bay pSAC.

[8] - A seabird assemblage of international importance. The area regularly supports at least 20,000 seabirds. Or a wetland of international importance. The area regularly supports at least 20,000 waterfowl.

Figure A3j.2 – UK coastal and offshore SACs

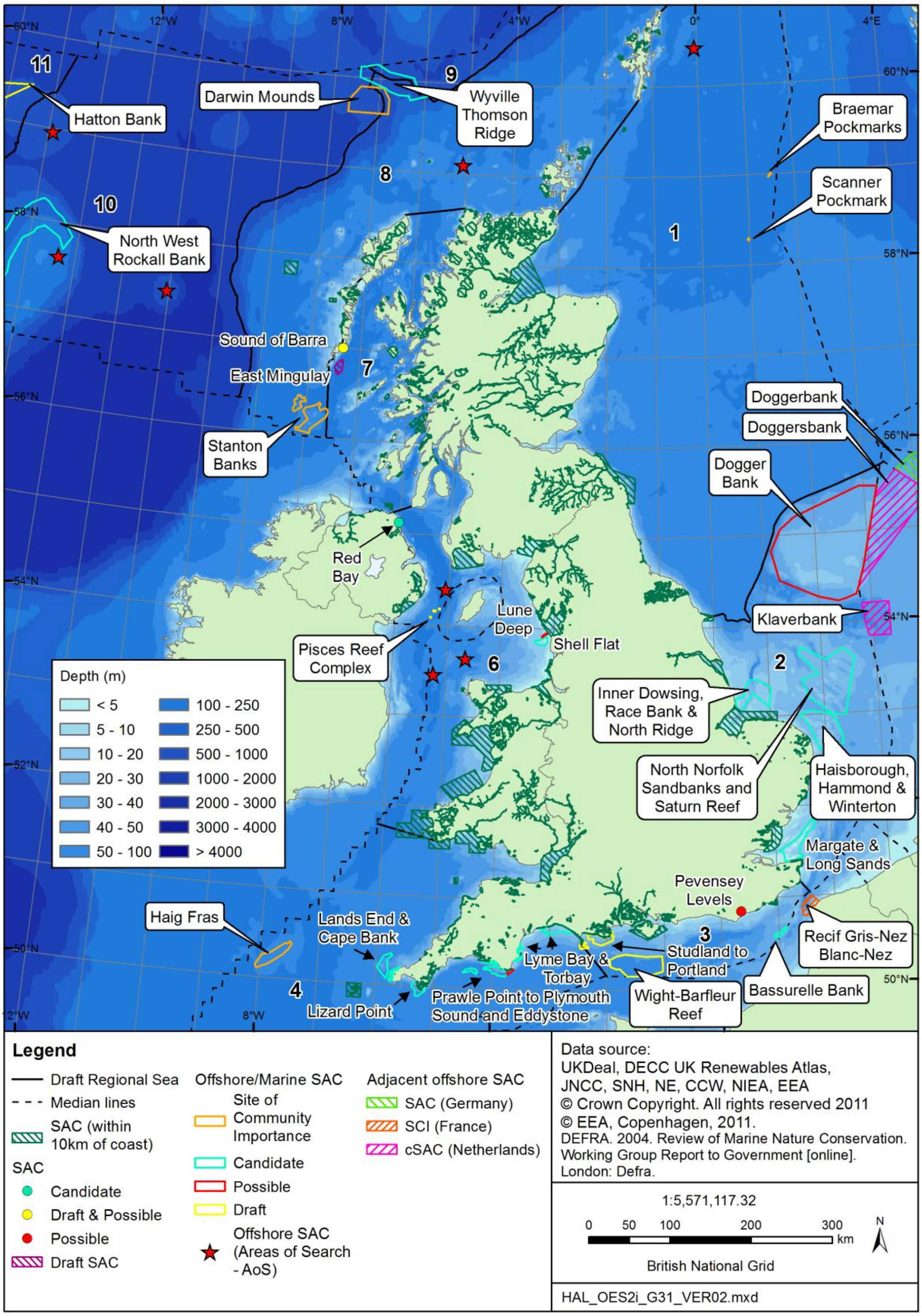


Table A3j.2 – Inshore SACs and their qualifying features

Site Name	Area (ha)	Annex 1 Habitat Primary	Annex 1 Habitat Qualifying	Annex II Species Primary	Annex II Species Qualifying
Regional Sea 2					
Margate and Long Sands cSAC	64,914	Sandbanks	N/A	N/A	N/A
Regional Sea 4					
Lands End and Cape Bank cSAC	30,172	Reefs	N/A	N/A	N/A
Lizard Point cSAC	13,988	Reefs	N/A	N/A	N/A
Lyme Bay and Torbay cSAC	31,248	Reefs Sea Caves	N/A	N/A	N/A
Prawle Point to Plymouth Sound cSAC	31,525	Reefs	N/A	N/A	N/A
Regional Sea 6					
Shell Flat cSAC	9648	Sandbanks	N/A	N/A	N/A
Red Bay cSAC	965.54	Sandbanks	N/A	N/A	N/A
Regional Sea 7					
East Mingulay dSAC	11,958.56	Reefs	N/A	N/A	N/A

Since August 2007 the UK has had the legal mechanism to designate SACs in the UK offshore marine area under the Offshore Marine Conservation (Natural Habitats &c.) Regulations 2007 (as amended). Eleven sites in UK offshore waters have now been submitted to the European Commission. The first five were submitted on 31st August 2008 and the next six on 20th August 2010 (two of these sites are joint inshore:offshore sites). The six later submissions are listed in Table A3j.3, and are all candidate SACs. The first five sites, Haig Fras, Darwin Mounds, Braemar Pockmarks, Scanner Pockmarks and Stanton Banks are all Sites of Community Importance, meaning they have been adopted by the European Commission, but are awaiting formal designation by the UK government. A number of further sites have been formally recommended to Government by JNCC. One of these, the Dogger Bank, is a possible SAC and three, Hatton Bank, Pisces Reef Complex and Wight-Barfleur Reef are draft SACs. Current offshore Areas of Search are listed in Table A3j.4.

Table A3j.3 – Offshore SACs and their qualifying features

Site Name	Area (ha)	Annex I Habitat	Annex II Species
North West Rockall Bank cSAC	436,526	Reefs	N/A
Bassurelle Sandbank cSAC	6,709	Sandbanks	N/A
Wyville Thomson Ridge cSAC	173,995	Reefs	N/A

Site Name	Area (ha)	Annex I Habitat	Annex II Species
North Norfolk Sandbanks and Saturn Reef cSAC	360,341	Sandbanks Reefs (biogenic Sabellaria spinulosa)	N/A
Haisborough, Hammond and Winterton cSAC	184,808.77	Sandbanks	N/A
Inner Dowsing, Race Bank and North Ridge cSAC	90,626.23	Sandbanks Reefs	N/A

Table A3j.4 – Offshore areas of search in UK waters

Regional Sea	Area of Search	Annex 1 Habitat
1	Reef East of Shetland Isles	Reef
6	Submarine Structures in the mid-Irish Sea	Submarine Structures
6	North-west Anglesey Reef	Reef
6	Northwest Irish Seamounds	Reef
8	Solan Bank	Reef
10	Anton Dohrn Seamount	Reef
10	East Rockall Bank	Reef
10	George Bligh Bank	Reef

Other internationally important sites

The following text provides an update to the list of other internationally important sites described in the OESEA. No additional World Heritage Sites or European Diploma sites of relevance have been designated since the publication of the OESEA. A number of UK Coastal Biogenetic Reserves that were not listed previously in the OESEA but which are of relevance are shown in Table A3j.5. The locations of coastal internationally important sites may be seen in Figures A3j.3-A3j.6.

Table A3j.5 – UK coastal biogenetic reserves

Name	Site Code	Country	Area (ha)	Latitude	Longitude	Status
Castle Hill	UK930001	England	47	50° 51 00 N	0° 03 00 W	Designated
Summary: The site is an area of chalk grassland with good chalk flora and invertebrate fauna, with areas of gorse and mixed shrub.						
Arne	UK930008	England	430	50° 41 00 N	2° 02 00 W	Designated
Summary: The site is an area of open heath and valley bogs, deciduous and coniferous woodland fresh and saltmarsh and tidal mudflats on a low-lying peninsula. The reserve comprises four major habitats which, in decreasing order of predominance are: dry heath, tidal *Spartina* beds, wet heathland bog and coniferous woodland. Small areas also consist of deciduous woodland including carr, *Phragmites* reedswamp, freshwater marsh and sand/gravel beaches and cliffs.						

Name	Site Code	Country	Area (ha)	Latitude	Longitude	Status
Hartland Moor	UK930011	England	443	50° 40 00 N	2° 04 00 W	Designated
Summary: The area is part of a formerly large tract of heathland and is the finest remaining example of Purbeck heathland. It consists of extensive dry and wet heathland, a "y"-shaped bog system, and a valley, on the southern edge, draining into Poole Harbour. The reserve is mostly on the Eocene Bagshot Sands with local outcrops of ironstone and pipeclay. The bog has superficial peat deposits and the valley has alluvium. The drier soils are podsolised. Plant associations: dry heath; wet heath; base-poor bog; more base-rich bog; reedswamp; saltmarsh; open water; trackway.						
Studland Heath including Godlingston Heath	UK930015	England	631	50° 39 00 N	1° 58 00 W	Designated
Summary: A sand dune system, with extensive dry and wet heathland and including a mere, woodland and carr. The area has a relatively recent, and well documented history as a sand peninsula. A series of dune ridges, the youngest with *Ammophila*, succeeding ones with increasingly stable mature dry *Calluna* heathland. Between the ridges are dune slacks with areas of wet heath, bog and well established carr (*Salix*/*Betula*). There is also a mere of Little Sea, now fresh-water, but formerly a coastal lagoon. This mesotrophic water has some fringing *Phragmites* swamp and the inner (south & west) shores are formed on the Bagshot Sands, also carrying heathland. Here there is also a limited area of acid grassland and woodland. There are also some areas of shallow peat with *Sphagnum* and associated bog flora.						

A3j.1.2.2 Sites of national importance and non-statutory sites

The following text provides an update of sites of national importance and non-statutory sites, as previously listed in the OESEA.

National Parks

There are 15 National Parks in the UK as detailed in the OESEA. The South Downs became the UK's newest National Park in March 2010, with an area of 634 square miles.

Marine Conservation Zones

Work is continuing on the establishment of Marine Conservation Zones in UK waters. The first Marine Conservation Zone was established in January 2010, when the Marine Nature Reserve around Lundy Island in the Bristol Channel was re-designated. Skomer Island Marine Nature Reserve will also be re-designated to a Marine Conservation Zone in 2010.

Other nationally important sites

There have been no additions to UKBAP priority species or habitats since publication of the OESEA. The locations of coastal sites of national importance can be seen in Figures A3j.3-A3j.6.

Figure A3j.3 – Nationally and internationally important UK sites (north)

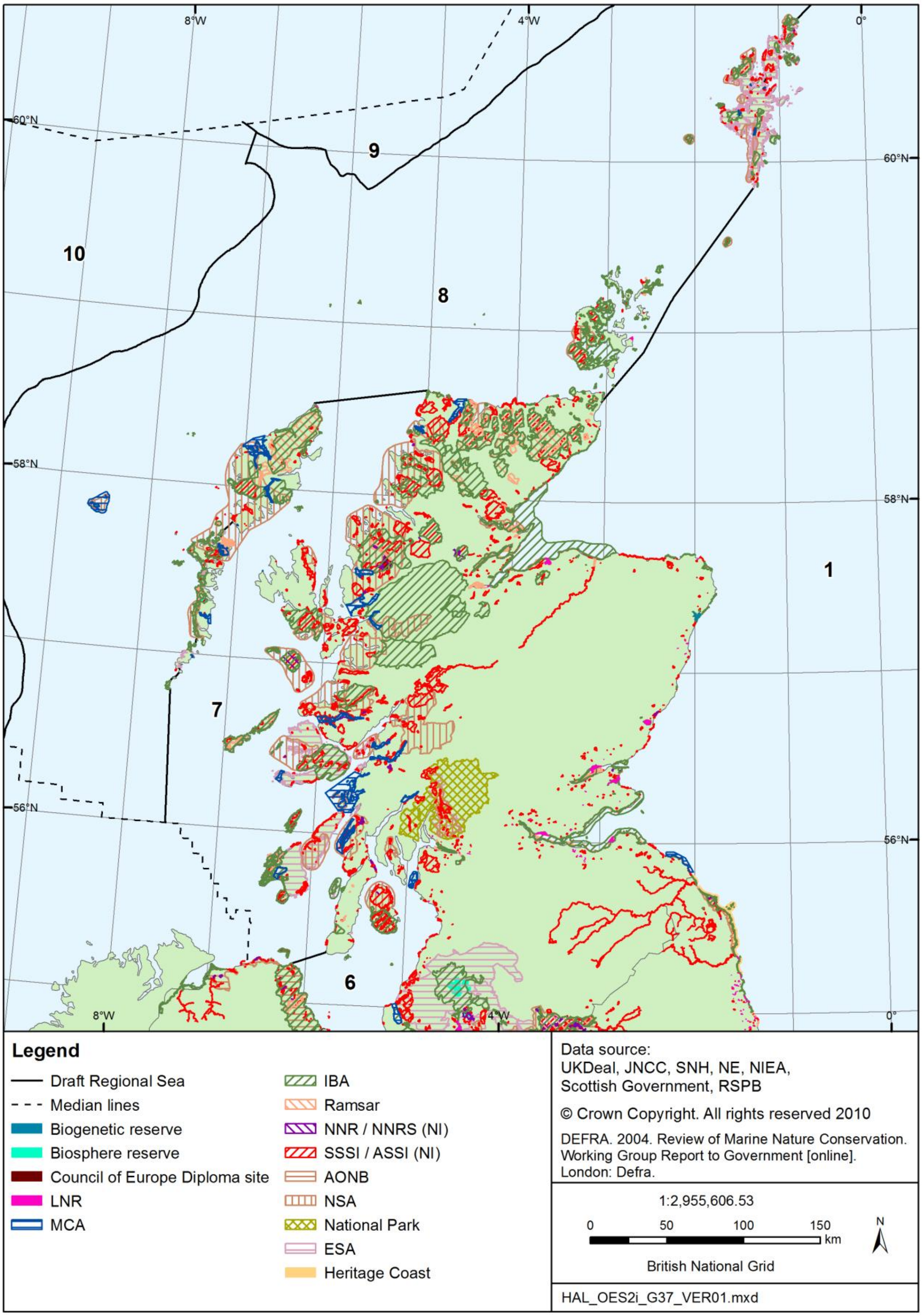


Figure A3j.4 – Nationally and internationally important UK sites (south)

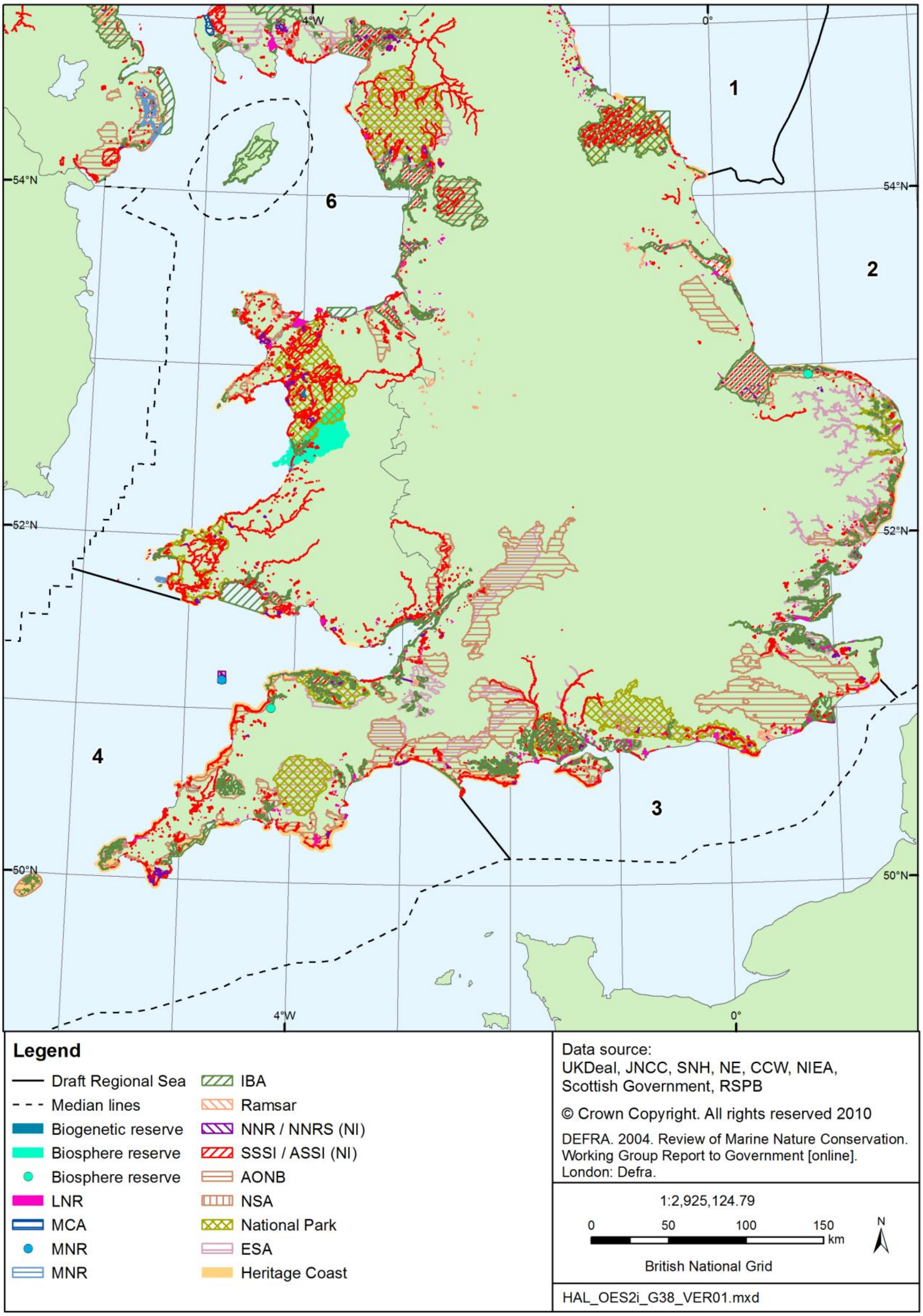


Figure A3j.5 – Nationally and internationally important UK sites (north)

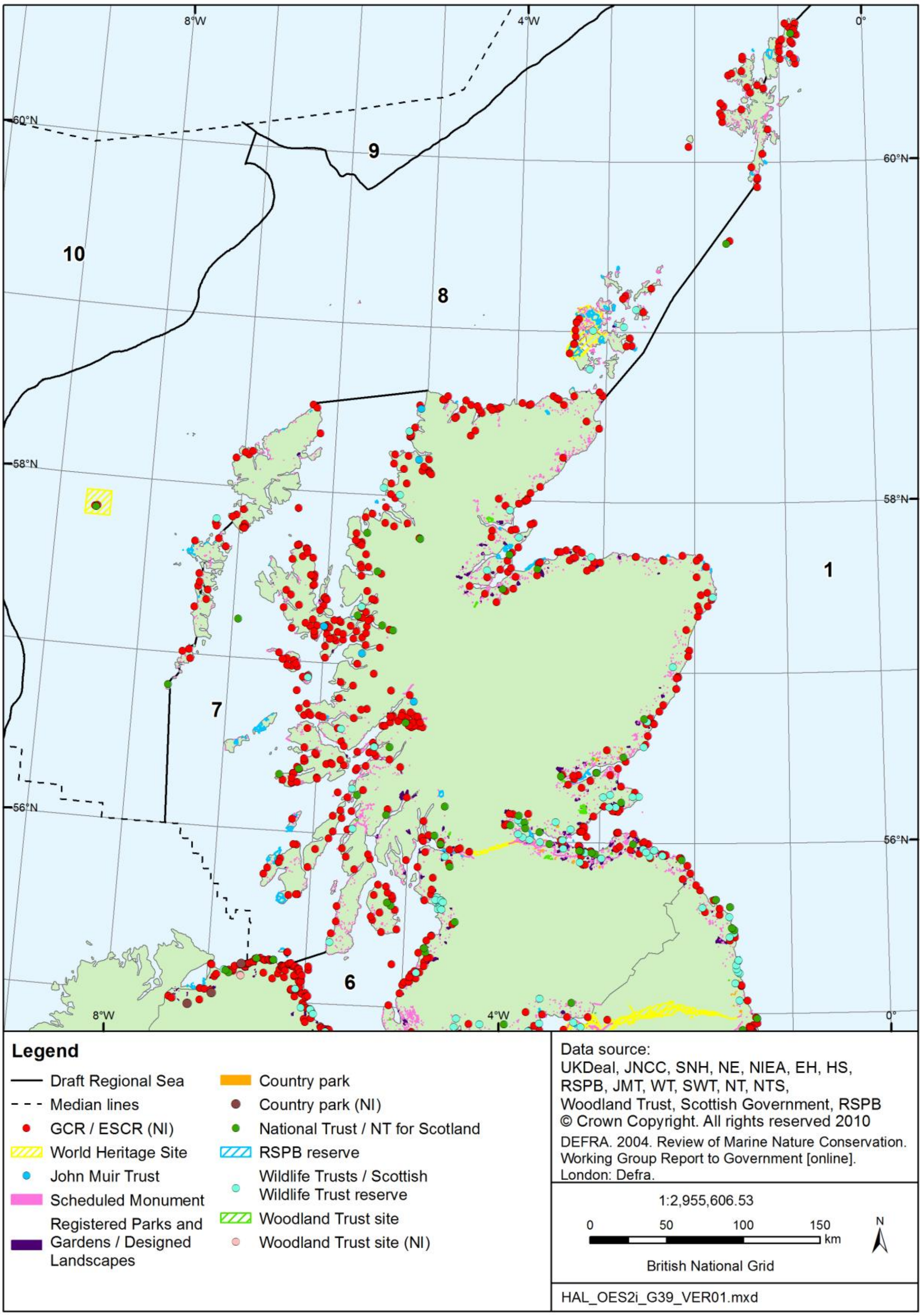
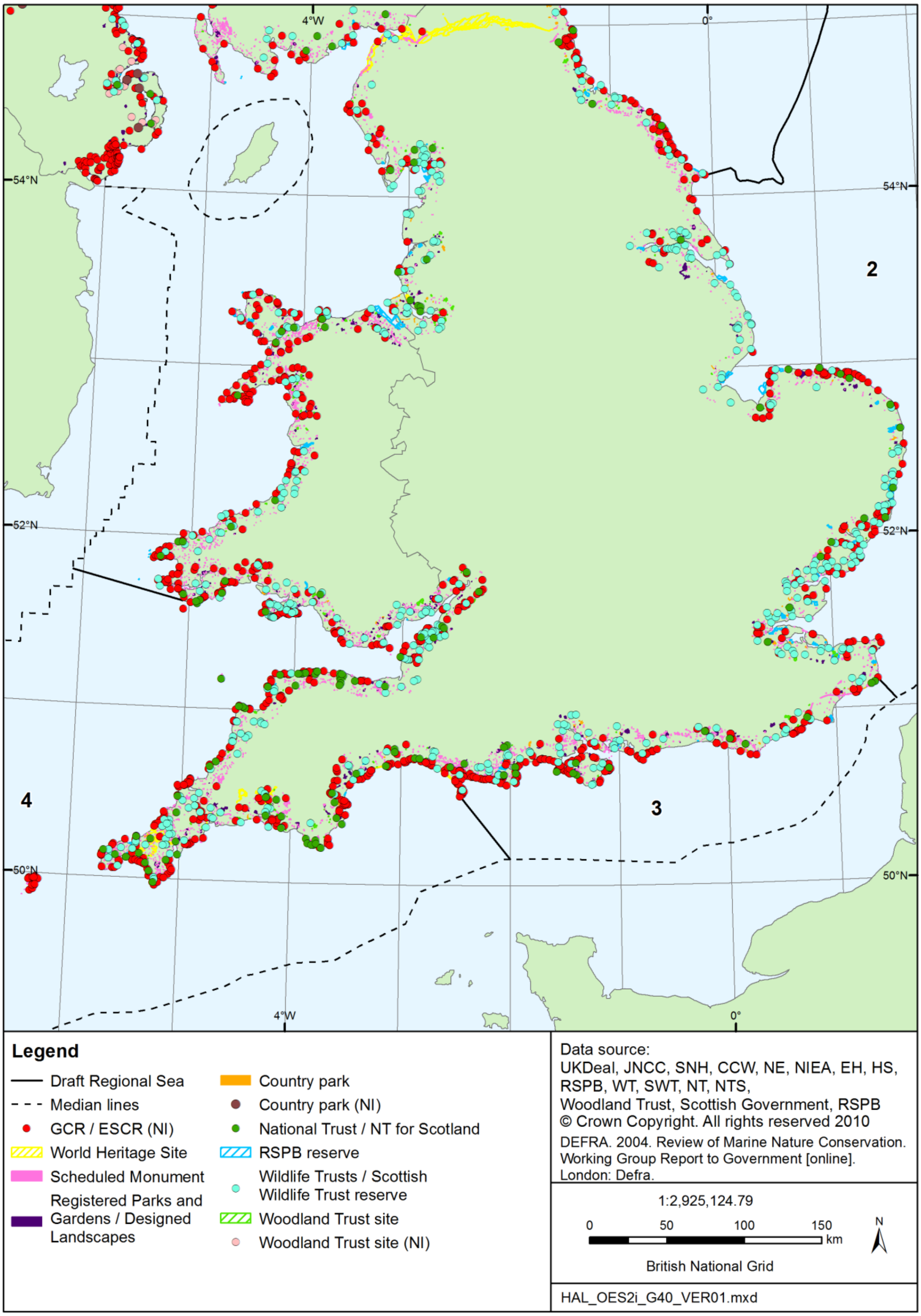


Figure A3j.6 – Nationally and internationally important UK sites (south)



A3j.1.3 Evolution of the Baseline and Environmental Issues

A3j.1.3.1 Evolution of the Baseline

The Marine and Coastal Access Act 2009 (and equivalent Acts/Bills of the devolved administrations) will aid the completion of an ecologically coherent and well-managed network of Marine Protected Areas. These sites will be known as Marine Conservation Zones (MCZs) in England and Wales and Marine Protected Areas (MPAs) in Scotland. These, together with existing and future Natura 2000, OSPAR and other conservation sites should contribute to the achievement of good environmental status in the Marine Strategy Framework Directive.

A3j.1.3.2 Environmental Issues

The OSPAR QSR 2010 (OSPAR 2010a) identifies a series of environmental problems in relation to the protection and conservation of biodiversity and ecosystems. These apply to the OSPAR marine area but are equally relevant to UK waters and include:

Pressures such as the removal of species (e.g. by fishing), loss of and damage to habitats, the introduction of non-indigenous species, obstacles to species migration and poor water quality are still present. Some pressures are still increasing in parts of the OSPAR area and all can act in synergy or be exacerbated by climate change. These pressures result in loss of biodiversity, including declines in the abundance and variety of species and habitats. Interruption of ecological processes, such as spawning, migration, and biological communication, may also occur.

The most sensitive features are those that are easily damaged and slow to recover. Reefs of the cold-water coral Lophelia pertusa and individuals of the fan mussel Atrina fragilis are slow-growing and delicate and can be severely damaged by bottom trawl fisheries.

Coastal waters contain feeding grounds, spawning and nursery areas, and feature on migration routes for seabirds and some fish species. These areas also host intense and varied human activities, which exert a wide range of pressures and can lead to the damage or loss of key habitats in estuaries and intertidal areas. Salt marshes and seagrass beds, which are highly productive and act as natural carbon sinks, are under pressure from relative sea-level rise and coastal development. Key areas of the shelf seas, including offshore banks and reefs, and frontal zones between different water masses, play important roles in pelagic productivity. Fishing is recognised as a key pressure on species and habitats in the shelf seas and there continues to be a need for information about ecologically important areas to guide improvements in management.

Although the general situation for most estuarine and marine fish communities seems to have improved in recent years, the status of certain vulnerable fishes has continued to deteriorate. This includes many deep-water fish species; sharks, rays and skates; and transitional/diadromous species that move between fresh and salt water (Defra 2010a). Many of these fish are listed as requiring protection under appropriate legislation and have been identified by OSPAR as being under threat and in decline (OSPAR 2010a). For example, the number of juvenile and adult European eels has fallen in many of the regions where this species occurs reflecting an Atlantic-wide downturn in the numbers of elvers returning to rivers. Causes of this decline are unclear but suggestions include changes in oceanic conditions, overexploitation, freshwater habitat destruction and contaminants (Defra 2010a).

With reference to habitats and species protected under the Habitats Directive, JNCC have assessed their conservation status. This assessment of conservation status does not only relate to that component of the habitat area or species population to be found in Special Areas of Conservation, but to the totality of the habitats and species throughout the United Kingdom. The 2007 Article 17 report (JNCC website - http://www.jncc.gov.uk/page-4096) prepared under the Habitats Directive is the second six year report.

When assessing the conservation status of habitats, four parameters were considered. These were: range, area, structure and function (referred to as habitat condition) and future prospects. For species, the parameters are: range, population, habitat (extent and condition) and future prospects. Each of these parameters was assessed as being in one of the following conditions: Favourable, Unfavourable-inadequate, Unfavourable-Bad, or Unknown. An overall assessment was determined by reference to the conclusions for the individual parameters, and, in general, reflects the least favourable of the individual parameter conclusions.

The overall UK assessments for seven Annex I marine habitats assessed included: 4 which were determined to be in 'bad and deteriorating' condition (sandbanks which are slightly covered by seawater all the time; estuaries; mudflats and sandflats not covered by seawater at low tide; large shallow inlets and bays); 1 in 'inadequate' condition (coastal lagoons), and 2 in 'unknown' condition (reefs; submarine structures made by leaking gases).

Of the 22 Annex II marine species assessed: 1 was considered in 'bad' condition (allis shad); 1 in 'inadequate and deteriorating' condition (maerl); 3 in 'inadequate' condition (twaite shad, Atlantic salmon, harbour seal); 3 in 'inadequate but improving' condition (sea, brook and river lampreys); 7 in 'favourable' condition (bottlenose dolphin; harbor porpoise; otter; grey seal; white-beaked dolphin; minke whale; fin whale), and 7 in 'unknown' condition (leatherback turtle, common dolphin, killer whale, long-finned pilot whale, Risso's dolphin, Atlantic white-sided dolphin, sperm whale).