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Dogger Bank Zonal Characterisation

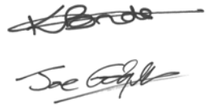
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Executive Summary

This 2nd interim Zonal Characterisation (ZoC) document presents the findings of a characterisation exercise originally compiled in July 2010 and updated in August 2011 in order to present the current understanding of the environmental character of the 'Zone Development Envelope' (ZDE) within which Forewind are proposing to deliver up to 13 GW of offshore wind farm projects. This document will inform:

- The on-going Zone Appraisal and Planning (ZAP) process and the selection of 'Tranches' for development; and
- The scope of Environmental Impact Assessments (EIAs) that will be undertaken to support planning applications made for each offshore wind farm project.

This 'interim report' presents the information currently compiled by Forewind to describe the Dogger Bank ZDE, including the Dogger Bank Zone and an area within which associated development such as export cables (offshore and onshore), converter stations and potential substation connections to the National Grid Transmission Network may take place. This information includes updated reports on the status of sites identified for potential designation under the European Commission's Birds and Habitats Directives (in particular the progression of the Dogger Bank possible Special Area of Conservation (pSAC) to a candidate SAC (cSAC) and references to the on-going process to designate Marine Conservation Zones (MCZs) under the Marine and Coastal Access Act 2009.

The ZoC document provides information on the character of the ZDE which forms a key component of Forewind's Zone Appraisal and Planning (ZAP) strategy, described in the preamble, 'Zone Appraisal and Planning', on page xxv.

The information provided by this report has been used to support the identification of the first two 'Tranches' or areas for development within the Dogger Bank Zone, a process which is outlined in Forewind's Tranche A and Tranche B Identification Reports[1]. As Forewind move forward with their development activities and collate further information about the ZDE, the characterisation will be updated in order to support the selection of subsequent Tranches throughout the course of ZAP.

The ZoC Document is comprised of three parts:

Part I. Introduction to Zonal Characterisation;

Part II. Offshore Zonal Characterisation, describing the Dogger Bank Zone and Offshore Cable Area; and

Part III. Onshore Zonal Characterisation, describing the Onshore ZDE and a site-specific Substation Study Area.

The Offshore Zonal Characterisation provides a high level baseline of environmental information (physical, biological and human) at a resolution and geographical coverage suitable to understand the environmental issues that may influence the selection of suitable areas for wind farm and cable route projects. The Onshore Zonal Characterisation will be updated as further grid connection points are identified through the grid connection application process with National Grid and is used to inform the Scoping and Site Selection processes associated with the individual project development phase. It currently includes a section associated with an accepted grid connection offer at the existing Creyke Beck substation.

Offshore Zone Development Envelope

The Offshore Zonal Characterisation presents 14 environmental baseline chapters, each describing an aspect of the environment within the Dogger Bank Zone and the Offshore Cable Area.

The *Physical Environment* chapter summarises bathymetry, bedforms, seabed sediments and geology of the Dogger Bank Zone and the shallow geology of the Offshore Cable Area.

The Dogger Bank Zone covers a relatively shallow elongate northwest oriented area of approximately 8,660 km^2 surrounded by deeper water, which extends northeast into the Danish Sector of the North Sea and south onto the shallowest part of the Dogger Bank. Water depths range from 18 to 63 m and are typically between 25 and 30 m below Lowest Astronomical Tide (LAT). In the Offshore ZDE the water depth ranges from 98 m LAT in the northwest, and gets progressively shallower again towards the mean high water mark at the coast.

Coastal tidal currents are strong with average surface velocities reaching 2 m/s at the mouth of the Humber, decreasing in strength offshore to the northeast with lows of 0.2 m/s over the Dogger Bank, while stronger tidal currents flow around the western side of the Dogger Bank.

Holocene sands and gravels overlie Pleistocene deposits across much of the Offshore ZDE with muds dominating intertidal estuaries such as the Humber Estuary and The Wash. Most of the Dogger Bank Zone is dominated by the heavily channelled Dogger Bank formation and interpreted palaeo-land surfaces, underlain by glacial Pleistocene gravel, sand and clay formations. Sediments are generally up to 1 m thick across the eastern part of the Dogger Bank Zone, increasing to between 1 and 5 m in the west and southwest, and up to 35 m thick in areas of the Offshore Cable Area. Recognisable bedforms are rare over the Dogger Bank, while large sandwaves and bedfoms occur to the west and southwest. Please also refer to notes from the British Geological Survey in Chapter 2 for clarifications.

Benthic ecological communities in the Offshore ZDE are described in the *Benthic Ecology* chapter. They are largely structured by physical variables such as seawater temperature, salinity, tidal/wave-induced bed stress, depth, organic input and sediment type. The Offshore ZDE falls predominantly in the southern North Sea which has strong thermally-mixed waters all year round. The offshore area including the Dogger Bank is broadly characterised by 'Infralittoral fine sand' or 'Infralittoral muddy sand', although two other EUNIS classifications are also common, namely, 'Infralittoral coarse sediment' and 'Circalittoral fine sand' or 'Circalittoral muddy sand'. The deeper waters between the Dogger Bank and the coast are dominated by 'Deep circalittoral sand' while the coastal waters north of Flamborough Head are dominated by 'Deep circalittoral coarse sediment'. The shallow waters extending offshore from the Holderness and Norfolk coasts are associated with distinct seabed features and are characterised by 'Circalittoral coarse sediment'. In general the coastal waters contain the most diverse habitat types compared with the more offshore areas. Priority lists such as those produced by OSPAR and the UK BAP were used to help identify important habitats and species within the Offshore ZDE.

Information on fish species with spawning and nursery areas in the Offshore ZDE and their adult distributions and ecology are summarised in the *Fish Resource and Ecology* chapter. The chapter identifies those species which occur on priority lists such

[1] Available online at: http://www.forewind.co.uk/downloads/zone.html

as those produced by OSPAR and the UK BAP. The protected habitat 'seapen and burrowing megafauna' may be present on the northern edge of the Dogger Bank Zone and this is known to be used as a nursery area for several fish species including the UK BAP priority species, hake. Grounds supporting elasmobranch species were found in the southwest of the Offshore ZDE and a stable epicentre of brown crab spawning was highlighted. Important sandeel fishing grounds exist on the western edge of the Dogger Bank Zone in particular, and to the south and east of this in the Offshore Cable Area. An important *Nephrops* fishery was noted offshore of the Tyne.

The distribution and abundance of seabird species in the Offshore ZDE is discussed in the *Birds* chapter and varies throughout the year. A number of seabird species are likely to occur regularly in the Offshore ZDE. Ten of these species are noted as key seabird species, based on their likely distribution within the Dogger Bank Zone and their potential response to offshore wind farms. The focal species are white-billed diver, fulmar, gannet, kittiwake, lesser black-backed gull, great black-backed gull and species of auks (guillemot, razorbill, little auk and puffin). In addition, great skua, little gull and herring gull may also be important species in the Dogger Bank Zone. Important seabird colonies and the occurrence of various wildfowl, waders, and land birds are also discussed.

Three species of cetacean (minke whale, white-beaked dolphin and harbour porpoise) are highlighted in the *Marine Mammals* chapter as being likely to occur regularly within the Offshore ZDE. Bottlenose dolphin, common dolphin, Atlantic white-sided dolphin, Risso's dolphin, grey seal and common seal may also occur occasionally. Although both grey seal and common seal occur regularly in the Offshore ZDE, common seals are less likely to occur far offshore in the Dogger Bank Zone than grey seals. Key breeding colonies, haul out sites and offshore nature conservation designations of importance to marine mammal populations are also identified.

The *Nature Conservation* chapter provides background data on designated sites within the boundaries of the ZDE, including coastal designations, which support a wide range of habitats and species. The Dogger Bank Zone overlaps with the Dogger Bank cSAC which lies within UK offshore waters and qualifies for the Annex I habitat 'sandbanks which are slightly covered by seawater at all times'. In addition to these, sites outside of the ZDE in other North Sea nations' waters support mobile species, birds and marine mammals. Estimated foraging ranges for the key seabird species identified in the *Birds* chapter were used to identify far field coastal Special Protection Areas (SPAs).

The *Archaeology and Cultural Heritage* chapter summarises the potential for the presence of shipwrecks, aircraft crash sites and prehistoric archaeological sites and materials. The chapter highlights the potential in the Dogger Bank area for the discovery of submerged prehistoric landscapes and associated deposits. Within the last 700,000 years, the area around the Dogger Bank Zone would have been habitable by Palaeolithic hominins, and there is the potential for the survival of a long sediment sequence within the Offshore ZDE, which can provide deep palaeo-environmental and climatic information and contain archaeological sites and material.

The maritime and aviation archaeological potential of the Offshore ZDE is described using records of known marine casualties and the wider maritime history of the North Sea. More than 4,000 ship- and aircraft wrecks are known within the Offshore ZDE, the majority of which are 19th and 20th century in date. Maritime archaeological remains covering the entire period back to the late Mesolithic (c. 8,000 years BP) should also be expected in the area. In addition to maritime archaeological material the Offshore Cable Area may also contain the remains of coastal villages, likely to lie within four miles of the present coast, recorded as being lost to the sea since the Roman period as a result of the retreat of the Holderness coast.

The *Archaeology and Cultural Heritage* chapter also provides an overview of the potential for unexploded ordnance (UXO) within the Offshore ZDE.

The Dogger Bank Zone and the Offshore Cable Corridor are navigated by a wide range of vessels. The *Navigation and Shipping* chapter analyses pre-existing data as well as data collected during an on-going and bespoke survey. The main shipping activity within the Dogger Bank Zone recorded during the survey mostly consisted of fishing vessels, cargo ships and tankers. The commercial shipping density recorded in the Dogger Bank Zone was low by comparison with densities experienced elsewhere in the Offshore ZDE and around the UK, though there is an indication of moderate densities of traffic transecting the western and southeastern areas of the Zone. Within the Offshore Cable Area, the busiest areas are just off the east coast where shipping traffic transits between ports. Fishing vessel densities are greatest along the western margin of the Zone and southwest of its centre. The majority of fishing vessels tracked within the Dogger Bank Zone by satellite were trawlers.

Recreational vessel activity in the Dogger Bank Zone includes two medium-use cruising routes and four light-use routes, though recreational boating is likely to be highly seasonal and highly diurnal.

There are no IMO (International Maritime Organisation) routeing measures or offshore installations within 10 nm of the Dogger Bank Zone. However, a number of navigational features are described in the Offshore ZDE, mostly confined to the southern part of the Offshore Cable Area, including oil and gas surface installations, the Humber Traffic Separation Scheme, charted anchorages, Round 1 and 2 licensed wind farm areas, and marine aggregate licence and application areas.

The *Commercial Fisheries* chapter provides further information on commercial fishing interests and activities, beyond that identified in *Navigation and Shipping.* The larger part of the fishing effort on and around the Dogger Bank is beam trawling (targeting plaice, lemon sole, turbot and skates & rays, with Dover sole caught on a seasonal basis), Danish seine netting for similar species, twin rigging for prawns, gill netting for turbot and other flatfish, pelagic fishing (targeting herring or mackerel), and industrial fishing for sandeels. Demersal activity such as otter trawling also occurs on the outer edges of the Dogger Bank into deeper water for species such as cod, haddock and whiting. Fishing vessel density data within the Offshore Cable Area demonstrates considerable variation. Small vessels are likely to be particularly active near to the shore and the coastal waters in this area are known to support an important shellfishery.

Hydrocarbon interests are discussed in the *Oil and Gas* chapter. Currently, oil and gas activity in the Dogger Bank Zone is mainly restricted to a low density of plugged and abandoned exploration wells throughout the Zone and licence applications in the southeast part of the Zone. Licence blocks to the south of the

Dogger Bank Zone are licensed for gas production where there is a high concentration of surface infrastructure in the southwestern part of the Offshore ZDE.

The chapter, *Military, Aviation and Radar*, investigates military and civil aviation interests, as well as the potential for turbine development offshore to interfere with any land based communications, navigation and surveillance infrastructure such as radar. The Offshore ZDE incorporates a number of Practice and Exercise Areas including a RAF Danger Area and a Submarine Exercise Area which both overlap the southwest corner of the Dogger Bank Zone. There are also five live firing areas at the coast. The Dogger Bank Zone is sufficiently far offshore that there is no apparent likelihood of interference with radar or other technical sites. Helicopter Main Routes serving oil and gas installations are currently confined to the southern part of the Offshore ZDE and do not occur inside the Zone

The occurrence of aggregate licences and disposal sites are described in the *Marine Aggregates and Disposal* chapter. Aggregate licences are mostly confined to the southwest part of the Offshore ZDE in the Humber region. However, there is one application area in the western part of the Zone, which has the potential to become licensed and actively dredged. Disposal sites are mostly confined to within 12 nm of the coast.

The *Cables and Pipelines* chapter identifies two active subsea cables passing through the southwest part of the Dogger Bank Zone and an out-of-service cable transecting the northwest part. Other active and out-of-service cables pass to the north of the Zone, while in the southwest Offshore ZDE there are a number of existing and proposed cable routes associated with Round 1 and Round 2 wind farm developments. A concentrated network of gas pipelines serves installations concentrated to the south of the Dogger Bank Zone. A gas pipeline passes from north to south down the Dogger Bank Zone's western side and three other pipelines occur to the west of the Zone.

Offshore renewable energy projects and the emerging industries of Underground Coal Gasification (UCG), Carbon Capture and Storage (CCS) and potash mining are discussed in the *Other Marine Users* chapter. In addition to existing and proposed Round 1 and Round 2 wind farm developments, mostly sited in the region of the Humber and The Wash, the Hornsea Round 3 Zone is approximately 60 km to the south of the Dogger Bank Zone. The Pulse tidal energy test site is located approximately 1 km off the south bank of the Humber Estuary. An offshore wind turbine demonstration site off the coast at Blyth in Northumberland is in the planning stages and would be located in close proximity to two existing offshore turbines at the site.

Other Marine Users also discusses some of the principle recreation and tourist interests within the ZDE. Coastal bathing waters and Blue Flag beaches indicate areas of the coast which are likely to be popular with tourists and coastal watersports enthusiasts. Recreational boating is considered based upon cruising routes which transect the Dogger Bank Zone and sailing areas, racing areas, marinas, clubs and training centres along the coast. Wildlife boat tours out to the Dogger Bank area are also acknowledged.

Onshore Zone Development Envelope

The Onshore Zonal Characterisation adopts a different approach compared with the offshore characterisation. It provides a high level description of the Onshore ZDE and identifies a Substation Study Area boundary around a confirmed National Grid offer at Creyke Beck in Yorkshire, which is then characterised in more detail.

The Onshore ZDE is largely greenfield with relatively few large urban centres, with the exception of Hull, Newcastle, Sunderland and Middlesbrough. Consequently there are also relatively few major transport routes. The key features of the Onshore ZDE include a number of Habitats and Birds Directive designations, with a high proportion being coastal SPA sites; the Northumberland Coast, Norfolk Coast and Lincolnshire Wolds Areas of Outstanding Natural Beauty; five Heritage Coast areas existing along key parts of the study coastline; Scheduled Monuments and two World Heritage Sites at Durham Cathedral and Hadrian's Wall; national trails; and the North York Moors National Park.

The review of the Creyke Beck Substation Study Area has identified nature conservation designations at Hornsea Mere and the Humber Estuary; the Spurn Head National Nature Reserve and Heritage Coast; Scheduled Monuments and listed buildings; a number of Sites of Special Scientific Interest (SSSIs); and local nature reserves. Further, a flood risk zone associated with the River Humber and Holderness Drain; coastal erosion; drainage and river crossings; ground water source protection zones, a military firing area; caravan parks and campsites; a number of transport, utilities and infrastructure networks; and planning constraints have been identified.

In addition to the data reviewed for the Creyke Beck Substation Study Area, initial dialogue between Forewind and consultees identified significant technical, health, safety and environmental concerns with respect to the installation of cables up the Humber Estuary. Forewind have therefore decided to remove the Humber Estuary as a potential cable route for the Creyke Beck substation.

As the zonal development process progresses and more information becomes available it is intended that this document will be updated to assist with further Tranche identification.

Summary of updates made to the Dogger Bank Zonal Characterisation since October 2010

ZoC Chapter	Updates made in 2nd Edition (October 2011)	Amendments made in 3rd and final report (expected 2012)
Executive Summary	Updates made to text to reflect current understanding.	
Zone Appraisal and Planning (ZAP)	Updated to reflect the status of Forewind's ZAP programme.	
Part I – Introduction to Zonal Characterisation		
1. Introduction	Updates made to text to reflect current understanding.	
Part II – Offshore Zonal Characterisation		
2. Geology and Physical Environment	Incorporation of data which has become available since October 2010, namely: • Interpreted Zone, Tranche A and cable route geophysical survey data (2010); • Interpreted Zone, Tranche A and cable route geotechnical survey data (2010); and • Initial findings of the 2011 British Geological Survey (BGS) Preliminary Geological Interpretation.	
3. Benthic Ecology	No updates made this edition, though further data have been identified and will be considered for the final edition of the ZoC in 2012, namely: • Forewind geophysical/Acoustic Ground Discrimination System (AGDS) survey data (2010-2011); • 2010 Joint Nature Conservation Committee (JNCC) survey data of the Dogger Bank candidate SAC; and • The Outer Humber Regional Environmental Characterisation (REC) (March 2011).	
4. Fish Resource and Ecology	General revision to reflect: • A review of species-specific spawning and nursery areas, as published by Ellis *et al*. (2010) and other relevant literature; • A review of literature and online databases relating to elasmobranch species; and • A review of literature and online databases relating to diadromous species.	

ZoC Chapter	Updates made in 2nd Edition (October 2011)	Amendments made in 3rd and final report (expected 2012)
5. Birds	Chapter content revised and extended to account for: • Additional information on foraging ranges, biogeographic populations and important coastal sites for key seabird species; and • Preliminary statistical analyses of boat-based survey data (January 2010 – March 2011), providing relative abundance and distributions for key seabird species, with further context on the proportions of species groups provided by Zone and Tranche level aerial (visual and high-definition video) surveys.	
6. Marine Mammals	Chapter extended to provide: • A summary of boat and aerial (visual and high-definition video) survey data collected up to June 2011 (prior to comprehensive statistical analyses being undertaken to determine relative abundance, distribution and absolute abundance of key species occurring in the Dogger Bank Zone); and • An overview of the Special Areas of Conservation (SACs) / Sites of Community Importance (SCIs) in the North Sea and surrounding coastline where Annex II cetacean and seal species are listed as qualifying features.	
7. Nature Conservation	Chapter content revised and extended to account for: • Updated information obtained on SACs and cSACs in the Offshore ZDE and on transboundary SACs / SCIs in the North Sea as identified in The Crown Estate's Round 3 plan-level Habitats Regulations Assessment (HRA) (Entec, 2009) and site management documents; • A review of SPAs supporting breeding populations of key seabird species within the mean maximum foraging ranges identified in Chapter 5 – *Birds*; and • A summary of the draft Marine Conservation Zones (MCZs) and reference areas and their features of conservation interest, as proposed by Net Gain in July 2011 under the Marine and Coastal Access Act 2009.	
8. Archaeology and Cultural Heritage	Chapter extended to include: • A review of recent literature (Van de Noort, 2011) relating to palaeolandscapes; • Wrecks identified during Forewind's 2010 geophysical surveys; and • Potential for war-time artefacts and unexploded ordnance (UXO).	
9. Navigation and Shipping	Chapter extended to include: • Latest AIS and radar survey data and vessel densities within the Dogger Bank Zone (up to August 2011); and • Identification of the main commercial vessel routes transecting the Dogger Bank Zone.	

ZoC Chapter	Updates made in 2nd Edition (October 2011)	Amendments made in 3rd and final report (expected 2012)
10. Commercial Fisheries	Chapter content revised based upon: • 2010 – 2011 surveillance data provided by the Marine Management Organisation; and • Consultation with fisheries stakeholders.	
11. Oil and Gas	Chapter fully revised to capture: • The latest (July 2011) field, licence and infrastructure data available from the Department of Energy and Climate Change (DECC), UK DEAL and SeaZone; and • Data on activity in adjacent waters acquired from TNO Geological Survey of the Netherlands (July 2011), the Norwegian Petroleum Directorate (June 2011), the Denmark Energy Agency (July 2011), and the German Landesamt für Bergbau, Energie und Geologie (July 2011).	
12. Military, Aviation and Radar	Content confirmed during a review of 2011 military, aviation and radar charts, safeguarding and self-assessment datasets.	
13. Marine Aggregates and Disposal	Chapter updated with the latest marine aggregate licence information available from The Crown Estate (January 2011) and disposal site details provided by Cefas (April 2011).	
14. Cables and Pipelines	Cable and pipeline information updated based upon the latest data from DECC (July 2011), UK DEAL (July 2011) and KIS-CA (August 2011). Addition of cable and pipeline GIS shapefiles provided by developers, including: • Hornsea Project One proposed cable route options (SMartWind, July 2011); and • The Breagh pipeline development (RWE Dea UK, June 2011).	
15. Other Marine Users	Chapter content revised to include up to date information on Underground Coal Gasification (April 2011) and Carbon Capture and Storage developments (July 2011). An update to the summary of coastal bathing waters and blue flag beaches as of June 2011 has also been included.	
Part III – Onshore Zonal Characterisation		
16. Onshore Zone Development Envelope	No amendments made this edition	
17. Creycke Beck Substation Study Area	No amendments made this edition	
Further Substation Study Area chapters will be added as additional grid connections are accepted by Forewind and will be available in the final iteration of the ZoC Document in 2012.		

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Glossary of Terms

Anglian Glaciation	One of the greatest glaciations that the UK experienced during the Pleistocene, c. 480,000 to c.424,000 BP. It is estimated that the Anglian ice sheet, which diverted the Thames onto something like its present course was up to 1,000 m thick, reaching as far as London and Bristol.
Alluvium	Loose, unconsolidated, soil or sediments that have been eroded, deposited, and reshaped by river action.
Anastomosing	Reconnection of channels that have previously branched out.
Application Areas (aggregates)	An area within which a marine aggregate producer has identified commercially viable aggregate resources, has secured an exclusive option with the mineral owner (normally The Crown Estate) and for which a permission to dredge is being sought.
Archaeology	Study of past human societies, through the recovery and analysis of the material remains and environmental data they have left behind.
Biotope	An area uniform in environmental conditions as well as providing a living place for a specific assemblage of plants and animals.
Botney Cut Formation, Volans Member and Swarte Bank Formation	Channel features in the Dogger Bank area.
British Fishery Limit	The British fishery limits extend to 200 miles from the territorial sea baseline.
Cetacean	Marine mammals of the order Cetacea, including the whales, dolphins, and porpoises.
Circalittoral	The area of the continental shelf that lies below the zone of periodic tidal exposure.
Countryside Project	This project aims to implement landscape improvements and improve the recreational use of the project area, around Brandesburton.
Cretaceous	Approximately 145 to 65 million years ago.
Cromerian Interglacial	Major interglacial dating from c.780,000 to 450,000 BP and named from the fossil rich Cromer Forest Bed formation.
Devensian	The most recent glacial period, started *c.* 115,000 BP, and ended with the onset of the Holocene. The Devensian ice sheets reached their maximum extent roughly 26-21,000 years ago, covering much of the UK, and in places was up to a mile thick.
Dogger Bank Zone	The Round 3 'Zone' as identified on the Dogger Bank within UK North Sea Boundary limits.
Eemian	Approximately 130,000 and ended 114,000 years ago.
Egmond Ground Formations	Open marine deposits.
Elasmobranches	Fish characterized by a cartilaginous skeleton and placoid scales and including the sharks, rays, and skates.
Eocene	Approximately 56 to 34 million years ago.
Epibenthic communities	Living on the surface of seabed.
Epifauna	Animals living on the surface of marine or freshwater sediments.
Espoo (EIA) Convention	Convention on Environmental Impact Assessment in a Transboundary Context.
Fluvial	Processes associated with rivers and streams and the deposits and landforms they create. When the rivers or streams are associated with glaciers, ice sheets or ice caps, the terms glaciofluvial or fluvioglacial are used.
Geneva Convention on the Continental Shelf 1958	One of four conventions opening for signature, and a product of the (first) United Nations Conference on the Law of the Sea.
Genus	A class, group, or kind with common attributes.
Habitats Directive	The main aim is to promote the EU's biodiversity by requiring Member States to take measures to maintain or restore natural habitats and wild species at a favourable conservation status.
Habitats Regulations	Is the Conservation (Natural Habitats & c.) Regulations 1994 (as amended) and the Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007 for sites beyond 12 nm.
Heavy Recreational Routes	Very popular routes on which a minimum of six or more recreational vessels will probably be seen at all times during summer daylight hours.
Historical Environment	All aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged.
Holocene	Geological epoch, *c.*11,000 BP to present day. The Holocene began at the end of the last (Devensian) glaciation and has been a relatively warm, interglacial period.
Hominin	A term used to describe what used to be termed a hominid; a creature that paleoanthropologists have agreed is human or a human ancestor. This includes all of the Homo species (*Homo sapiens, H. ergaster, H. rudolfensis*), all of the Australopithecines (*Australopithicus africanus, A. boisei*, etc.) and other ancient forms like *Paranthropus* and *Ardipithecus*.
Hoxnian	The interglacial between the Anglian and Wolstonian glaciations, c.424, 000 to 374,000 years ago.
Infauna	Animals living in the substrate of a body of water.
Infralittoral	The region of shallow water nearest the shore.
Ipswichian	Interglacial period between c. 135,000 and 73,000 years ago.
Jurassic	Approximately 200 to 145 Million years ago.
Light Recreational Routes	Routes known to be in common use but which do not qualify for medium or heavy classification.
Marine transgression	Occurs when an influx of the sea covers areas of previously exposed land. Usually associated with rises in sea level during interglacial periods.
Medium Recreational Routes	Popular routes on which some recreational craft will be seen at most times during summer daylight hours.
Megafauna	Large or relatively large animals of a particular place or time period.
Mesolithic	Period of prehistoric human technological development following the Palaeolithic and characterised by the use of microlithic stone tools. The Mesolithic (or Middle Stone Age) in the UK began *c.*11,500 years ago at about the start of the Holocene, and ended *c.* 5,500 years ago.
Mesozoic Era	Approximately 250 million to 67 million years ago.
Miocene	Approximately 23 to 5 million years ago.
Moribund linear ridges	No longer undergoing active sediment transport.
Natural Environment and Rural Communities (NERC) Act 2006	Requires the Secretary of State to publish a list of habitats and species which are of principal importance for the conservation of biodiversity in England.
Net Gain (The North Sea Marine Conservation Zones Project)	Has been established to work with stakeholders to identify and recommend MCZs in the English North Sea only.
Offshore Cable Area	Area within the Offshore ZDE where potential routes for the cables may be located.
Offshore Petroleum Activities (Conservation of Habitats) 2001 Regulations	UK Statutory Instrument for Conservation of Habitats during offshore petroleum activities. Revised in 2007 .
Offshore ZDE	Covers all the marine aspects of the ZDE, including the Dogger Bank Zone and Offshore Cable Area.
Oligocene	Approximately 34 to 23 million years ago.
Onshore ZDE	Covers all the terrestrial aspects of the ZDE.
Orogeny	Forces and events leading to structural deformation of the Earth's crust due to the engagement of tectonic plates.
Palaeo	Prefix meaning ‘old’ or ‘ancient’. For example it is used in reference to ancient or past environments or landscapes.
Palaeocene	Approximately 65.5 to 56 million years ago.
Palaeolithic	Earliest of the three divisions of the Stone Age, dating from the first use of stone tools *c.*2.6 million years ago to the appearance of microlith-using hunter-gatherers at the start of the Mesolithic (*c.*11,500 years ago).
Permian	Approximately 299 to 250 million years ago.
Petroleum Act 1998	A consolidating act of previous legislation regarding oil and gas licensing.
Pleistocene	Epoch covering the period c.2.5 million to 11,000 years ago.
Pliocene	Approximately 5 to 3 million years ago.
Prehistoric	Period of human history pre-dating written records, the archaeological study of which is based on material remains or artefacts that survive into the present.
Production Licence (aggregates)	A licence which permits the removal of aggregates from the seabed within a Licence Area. Production licences are usually zoned to ensure that the area available to be dredged is minimised as far as possible.
Project	Is an offshore wind farm as defined under the Zone Development Agreement. It might comprise a ‘package’ of wind farm sites and/or a single site and may include onshore and grid connection components relevant to the Zone Development Envelope, but this is subject to a developers consenting strategy.
Prospecting Areas (aggregates)	Areas undergoing study as to their viability for aggregate extraction.
Quaternary	Most recent of the three periods of the Cenozioc Era, the Quaternary spans the last roughly 2.5 million years, and includes the Pleistocene and Holocene Epochs.

Radiocarbon dating (^{14}C)	Dating method based on measuring the observed abundance of a naturally occurring radioactive carbon isotope (^{14}C) and its decay products in a sample, using known decay rates.
Ramsar Convention	Convention on Wetlands of International Importance especially as Waterfowl Habitat, adopted in 1971, entered into force in 1975.
Regional Environmental Characterisation (REC)	Term for a series of regional surveys commissioned by the Marine Aggregate Levy Sustainability Fund to develop understanding of the UK's submerged habitats and heritage. The RECs are being conducted on the South Coast, the Outer Thames region, on the East Coast, and around the Humber.
Round 1	The first round of UK offshore wind farm development announced in 2000 as a demonstartion round.
Round 2	In 2003 a competitive tender process for wind farm development was begun. Extensions to some of the subsequent sites occured in 2009.
Round 3	Round three is the third round of wind farm development in UK aiming to harness an extra 25 GW of wind power. The bid and award process was started at the end of 2009 and developers are now in the early planning stages.
SCANS II project	Survey of cetaceans in the European Atlantic and North Sea.
Scheduled Monuments	These range from prehistoric burial mounds to medieval castles, to abandoned villages and relatively recent mining activities.
Site of Community Importance (SCI)	A site that has been adopted by the European Commission but not yet formally designated as a Special Area of Conservation (SAC) by a nation's Government.
SeaZone	Marine geospatial data provider.
Shoreline Management Plans	Coastal defence policies for coastal sediment cells and sub-cells.
Special Area of Conservation (SAC)	Protected sites designated under the EC Habitats Directive for qualifying habitats and species.
Special Protection Area (SPA)	Protected sites designated under the EC Birds Directive for qualifying bird species.
Static (anchor) dredging	Where a dredger anchors over a thick, localised deposit and extracts from a localised point.
Substation Study Area	Area around a substation (identified by Forewind as a potential National Grid connection) to be studied regarding potential cables routes.
Terchillingerbank formation	This formation has a steeper south-eastern margin.
The Field Determination Boundary	Before consent is given by the Minister a field determination must be made. This involved the proposal by all licensees showing the area within the Licence Block where their interest lies. Fields can be re-determined at any time to reflect the acquisition of any new information.
Trailer suction hopper dredging	Where the aggregate is extracted as the vessel is underway.
Tranche	An approximately 3 GW apportionment of the total proposed 12.8 GW target generating capacity of the Dogger Bank Zone. Tranche areas will be identified throughout Forewind's ZAP programme and each Tranche will comprise a number of individual wind farm projects.
Triassic	Approximately 250 to 200 million years ago.
UK DEAL	Gateway to information on the UK Offshore Oil & Gas Industry and provides quick and easy access to catalogues of data available from release agents, specific companies and operators.
Wave Period	The time it takes for two successive wave crests to pass a given point.
Weichselian glacial and interglacial	110,000 to 10,000 years ago, it is the last glacial period of the Pleistocene.
Wolstonian	Middle Pleistocene glacial stage dating to between c.352,000 and 130,000 years ago, and which includes three distinct periods of glaciation.
World Heritage Sites	Sites of world importance for culture and heritage.
Yarmouth Roads Formation	Non-marine and marine fine sands, stiff shallow-marine micaseous clays and sand-clay rythmites with sporadic peaty horizons.
Zone Development Envelope (ZDE)	The area comprising all development associated with the Zone including: onshore grid connection corridors and infrastructure and offshore cable corridors.
Zonal Characterisation (ZoC) Document	The Zonal Characterisation document (this document) used to inform regarding environmental factors.
Zone	An area of the seabed (which may be within the territorial limits of the UK and/or within the Renewable Energy Zone (REZ)) demarcated by The Crown Estate for wind farm development in Round 3.

Acronyms and Abbreviations

AA	Appropriate assessment
ACMI	Air Combat Manoeuvring Instrumentation
AGA	Air-Ground-Air
AIP	Aeronautical Information Publication
AIS	Automatic Identification System
AON	Apparently occupied nests
AONB	Areas of Outstanding Natural Beauty
AOS	Apparently occupied sites
ASACS	Air Surveillance and Control System
BGS	British Geological Survey
BMAPA	British Marine Aggregate Producers Association
BMEWS	Ballistic Missile Early Warning System
CA	Cruising Association
CAA	Civil Aviation Authority
CAP	Civil Aviation Publications
CATS	Central Area Transmission Service
CCS	Carbon Capture and Storage
CEFAS	Centre for Environment, Fisheries & Aquaculture Science
CNS	Communications, Navigation and Surveillance
COWRIE	Collaborative Offshore Wind Research into the Environment
cSAC	Candidate Special Area of Conservation
DAP	Directorate of Airspace Policy
DECC	Department of Energy and Climate Change
Defra	Department for Environment Food and Rural Affairs
DME	Distance Measuring Equipment
dSAC	Draft Special Area of Conservation
DTI	Department of Trade and Industry
EA	Environment Agency
EIAs	Environmental Impact Assessment
EPS	European Protected Species
ERY	East Riding of Yorkshire
ES	Environmental Statements
ESAS	European seabirds at sea
EUNIS	European Nature Information System
EurOBIS	European Ocean Biogeographic Information System
EWEA	European Wind Energy Association
EWTR	Electronic Warfare Tactics Range
FEPA	Food and Environmental Protection Act
FOCI	Feature of Conservation Interest
FPSOV	Floating Production, Storage and Offloading Vessels
GPS	Global Positioning Systems
HECAG	Humber Estuary Coastal Authorities Group
HMR	Helicopter Main Routes
HRA	Habitats Regulations Assessment
IBA	Important Bird Areas
IBTS	International Beam Trawl Survey
ICES	International Council for the Exploration of the Sea
ICPC	International Cable Protection Committee
IDB	Internal Drainage Board
ILS	Instrument Landing Systems
IMO	International Maritime Organisation
IPC	Infrastructure Planning Commission
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
KIS-CA	Kingfisher Information Service-Cable Awareness
LAT	Lowest Astronomical Tide
LDF	Local Development Framework
LFS	Low Flying System
LNR	Local Nature Reserve
LSE	Likely significant effect
MAIB	Maritime incident data
MarBEF	Marine Biodiversity and Ecosystem Functioning
MarLIN	Marine Life Information Network
MCZ	Marine Conservation Zone
MDA	Managed Danger Area
MESH	Mapping European Seabed Habitats
MHWS	Mean High Water Springs
MLS	Microwave Landing System
MMO	Marine Management Organisation
MNCR	Marine Nature Conservation Review
MoD	Ministry of Defence
Narec	New and Renewable Energy Centre
NATO	North Atlantic Treaty Organisation
NATS	National Air Traffic Services
NBN	National Biodiversity Network
NDB	Non-Directional Beacons
NE	Natural England
NERC	Natural Environment and Rural Communities
NNR	National Nature Reserve
NRA	National Rivers Authority
NSBP	North Sea Benthos Project
NSBS	North Sea Benthos Survey
NSPP	North Sea Palaeolandscapes Project
ODIS	Offshore Development Information Statement
OSPAR	Oslo Paris Commission
PAR	Precision Approach Radar
PEXA	Practice and Exercise Areas
pSAC	Possible Special Area of Conservation
REC	Regional Environmental Characterisation
RSPB	Royal Society for the Protection of Birds
RYA	Royal Yachting Association
SAC	Special Area of Conservation
SAR	Search and Rescue
SCI	Site of Community Importance
SEA	Strategic Environmental Assessment
SEAL	Shearwater Elgin Area Line (pipeline)
SKM	Sinclair Knight Merz
SOLAS	Safety Of Life At Sea
SPA	Special Protection Areas
SPZ	Source Protection Zone
SSR	Secondary Surveillance Radar
SSSI	Sites of Special Scientific Interest
TACAN	Tactical Air Navigation systems
TCE	The Crown Estate
TIS	Tracking Instrumentation Sub-system Towers
UCG	Underground Coal Gasification
UK BAP	United Kingdom Biodiversity Action Plan
UKCPC	UK Cable Protection Committee
UKCS	United Kingdom Continental Shelf
UKHO	United Kingdom Hydrographic Office
UKOOA	United Kingdom Offshore Operators Association
UNCLOS	United Nations Convention on the Law of the Sea
UXO	Unexploded Ordnance
VMS	Vessel Monitoring System
VOR	VHF Omni-directional Radio Range
WCA	Wildlife and Countryside Act
WeBS	Wetland Bird Survey
WEDCA	Wind Energy, Defence & Civil Aviation
WWT	Wildfowl and Wetlands Trust
ZAP	Zone Appraisal and Planning
ZDE	Zone Development Envelope
ZoC	Zonal Characterisation

Zone Appraisal and Planning (ZAP)

ZAP is a non-statutory strategic planning process, which is being advocated by The Crown Estate (TCE) as part of the development process for the larger Round 3 Zones. One of the objectives of this zonal approach is to assist developers in making informed decisions on the location of their projects by providing a mechanism for the early consideration of environmental, planning and engineering constraints associated with the delivery of their projects. The ZAP phase involves the characterisation of a Zone, or a broader Zone Development Envelope, from data and information provided by:

- The developer and/or development partner;
- Consultants;
- Stakeholders; and
- TCE Marine Resource System (MaRS) database.

It also involves consideration of the technical and commercial challenges of delivering offshore wind farms and their associated infrastructure and will ultimately inform the identification of Tranches for on-going development.

TCE has published a framework document (TCE, 2010 [2]) which sets out the common principles of ZAP across all Round 3 developments. Forewind have adopted the principles of ZAP, establishing a bespoke ZAP strategy in accordance with TCE framework document. Forewind's ZAP process is being undertaken across the full ZDE, comprising the Dogger Bank Zone and areas for potential offshore and onshore export cable routes, substations and converter stations. The ZDE is presented in Figure 2.

To date, stakeholder workshop reports, this ZoC document, and Tranche A and Tranche B Identification reports have been developed as part of the ZAP programme, to guide Forewind in the process of identifying offshore wind farm 'Projects' to be taken forward for Environmental Impact Assessment (EIA) and consent with the Infrastructure Planning Commission (IPC) (to be replaced in April 2012 by the Major Infrastructure Planning Unit (MIPU), operating as part of the Planning Inspectorate under the coalition Government).

Background to ZAP

In previous leasing rounds for offshore wind, including Rounds 1 and 2, developers bid for self-selected wind farm sites located within broad regions that, to a greater or lesser extent, were defined by TCE. By the end of 2009, these leasing rounds had yielded operational offshore wind farms with an installed capacity of approximately 1 GW. The lessons from Rounds 1 and 2 indicated that, if UK targets for offshore renewables are to be met by 2020, a different, more strategic approach to development had to be adopted in Round 3.

Therefore, in Round 3, TCE elected to identify Zones which its own strategic planning indicated supported considerable potential for offshore wind farm development. At the same time they promulgated the concept of ZAP to assist developers in optimising the capacity of a Zone and identifying and appraising potential wind farm sites therein.

The ZAP approach has a number of elements, which include:

- Understanding and managing development opportunities and constraints for the ZDE;
- Iterative Zone Planning;
- Identifying and specifying Projects within the ZDE;
- Informing a consent strategy and a Zone development programme; and
- Developing relationships with stakeholders and an appropriate engagement strategy.

Forewind's delivery strategy has been structured around the objective of delivering up to 13 GW of offshore wind farm projects at the Dogger Bank Zone. In order to ensure that the works associated with achieving this objective are managed effectively, and to reduce the demand on our stakeholders and the supply chain, Forewind proposes to develop the Dogger Bank Zone in phases.

The on-going Zone Appraisal and Planning (ZAP) phase will use available information and the outcome of stakeholder consultations to identify the optimum location of "Tranches" or areas for development within the Zone.

At this stage it is anticipated that ZAP will identify four Tranches for development in accordance with the programme outlined below:

- Tranche A – Identified in Autumn 2010;
- Tranche B – Identified in Autumn 2011; and
- Tranches C and D – Areas to be defined.

Within each Tranche area, a number of separate wind farm projects will be identified and will be the subject of independent applications for Development Consent under the Planning Act 2008 ("the 2008 Act"). Projects will be optimised in accordance with the location, capacity and timing of grid connections, secured through the application process with National Grid.

For Tranche A it is likely that three projects of a similar size will be identified and taken through to the planning process. The ZoC Document will inform and provide a common framework for the scope of the Environmental Impact Assessment and any associated Habitats Regulations Assessment for those projects.

[2] The Crown Estate (2010). *Round 3 Zone Appraisal and Planning: A strategic approach to zone design, project identification and consent*. Available at: http://www.thecrownestate.co.uk/enabling-actions

Forewind Approach to ZAP

Forewind has adopted ZAP as a critical component of its planning process for offshore wind farm projects in the Dogger Bank Zone. It provides a transparent and robust approach to project identification and development and presents an opportunity to establish relationships and initiate dialogue with regulators and stakeholders from an early stage. The ZAP strategy for Dogger Bank has been informed by the principles set out in the ZAP framework document produced by The Crown Estate 2.

The principle components of Forewind's ZAP strategy are shown conceptually in Figure 1 and include:

- A defined ZDE encapsulating the Dogger Bank Zone and an area for potential offshore and onshore cable routes and connections to the National Grid;
- A Development Programme which accommodates ZAP and timescales for the identification of four Tranches of wind farm projects;
- A Stakeholder and Consent Strategy;
- A GIS and Data Management Policy;
- An on-going Zonal characterisation initiative to obtain baseline information for the environmental aspects of the ZDE (physical, biological, human) and understand development opportunities and constraints;
- An integrated and on-going planning interface to identify Tranches of projects that will be taken forward into EIA for consent, and which balances all environmental, engineering, grid connection, financial, and strategic factors;
- A common framework for cumulative and in-combination impact assessments for projects within the Zone; and
- An interface between ZAP and EIA.

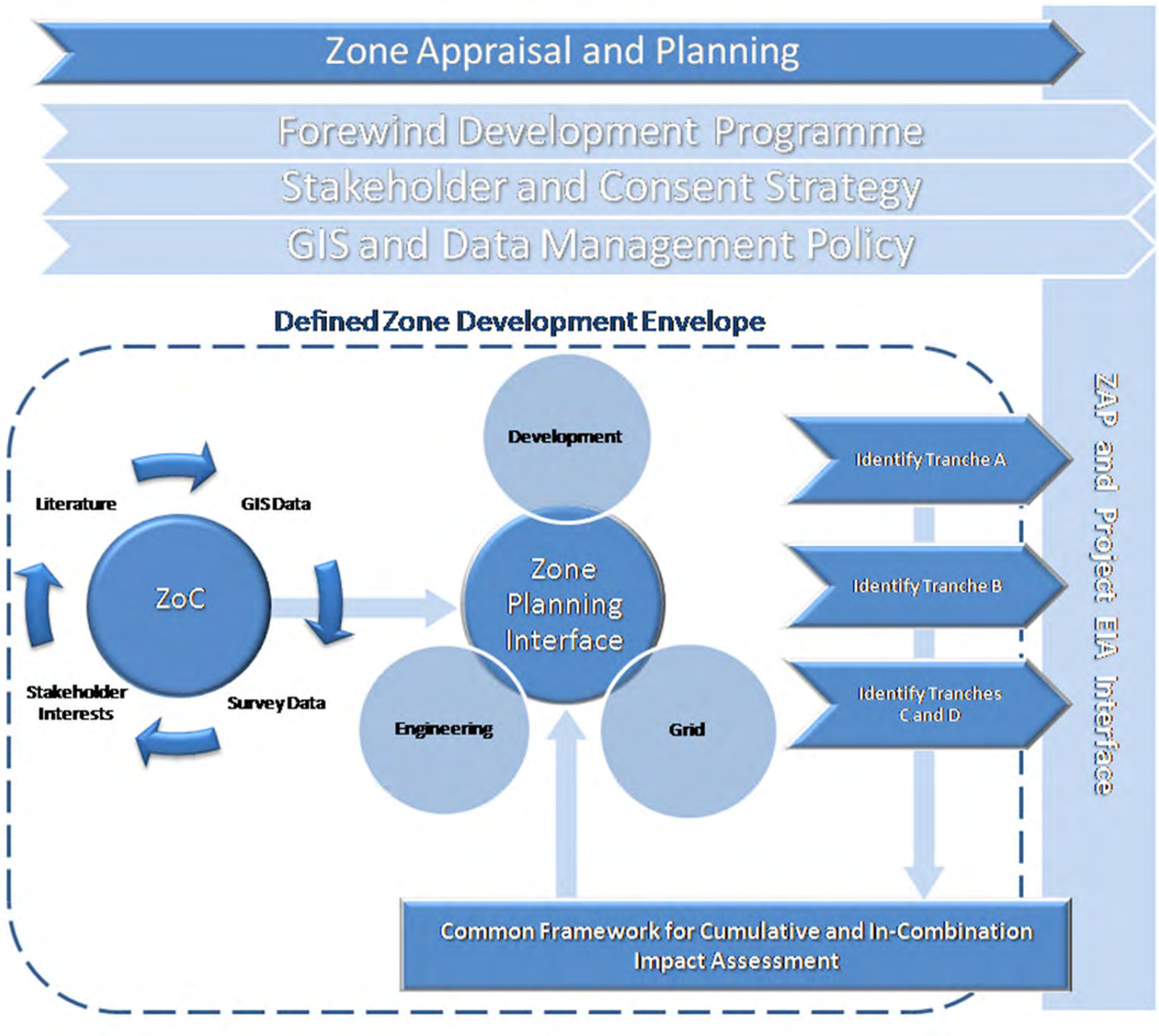


Figure 1: The principle factors comprising Forewind's ZAP strategy.

Dogger Bank Zone Development Envelope (ZDE)

The Dogger Bank Zone Development Envelope (ZDE) incorporates the Dogger Bank Zone, as defined by TCE, but also the wider area within which associated development may take place. Turbines and associated connection networks will be installed within the Zone, though export cable corridors (offshore and onshore) and associated infrastructure have also been considered within the wider planning and design context. Consideration was given to potential substation connections to the National Grid Transmission Network, including connection points identified in the ODIS report (National Grid, 2009[3]). The ZDE can therefore be divided into an Offshore ZDE component and an Onshore ZDE component (Figure 2).

Offshore ZDE

The Offshore ZDE includes the Dogger Bank Zone and a wider area for cable routes to shore. The Dogger Bank Zone is located in the southern North Sea, between 125 and 290 km off the east coast of Yorkshire with the eastern margin of the Zone aligned with the UK Continental Shelf median. The Zone covers an area of 8,660km^2 with depths ranging from 18 m in the shallower waters over the Dogger Bank to 63 m on the bank's edges. The wider Offshore ZDE extends from the Dogger Bank Zone to the coast of Northumberland, Yorkshire, Lincolnshire and East Anglia, encapsulating a potential offshore export cable area of approximately 45,000 km^2. The length of coast captured within the ZDE begins near Cromer in Norfolk and ends north of Blyth in Northumberland.

Onshore ZDE

The Onshore ZDE extends inland from Mean High Water (MHW) at the coastline covering an area of approximately 15,464 km^2, to include all National Grid infrastructure as defined within the December 2009 ODIS report. The Onshore ZDE was also extended northwards to investigate cable connection options that minimise offshore cable route distances, and covered a wider area to ensure that coverage is provided should there be any future changes to the National Grid ODIS report.

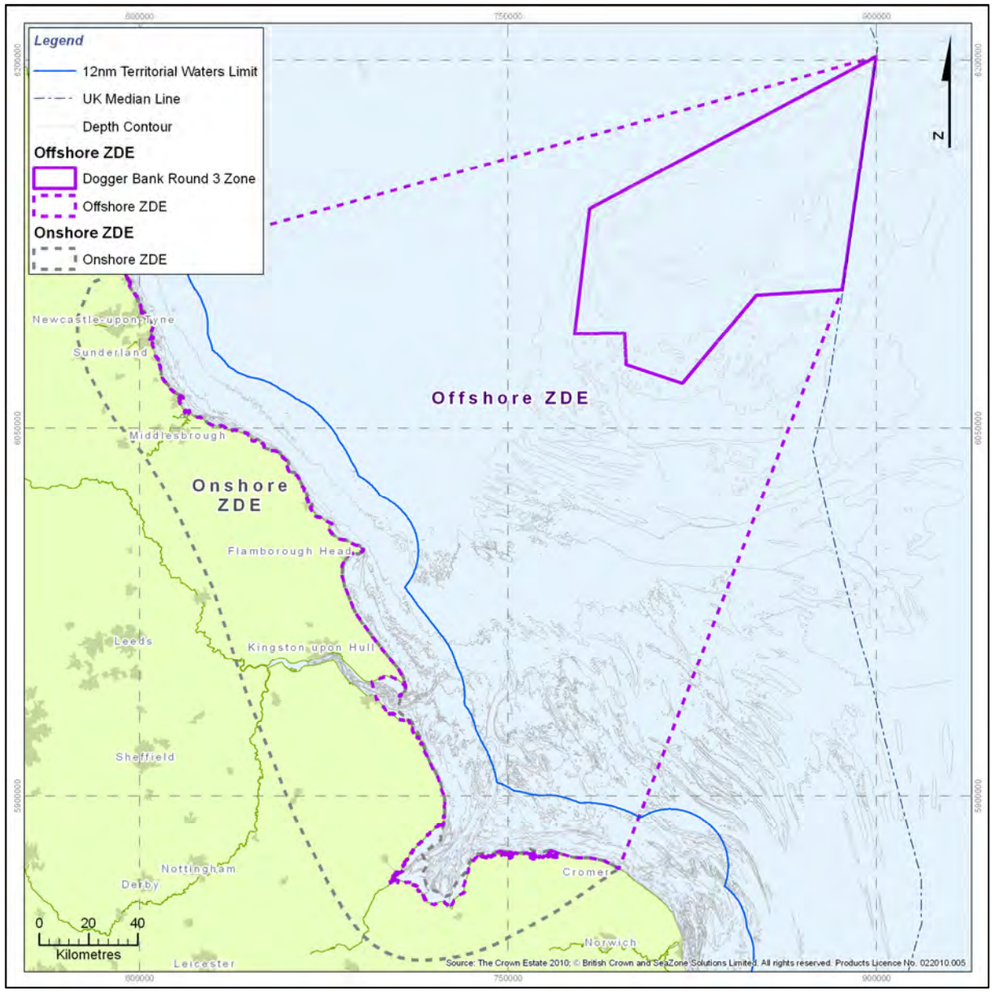


Figure 2: The Dogger Bank Zone Development Envelope.

Forewind Development Programme

The overall timetable for developing the Dogger Bank Zone, as discussed previously, is to generate 13 GW of energy within the Dogger Bank Zone. To achieve these targets, Forewind's ZAP strategy has been integrated within the planning phase of Forewind's development programme, with the completion of the principle phase of ZAP corresponding with the identification of the final Tranche of projects in 2012.

Stakeholder and Consent Strategy

Forewind recognise the importance of effective stakeholder engagement throughout the delivery process at both a ZDE and project level. Good relationships with stakeholders and a transparent approach to development will more readily establish an enhanced appreciation of opportunities and constraints within the Dogger Bank ZDE, enable the most appropriate development strategy and provide a robust basis for decision making.

[3] National Grid (2009). *Transmission Networks: Offshore Development Information Statement (ODIS)*, December 2009.

A well informed consultation strategy at both ZDE and project level has therefore been adopted to support the development process. The pre-application consultation requirements of the Planning Act 2008 are extensive and being able to demonstrate that Forewind have adequately achieved those requirements is critical if planning applications for individual projects are to be accepted by the IPC. Further to that, taking measures to establish and maintain sound relationships with all its stakeholders will help to ensure that genuine concerns can be quickly identified and more readily addressed during the pre-application stage, decreasing the likelihood that an application will be held up by an objection during the determination stage. A robust stakeholder engagement strategy starts at ZDE level and Forewind will use the outcomes of early consultation and stakeholder events as their development activities continue.

GIS and Data Management Policy

Forewind have developed a data management and GIS policy to ensure a consistent approach to storing, archiving, accessing and presenting the significant quantities of data that currently exist and that will be produced by further desk-based studies and field surveys as development moves forward.

Throughout the Tranche A phase of ZAP and the production of the ZoC Document, all spatial data has been collated into a navigable repository of data files that can be accessed and drawn upon by Forewind and demonstrated to TCE, IPC and stakeholders.

Zonal Characterisation

Robust spatial and temporal appraisal of the ZDE is crucial in understanding and identifying environmental and consenting risks. It is also important to identify and avoid areas unsuitable for construction from a technical or engineering perspective. This process is termed Zonal Characterisation. It provides the context for Tranche location selection and on-going development work both onshore and offshore. Zonal Characterisation is therefore key to 'understanding and managing development opportunities and constraints within the ZDE, one of the principle components outlined in the TCE ZAP framework document 2.

The ZoC is essentially an on-going data gathering, storage and presentation exercise and will require close adherence to Forewind's Stakeholder and Consent Strategy and Data Management and GIS Policy. The primary role of the ZoC Document is to provide data that supports the process of determining a realistic distribution of wind farms and associated cable infrastructure within the ZDE. The datasets comprise information on physical, biological and human factors at a resolution and geographical coverage sufficient to ultimately provide:

- Spatial information on environmental and technical issues and support identification of Tranches for development;
- The basis for the data that are needed for the Environmental Impact Assessment; and
- The basis for any subsequent data collection and analysis to study and assess cumulative and in-combination effects.

The ZoC Document will be updated with additional relevant information that is collected throughout the course of ZAP. This 2nd edition ZoC Document has been produced to support the identification of Tranche B.

Zone Planning Interface

Iterative and on-going Zone planning is another key component of ZAP (TCE, 2010). Forewind have structured an interface between its Development, Engineering and Grid teams to balance the consent, construction, connection and operation factors of Tranche area identification. This interface considers areas within the Dogger Bank Zone within which development of the potential 13 GW connection capacity is considered achievable by 2023 from an environmental, engineering, grid connection and commercial perspective.

The integrated approach encourages innovative thinking by engaging with all relevant disciplines and ensures all factors are considered equally, rather than isolating thinking to just environmental issues or technical challenges.

A report supports the recent identification of Tranche B and provides complete details of the method used to determine an appropriate location.

Common Framework for Cumulative and In-Combination Impact Assessment

One of the most significant environmental components of the ZAP Strategy is the cumulative impact assessment methodology which will be produced in consultation with statutory stakeholders and the IPC and which will set out the level of appraisal and assessment that can be reasonably undertaken to provide meaningful results on the impact sensitivities associated with the relevant receptors. The ZoC Document is intended to support project level cumulative impact assessments through provision of a common framework and relevant information.

ZAP / EIA Interface

As discussed, the ZAP process combines and assesses the information from four main perspectives: environment, engineering, grid connection, and operations, to define suitable areas for each Tranche. Within these Tranche areas, the EIA process considers the specific needs of each Project, focussing on the environmental impact of different engineering options to define consentable sites. These EIAs will draw on the information collected and assessed as part of the ZAP, but apply them to the individual Project areas in conjunction with more detailed site-specific data.

For the onshore study area the characterisation of the Zone requires the identification of environmental, planning and land use baseline conditions to enable the analysis and mapping of constraints which feed into individual project level EIAs.

As data are collected and assessed at both a ZDE and project level, knowledge of the ZDE will increase and therefore the definition of the areas for subsequent Tranches, and the sites within them, and definition of the onshore grid connection study areas will become more detailed. However, using the ZAP Strategy to maximise available data at each stage ensures that early projects are consistent with the overall ZDE optimisation and the level of impact is minimised.

Part I – Introduction to Zonal Characterisation

1. Introduction

A high level description of environmental issues is provided in this document to support the process of identifying areas within the Dogger Bank Zone which can be taken forward to the development stage from an environmental, consenting and technical perspective. This high level description is called Zonal Characterisation (ZoC).

This ZoC document describes and presents the data and information that were identified and collated up until August 2011 to describe the Zone Development Envelope (ZDE) and support the identification of the first two Tranches (Tranches A and B). This information includes updated reports on the status of sites identified for potential designation under the European Commission's Birds and Habitats Directives (in particular the progression of the Dogger Bank possible Special Area of Conservation (pSAC) to a candidate SAC (cSAC) and references to the on-going process to designate Marine Conservation Zones (MCZs) under the Marine and Coastal Access Act 2009.

While this document deals with the data used to support the identification of Tranches A and B, the Dogger Bank ZoC Document will evolve as further data come on line throughout the development process.

1.1 ZoC Document Structure

The ZoC Document is comprised of three parts:

Part I. Introduction to Zonal Characterisation (this chapter);

Part II. Offshore Zonal Characterisation, describing the Dogger Bank Zone and Offshore Cable Area; and

Part III. Onshore Zonal Characterisation, describing the Onshore ZDE and a site-specific Substation Study Area.

The Offshore and the Onshore ZoC each provide an environmental reference with a level of detail appropriate to inform ZDE-level planning and support more detailed project-specific EIA studies. However, there are distinct differences in approach, owing to the different scales of the areas being researched, the level of interpretation required, and the type, completeness and resolution of data available. Further, the Offshore ZoC is required to inform the identification of large Tranche areas, while the purpose of the Onshore ZoC is to identify study areas around substations with grid connection offers, so that these areas can also be characterised in terms of environmental, planning and land use constraints. The differences in approach are discussed in more detail in Sections 1.3 and 1.4.

1.2 Integration at the Coastline

It is essential that both the Offshore and Onshore ZoCs have some form of overlap. This is particularly important to ensure the identification of constraints to help inform landing points and cable landing construction methods. Principally, this means that each section considers opportunities and constraints to the Mean High Water (MHW) level with overlap between each part of the ZDE to include relevant issues (e.g. land-based issues such as radar stations have been considered in the Offshore ZoC owing to the potential for turbines offshore to affect radar performance).

The Onshore ZoC has considered key offshore opportunities and constraints which influence the selection and refinement of the site-specific substation study areas and possible cable corridors. The Onshore ZoC has also considered key constraints, such as nature conservation and heritage designations that occur in estuarine areas and up to 500 m seaward of MHW, to provide adequate duplication with the Offshore ZoC and ensure that all relevant data is collated through the combined studies.

1.3 Offshore Zonal Characterisation

The Offshore ZoC captures a range of issues pertaining to the physical, biological and human environment. Specifically, the chapters and constraints that have been addressed include:

- *Geology and Physical Environment* – Bathymetry, seabed sediments and features, Quaternary and bedrock geology;
- *Benthic Ecology* – Habitats, biotopes, benthic species and assemblages;
- *Fish Resource and Ecology* – Fish spawning, migration, nursery, juvenile and adult distribution;
- *Birds* – Key species abundance and coastal breeding colonies;
- *Marine Mammals* – Cetaceans and seals;
- *Nature Conservation* – Offshore and coastal designations, and features of qualifying interest;
- *Archaeology and Cultural Heritage* – Palaeo-landscapes and maritime archaeology;
- *Navigation and Shipping* – Vessel densities, fishing vessel activity;
- *Commercial Fisheries* – Key commercial fishing interests, distributions of vessels and gear types;
- *Oil and Gas* – Licences, fields, surface and subsea infrastructure;
- *Military, Aviation and Radar* – Practice areas, aerodromes, air traffic control and surveillance systems;
- *Marine Aggregates and Disposal*;
- *Cables and Pipelines*; and
- *Other Marine Users* – Renewable energy, underground coal gasification, carbon capture and storage, potash mining, tourism and recreation.

It is acknowledged that this 2nd edition ZoC Document does not make specific reference to meteorological or oceanographic conditions. Forewind have commissioned a series of wave buoy and metmast deployments in and around the Dogger Bank Zone. As information from these becomes available, it will be analysed and integrated into EIA and later ZoC Documents.

Each of the chapters presented in this ZoC Document focuses on a specific environmental topic and is structured as follows:

1. Introduction – A general introduction to the topic, setting out the issues that have been considered.
2. Data and literature – The key data and literature sources used to compile the chapter. Each chapter also presents relevant constraints identified by stakeholders at Forewind's April 2010 workshops and considers these in the chapter. Any notable data limitations or data gaps are also identified.
3. Overview – A summary of the occurrence within the Dogger Bank Zone and Offshore Cable Area.

4. Sub-sections describing the issues in detail. Where appropriate, occurrences within the Zone are discussed separately to those in the Offshore Cable Area, to allow for ease of reference when considering turbine or cable development matters.

5. Summary – A concluding summary of the chapter.

1.3.1 Data and Literature Sources

Data gap analyses were undertaken in March 2010 and March 2011 (EMU Ltd, 2010a, 2011) which identified the key data and additional work required (and achievable within the ZAP programme) to:

- Enhance current understanding of the ZDE to complete interim editions of a ZoC document in support of Tranche identification exercises in 2010 (Tranche A) and 2011 (Tranche B);
- Complete a full ZoC exercise in 2012 to support the identification of Tranches C and D prior to completion of the ZAP process.

Essentially, three categories of data are considered:

1. Digital and spatial datasets that can be mapped;
2. Literature and data in report form that can provide further quantitative and qualitative detail;
3. Input gained through regulator and stakeholder consultation.

These data have been considered and incorporated into each chapter of this report. Other non-digital spatial information collected throughout the characterisation has been manually digitised into the GIS database.

1.4 Onshore Zonal Characterisation

The Onshore ZoC characterises the environmental, planning and land use constraints occurring in the Onshore ZDE. It is split into two chapters:

- A high level characterisation of the Onshore ZDE based on environmental, planning and land use constraints; and
- A more comprehensive characterisation of a Substation Study Area encompassing the Creyke Beck substation, following a confirmed National Grid offer.

Further Substation Study Area chapters will be added to as additional grid connections are accepted by Forewind during the course of the project development and the new Substation Study Areas are defined. Constraint information and environmental evaluation will inform the decision making process when accepting a grid offers on the potential substation locations identified.

1.4.1 Data and Literature Sources

As with the Offshore ZoC, a data gap analysis (SKM Enviros and EMU Ltd, 2010) was undertaken to identify the key data required to characterise the Onshore ZDE. The majority of the data identified is available digitally and in a format compatible for analysis using GIS. The data sources used fall into four main categories:

- Ordnance Survey OpenData – Freely available mapping data covering small and mid-scale mapping;
- Bespoke data purchases – more detailed 1:25,000 mapping purchased for the selected Substation Study Area from emapsite (2010);
- Publicly available information from government agencies – official designated sites from Natural England and English Heritage; and
- Issues identified by stakeholders in 2010 and 2011 (EMU Ltd, 2010b, 2010c, 2010d; Forewind, 2010).

The datasets have further been sub-divided into four main themes of data, defined as:

- Environmental data – Geology, topography, nature conservation designations, ecology, landscape and visual;
- Cultural heritage data – World heritage sites, Heritage Coast, Scheduled Ancient Monuments, listed buildings and historic gardens;
- Land use and infrastructure data – Airports, hospitals, residential areas, schools, transport, water and services; and
- Planning policy data - Greenbelt, land designations/allocations and Shoreline Management Plans informing likely coastal retreat issues.

Planning policy information at this stage of the study has been collected by reference to information held on local planning authority websites. For substation study areas information from these websites has been used, although for the purposes of this study the information has been manually digitised into the GIS database.

1.5 Acknowledgments

During the production of this ZoC document, EMU Ltd has worked with other consultancies to achieve a characterisation of a broad range of environmental topics, namely:

- SKM Enviros, for producing a thorough characterisation of the Onshore ZDE to inform planning and development decisions relating to onshore cable routes and connections to National Grid substations;
- RPS Energy, for providing the geology and physical environment characterisation in the Offshore Zonal Characterisation and interpretation of geophysical data;
- The British Trust for Ornithology, for a description of bird species and potential distributions occurring in the Offshore ZDE;
- Cork Ecology for preliminary bird and marine mammal information;
- Anatec UK Ltd, for their characterisation of navigation and shipping in the Offshore ZDE, and their on-going analysis of AIS ship data; and
- Brown & May Marine, for providing the commercial fisheries characterisation in the Offshore Zonal Characterisation.

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Part II – Offshore Zonal Characterisation

2. Geology and Physical Environment

Note from the British Geological Survey (BGS) on the stratigraphy and mapping in the Dogger Bank area.

The BGS conducted an extensive programme of regional geological surveys in the 1970s and 1980s funded by the Department of Energy and subsequently by the Department of Trade and Industry, which resulted in the production of a series of 1:250,000 scale maps depicting seabed sediments, Quaternary Geology and the underlying Solid Geology. A summation of these studies was presented in a series of regional reports in the early 1990s (Cameron *et al*., 1992; Gatliff *et al*., 1994).

As the Quaternary mapping of the offshore UK began, it quickly showed significant changes in style and extent compared with the onshore sequences. Therefore BGS set to, to establish appropriate seismo-stratigraphies. These were begun at three different locales in the North Sea, reflecting initial areas of survey and mapping. These stratigraphies were then extrapolated outwards as new map sheets were surveyed until these stratigraphies were intra correlated (Cameron *et al*., 1987). The Dogger Bank area was one of the last areas mapped.

The published map sheets that cover the Dogger Bank Zone are 54+00 California, 54+02 Indefatigable, 55+00 Swallow Hole and 55+02 Dogger. These were published over a period of five years and changes in interpretation have resulted in incompatibility of the maps along sheet boundaries. The stratigraphy drawn up in the 1980s (Cameron *et al*., 1992) reflects knowledge of glacial processes at the time and the data available at the time. The detail on the maps reflects the wide spacing of survey lines, typically 5 – 10 km apart and the resolution of the sparker records. The seabed pulse width sometimes reached 10 m, reducing the level of detailed interpretation in the upper units. The regional surveys over the Dogger Bank Zone comprise pinger records collected in 1977 and sparker records gathered in 1981 and 1982. Unlike many areas, no shallow boreholes were drilled by BGS in this area to lithologically calibrate the shallow stratigraphy and the only ground trothing was from gravity cores and vibrocores with a maximum penetration of 6 m.

It is worth noting that revisions to the stratigraphy have been made in the adjacent Dutch sector following the acquisition of more recent seismic data and samples. Revisions to some Quaternary formation boundaries within the Dogger Bank Zone were made following re-examination of the original seismic data as part of BGS's participation in the JNCC Dogger Bank project in 2008. The project also acquired new seabed sediment information leading to an upgrade of the seabed sediments map as shown in the JNCC report (Diesing *et al*., 2009) and in the BGS digital product DigSBS250v2.

BGS's involvement in the Forewind project has confirmed that the 1:250,000 maps cannot be used exclusively for high resolution studies and that the opportunity will be sought in the future, subject to the Forewind partners agreement, to include recently acquired data in 1:50,000 scale digital maps under the MareMap project (www.maremap.ac.uk). The first of this map series are being released as an ongoing commitment from BGS to revise its offshore maps as high-resolution survey results become available.

D. Long, pers. comm. BGS. 18th November 2011.

Note from British Geological Survey (BGS) on seabed mapping.

The 1:250,000 seabed sediment map series show a snapshot in time of modified Folk classification derived from particle size analysis of successful grab samples, which would then be extrapolated outwards. The spacing of grab samples undertaken in the 1970s and 1980s is typically 5 km apart. It is possible that several unsuccessful attempts at grab sampling may have occurred prior to a successful recovery.

However, it is the analysis of the successful one that will be displayed on the published map although non-recovery attempts may be due to rock at outcrop or the presence of gravel of a size to prevent closure of the sampling equipment, usually a shipek grab. In some instances, the tops of cores were used to guide mapping. There are rare occurrences of rock outcrop depicted on the 1:250,000 map series reflecting where rock was recovered by rock drill or rock corer or was recognised by diver or camera.

Note all data on the published maps is >25 years old and any data derived from shallow seismic on the position of rock outcrop frequently involving seismic with a seabed pulse width of 5 m so confidence of rock outcropping without a thin cover of sediment was limited. Hence these maps should not be used as definitive representations of the seabed in cable surveys where the upper 1 m is needed in great precision.

The 1:250,000 seabed sediments map series has been digitised and issued as a seamless digital product known as DigSBS250 in the 1990s. In 2009, BGS was commissioned to produce a hard substrate map, where rock or boulders within 0.5 m of the seabed was mapped as rock outcrop, in recognition of the difficulty of using the seabed sediments maps for habitat mapping, particularly in areas of extensive rock outcrop. This was produced in coincident with revisions to the seabed sediments map, reflecting new sites of particle size analyses which have been included in DigSBS250v3.

D. Long, pers. comm. BGS. 18th November 2011.

2.1 Introduction

The Dogger Bank occupies a unique location geologically and geomorphologically, being part of the last area of the North Sea dry land mass to be inundated by the tsunami associated with the Storegga slide around 8,200 years BP (Weninger *et al*., 2008) and final Holocene sea level rise, 7,500 years BP after the last glacial retreat.

Within the glacial phase of the Pleistocene, there are three traditionally accepted episodes of glaciation:

- Elsterian/Anglian;
- Saalian/Wolstonian; and
- Weichselian/Devensian.

This chapter summarises the present physical and geological conditions present across the Offshore Zone Development Envelope (ZDE) and also attempts to correlate these with the interpreted evolution of the Dogger Bank and surrounding area based on known data. The current knowledge base has also been supplemented with the preliminary findings of the BGS Preliminary Geological Interpretation based on the findings of the 2010 geophysical and geotechnical surveys.

The key sedimentological and geological considerations addressed in this chapter, and used in the Zonal Characterisation can be defined as:

- Presence and thickness of sea bed sediments;
- Grain size and entrainment potential for seabed sediments;
- Mobility or transport potential of seabed sediments;
- Presence and size of any seabed feature;
- Presence of late glacial or post-glacial soft soils;
- Presence of glacially formed channels;
- Variation in glacial sediment types within the uppermost 50 m of sea bed; and
- Occurrence of infilled glacial channels within the uppermost 50 m of sea bed.

These issues are addressed in the following sections with particular reference to a programme of remapping of geophysical data currently being undertaken across the Dogger Bank Zone. Comments and implications relating to the reinterpretation are discussed in Section 2.10.

2.2 Data and Literature

The following data sets have been reviewed in order to derive the conclusions set out in this chapter of the ZoC document:

- Forewind 2010 Zone, Tranche A and cable route geophysical survey results;
- Forewind 2010 Zone, Tranche A and cable route geotechnical survey results;
- BGS published Charts;
- BGS raw geophysical survey lines (sparker, boomer, pinger);
- BGS sample logs;
- Assorted Geological Society Special Publications;
- Published papers (see references for individual papers used);
- Seazone hydrospatial GIS data;
- BGS digital seabed, Quaternary and solid geological data;
- RPS in-house geophysical and geotechnical database; and
- Initial findings of the 2011 BGS Preliminary Geological Interpretation.

As a result of the review of the BGS geophysical data set, errors were identified with the initial published interpretation when compared with the information presented in the original underpinning data. The published interpretation shows very little in the way of infilled channel features whereas the raw data depicts a complex sequence of potentially anastomosing channels. Consequently, a programme of reinterpretation of the BGS data was performed, in order to constrain the channel features and comment on their possible origin and infill material (Figure 2.1). This revision to the established geological model is currently on-going, based on detailed site data and will evolve as future data sets are acquired.

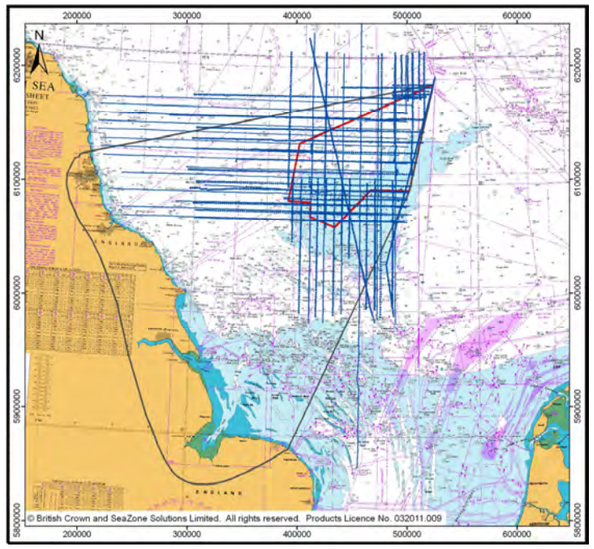


Figure 2.1: BGS geophysical data reviewed.

The interpreted geophysical lines have been incorporated into a GIS model in order to obtain an initial overview of the sub-seabed features upon which to base future work.

A geophysical calibration exercise was performed in 2010 to select the most appropriate tools with which to acquire data across the Dogger Bank Zone, subsequent to which a Zone-wide geophysical reconnaissance survey was conducted in order to obtain high resolution Zone-wide data. Line spacing for the reconnaissance survey was a 2.5 km x 2.5 km grid (Figure 2.2).

The Tranche A detailed geophysical survey was performed during the 2nd and 3rd quarters of 2010 at 100 m line spacing over the initial 2,300 km^2 area (Figure 2.3) followed by a geotechnical survey at 100 locations over the entire Zone, (Figure 2.4). A similar Tranche B survey is currently being developed.

These data, once interpreted, integrated and used to construct a 3D model, will be used to inform Tranche A Project selection and later Tranche selection. The 3D geological model will evolve incrementally as this process progresses.

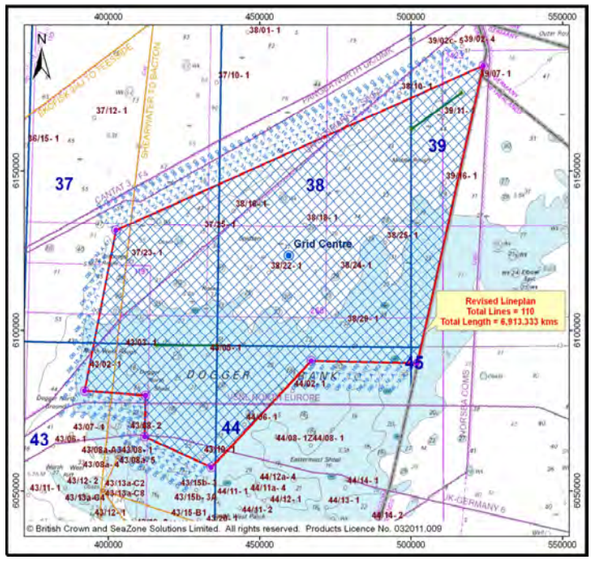


Figure 2.2: Reconnaissance geophysical survey line plan.

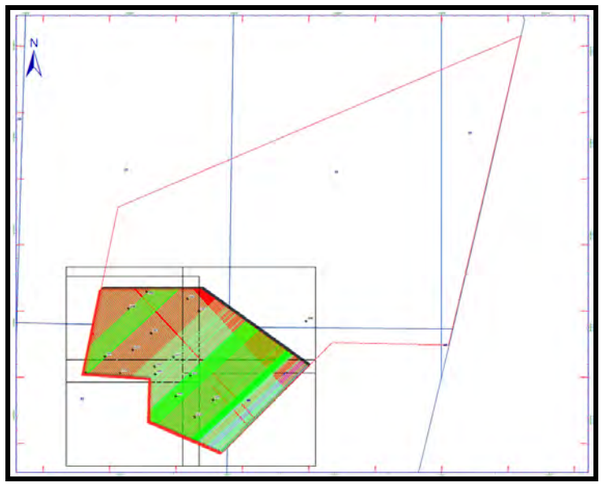


Figure 2.3: Tranche A survey area.

Detailed geophysical and geotechnical surveys will be performed across subsequent Tranches when selected, in order to derive final design parameters, populate the 3D model, and perform second order refinement for future engineering. The geospatial output from the 3D model will be used during future detailed work.

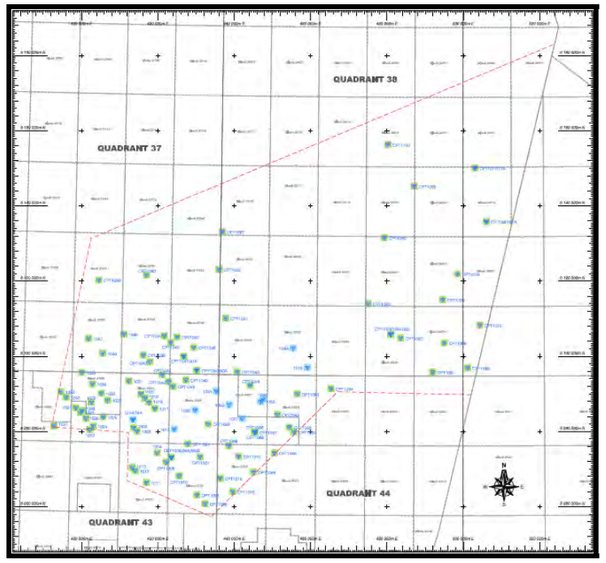


Figure 2.4: 2010 geotechnical investigation locations.

2.2.1 Data certainty and gaps

Significant data gaps existed in the original BGS data set and mapping has proved very difficult due to the scanned nature of the geophysical data which cannot be rescaled and integrated easily, and line spacing, generally in the order of 5 to 15 km leaving large areas without data. These issues are however in the process of being addressed as more detailed tranche-specific data becomes available and digital interpretation methods are used to complete the mapping and more fully understand the three dimensional geometry of any features identified.

It should be noted that the reconnaissance geotechnical investigation performed in 2010 identified some seismic anomalies which may have the potential to represent shallow gas deposits. At present work is on-going to quantify the initial findings.

2.3 Overview

2.3.1 Dogger Bank Zone

The Dogger Bank Zone outlined for development covers a relatively shallow, elongate, northwest oriented area of approximately 8,656 km^2. It is surrounded by deeper water although the Dogger Bank extends northeast into the Danish Sector of the North Sea and south onto Elbow Bank, the shallowest part of the Dogger Bank area.

The area of interest within Dogger Bank has not been subject to hydrocarbon extraction although areas to the north and south have undergone extensive exploration. Consequently prior to the surveys performed in 2010, very little shallow soils data was available with which to inform future decisions. Historical assessments relied on the use of soils data in similar formations from outside the Dogger Bank Zone, however significant improvements on the quantity of data and level of understanding are enabling much more informed decisions to be made.

2.3.2 Offshore Cable Area

The Offshore Cable Area covers a broad sector of the southern North Sea of approximately 45,000 km^2. The area extends along the English Coast between Happisburgh and Alnmouth, and offshore to the northeast, where it crosses the relatively shallow Dogger Bank to the UK North Sea Median Line.

The character of the sea floor within the Offshore Cable Area is variable, ranging from exposed bedrock to coarse gravelly lag deposits and active sand banks. This is reflected in the bathymetry, where the relatively flat pre-Holocene surface has been modified by later accumulation of elongate tidal sand ridges up to 35 m high (Cameron *et al*., 1992). However, whilst the morphology and lithology of the seabed is well mapped and defined, the thickness of the Holocene cover above Pleistocene glacial deposits is not.

An initial geophysical survey was performed in 2010 to identify broad scale features such as bedrock and sand waves in the general area of the proposed Tranche A cable route (Figure 2.5), whilst a more detailed corridor specific survey will be undertaken later in 2011.

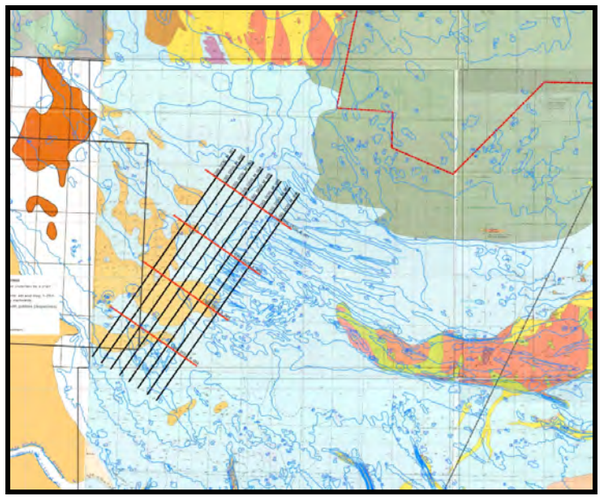


Figure 2.5: 2010 regional cable survey grid. IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

2.4 Bathymetry

2.4.1 Dogger Bank Zone

Water depths are interpreted to range from 60 m below Lowest Astronomical Tide (LAT) on the northern edge of the Dogger Bank Zone to 20 m below LAT, or shallower, in the southwestern region of the Dogger Bank Zone. Within these two extremes, the water depth generally shallows to the south from 40 m in the northern part of the Dogger Bank Zone to between 20 and 25 m below LAT in the southern part of the Dogger Bank Zone. The western margin of the Dogger Bank Zone coincides with the western edge of Dogger Bank and as such the water depth increases steeply.

The majority of the Dogger Bank Zone is between 25 and 30 m below LAT (Chart 1, page 24) with occasional elongate rises generally in the order of around 3 m. The northern and western margins of the Dogger Bank Zone are interpreted to be channelled, particularly in the north-western corner. Bed forms around Dogger Bank are limited and the tidal currents are complex (Stride *et al*., 1982). Stronger tidal currents flow around the Dogger Bank on the western side, their presence indicated by the presence of active sand bodies in The Sand Hills. The above trends and ranges in the general bathymetry have been generally confirmed by the 2010 surveys, however a significantly greater of detail and understanding is now available.

Tidal ranges are interpreted to be between 1 and 2 m across the Dogger Bank Zone. The ranges are thought to be higher in the western part of the Dogger Bank Zone and lower in the east. Tidal stream speed maxima for the eastern area of the Dogger Bank Zone are between 0.2 and 0.6 m/s, with the higher speeds present in the west, associated with the flow of water around the western edge of the Dogger Bank (Admiralty Charts 266 (1988), 268 (1986) and 1191 (1989)).

2.4.2 Offshore Cable Area

Water depths over the Offshore Cable Area range from 98 m below Lowest Astronomical Tide (LAT) in the northwest sector and along locally incised narrow deeps (e.g. Sole Pit and Silver Pit) to the mean high water mark along the coast (Chart 5, page 28).

The Dogger Bank dominates the bathymetry of the Offshore ZDE's northeast corner. It ranges in depth from 15 m in the south through to 45 m in the north, from where it increases to 80 m along the northern margin of the Offshore Cable Area. To the northwest of Dogger Bank, towards the English coast, the sea floor is generally between 40 and 90 m below sea level. At approximately 10 km out from the coast, the bathymetry begins to shallow from around 50 m deep to the foreshore.

Southwest of Dogger Bank, and along the eastern margin of the Offshore Cable Area, the bathymetry is generally characterised by tidal sand ridges (e.g. Norfolk Banks and The Sand Hills). These form elongate rises that extend above the sea floor attaining heights of between 35 and 42 m. This is reflected in the varied bathymetry across the area, which ranges from 10 to 30 m, deepening to between 30 and 60 m immediately to the southwest of Dogger Bank.

Maximum tidal ranges of 3 to 6 m (mean neap and spring tides respectively) occur along the coast between the Humber and The Wash. Offshore, to the northeast, spring tides are between 1 and 2 m (Admiralty Charts 266 (1988), 268 (1986) and 1191 (1989)). Local tidal currents are strong with average surface velocities reaching 2 m/s at the mouth of the Humber, decreasing in strength offshore to the north-east with lows of 0.2 m/s over the Dogger Bank (Figure 2.6). There is little variation in the near-bottom velocities due to the generally uniform bathymetry.

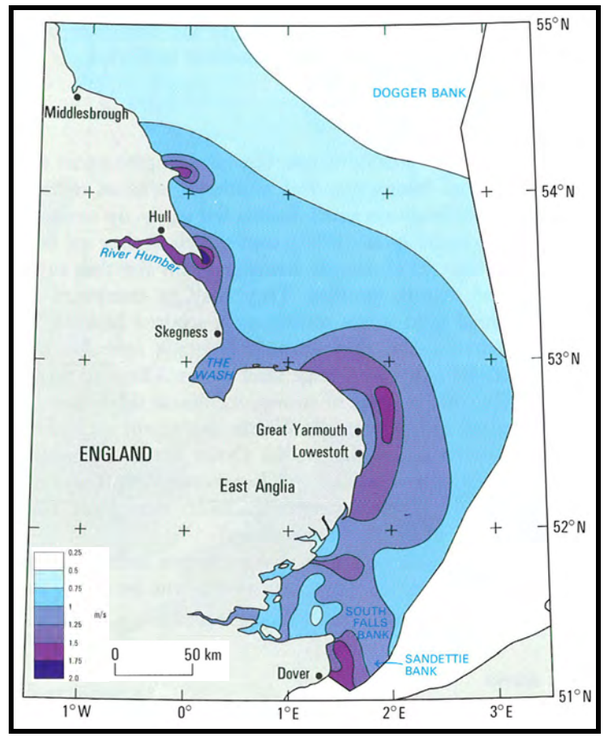


Figure 2.6: Maximum surface-current velocities for mean spring tide (modified from Cameron *et al*., 1992). IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

2.5 Seabed Sediments

2.5.1 Dogger Bank Zone

Seabed sediments deposited during the Holocene in the Dogger Bank Zone lie unconformably on late glacial deposits. The thickness of seabed sediments is generally up to 1 m across most of the eastern Dogger Bank Zone, generally increasing to between 1 and 5 m in the west and southwest. The eastern margin of the Dogger Bank Zone has considerably thicker Holocene sediment accumulations due to the proximity to the topographic high of Elbow Spit located in the Dutch sector. Elbow Spit is composed of tidal flat deposits comprising grey, clayey, shelly sand inter-bedded with clay. Though limited data on the thickness of the Holocene formations are available for the southwest of the Dogger Bank Zone, the presence of the Dogger North Shoal may indicate a locally thicker cover of Holocene gravel and sandy gravel. Recent work by the BGS has, however, identified Holocene Formations,

(Elbow) not previously interpreted to be present across the Dogger Bank Zone. The Holocene formations interpreted to be present across the Dogger Bank Zone are tabulated in Table 2.1 below.

Table 2.1: Holocene sediment formations present across the Dogger Bank Zone and Offshore Cable Area.

Formation	Description	Thickness
Bligh Bank	Mobile fine- to medium-grained marine sands	1 m to > 35 m in sandbanks
Indefatigable grounds	Sandy gravel and gravelly sand. Sand content is fine and shelly	Typically less than 2 m thick and forms a thin veneer
Terschillingerbank (Nieu Zeeland grunden)	Greyish brown fine to medium sand possibly with fine gravel and can be slightly silty	Generally <10 m thick
Elbow	Fine-grained clayey/silty sands with interbedded clay	2-6 m thick up to a maximum of 12 m
Well Hole	Fine-grained sands and sandy silts/clays	Typically 5-20 m thick up to 25 m
Note:. Hatched with white background – Present in the Offshore Cable Area. Hatched with Yellow background – Present in both the Dogger Bank Zone and the Offshore Cable Area.		

Assignment as candidate Special Area of Conservation

Current publications (Diesing *et al*., 2009) and the JNCC (Joint Nature Conservation Committee, 2010) ascribe the Dogger Bank region as a "sand bank". Current published information from the BGS, (Jeffery *et al*., 1988 and 1990) describes the majority of the area as having little in the way of sand cover (0.1 to 0.2 m) (Figure 2.7).

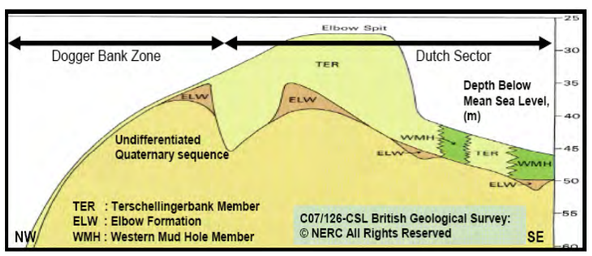


Figure 2.7: Seabed Profile of the Dogger Bank and Elbow Spit (after Jeffery *et al*., 1990). (Note accumulation of sand and bank morphology outside the Dogger Bank Zone). IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

The raised area within which the Dogger Bank Zone is located is underlain by variable glacial and interglacial materials including the Dogger Bank, Botney Cut, Cleaver Bank, Egmond Ground and Yarmouth Roads Formations, none of which have modes of formation or sedimentological composition associated with that of a recognised sand bank. Indeed the interpreted presence of stiff clays and peat which may locally crop out at the seabed offer evidence suggesting that the Dogger Bank Zone may not be entirely sand veneered. This does not fit with the definition of sand banks and other mobile features as defined by Stride (1982) and Nemeth (2003). However, the habitats associated with the Dogger Bank, as discussed in Chapter 3 – *Benthic Ecology*, are representative of the sand bank classification.

Most modern tidal sand banks show active sediment migration and associated bedforms (Kenyon, 1981). The Dogger Bank Zone is benign and, based on available data, shows no bedforms.

Stride (1982) ascribes the general mode of sand bank formation as early Holocene coincident with the marine incursion, however the morphology of the Dogger Bank Zone is due to pre-Holocene, (Weichselian glacial and interglacial) events

Elbow Spit, where a significant thickness (15 to 20 m) of sand is interpreted to be present, exists to the southeast and outside of the Dogger Bank Zone. Fitch *et al*. (2005) identifies this area and indicates the nature of the core material as that of the Terschellingerbank Formation. A review of the available raw BGS data indicates a thickening of a near seabed seismostratigraphic unit in a southeasterly direction away from the southeastern margin of Dogger Bank. Elbow Spit has a steeper southeastern margin which can clearly be picked out on north to south trending BGS sparker profiles (Figure 2.8).

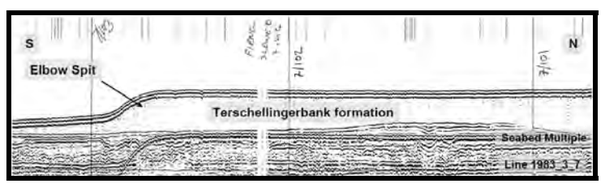


Figure 2.8: Line 1983_3_7: Interpreted to be Terschellingerbank Bank formation south to the left of image. The sand unit is interpreted to be 10-15m thick.

The JNCC (2010) includes this area to the southeast of the Dogger Bank as part of the candidate Special Area of Conservation (cSAC), as well as the Dogger Bank Zone to the north, although from a geological perspective there are sedimentological, historical and morphological differences between the two. It should be noted that this area of thicker sand (Figure 2.8) is outside the Dogger Bank Zone.

Seabed features and seabed sediment transport

Recognisable bedforms are either rare or absent across the Dogger Bank (Lott, 1987). To the south, numerous sand banks and sand ridges are aligned with their long axes following the periphery of the Bank (Figure 2.9). They have measured lengths of up to 60 km and amplitudes of up to 40 m. To the northwest of Dogger Bank lies a series of moribund linear ridges known as the East Bank Ridges, up to 60 km in length and 30 m in amplitude.

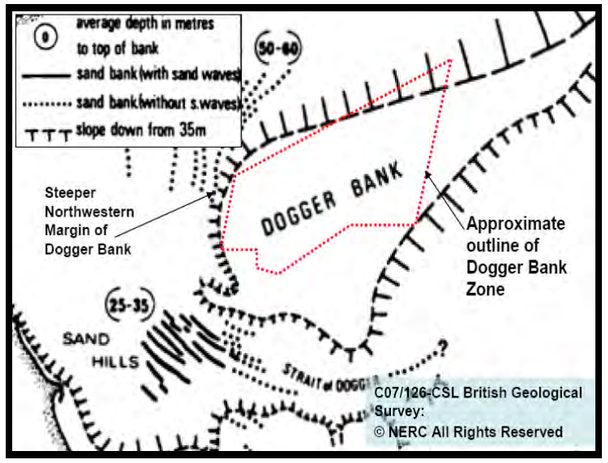


Figure 2.9: Seabed features of the Dogger Bank and the surrounding area (after Cameron *et al*., 1992). IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

The seabed features across and around the Dogger Bank are largely the result of topography created during the Pleistocene by the repeated glacial and interglacial cycles, with Holocene post-sea level rise features superimposed onto the glacial landscape around the edge of the Bank. The glacial cycles are interpreted to be responsible for the erosion of units creating channel features on the north and western edge of Dogger Bank. The shallow part of

the Dogger Bank contains generally small bedforms which comprise mainly ripples. Sand waves are thought to be rare or absent (Cameron *et al.,* 1992) possibly due to low tidal currents and limited sediment supply. The mean grain size of the area is generally that of fine sand, however, coarser gravelly sand dominates in the central and southern parts of the Dogger Bank Zone and gravel deposits are interpreted to be present in the far western part of the Dogger North Shoal (Chart 2, page 25).

Based on the available data and the low tidal currents, seabed features are considered to be of limited coverage and size across the Dogger Bank Zone. In the very southwest of the Dogger Bank Zone, sand ribbons are interpreted to be present. Elsewhere, based on currently available survey data, the seabed is interpreted to be comparatively benign and featureless.

2.5.2 Offshore Cable Area

Seabed sediments in the southern North Sea were deposited during the Holocene and unconformably overlie Pleistocene glacial deposits, or older deposits, as a thin veneer. The thickness of seabed sediments varies across the area. Typically less than 2 m, thicknesses of up to 35 m can be reached where depressions are filled and tidal sand banks occur (e.g. Sand Hills). Beyond this, there are limited data on the thickness of the Holocene cover across the Offshore Cable Area where cables may be routed.

Seabed sediments are described, classified and mapped by the BGS according to Folk (1954). Under this scheme the term “mud” includes silt and clay sized grains (Figure 2.10).

Holocene sediments have been assigned to a number of different formations that are broadly defined by location and lithology. The nomenclature has been devised for the Dutch sector and adopted by the BGS for the UK sector (Cameron *et al.,* 1992).

Sediment types

Seabed sediments are divided into three major types, described below, based on numerous sea-bed samples collected by the BGS. The sediments are classified after Folk (1954). These data have been used to compile seabed sediment charts at 1:250,000 scale (Chart 6, page 29), which have been used for this characterisation of the Offshore Cable Area.

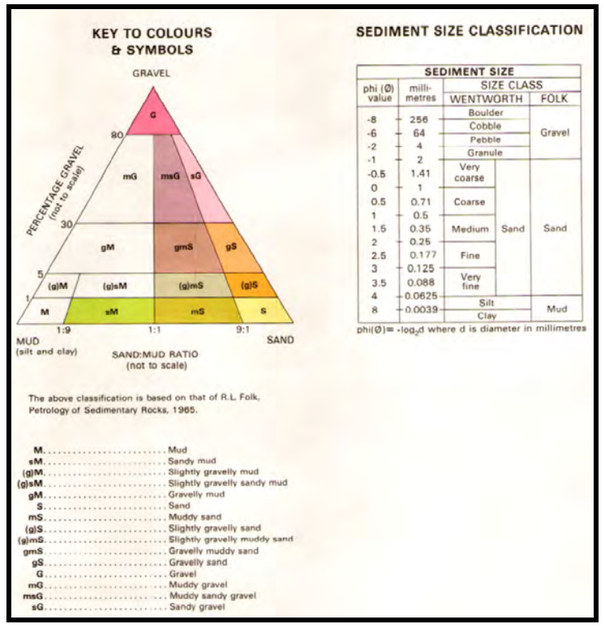


Figure 2.10: Sediment classification used by the BGS to describe seabed sediments (after Folk 1954). IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

Coarse gravelly deposits

Gravel dominated sediments are widespread across the region and generally occur as static lag deposits. The polymitic gravels contain flint, sandstone, limestone and chalk. A minor biogenic component of mollusc shells is found at localised centres of carbonate production (Pantin, 1991). Sediment size generally varies from sandy gravel to gravel with patches of muddy sandy gravel (Chart 6, page 29).

The largest concentration of gravels is present along the coast, from Happisburgh to Flamborough Head, where a thin layer, tens of centimetres thick, rests unconformably on glacial till or chalk bedrock (Cameron *et al.,* 1992). This area of gravel deposition extends offshore for approximately 70 km as a wide belt that thins to a width of approximately 20 km, to the north of Hornsea. The gravel is considered to be derived from glacial fans and moraines, which have been reworked since the retreat of the Weichselian ice sheet. Active erosion of coastal cliffs and chalk outcropping at the sea floor has also likely contributed a gravel component to the seabed sediments (Cameron *et al.,* 1992).

South of Outer Silver Pit and across the Dogger Bank, patches of gravelly sediment tens of kilometres wide are also found. These are interpreted to be derived from glacial deposits (e.g. moraines or outwash fans) that have been subject to active winnowing (Veenstra, 1969).

Sandy sediment

The Offshore Cable Area is dominated by sandy sediments (Chart 6, page 29), which are in equilibrium with the hydrodynamic regime and mobile under present-day conditions. The sands are mostly composed of fine to medium, moderately well to very well sorted sands. Medium-grained sands dominate with finer sediment concentrated towards the mouths of estuaries and intertidal flats (Cameron *et al.,* 1992).

Coarser and gravelly sands are associated with winnowing by tidal currents along the coast and towards Dogger Bank. Generally, the sand grade fines northwards due to the tidal related bed-load parting and net sediment transport to the north (Johnson *et al*., 1982).

Muds

Intertidal zones associated with estuaries are dominated by muddy sediment (a mixture of silt and clay). Mud deposits exceed 15 m and 30 m thickness in the Humber Estuary and The Wash respectively (Cameron *et al*., 1992). Away from these coastal zones only offshore depressions such as Outer Silver Pit, which act as sediment traps for fine-grained sediment, are significant zones of mud-rich deposition (Eisma, 1975; Cameron *et al.,* 1992).

Bedforms and seabed sediment transport

A significant area of the Offshore Cable Area is characterised by active sediment movement. Seabed features of the southern North Sea fall into three main bedforms - sand ribbons, sand banks and sand waves (Chart 7, page 30). The former are longitudinal bedforms with their axes running parallel to the dominant tidal form, whereas the later are orientated transverse to flow. Sand accumulation in the lee of obstacles on the seabed (e.g. wrecks) is a minor bedform feature (Cameron *et al.,* 1992). Areas with no recognisable bedforms and where bedrock outcrops at the seabed also occur. Gravel-dominated seabed sediment zones are considered to be largely inactive and immobile (Chart 7, page 30).

Sand ribbons are typically thin, measuring less than a metre in depth, but can extend for several kilometres in length and be tens of metres wide (Belderson *et al*., 1982). They grade laterally into sheet sands with sand waves. Characteristic of strong tidal currents >1 m/s (Belderson *et al*., 1982) they are best imaged by side scan sonar. Due to the predominately moderate tidal currents (<1 m/s) (Figure 2.6), sand ribbons are a relatively minor bedforms which have only been recorded over small areas off Flamborough Head (BGS Tyne-Tees and California Seabed Sediment sheets).

Sand waves are a significant feature of the southern North Sea and occur over large areas within the southern section of the Offshore ZDE, particularly to the southwest of Dogger Bank (Figure 2.11). Typically consisting of fine to medium grained sand there is a large variation in their morphology (Cameron *et al*., 1992). The largest sand waves are up to 5 m in height with wavelengths between 50 and 500 m. They may be covered by smaller sand waves with wavelengths of between 1 and 2 m. The larger sand waves appear to be orientated oblique to the tidal flow with smaller waves orientated 60° to the main crest they cross (Cameron *et al*., 1992). The migration of these waves has been estimated at as much as 15 m/year (McCave, 1971). This is in the direction of their lee slopes, which are ~12°, while their stoss slopes are between 1° and 3°. They occur in water depths of 18 to 60 m, and within sheltered intertidal zones.

Sand banks, or tidal sand ridges, are the largest bedforms and groups of these features are present within the Offshore Cable Area, including the Sand Hills, East Bank Ridges and the western edge of the Norfolk Banks (Figure 2.12).

The Sand Hills group is found in the centre of the Offshore Cable Area to the southwest of Dogger Bank (Figure 2.9 and Figure 2.11). These sandbanks occur in water depths of ~50 m and have heights of between 12 and 21 m, placing the crests of the banks at between approximately 10 and 30 m water depth. Large sand waves mantle the westerly banks and indicate active sand transport but the smooth profiles of banks to the east suggest local currents are insufficient and that they have become moribund (Kenyon *et al*., 1981).

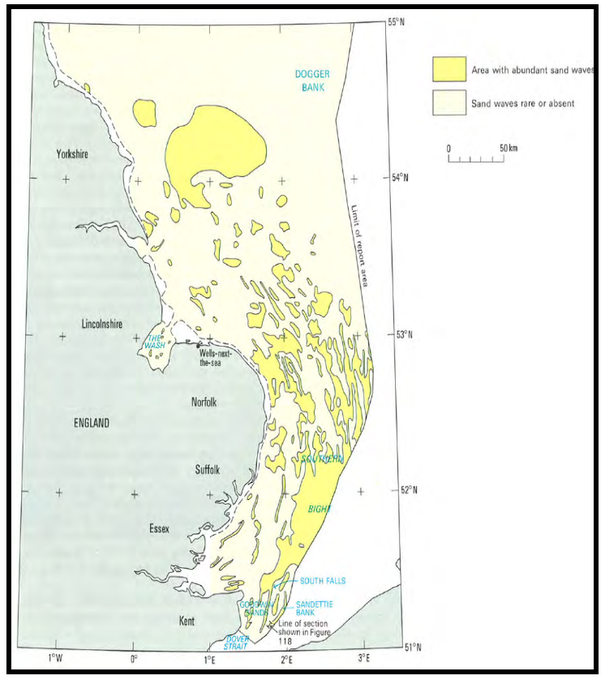


Figure 2.11: Area with abundant sand waves across the Offshore Cable Area (Cameron *et al*., 1992). IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

The western edge of the Norfolk Banks extends into the southeast corner of the Offshore Cable Area. They occur in shallower water with banks up to 42 m high, the crests at up to 10 to 30m below sea level; however some are exposed at low tide (Caston, 1972). They become shorter, straighter, more linear and less active offshore, although these fall outside of the Offshore Cable Area to the east. The nearshore banks are generally asymmetric with steeper slopes of 7° on the north-east flanks (Cameron *et al.,* 1992). Movement of these banks is considered to be along their long axes to the northwest, in the direction of net sand transport, with some evidence for lateral migration to the northeast (Caston, 1972).

A series of Holocene tidal sand ridges that are considered to be relict are situated on East Bank immediately to the northwest of Dogger Bank (Gatliff *et al.,* 1994). They are found in water depths of between 45 and 60 m and occur over an area ~30 km wide. Orientated northeast to southwest, their typically smooth symmetrical profiles with no cover of sand waves suggests they are no longer active (Kenyon *et al*., 1981). These moribund ridges are up to 5 km long and 3-4 km wide with heights of between 10 and 30 m.

Based on available data the Dogger Bank seabed is largely considered to be benign and featureless due to the low tidal currents and limited sediment supply (Cameron *et al.,* 1992). Bedforms, where present, are generally small and represented by ripples and sand ribbons. In some places (e.g. Norfolk Banks) it is likely that the migration of sand ridges has covered a thin deposit of gravels that could lie at their base (Cameron *et al.,* 1992).

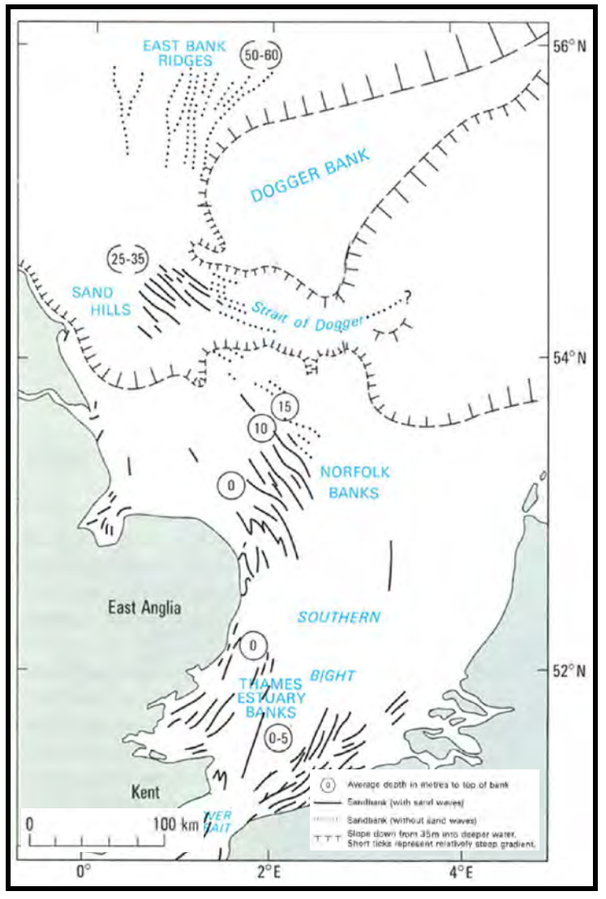


Figure 2.12: Distribution of major sandbanks in the southern North Sea (After Cameron *et al*., 1992). IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

2.6 Quaternary geology

Table 2.2 below, summarises the Quaternary formations present in the Dogger Bank Zone and the wider Offshore Cable Area. The geotechnical properties of the formations found within the Dogger Bank Zone are summarised in Table 2.3.

2.6.1 Dogger Bank Zone

The Dogger Bank Zone is located in an area containing a complex sequence of Quaternary Formations deposited during glacial and interglacial periods (Chart 3, page 26), the precise relationships and geometry of which have yet to be established in detail. The Formations, highlighted in yellow in Table 2.2, are interpreted to occur within the topmost 100 m or so of the seabed, (Cameron *et al*., 1992). It should be noted that older Quaternary Formations are present underlying the area beyond the depth of interest, however they are not described in detail.

The Quaternary deposits are illustrated in section and plan view in Figure 2.13 and Figure 2.14, the plan view shown in Figure 2.14 being composed of two BGS map excerpts. Work performed in 2010 has identified and sampled a highly complex sequence of infilled channels not represented in the currently published data and also indications of glaciotectonic activity across the Bank.

The data presented and used here as an initial point of reference for geotechnical properties are based on a summary of data acquired during the 2010 campaign and are subject to refinement as further detailed work in the area progresses. Additionally, the actual values for given units at specific sites may differ from the summary values.

The entire Quaternary succession has recently been divided in three major subdivisions (Stoker *et al*., in press). These are:

- Southern North Sea Deltaic Group, from Lower Pleistocene to Lower Middle Pleistocene;
- Dunwich Group – delta top sequence of Lower Middle Pleistocene age; and
- Californian Glacigenic Group from Middle Pleistocene to Holocene.

The Divisions and Elements within each group are in Table 2.2.

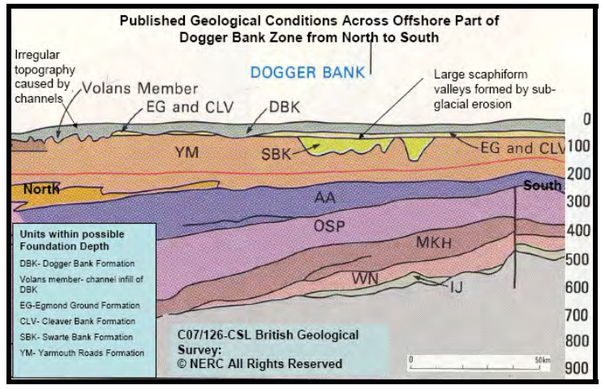


Figure 2.13: Published Quaternary profile across the Dogger Bank Zone (Gatliff *et al*., 1994). IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

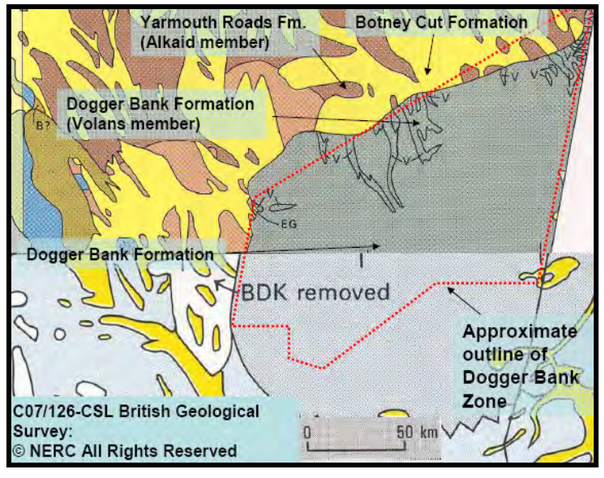


Figure 2.14: Published Quaternary sequence across the Dogger Bank Zone, (Gatliff *et al*., 1994, Cameron *et al*., 1992). IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

Mapped Quaternary channels

Original interpretation

The published BGS interpretation of the Dogger Bank shows a limited number of channel features across the Dogger Bank Zone divided into three main complexes. These are interpreted to comprise Botney Cut Formation, Volans Member, (Dogger Bank Formation) and Swarte Bank Formation (Figure 2.15). The interpreted distributions are presented in Table 2.4.

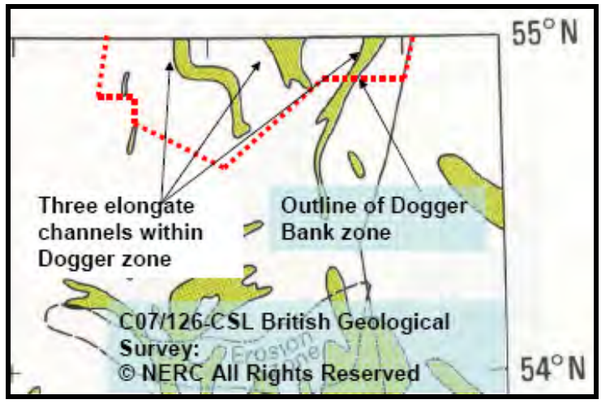


Figure 2.15: Published occurrence of Swarte Bank channels. IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

Revised interpretation

Initial review of the BGS sparker data indicates a more complex system of channels than initially interpreted by the BGS, and are now being reassessed. The units interpreted to be present across the Zone by the BGS are generally present in the sequence identified; however a major departure from the original interpretation is present in the upper 30 to 40 m of the soil profile and is related to the presence of a complex sequence of channel features with infills of varying acoustic character across the Dogger Bank Zone. This departure has been confirmed by the 2010 survey results.

The BGS sparker data have been reviewed as, at present, these data give the best coverage in terms of depth and resolution for the sediments interpreted to be within foundation depth. Note all interpretation has been carried out using a seismic velocity of 1,650 m/s. Initial interpretation of the Zone and Tranche wide geophysical data not only reaffirms the projected complexity but enhances it.

Table 2.2: Holocene sediment formations present across the Dogger Bank Zone and Offshore Cable Area.

System		Stage	Formation	Environment/Soil/ Rock type
Quaternary	Upper Pleistocene	Upper Weichselian	Forth	**Marine, glacio-marine, fluvio-marine**: Interbedded sands and clays.
			Hirundo	**Subglacial:** Soft to Stiff reddish brown gravelly sandy clay (non-calcareous).
			Botney Cut	**Subglacial:** Soft to Stiff reddish brown gravelly sandy clay with interbedded sand and grey sandy pebbly glaciomarine clay.
			Wee Bankie	**Subglacial:** Stiff sandy gravelly clay with interbeds of sand and silt/clay.
			Bolders Bank	**Sub-glacial:** Stiff reddish- greyish brown sandy gravelly clay.
			Twente	**Periglacial:** Aeolian fine sand deposits and organic detritus.
			Well Ground	**Proglacial: Glaciofluvial Stiff clay and sand**
			Dogger Bank	**Glacimarine to glacilacustrine**: Stiff to very stiff clay, and laminated gravelly sandy clay.
		Eemian	Eem	**Marine:** Shelly sands remnants of tidal channels.
	Middle Pleistocene	Saalian	Tea Kettle Hole	**Periglacial:** Aeolian deposits of fine grained sands with organic detritus.
		Holsteinian	Cleaver Bank	**Proglacial:** Stiff laminated dark grey clays with scattered angular chert and chalk gravel.
			Egmond Ground	**Marine:** Gravelly sands interbedded with silt and clay.
		Elsterian	Swarte Bank	**Sub-glacial:** Gravely sandy clay which can be accompanied by dense fluvio-glacial sands, overlain by stiff grey laminated glacio-lacustrine clays.
			Yarmouth Roads	**Fluvial to intertidal:** Marine and non-marine sands with scattered pebbles and plant debris with intertidal sand and mud rythmites.
		Cromerian	Batavier	**Marine**: Stiff grey clay and silty clay with sand laminae.
	Lower Pleistocene	Bavelian		
		Menapian	Aurora	**Marine**: Interbedded glauconitic, fine grained sand and grey clay.
			Outer Silver Pit	**Marine:** Stiff dark grey clay.
		Waalian	Markhams Hole	**Marine:** Stiff dark grey clay, includes marginal sandy facies.
		Eburonian	Winterton Shoal	**Marine:** Clays and very fine grained sands.
		Tiglian	Ijmuiden Ground	**Marine:** Calcareous, bioturbated, dark grey silt clay with thin beds of very fine sand.

Note:
Yellow background – Present in Dogger Bank Zone.
Hatched with white background – Present in Offshore Cable Area.
Hatched with Yellow background – present in both the Dogger Bank Zone and the Offshore Cable Area.
White background – not interpreted to be present in either.

Table 2.3: Table of interpreted geotechnical properties.

Formation	Submerged unit weight (γ') (kN/m^3)	Relative Density (Dr) (%)	Effective angle of internal friction (Φ') (°)	Undrained Shear Strength (S_u) (kPa)	Epsilon 50 (ε_{50}) (%)	Cone end resistance (q_c) (MPa)	Typical thickness of units
Seabed sediments	6.0 – 8.5	20 - 100	-20 - 40	20 – 70, (Organic Clay)	1.5 - 3	0.4 - 35	<1 m, (up to ~10 m)
Botney Cut	7.0 - 10.0	20 - 100	20 - 35	40 - 130	0.8 - 1.4	0.5 – 2, (Clay) 1.5 – 60, (Sand)	Present in channels generally 20 - 30 m deep
Dogger Bank	8.3 - 11.6	60 - 100	25 - 40	60 - 350	0.5 – 2.0	1.8 - 60	Generally tabular between 20 - 40 m thick
Cleaver Bank	8.1 - 9.5	-	-	270 - 450	-	-	Interpreted to be <10 m where present
Egmond ground	7.8 - 10.9	80 - 100	30 - 35	-	-	25 - 55	Interpreted to be <10 m where present
Swarte Bank	10.1 - 10.8	85+ where sand	30 - 35 where sand	200 - 390 where clay	0.5 - 2.0 where clay	3.5 - 7.0	Present in deep channels ~100 m thick
Yarmouth Roads	8.2 - 10.3	80 - 100	35 - 40	250 - 500	2.0 - 3.0	15 - 40 in sand	Generally from 40 m to beyond foundation depth

Table 2.4: Published distribution of glacial channel infill.

Formation	Distribution	Depth to top below seabed	Material Type
Botney Cut	Sporadic – random Beneath Holocene, sand southeast of Zone	0 – 1 m	Soft to Stiff reddish brown gravelly sandy clay with interbedded sand and grey sandy pebbly glaciomarine clay
Volans Member (Dogger Bank)	Oriented NW-SE near NW margin of Dogger Bank	0 – 1 m	Stiff to very stiff sandy gravelly clay with sand layers
Swarte Bank	Oriented NW-SE only mapped over southern half of Dogger Bank	30 – 40 m	Stiff to very stiff becoming hard clay, gravelly clay and dense sand

Channel features

Channel features vary across the site in width, depth and acoustic character of fill material. At least three major phases of channelling have taken place leading to the deposition of soils interpreted to belong to the Swarte Bank and the Botney Cut Formations. The top of the Swarte Bank Formation is generally interpreted to be deeper than 40 m below seabed and can extend down to the region of 150 m below seabed in the larger channel features. The Botney Cut Formation lies directly below the thin veneer of seabed sediments. Within the Dogger Bank Zone, the base of channels interpreted to be filled with material analogous to the Botney Cut Formation rarely reach depths greater than 50 m below seabed.

In addition to these two major phases of channelling, a third channel fill deposit known as the Volans Member of the Dogger Bank Formation is interpreted to be present along the northern margin of the Dogger Bank Zone. Examples of the characteristic channel fill material at surface are shown in Figure 2.16 and Figure 2.17. It should also be noted that 2010 survey results suggest that the Dogger Bank Formation contains internal erosional and depositional channel features, which have yet to be mapped.

According to the BGS the Volans Member of the Dogger Bank Formation is acoustically identical in character to the surrounding Dogger Bank formation. The channel fill in Figure 2.16 appears to have an orientation consistent with that interpreted by the BGS.

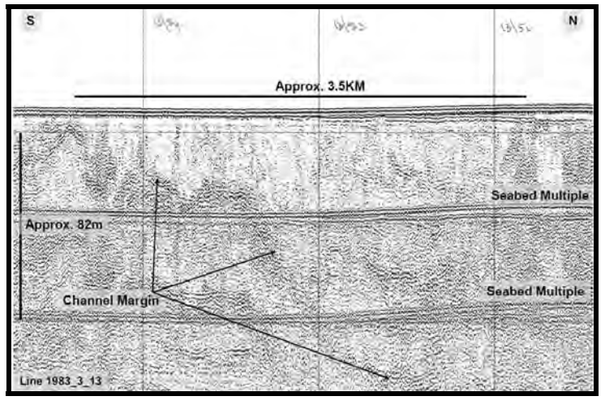


Figure 2.16: Line 1983_3_13: Deep channel in the Northwest of the site Scale lines approx 82 m apart, channel approx. 3.5 km wide.

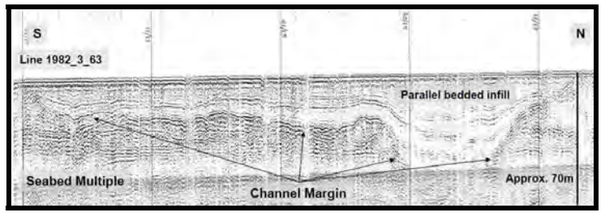


Figure 2.17: Line 1982_3_63: deepest part of channel approx. 70m deep. Parallel bedded possible BCT.

The parallel bedded nature of the channel fill material illustrated in Figure 2.18 is consistent with the acoustic character that has been interpreted to represent the Botney Cut Formation at other locations. Deep channels with this acoustic character are observed to the North of the Dogger Bank Zone, but similar fill to this is generally observed in much shallower channels in the south and south east of the Dogger Bank Zone. These channels can be broad and often are acoustically less distinct than the surrounding material. However, faint, dipping reflectors can often be picked out leading to the interpretation that these sediments could be similar in acoustic character and thus possibly contain soils with geotechnical parameters similar to those of the Botney Cut Formation. This has been proven from the 2010 survey results. Other channels have been identified infilled with more sandy sediments subsequent to late glacial transgression. Multiple channels of this character are often present which can cross cut each other as illustrated in Figure 2.19.

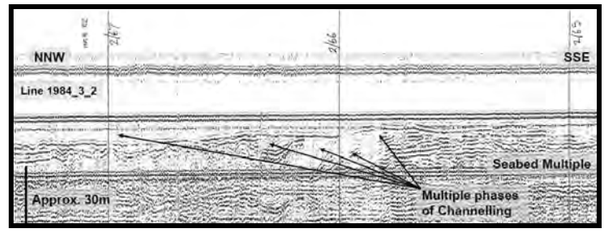


Figure 2.18: Line 1984_3_2: complex multi phases of channelling with dipping parallel bedded fill. Depth of channel approx. 25-30m.

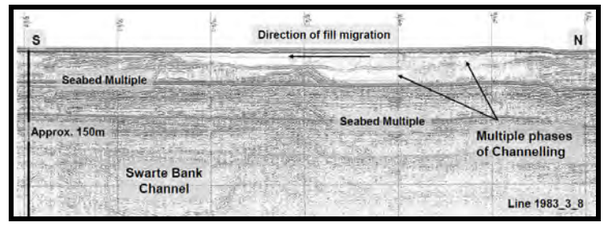


Figure 2.19: Line 1983_3_8: North South section showing complex nature of units in the Dogger Bank Zone.

Channels of this character have been picked out in the centre of the Dogger Bank Zone and are generally between 15 and 20 m deep (Chart 4, page 27). The general orientation of these channels cannot be traced from line to line due to the line spacing run by the BGS, however the Tranche A data is sufficiently detailed to permit detailed mapping of all significant features. Fill material is generally deposited in a north to south direction and may indicate sediment transport in that general direction.

The locations of identified channel features and their associated interpreted maximum depths are indicated in Chart 4 (page 27) and clearly show the trend of deeper larger channels to be present along the northern and western margin of the Dogger Bank Zone. Shallower channels are present across the Dogger Bank Zone and in the central south area these channel sequences can be complex with multiple phases of channelling.

Features generally confined to isolated parts of the east of the site with a highly variable undulating base were initially interpreted to be a buried palaeo-landscape (Figure 2.20). However it is now believed that they represent a glaciotectonic event where advancing ice deformed already deposited tills. These features are often draped by parallel layers of sediment. This unit is

observed in the east of the Dogger Bank Zone and is not consistent with any of the formations previously outlined.

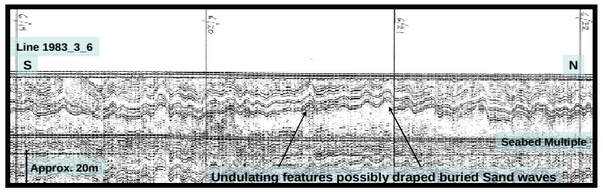


Figure 2.20: Line 1983_3_6: Acoustic character seen rarely elsewhere in zone. Possible sand features (Sand waves) draped by fine material (depth to base of strong undulating reflector approx. 20m).

2.6.2 Offshore Cable Area

The influence of glaciation throughout the Pleistocene has resulted in glacigenic sediments being the most widespread deposits beneath the Holocene seabed cover (Chart 8, page 31). The stratigraphy is divided into Lower to Middle Pleistocene shallow-water marine and non-marine sediments deposited in a northward advancing delta complex and Middle to Upper Pleistocene glacigenic and non-deltaic marine deposits (Figure 2.21). The units have been defined on the basis of seismic character with lithological information gathered from borehole data.

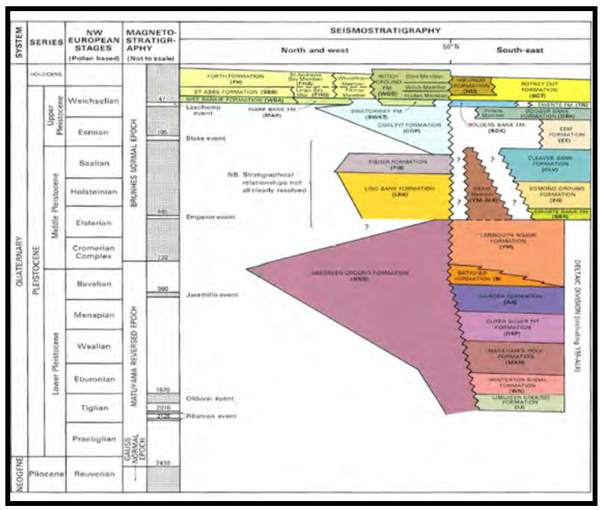


Figure 2.21: Quaternary stratigraphy of the North Sea as relates to the geology of the Offshore Cable Area (modified from Gatliff *et al*., 1994). IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

Consequently, a precise understanding of their geology is not well defined. A description of the formations and their mapped surface distribution beneath the Holocene cover over the Offshore Cable Area is presented below.

2.7 Bedrock geology

2.7.1 Dogger Bank Zone

Sequences older than the Quaternary are not within the depth of interest and so will not be considered in detail. They will however be summarised for completeness along with the event chronology that preceded and affected the Quaternary sequence. It should be noted that basement sequences older than the Carboniferous have been omitted from the summary. Events are detailed in Cope *et al*. (1992) and summarised below:

- Deposition of Carboniferous sandstone, mudstone and limestone and igneous intrusion: 355-300 Ma;
- Deposition of Permo-Trias Mudstones, Halite, Gypsum, Anhydrite, Sandstones and undifferented mudstones: 300-204 Ma;
- Deposition of Jurassic sandstones, mudstones and limestones; 204-130 Ma;
- Deposition of Lower Cretaceous sandstones and mudstones; 130-95 Ma;
- Deposition of Upper Cretaceous Chalk; 95-65.5 Ma;
- Early Palaeocene: Erosion of the Upper Cretaceous Chalk; 65.5-55 Ma;
- Deposition of the Late Palaeocene, Eocene and Oligocene, Miocene, Pliocene, (Tertiary) sands and clays and limestone units separated by erosive episodes; 55-1.5 Ma;
- Alpine Orogeny: Folding, uplift and erosion of the Jurassic, Cretaceous and Tertiary strata; 65.5-2.6 Ma; and
- Erosion of the solid strata associated with glacial activities during the Pleistocene (ice age); 1.5 Ma-present.

2.7.2 Offshore Cable Area

The solid geology is found to outcrop at the seabed and within the top two metres across Area A of the Offshore Cable Area (Chart 9, page 32). Bedrock exposure is confined to the northwestern sector, extending ~50 km offshore from Flamborough Head and trending north parallel to the coast (Figure 2.22).

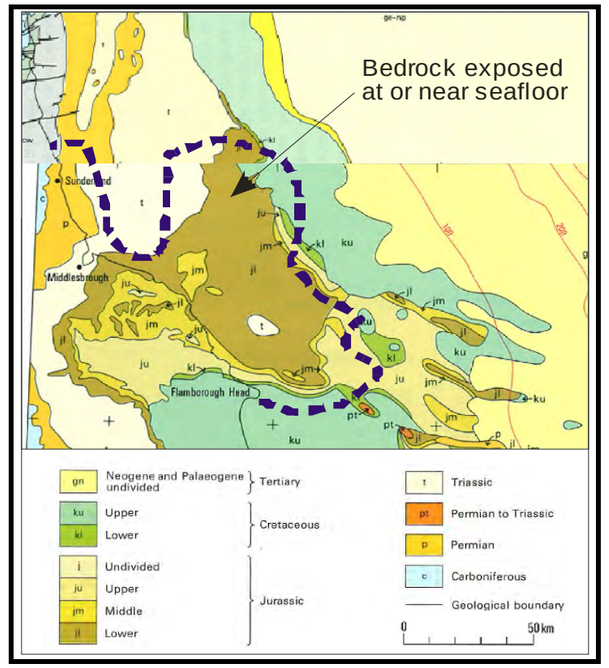


Figure 2.22: Generalised bedrock geology exposed at or near the sea bed across the Offshore Cable Area (modified from Gatliff *et al*., 1994 and Cameron *et al*., 1992). IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

The bedrock runs in narrow (<5 km) east-west orientated bands, exposing Upper Cretaceous units in the south below Reighton Gap through to Upper Jurassic strata at Gristhorpe (Figure 2.22). From Gristhorpe, Middle Jurassic beds extend offshore and follow the coastline north to Robin Hoods Bay in a thin (<5 km) arcuate band.

North of Robin Hood Bay a faulted block of Middle Jurassic strata offshore is enclosed by Lower Jurassic beds, which extend along the coast to Tees Bay and offshore to the east. The eastern margin of the bedrock outcropping at the seabed again exposes thin (<5 km thick) bands of older Jurassic and Cretaceous strata due to structural folding of the bedrock.

From Tees Bay to Hartlepool, Triassic beds outcrop along the coast extending offshore to the east. North of Hartlepool Upper

Permian carbonates extend in a broad band along the coast extending offshore for up to 20 km where they come in contact with Triassic beds that continue east and north.

The lithology of these strata, which could be encountered at or near the seabed, is briefly described below.

- Upper Cretaceous Strata: Chalk, fine grained thickly bedded WEAK to locally STRONG pure limestone with occasional nodular beds and hard grounds (S_u: 50 – 250 kPa weathered to UCS 1.25 – 50 MPa unweathered);
- Lower Cretaceous strata: glauconitic calcareous sandstone and limestone underlain by variably calcareous mudstones and shales with occasional sandstone and siltstone horizons, underlain by largely uncemented (VERY DENSE) sands with some localised and patchy calcareous cementation. (UCS: 5 MPa - 50+ MPa);
- Upper Jurassic Strata: Kimmeridge Clay, a dark locally shaley mudstone with occasional layers of cementstone and Corallian strata composed of MODERATELY WEAK to STRONG calcareous sandstones and sandy, oolitic and reef limestones with occasional chert bands (UCS: 500 kPa – 15 MPa);
- Middle Jurassic strata: interbedded marine, MODERATELY STRONG sandstones and WEAK to MODERATELY STRONG mudstones with oolitic and bioclastic limestones;
- Lower Jurassic Strata: predominantly WEAK to MODERATELY STRONG mudstones with MODERATELY STRONG to STRONG limestones (UCS: 70 kPa where weathered to +1 MPa);
- Triassic Strata: Continental mudstone facies with sandstones and thin beds of dolomite, anhydrite sandstone and widespread halite; and
- Upper Permian Strata: predominantly evaporites with carbonates and anhydrites at the base and grading to halite and anhydrite deposits above. Lateral shift to marine carbonate facies offshore.

2.8 Halokinesis

The North Sea has been an area of active subsidence since the Pliocene and combined with global sea level fluctuations associated with climatic changes during the Quaternary means that there have been dramatic changes in the geometry and morphology of the North Sea seafloor. However, in the southern part of the Dogger Bank between 53° 50'N and 54°30'N salt movement has also had a local effect. A series of synclines and anticlines have developed within the Pleistocene deposits due to salt movement (known as halokinesis) in the deeper bedrock.

Previous interpretations as to how and why the Dogger Fault Zone and Dowsing Fault system, (Figure 2.23), that encircle the area to the south of Dogger Bank area, evolved include differential loading and centrifugal salt migration towards the basin margins, with the fault zone developing as salt withdrew into shelf parallel diapers (Jenyon, 1985), and as a Jurassic extensional graben (Cameron *et al*., 1992). However, Griffiths *et al*. (1995) have an alternative hypothesis, again centred around movement of salt linked to the development of the Hardegsen unconformity.

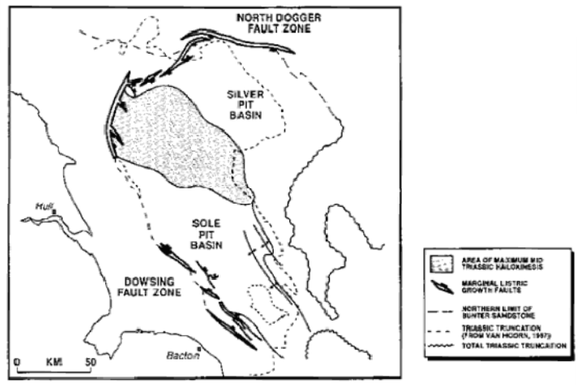


Figure 2.23: Generalised bedrock geology exposed at or near the sea bed.

2.9 Seismic Hazard

The North Sea is an epicentre for periodic seismic events. The area of the Sole Pit Basin, to the south of the Dogger Bank Zone, is the major seismic centre of the southern North Sea (HSE 2002) and the Dogger Bank earthquake of 1931 is recorded to have had its epicentre in this area. It is understood that the cause of this was the collapse of a salt dome and although more events with this origin are possible the frequency and likely magnitude are not determinable. Magnitude 5 Ms and 4 Ms events have been recorded in 1900 and 1950 respectively (where Ms is the logarithm of the surface rayleigh wave magnitude which equates to the intensity IV-VI on the modified Mercalli scale) (HSE 2002) (Figure 2.24).

The seismic activity in this area is generally attributed to the South Hewitt Fault, and other faults within the Indefatigable area, to the south of the Dogger Bank Zone. Movement on this fault is observed to have cut Pleistocene deposits. Observed down-faulting of up to 15 m of sediments is thought to be pre-Eemian. This fault is a major structure in the Mesozoic strata with a down throw to the south-west (HSE, 2002). Displacement has not however been observed to extend to post Eemian sediments.

Maps of contoured ground acceleration for the North Sea are shown in Figure 2.25 and illustrate the maximum expected ground accelerations for a 10,000 year event. Maximum ground accelerations for the 100 year event are interpreted to be between 0.1 and 0.16 m/s^2. For the 10,000 year event ground accelerations are between 0.8 and 1 m/s^2 (HSE, 2002).

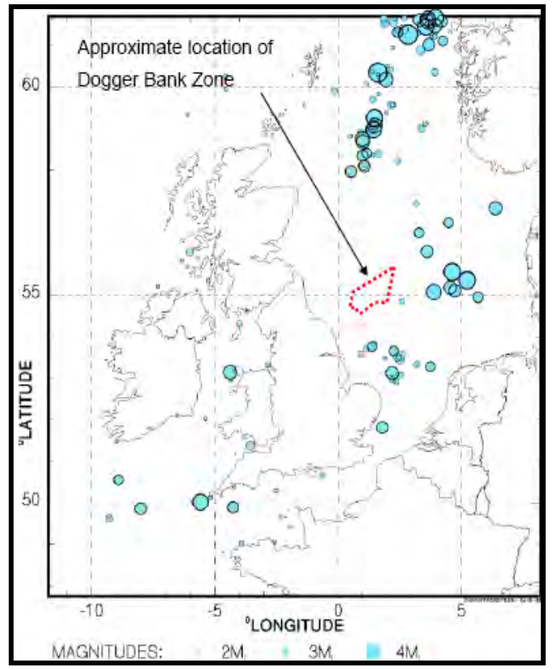


Figure 2.24: Magnitude of events and epicentres in the UK and in coastal waters (after HSE, 2002) 1990-1996, Magnitude >2 M.

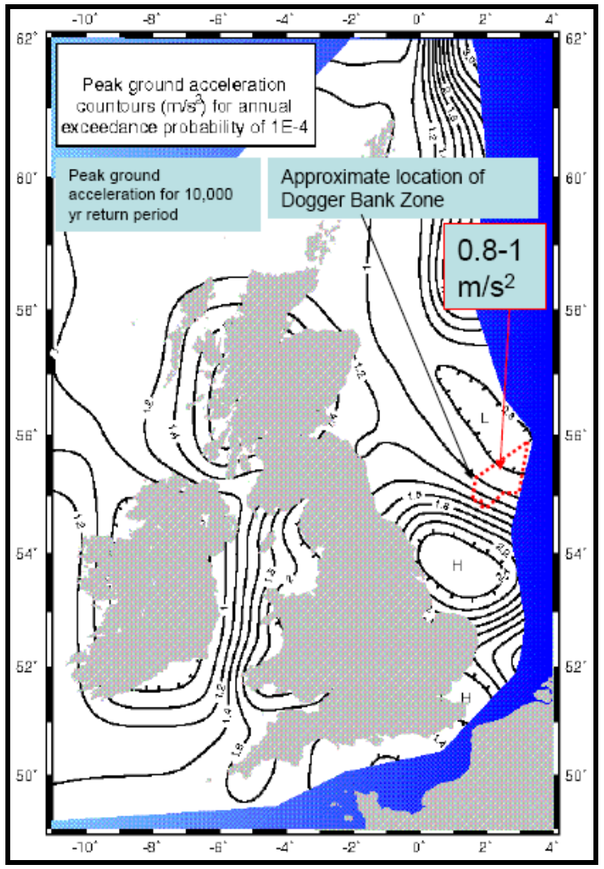


Figure 2.25: Diagrams of peak ground accelerations for a 10,000 year event, Accelerations highlighted are in the approximate area of the Dogger Bank zone. (after HSE, 2002).

2.10 Geology of the top 50 m of the Dogger Bank Zone

The Dogger Bank Zone has been split into areas where broadly similar geological characteristics are interpreted to be present (Chart 4, page 27).

Area 1

Area 1 relates to areas that generally have a thicker sand covering glacial and interglacial sediments that form the Dogger Bank. Two areas are identified on Chart 4 (page 27) along the western margin of the Dogger Bank Zone, and a larger area in the southwestern corner of the Dogger Bank Zone where thicker sand deposits are generally more prevalent at the surface and interpreted to be underlain by the Dogger Bank Formation (Chart 4, page 27).

Area 2

Area 2 occurs in discrete groups over the central part of the south of the Dogger Bank Zone and the east of the Dogger Bank Zone (Chart 4, page 27) where shallower channels (generally <30 m) with parallel bedded infill sediments are present. The channel-fill material in the southern-central and eastern parts of the Dogger Bank Zone may be potentially soft soil related to the Botney Cut Formation. The parallel bedded channel fill associated with the area in the south and east of the site will require further investigation to ascertain the nature of the materials present.

Area 3

Area 3 covers the northern borders of the Dogger Bank Zone and bounds the regions where deeper channels are more prevalent. The deeper channels (up to 150 m) are interpreted from seismic records to have a variety of infilling material, some of which is analogous to the Botney Cut Formation. This material may comprise soft to firm clay in the upper units. There are multiple deep channels located in the northern and western parts of the Dogger Bank Zone. The soil conditions and extent of the channel features will need to be accurately investigated to enable the 3D geological model to be accurately developed to optimise future work.

Area 4

Area 4 constitutes the largest area of the Dogger Bank Zone and is dominated by chaotic reflectors which show multiple erosional surfaces but where deeper channels and parallel bedded fill is generally less prevalent. The area with least interpreted variation across the site, based on available BGS data, is in the central region in the Dogger Bank Zone, stretching from east northeast to west southwest and across the southwestern corner. This area is interpreted to avoid the parallel bedded channel fill to the south and the larger channels located in the north of the Dogger Bank Zone. This area of the Dogger Bank is interpreted to show significant channelling and may be composed of material with a range of geotechnical properties possibly similar to that of the surrounding material. Sediments analogous to the Botney Cut Formation are not interpreted to be prevalent and deeper channels are less common.

2.11 Shallow Geology of the Offshore ZDE

The entire Offshore ZDE (Dogger Bank Zone and Offshore Cable Area) has also been divided into areas with similar shallow geological characteristics, to approximately 5 m depth (Chart 9, page 32). Each area is considered under one section, due to the interpreted general similarities in ground conditions.

Area A

Area A consists of areas where bedrock is interpreted to outcrop at or near the surface (Chart 9, page 32; Figure 2.26). Generally the bedrock exposure occurs as a band in the northwest with proximity to the Yorkshire coast and along the Norfolk coast to the south. Small areas up to 10 km in extent occur seaward of the main band, and an elongate north-south orientated exposure is present offshore from The Wash. Holocene sediments, typically gravel or sand rich, form a thin veneer (<1 m) on top of bedrock of varying strengths (see Section 2.7 for details).

Area B

This area covers the Offshore Cable Area as it approaches the coast to the southwest of the Dogger Bank Zone. It is characterised by gravel sediments, which dominate, and can be mantled by sand ribbons, sand streaks and rare sandwaves. The gravel is interpreted to be <1 m thick and underlain by the generally stiff to hard Boulders Bank Formation (glacial clay).

Area C

Characterised by large sandbanks and active sand waves, this zone generally occurs through the centre of the cable zone (e.g. Sand Hills and Norfolk Banks; Figure 2.9 and Figure 2.26). There is potential for high sand mobility associated with actively migrating sand waves in the area. There is some variation in the underlying Quaternary geology in Area C. Such an area occurs in the Outer Silver Pit area where Markham's Hole Formation outcrops adjacent to Swarte Bank Formation beneath active sank banks.

Area D

This area is characterised by large sandbanks and sand waves, some of which are no longer considered to be active, e.g. East Bank Ridges to the west of Dogger Bank. The sandbanks are locally underlain by firm to stiff clay of the Botney Cut Formation, but mostly stiff to hard glacial clay of the Dogger Bank Formation and possible interbedded sand and stiff to hard clay of the

Yarmouth Roads Formation. These formations have different strengths and densities.

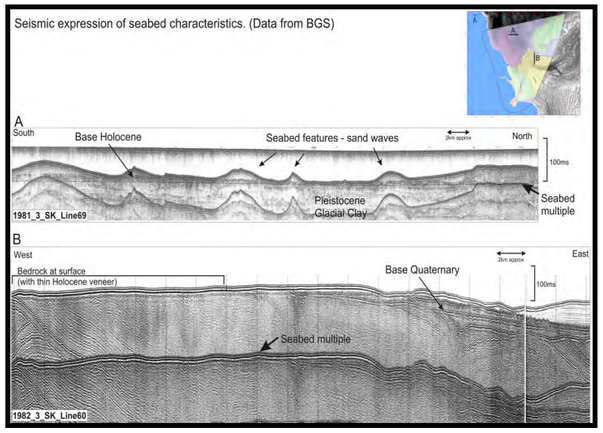


Figure 2.26: Seismic expression of seabed and sub seafloor characteristics that may be encountered by trenching. (Geophysical data from BGS).

Area E

This area is largely confined to the Dogger Bank Zone, where the Dogger Bank Formation is incised by unmapped late Pleistocene channels. The channels cut through stiff glacial clay and may be filled with sand or soft to firm or stiff clay. These channels have not previously been mapped and as such are poorly defined. Consequently, the interpretation of their extent across the area will continue throughout the zone appraisal process as site-specific data becomes available. The sequence is overlain by a thin (~1 m) cover of sand and slightly gravelly to gravelly sand.

Shore approaches

The Wash and Humber Estuary

The Wash and Humber Estuary (Area F on Chart 9, page 32) are characterised by intertidal mudflats where a thick deposit (up to 30 m and 15 m respectively) of Holocene estuarine sandy silt and sandy clay, has accumulated. Fine-grained sand is deposited at the mouth of the estuary, commonly as active sand waves and banks. The large tidal ranges result in numerous tidal channels that meander and migrate across the broad intertidal zone.

Coastal cliffs

Much of the coast is characterised by gently sloping shorelines with sandy beaches. However, there are some sections of the coastline where the local bedrock geology is exposed as a coastal cliff (e.g. sections of the coast between Flamborough Head and Whitby). Certain areas of coastline within the ZDE are particularly prone to coastal erosion processes. It has been estimated that the cliffs along the north Norfolk coast, for example, are retreating at a rate of 0.9 m/year (Clayton, 1989).

2.12 Summary

2.12.1 Dogger Bank Zone

The conclusions of this chapter are based on the integration of previously published data and the revised interpretation of the BGS geophysical data covering the Dogger Bank Zone. The revised interpretation has highlighted the variability of the ground conditions and the prevalence of channel infill deposits across the site. The main conclusions of this initial assessment are:

- The Dogger Bank Zone is dominated by glacial and interglacial soils of varying types and provenance with a surface covering of generally fine sand. The Dogger Bank Formation is present across the Dogger Bank Zone, thinning to the north, and is underlain by varying thicknesses of Cleaver Bank and Egmond Ground Formations. This area is underlain by the Yarmouth Roads Formation to more than 50 m below the seabed;
- Three major phases of channelling are present across the zone: the Botney Cut Formation and the Volans Member of the Dogger Bank Formation are present below the surface sands, cutting the Dogger Bank Formation; and the Swarte Bank Formation is present generally below 40 m below the seabed cutting the Yarmouth Roads Formation. It should be noted however that minor channelling associated with the subaerial exposure and development of palaeochannel surfaces prior to marine inundation may also be present;
- Soils related to channel fill material may be more widespread across the zone than suggested by BGS published data; and
- Most of the Dogger Bank Zone is dominated by what is interpreted to be a heavily channelled Dogger Bank Formation containing multiple erosion surfaces which may result in significant variation in geotechnical properties. Features interpreted to be palaeo-land surfaces have been identified over some parts of the Zone. Possible buried sand wave and sand bank systems, and erosion surfaces may be present.

2.12.2 Offshore Cable Area

The seabed sediments across the Offshore ZDE comprise a mixture of sands, gravelly sands and gravels with clayey sand and gravel more prevalent towards the coast. They form a cover that is typically less than 2 m thick. Thick accumulations of fine to medium grained sand form sand waves and tidal sand ridges up to 35 m high. These elongate features are actively mobile and migrate laterally with the net direction of sand transport to the north.

The morphology of the sea floor is relatively flat but in some areas it has been extensively modified by sediment accretion and erosion. This has resulted in the formation of tidal sand banks, channels and similar features. These and other seabed features can be characterised by steep slope angles (e.g. lee slopes of sand banks up to 12°).

The Holocene seabed sediments are underlain by Pleistocene glacial deposits that are variably characterised by glauconitic, clayey sand; gravelly sands interbedded with silts and clays; and stiff tills and glacial clays. Outcrops of pre-Quaternary bedrock are also interpreted to be present on the shore approaches in the northwest sector of the Offshore ZDE.

Six representative areas have been defined based on similar shallow geological conditions across the Offshore ZDE (Chart 9, page 32). These areas take into account the presence, distribution and type of Holocene seabed sediments, their mobility and the underlying Quaternary and bedrock geology.

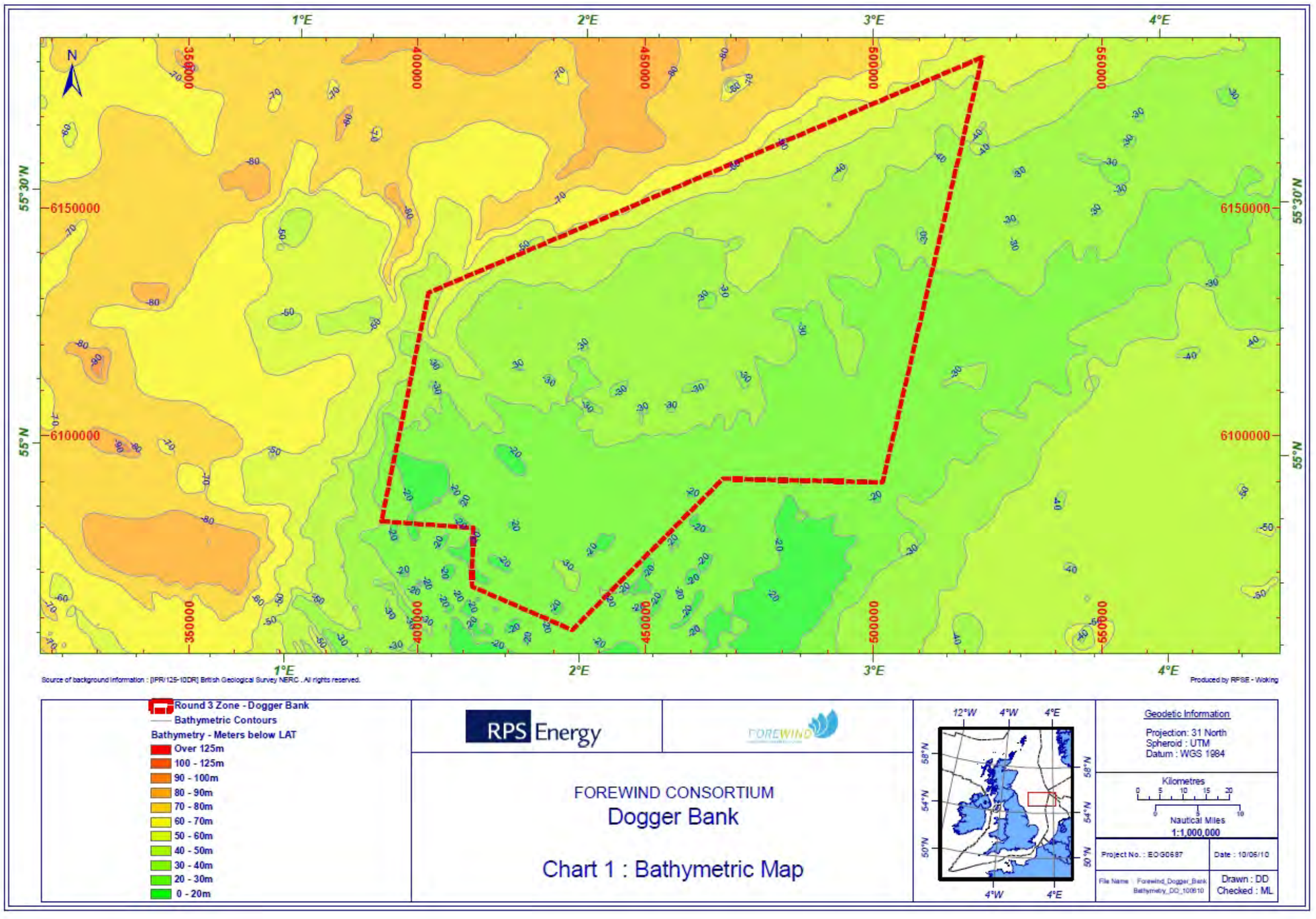


Chart 1: Bathymetric Map. Derived from BGS geological digital data. IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

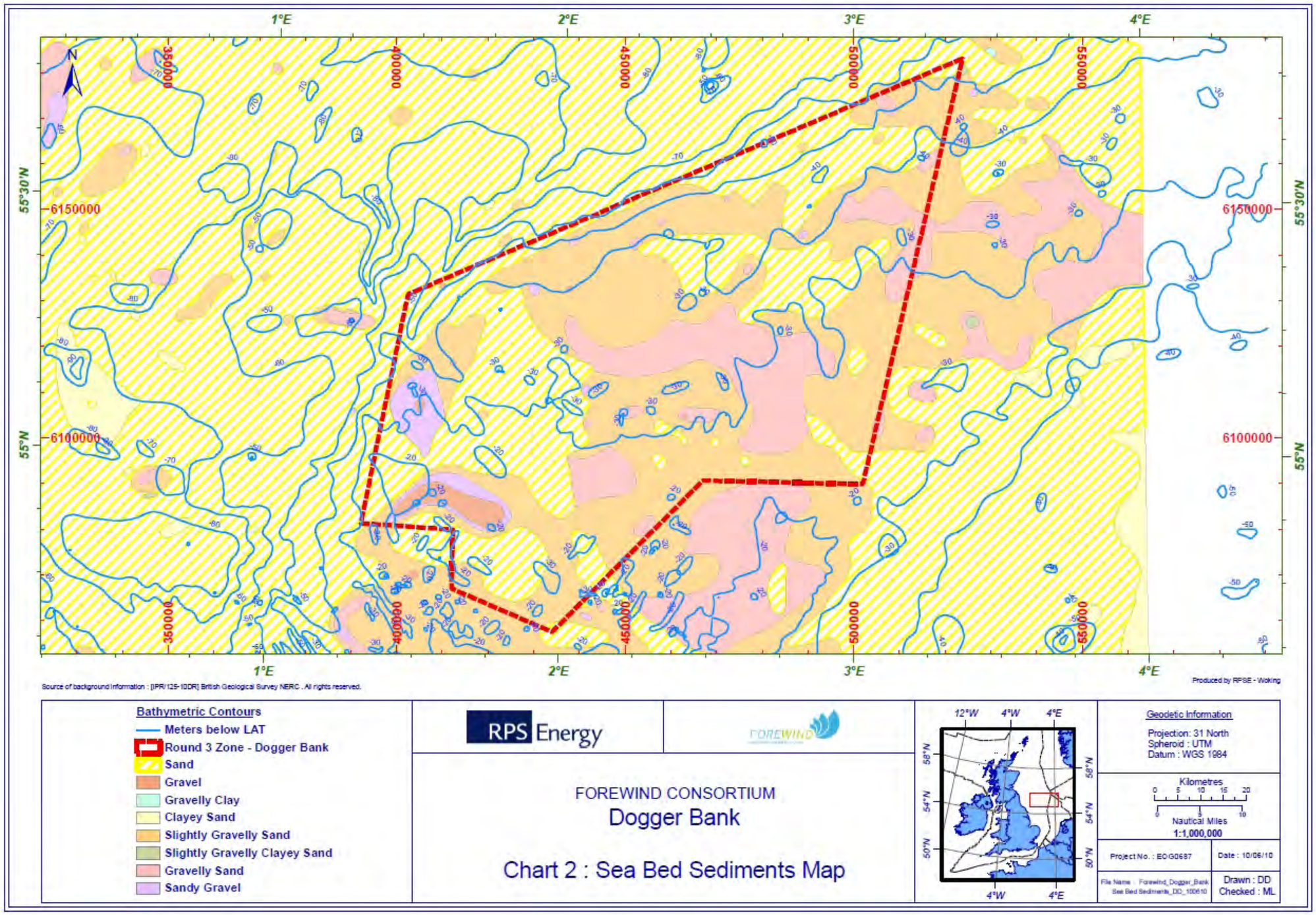


Chart 2: Sea Bed Sediments Map Derived from BGS geological digital data. IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

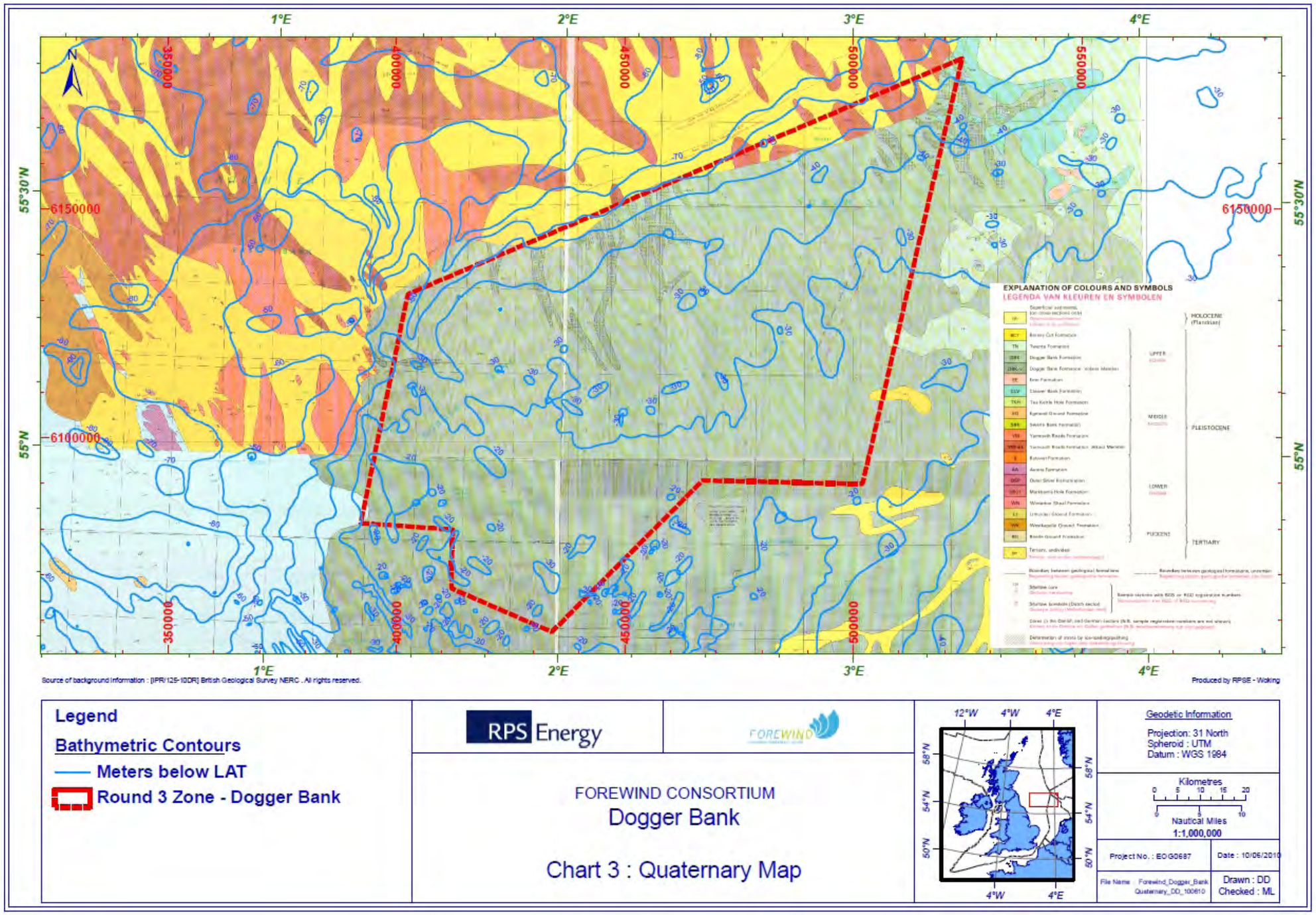


Chart 3: Quaternary map showing the Dogger Bank Round 3 Zone. Derived from BGS geological digital data. IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

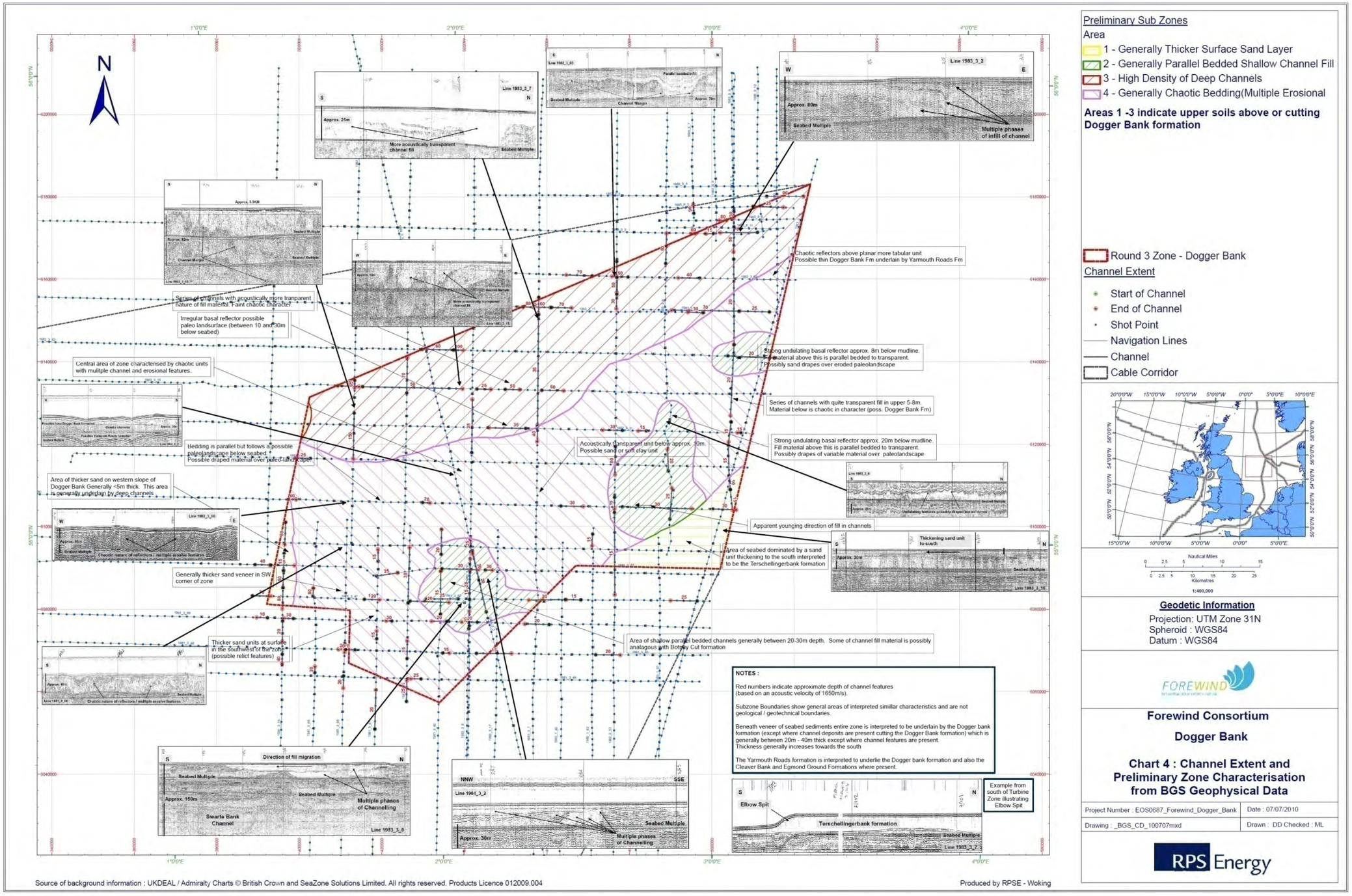


Chart 4: Channel Extent and Preliminary Zone Characterisation from BGS Geophysical Data. Source: UKDEAL/ Admiralty Charts British Crown and SeaZone Solutions Limited. Products Licence 012009.004.

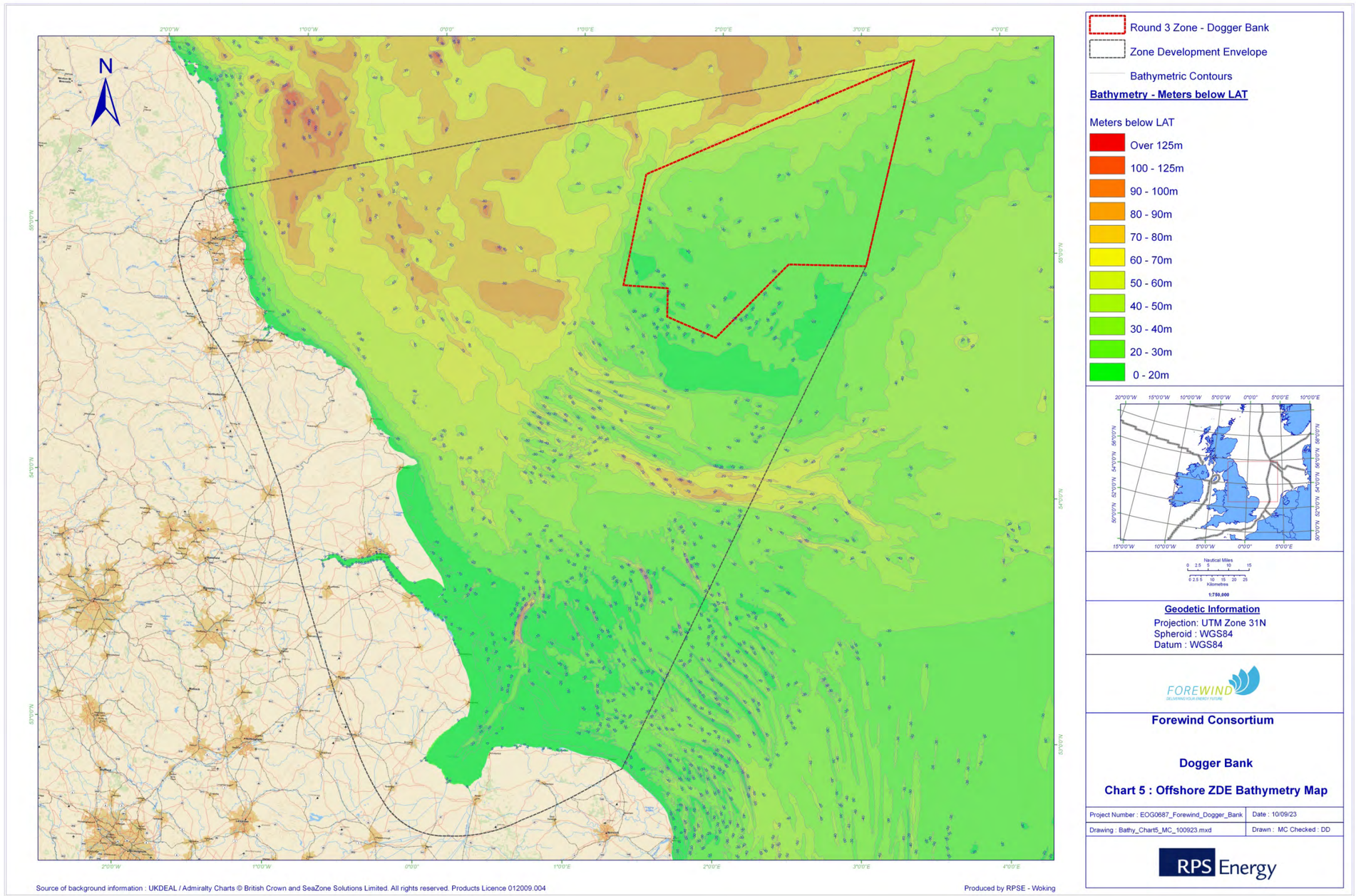


Chart 5: Offshore ZDE Bathymetry. Source:UKDEAL/ Admiralty Charts British Crown and Seazone Solutions Limited. All rights reserved. Products Licence 012009.004.

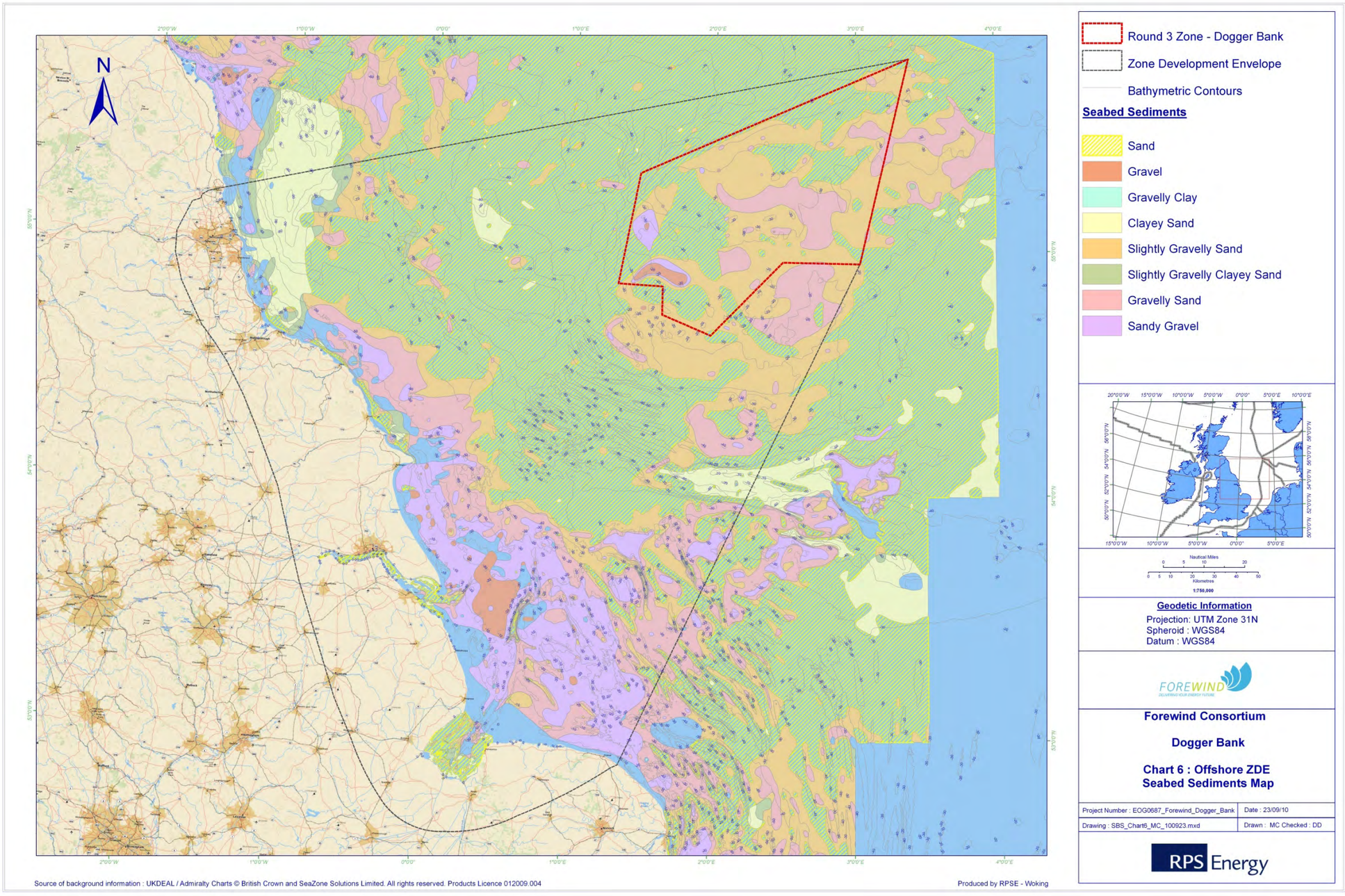


Chart 6: Offshore ZDE Seabed Sediments map. Source: UKDEAL/ Admiralty Charts British Crown and Seazone Solutions Limited. All rights reserved. Products Licence 012009.004.

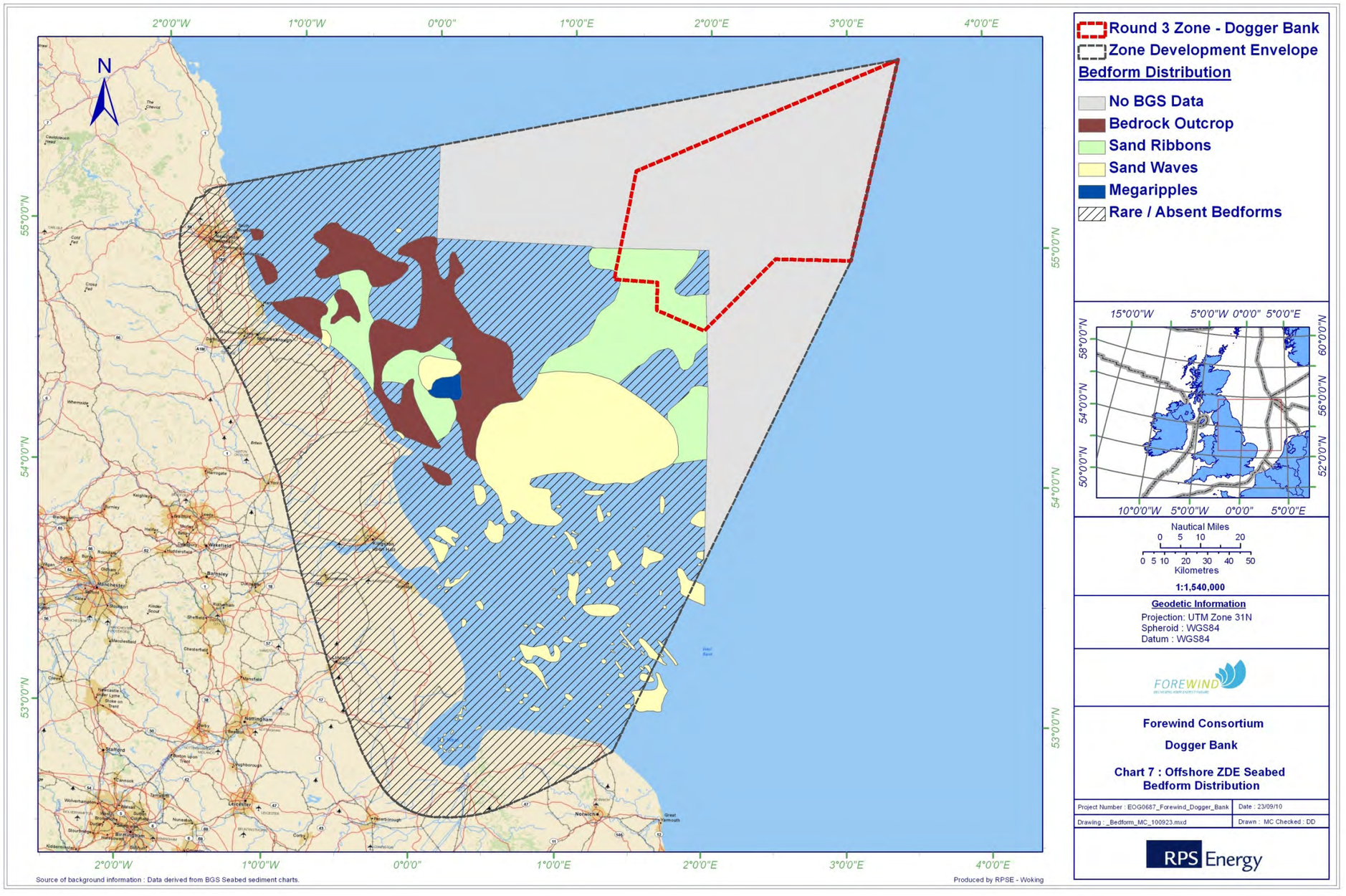


Chart 7: Offshore ZDE Seabed Bedform Distribution. Source: Data derived from BGS Seabed Sediment Charts. Derived from BGS geological digital data. IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

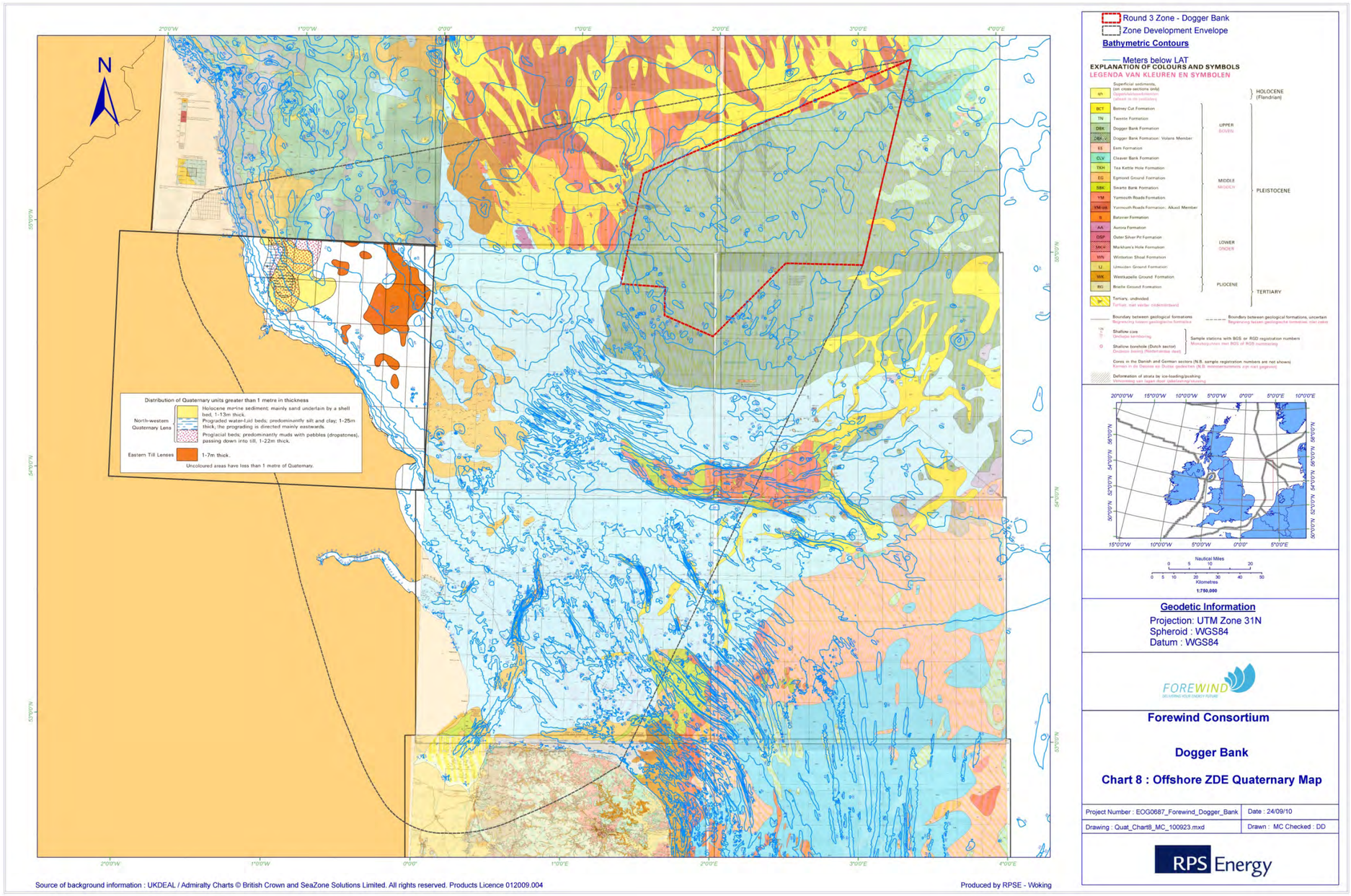


Chart 8: Offshore ZDE Quaternary Map. Source: UKDEAL/ Admiralty Charts British Crown and SeaZone Solutions Limited. All rights reserved. Products Licence 012009.004 Derived from BGS geological data. IPR/141-29C British Geological Survey. © NERC 2008. All rights reserved.

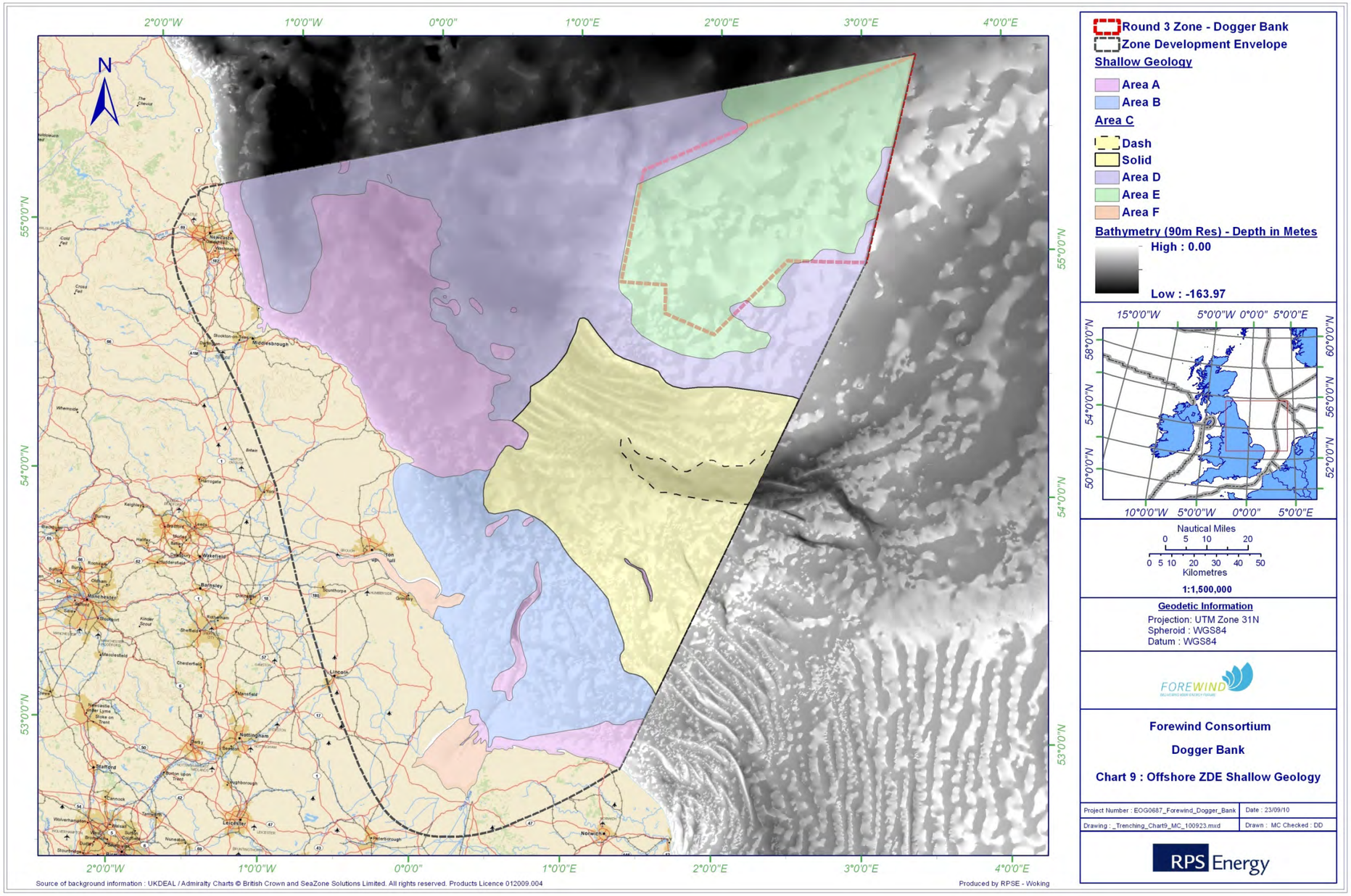


Chart 9: Offshore ZDE Shallow Geology. Source: UKDEAL/ Admiralty Charts British Crown and SeaZone Solutions Limited. All rights reserved. Products Licence 012009.004.

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3. Benthic Ecology

3.1 Introduction

This chapter provides a broad scale characterisation of the benthic ecology in the Offshore Zone Development Envelope (ZDE). The Offshore ZDE can be split into the Dogger Bank Zone and the Offshore Cable Area. This chapter includes a description of the seabed habitats and the macro-invertebrate communities associated with them, their importance in terms of nature conservation and the various physical factors influencing community structure and distribution.

To broadly characterise the benthic ecology of this area, the EUNIS high-level habitat classification for the North Sea was used (see MESH, 2008) (Figure 3.1). Using this data has a number of advantages, namely:

- It is the only large-scale habitat map covering the entire Offshore ZDE and is at an appropriate scale for ZAP;
- It is a Joint Nature Conservation Committee (JNCC) lead initiative and so considered acceptable to the statutory authorities;
- It allows for the large volumes of information and data on benthic ecology to be more meaningfully organised; and
- It provides the context for interpreting the diversity and complexity of ecological knowledge within the Offshore ZDE.

To facilitate researching and the interpretation of benthic data within the Offshore ZDE, four distinct areas were identified by broadly grouping EUNIS habitats as follows (Figure 3.1): (*Note:* these areas do not reclassify EUNIS habitats. Rather they provide a logical framework to organise benthic ecology and add meaning to a complex and patchy knowledge-base).

1. Northeast offshore shallow waters associated with the Dogger Bank;
2. Central and northern deeps;
3. Western coastal shallows; and
4. Southern shallows associated with distinct seabed features.

These areas conform to broadly similar spatial patterns associated with sediment habitats. As noted by many previous benthic studies (including those reviewed as part of this ZoC study and referenced in the following sections) benthic community distribution patterns, composition and conservation status of benthic habitats and species are strongly associated with changes in water depth, sediment type, seabed features and proximity to coastal waters – upon which EUNIS is based (Figure 3.1).

3.2 Data and Literature

A detailed review of published and unpublished literature as well as data extracted from a range of databases was organised into the four search areas described in Section 3.1. Noteworthy papers include (but are not limited too) Glémarec (1973); Künitzer *et al*. (1992); Heip and Craeymeersch (1995); Kröncke and Reiss (2007); Rees *et al*. (2007); Reiss *et al.* (2009) and Diesing *et al.* (2009). A comprehensive list of the sources consulted is provided in the reference section. The benthic habitats and fauna of the Dogger Bank have been extensively investigated and a number of long-term datasets exist (1920-1980's).

Daan and Mulder (2001, 2006) have conducted benthic monitoring using 0.078 m^2 box cores to assess trends in macrobenthos on the Dutch Continental Shelf. One monitoring station falls just within the UK side of the Dogger Bank and within the Zone with a further six stations corresponding to the Dutch sector of the Dogger Bank for which quantitative infaunal data are obtained. Other surveys relevant to the current development have been completed and reported by Aberdeen University Marine Studies Ltd. (1989a, b). These included benthic monitoring surveys using 0.1 m^2 Day grabs to assess benthic conditions pre and immediately post oil drilling with a further survey conducted one year after the cessation of activities to assess benthic recovery.

Whilst the focus of this review has been on broad-scale characterisations, several Environmental Statements (ES) relating to oil and gas development at the Hunter Field (DTi, 2005) and Cavendish (Metoc plc, 2004) (both south of Dogger Bank), and an aggregate application within the wider Humber group of aggregate licences at Area 394 (Entec, 2000) have also been appraised. These provided localised data on benthic habitats to confirm the findings of the wider characterisations.

Databases interrogated include the European Ocean Biogeographic Information System (EurOBIS) available through the MarBEF (Marine Biodiversity and Ecosystem Functioning) network; a snapshot from the JNCC of the Marine Nature Conservation Review (MNCR) database, the UKOOA UK benthos database v3.01 (Oil and Gas UK, 2009) and both the North Sea Benthos Project (NSBP) 2000 and the North Sea Benthos Survey (NSBS) 1986. In several cases, the benthic faunal data have been reprocessed to determine benthic biotopes. Reprocessing was based on a consistent methodology developed by Emu Ltd (see Appendix A).

Detailed benthic surveys were conducted at two discrete areas on the Dogger Bank in support of aggregate extraction applications. These included grab, trawl and seabed video surveys at Northwest Rough (Area 466) (Emu Ltd, 2002) and Southernmost Rough (Area 482) (Emu Ltd, 2005). Data were used to characterise seabed habitats and communities to inform respective ESs.

A multinational, collaborative survey using 2 m beam trawl was conducted in the North Sea in 2000 (Callaway *et al.,* 2002). Examination of samples, which coincide with the Dogger Bank candidate Special Area of Conservation (cSAC), identified three variant and geographically distinct epibenthic communities characterised by the common starfish *Asterias rubens*, sand star *Astropecten irregularis*, hermit crab *Pagurus bernhardus*, brittlestar *Ophuira* spp., green sea urchin *Psammechinus miliaris*, dab *Limanda limanda* and solenette *Buglossidium luteum*. All three community types broadly corresponded with a discrete southern North Sea assemblage of free living epibenthos identified by Jennings *et al.* (1999) in terms of characterising taxa.

Finally, relevant shoreline management plans have been reviewed to assist descriptions of coastal habitats, designated sites and associated actions within potential cable landfall areas.

Further data have been identified for the interpretation of benthic habitats and ecology in the Offshore ZDE and will be considered for the next edition of the ZoC, namely:

- Forewind geophysical/Acoustic Ground Discrimination System (AGDS) survey data;
- The latest JNCC survey data supporting the Dogger Bank possible SAC recommendations (now a cSAC);
- The Outer Humber Regional Environmental Characterisation (REC) (British Geological Survey (BGS), 2011); and

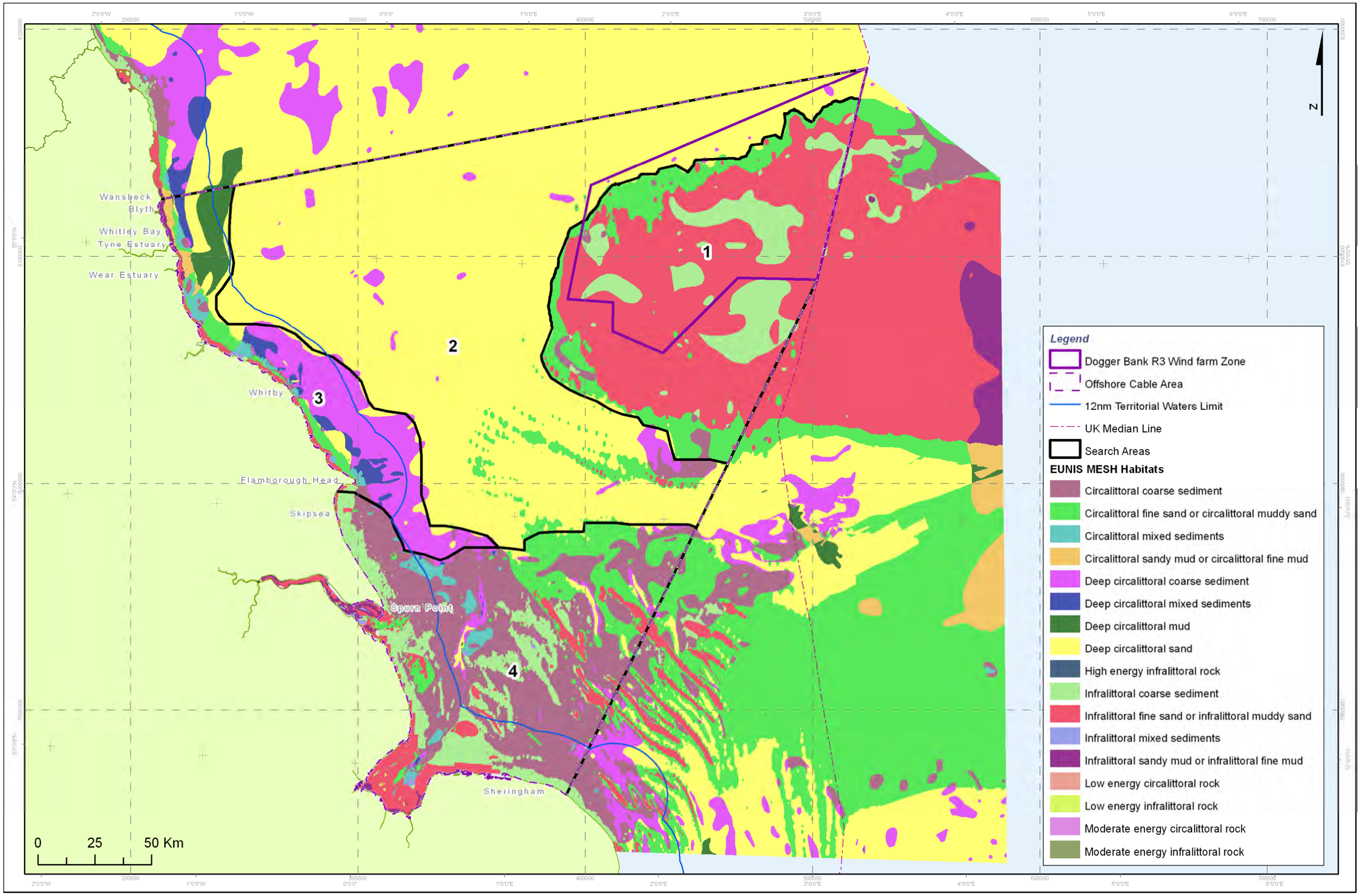


Figure 3.1: EUNIS habitat map for the Dogger Bank Zone and Offshore Cable Area with Search Areas 1-4 indicated.

- Future Marine Conservation Zones (MCZ).

3.2.1 Data limitations

Both infauna and epifauna broad scale survey information is relatively comprehensive, but not recently for the Offshore ZDE as a whole. Benthic ecological knowledge relies largely on point source sampling and cannot, therefore, provide a full picture of the nature of the seabed within the Offshore ZDE. Moreover, species distribution patterns can be variable and may shift seasonally and year on year depending on survivorship and changes in the prevailing physical climatic conditions (see Freeman *et al.,* 2001; Neumann *et al.,* 2008).

Information on the sensitivity of individual species changes with time, so that the Northern hatchet shell *Thyasira gouldi*, for example, while still protected under Schedule 5 of the Wildlife and Countryside Act 1981, has been recommended for removal from that list in the most recent review published by the JNCC (JNCC, 2008a).

3.2.2 Data gaps

There are gaps in the data across the Offshore ZDE, although there is sufficient knowledge to describe the broad-scale distribution patterns of species and habitats within the Offshore ZDE. The ecological functioning of the Dogger Bank is well studied in the scientific literature because of the importance and uniqueness of the area. The degree of importance of areas of habitat such as cobble reef is a growing area of research. Knowledge of the distributions of the sensitive habitats is work-in-progress as exemplified by the recent additions to the Horse-mussel bed map, and the possible location of seapen and burrowing megafauna habitat suggested by Diesing *et al.* (2009). Some records of individual sensitive species are fairly historical - such as for the amphipod crustacean *Allomelita pellucida*, where records in the Wash available through the National Biodiversity Network (NBN) website are from 1985 (NBN 2010c).

3.3 Overview

A number of studies have broadly characterised the North Sea benthos and their associated habitats that fall within the Offshore ZDE (Glémarec's 1973; Kröncke and Reiss, 2007; Rees, *et al.* 2007). The structure and distribution of these benthic communities can be explained largely by the physical variables of seawater temperature, salinity, tidal/wave-induced bed stress, depth, organic input and sediment type. These variables characterise differences between the northern and southern North Sea where, for example, the 50 m contour and a seasonally occurring thermal front (Flamborough Head front) are considered a major dividing line between the heterogeneous infaunal communities of the south and cold water communities of the north (Kröncke and Reiss, 2007). The Dogger Bank Zone falls just within this mixed shallow water contour and so many cold water northern species only occur north of the Bank. The Offshore ZDE is also predominantly within the southern North Sea and contains a variety of benthic community types associated with the strongly thermally-mixed waters resident all year round. Atlantic water from the north meets Channel inflow from the south here and is characterised by an overlap of typical northern and southern benthic communities and habitats.

The benthic ecology within the Offshore ZDE has been broadly characterised by seventeen EUNIS habitat types ranging from 'Deep circalittoral mud' to 'Low energy infralittoral rock' (see Figure 3.1). The northeast offshore shallow waters associated with the Dogger Bank are broadly characterised by 'Infralittoral fine sand' or 'Infralittoral muddy sand', although two other EUNIS classifications are also common, namely, 'Infralittoral coarse sediment' and 'Circalittoral fine sand' or 'Circalittoral muddy sand'. The central and northern deeps are dominated by 'Deep circalittoral sand' and the northwest coastal shallow waters are dominated by 'Deep circalittoral coarse sediment'. By contrast, the coastal waters contain the most diverse habitat types compared with the more offshore areas. The southern shallows are associated with distinct seabed features and are characterised by 'Circalittoral coarse sediment'.

A detailed analysis of the area can be found in Appendix A.

3.4 Benthic Ecology by EUNIS Habitat Area

The following sections describe the different habitats and species found throughout the Offshore ZDE, but divided into four broadly defined EUNIS habitat areas, as shown in Figure 3.1. Each section characterises the habitats and species found within the Dogger Bank Zone and the Offshore Cable Area. This is designed to aid interpretation of the ZoC findings.

3.4.1 Northeast offshore shallow waters associated with the Dogger Bank (Area 1)

Habitats and Communities

The EUNIS habitat classification identifies the following five different types (ordered by the most commonly occurring habitat to the least):

- 'Infralittoral fine sand or infralittoral muddy sand';
- 'Infralittoral coarse sediment';
- 'Circalittoral fine sand or circalittoral muddy sand';
- 'Circalittoral coarse sediment'; and
- 'Deep circalittoral sand'.

The Dogger Bank cSAC boundary covers the majority of the Dogger Bank Zone where the primary habitat interest feature of conservation importance is sandbanks that are slightly covered by sea water all the time. In a European context this feature was found to be Grade A (JNCC, 2010) which means that due to the extent of habitat and its representative communities and sediment type, it is considered of "*excellent conservation value*" by the JNCC (JNCC, 2010). Sand banks in water depths of 20 m or less are protected, although where sand banks extend below 20 m these are included because they are integral to the interest feature and it's Grade A designation (JNCC 2010).

The dominant biotope associated with the Dogger Bank is SS.SSa.IFiSa.NcirBat - *Nephtys cirro*sa and *Bathyporeia* spp. in infralittoral sand (see Appendix A). The biotope is thought to cover the majority of the Dogger Bank Zone which may also include areas comprising more mixed sediment types based on habitat maps published in Diesing, *et al.* 2009 as well as the EUNIS map, Figure 3.1). MarLIN (Budd, 2008) indicates with 'moderate' confidence that the sensitivity of this biotope to physical disturbance is 'very low'. MarLIN defines moderate confidence as an assessment which 'has been derived from sources that consider the likely effects of a particular factor on a species or biotope' as opposed to more generic evidence (low confidence) or more specific evidence including experimental work (high confidence). In shallow and mobile sand communities, the fauna are adapted to natural sediment disturbance and mobility and are characterized by highly fecund, short lived species capable of rapid recovery once the disturbance has abated. This community type corresponds well with the 'Bank' community described by Wieking

and Krönke (2001) which occupies the flat shallow seabed areas on top of the Dogger Bank and overlaps central and southern areas of the Dogger Bank Zone.

At greater depths, these typical sand fauna are replaced by species better adapted to living in more silty locations such as the bivalve mollusc *Fabulina fabula* and the polychaete worm *Magelona mirabilis.* Habitats in the deepest locations on the edge of the bank are inhabited by species such as the brittlestar *Amphiura filiformis* and the bivalve *Mysella bidentata*. Wieking and Krönke (2001) distinguished a "Northeastern Community" broadly coincident with the northern flanks for the Dogger Bank and northern areas of the Zone. This community type was regarded as a transitional association where the *Bathyporeia-Fabulina* assemblage from the top of the bank moves into the *Amphiura* assemblage of deeper waters.

Mixed heterogeneous substrates, where they occur, also support elevated diversity owing to the greater availability of micro-niches (Emu Ltd. 2002, 2005). The gravelly sand substrates in the northwestern region of the bank support the polychaetes, *Glycera lapidum, Chone duneri, Aonides paucibranchiata, Nereis longissima* and *Pholoe balthica* (Emu Ltd., 2002, 2005). Isolated patches of mixed coarse sandy gravel and cobble substrata at the northwest of the Dogger Bank supported the epifaunal brittlestar, *Ophiothrix fragilis* (SS.SMx.CMx.OphMx) which occurred in densities of up to 1,300 individuals/m^2 (Emu Ltd, 2002).

These types of communities can be considered illustrative of the UK BAP habitat 'Subtidal sands and gravels' (Table 3.1 and Appendix A). This is the most common habitat found below the level of the lowest low tide around the coast of the United Kingdom (UK BAP, 2008). It occurs in a range of environmental conditions, and the mix of sand or gravel, and any bedforms present on the surface of the seabed, depends on factors such as the strength of the waves and tides. The Annex I habitat 'Sandbanks which are slightly covered by sea water all the time' corresponds with this UK BAP habitat. Offshore sand and gravel seascapes are important nursery grounds for the young of commercial fish species such as flatfish, bass, skates, and rays as well as sharks (Natural England, 2010L). A useful map of these habitat types has been drawn by the Marine Conservation Zone (MCZ) Project (Natural England 2010L, MCZ, 2010).

Northern areas, below the 30 m contour, were characterised by the green sea urchin, hermit crabs and infaunal brittlestars *Ophiura* spp. Northwest and western flank areas of the Dogger Bank were characterised by sand star, dab, common starfish, flying crab *Liocarcinus holsatus* and hermit crabs Paguridae. Shallow central and southeastern areas were dominated by Solenette, common starfish, sand star and hermit crabs. Abundant sand gobies *Pomatoschistus minutus* were recorded over the southeastern flank areas of the bank.

Site specific 2 m trawl sampling and seabed video surveying at North West Rough and Southernmost Rough (Emu Ltd. 2002, 2005) identified commonly occurring epibenthic species within the boundaries of the Dogger Bank cSAC. These included the soft coral, dead man's fingers *Alcyonium digitatum*, hermit crabs *Pagurus bernhardus*, the flying crab, the sand star, common starfish and the dab consistent with the wider array sampling completed by Callaway, *et al.* (2002) and Jennings, *et al.* (1999). Other widely recorded species during the site specific surveys included the long-clawed porcelain crab *Pisidia longicornis*, common whelk *Buccinum undatum*, the green sea urchin, dragonet *Callionymus lyra* and gobies.

Species of Conservation Importance

Detailed information on protected species is presented in Appendix A. There are two protected benthic species with records in this area, namely the Northern hatchet shell and the ocean quahog *Arctica islandica*.

The Ocean Quahog is a large bivalve mollusc found buried in sediment on sandy and muddy sand from the low intertidal down to 400 m. It is a long-lived species with a very slow growth rate. Populations including 40-80 year old specimens have been observed as well as a substantial proportion of individuals over 100 years old (OSPAR, 2008). It is listed by OSPAR as a threatened/declining species for the greater North Sea. Past records show that it has been found in at least ten locations within the Dogger Bank Zone and that most of these are in the northeast quadrant with only two records, widely spaced apart in the south of the Zone (EurOBIS, 2010). Benthic surveys at aggregate sites (Emu Ltd., 2002, 2005) did not identify this species at Northwest Rough or Southernmost Rough.

The Northern hatchet shell is protected under Schedule 5 of the Wildlife and Countryside Act (WCA) 1981. Using data supplied by the NBN Gateway (and also available through the EurOBIS website, 2010) two records of this mollusc, from 1991, where found

Habitat	OSPAR	UK BAP	Habitats Directive	Area in ZDE
Blue mussel beds	✓	✓	✓	3, 4
Coastal saltmarsh		✓	✓	3, 4
Estuarine Rocky Habitats		✓	✓	3, 4
Horse mussel beds	✓	✓	✓	3
Intertidal mudflats	✓	✓	✓	3, 4
Intertidal Underboulder Communities		✓	✓	3
Littoral Chalk Communities	✓	✓	✓	3, 4
Peat and clay exposures		✓	✓	4
Sabellaria spinulosa reefs	✓	✓	✓	3, 4
Saline lagoons		✓	✓	3, 4
Seagrass beds	✓	✓	✓	4
Seapen and burrowing megafauna	✓	✓	✓	2, 3
Sheltered Muddy Gravels		✓	✓	3
Subtidal Chalk Communities		✓	✓	3
Subtidal sands and gravels		✓	✓	1, 2, 3, 4
Tide-swept channels		✓	✓	3

Table 3.1 Occurrence of UK BAP and OSPAR habitats in the Offshore ZDE Areas and the associated designation information as indicated by UK BAP, 2008.

from surveys carried out in the Murdoch Field on the southern boundary of the Dogger Bank cSAC and within the Offshore ZDE (UKOOA database v3.01 (Oil and Gas UK, 2009)). The 5th Quinquennial review of Schedule 5 and 8 of the WCA 1981 carried out by the JNCC (2008a) recommended the removal of the Northern Hatchet Shell from Schedule 5. The recommendation was based on Killeen and Oliver (2002) who noted, '*T. gouldi* is not recorded from the open North Sea and appears to be confined to inlets and sea lochs'. Old records, such as those in the Offshore ZDE, from the open North Sea are therefore questionable. However it should be noted that currently the species remains in the conservation designations spreadsheet published by the JNCC which indicates it is still protected under Schedule 5 (JNCC, 2010c).

3.4.2 Central and northern deeps (Area 2)

Habitats and Communities

The predicted EUNIS habitats recorded include (ordered by the most commonly occurring habitat to the least):

- 'Deep circalittoral sand';
- 'Circalittoral fine sand or circalittoral muddy sand';
- 'Deep circalittoral coarse sediment'; and
- 'Circalittoral coarse sediment'.

In the deeper waters along the northern edge of the Dogger Bank Zone, sea pens occur in association with the circalittoral fine sand / muddy sand habitats (Deising *et al.,* 2009). In these areas burrowing fauna communities and mounds (produced by the fauna) are prominent features on the fine mud seabed. Typically, these areas support conspicuous populations of the seapens *Virgularia mirabilis* and *Pennatula phosphorea* (UKBAP, 2008). The associated burrowing fauna includes crustaceans such as Norway lobster *Nephrops norvegicus* and the mud-shrimps *Callianassa subterranea* and *Calocaris macandreae*. However, the status of these communities has not yet been confirmed and the OSPAR distributional map does not currently record the presence of this community type within the Offshore ZDE (see Appendix A). Yet, Diesing *et al.* (2009) recorded that the deep (>55 m) muddy sand and sandy mud communities with burrowing fauna and *P. phosphorea* were found at the northern margin of the Dogger Bank.

The EurOBIS (2010) database supports this observation showing a record of *P. phosphorea* in the northwest of the Dogger Bank Zone as well as the Norway lobster. It also has a record of *C. subterranea* in the northeast of the Zone.

This habitat is on the OSPAR list of threatened and/or declining species and habitats as 'seapen and burrowing megafauna'. Furthermore, it provides an important nursery area for a number of fish including hake *Merluccius merluccius*, which is a UK BAP priority species (OSPAR, 2010a). In addition to being on the OSPAR list this community is also a UK BAP priority habitat called, 'mud habitats in deep water' (Table 3.1 and Appendix A).

Deep circalittoral sand (or in JNCC terms, 'offshore circalittoral sand') dominates the EUNIS habitat classification for the central and northern deeps. Deep circalittoral coarse sediment (offshore coarse sediment) and Circalittoral fine sand / Circalittoral muddy sand also contribute to this area. All three of these are biotopes listed under the UK BAP habitat subtidal sand and gravels (UK BAP, 2008). Subtidal sands and gravels have also been mapped as points in Area 2 by the MCZ project (MCZ, 2010).

Species of Conservation Importance

Protected species present here include the large long-lived bivalve the ocean quahog and the Northern hatchet shell. Both species have been recorded from the Murdoch field in the Offshore Cable Area in 1991 and the former, additionally, has also been recorded just south of the southern edge of the Dogger Bank cSAC, between the Dogger Bank Zone and the offshore Cable Area boundary to the north and off the Durham coast (Appendix A).

3.4.3 Western coastal shallows (Area 3)

Habitats and Communities

The predicted EUNIS habitats recorded include (ordered by the most commonly occurring habitat to the least):

- 'Deep circalittoral coarse sediment';
- 'Deep circalittoral sand';
- 'Deep circalittoral mud';
- 'Deep circalittoral mixed sediments';
- 'Infralittoral fine sand or infralittoral muddy sand';
- 'Circalittoral fine sand or circalittoral muddy sand';
- 'Circalittoral mixed sediments';
- 'Circalittoral sandy mud or circalittoral fine mud';
- 'Circalittoral coarse sediment';
- 'Infralittoral sandy mud or infralittoral fine mud'; and
- 'Low energy infralittoral rock'.

For more information on the habitats presented here, see Appendix A. For a summary of those habitats with UK BAP and OSPAR designations see Table 3.1.

The OSPAR designated habitat 'seapen and burrowing megafauna' is not recorded in the habitat map produced by the NBN mapper, which covers the Offshore ZDE (NBN OSPAR, 2010). However the EurOBIS database does have records of the seapen *P. phosphorea* and Norway lobster *N. norvegicus* co-occurring at two sites in the north of this area offshore of Sunderland and the Tyne which may indicate a possible seapen habitat.

Intertidal mudflats occur at Wansbeck, Blyth, Tyne and Wear, and the Tees. These habitats are highly productive areas which support large numbers of birds and fish. They provide feeding and resting areas for internationally important populations of migrant and wintering waterfowl, and during neap low tides provide the only readily available food source. They are nursery areas for fish such as plaice and dab (Elliott *et al.,* 1998 and UK BAP, 2008).

The importance of mudflats is recognised through their designation as Annex I habitat under the Habitats Directive, 'mudflats and sandflats not covered by seawater at low tide' (though no SAC's with this as an interest feature are found in the western coastal shallows area (JNCC, 2010d)). They are also protected under the Birds Directive as on the Tees estuary and they can be an important feature in estuary Sites of Special Scientific Interest, under the UK Wildlife and Countryside Act 1981. Furthermore mudflats are a UK BAP priority habitat and on the OSPAR List of Threatened and/or Declining Species and Habitats.

Littoral chalk communities are found at Flamborough Head and comprise horizontal ledges, vertical walls, broken rock and boulder fields, which extend from the intertidal rocky shores up to 6 km offshore into waters 30 m or more in depth (Flamborough Head Management Plan, 2007). These features are on the OSPAR list

of threatened and/or declining species and habitats and are also listed as a UK BAP priority habitat (UK BAP, 2008). This habitat is also found in Annex I of the Habitats Directive under 'submerged or partially submerged caves & reefs' (Natural England, 2010b).

Subtidal chalk communities, such as those found at Flamborough Head, have a unique characteristic in contrast to many harder rocky coasts of western and northern Britain i.e. the geomorphological structure which, because of sub-aerial and marine erosion, results in vertical cliff faces that abut an extensive foreshore (a wave eroded platform) often extending several hundreds of metres seawards. This is of significance in the formation of subtidal chalk sea cave and reef habitats and the occurrence of the associated communities / biotopes (Tittley *et al*., 1998 in UK BAP, 2008).

'Horse mussel *Modiolus modiolus* beds' are similarly listed on the OSPAR list (Appendix A) and have been recorded off Flamborough Head. The more recent map published by OSPAR (2010d) shows a second bed to the north on the North Yorkshire coast. Horse mussel beds occur at depths of up to 70 m (but may extend onto the lower shore), mostly in fully saline conditions and often in tide-swept areas. Although horse mussels are a widespread and common species, horse mussel beds (with typically 30% cover or more) are more limited in their distribution. These beds are found on a range of substrata, from cobbles through to muddy gravels and sands, where they tend to have a stabilising effect, due to the production of byssal threads (OSPAR, 2010d).

In addition to being on the OSPAR List of Threatened and/or Declining Species and Habitats this is also a UK BAP priority habitat listed as 'Horse mussel beds' (UK BAP, 2008). Horse Mussel beds can also be key features of habitats listed in Annex I of the Habitats Directive (Natural England, 2010c).

Blue mussel *Mytilus edulis* beds have a particularly important role where they occur on soft seabeds, as they provide a hard surface in otherwise muddy or sandy areas. This attracts and supports a greater range of marine life than would otherwise be found there. 133 different animals and plants have been recorded in blue mussel beds, including seaweeds, anemones, barnacles, sea snails, crabs, starfish and worms (Natural England, 2010f). Blue mussels are widespread on the shore and in shallow water around the coasts of the UK and Europe.

Significant beds of blue mussels on soft sea beds are found in scattered locations within this broad range (Natural England, 2010f). In Area 3 these beds have been recorded in 4 locations according to the MCZ project based on JNCC MNCR data (MCZ, 2010).

These are the on the Blyth, Tees and Esk estuaries, and at Fylingthorpe. Although also listed by OSPAR as a threatened/declining habitat the distribution map produced through the NBN hosted website does not indicate its presence anywhere in the Offshore ZDE (OSPAR, 2010f).

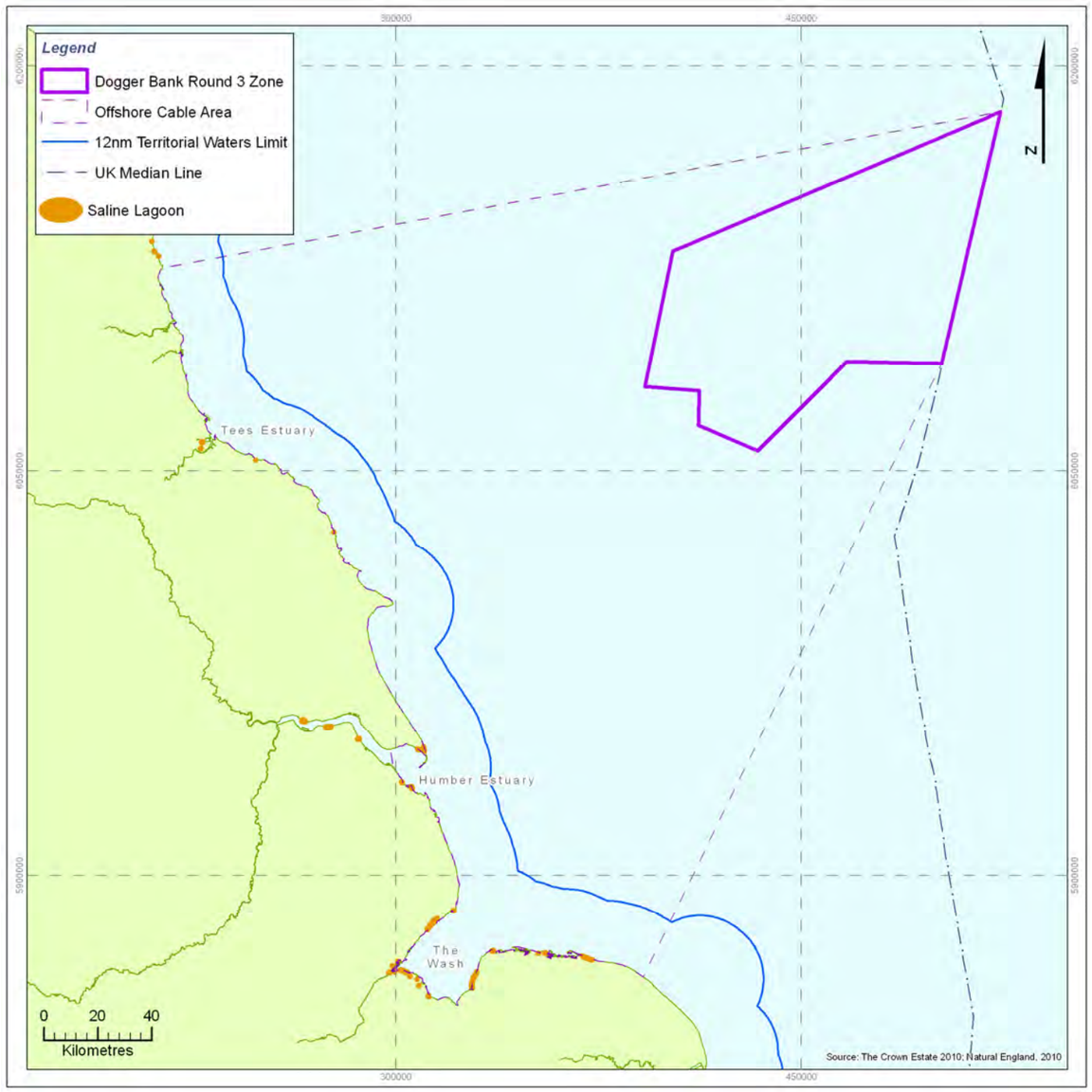


Figure 3.2: Distribution of the UK BAP priority habitat saline lagoons in the coastal area of the Offshore ZDE.

Sabellaria spinulosa reefs can provide a biogenic habitat that allows many other associated species to become established and acts to stabilise cobble, pebble and gravel habitats. They contain a more diverse fauna with sometimes more than twice as many species and almost three times as many individuals than nearby areas where *S. spinulosa* is absent (NRA, 1994 as cited in OSPAR, 2008). Given its few key requirements, and its tolerance of poor water quality *S. spinulosa* is common in the northeast Atlantic. Distinct reefs (as opposed to low crusts on the seabed) have been recorded from much of the British Isles (Natural England, 2010d). Reefs may persist in an area for many years although individual clumps may regularly form and disintegrate (Jackson and Hiscock, 2003; Jones, *et al.* 2000 as cited in OSPAR 2008).

Within Area 3, these reefs have been found at seven locations according to the NBN OSPAR (2010) habitat mapper. The most northerly is off Blyth followed by a cluster of three sites between Blyth and Whitley Bay, one between the Tyne and Wear and two around Whitby.

S. spinulosa reef (that is the habitat not the species) has the following designations (UK BAP, 2008):

- OSPAR threatened/declining habitat;
- UK BAP priority habitat; and
- Annex I of the Habitats Directive: Reefs, and as a feature of Sandbanks which are covered by seawater at all time; Large shallow bays and inlets; and Estuaries.

Coastal saltmarsh in the UK comprise the upper, vegetated portions of intertidal mudflats, lying approximately between mean high water neap tides and mean high water spring tides. Saltmarshes are usually restricted to comparatively sheltered locations in five main physiographic situations: in estuaries, in saline lagoons, behind barrier islands, at the heads of sea lochs, and on beach plains. The development of saltmarsh vegetation is dependent on the presence of intertidal mudflats. It is estimated that, at the mean high water line, 24% of the English coastline consists of saltmarsh vegetation (UK BAP, 2008). Saltmarsh is a UK BAP priority habitat as well as being listed in an Annex of the Habitats Directive for Estuaries, *Salicornia* and other annuals colonising mud and sand, *Spartina* salt meadows and Mediterranean and thermo-Atlantic halophilous scrubs. In the northwest coastal shallows saltmarsh is found on the Tees, Tyne and Wear, Blyth and Wansbeck estuaries in particular.

Estuarine rocky habitats are rare and mostly found in the north and western UK (Natural England, 2010g). In Area 3 they are found just north of Flamborough Head and on the Esk, Tees, Tyne and Blyth estuaries according to the JNCC MNCR database as mapped by the MCZ project (MCZ, 2010).

Intertidal under-boulder communities do not all have boulder seascapes with rich, varied communities of animals living beneath them. These are nonetheless found all around the UK and often occur in areas of strong tidal currents. This habitat has been found

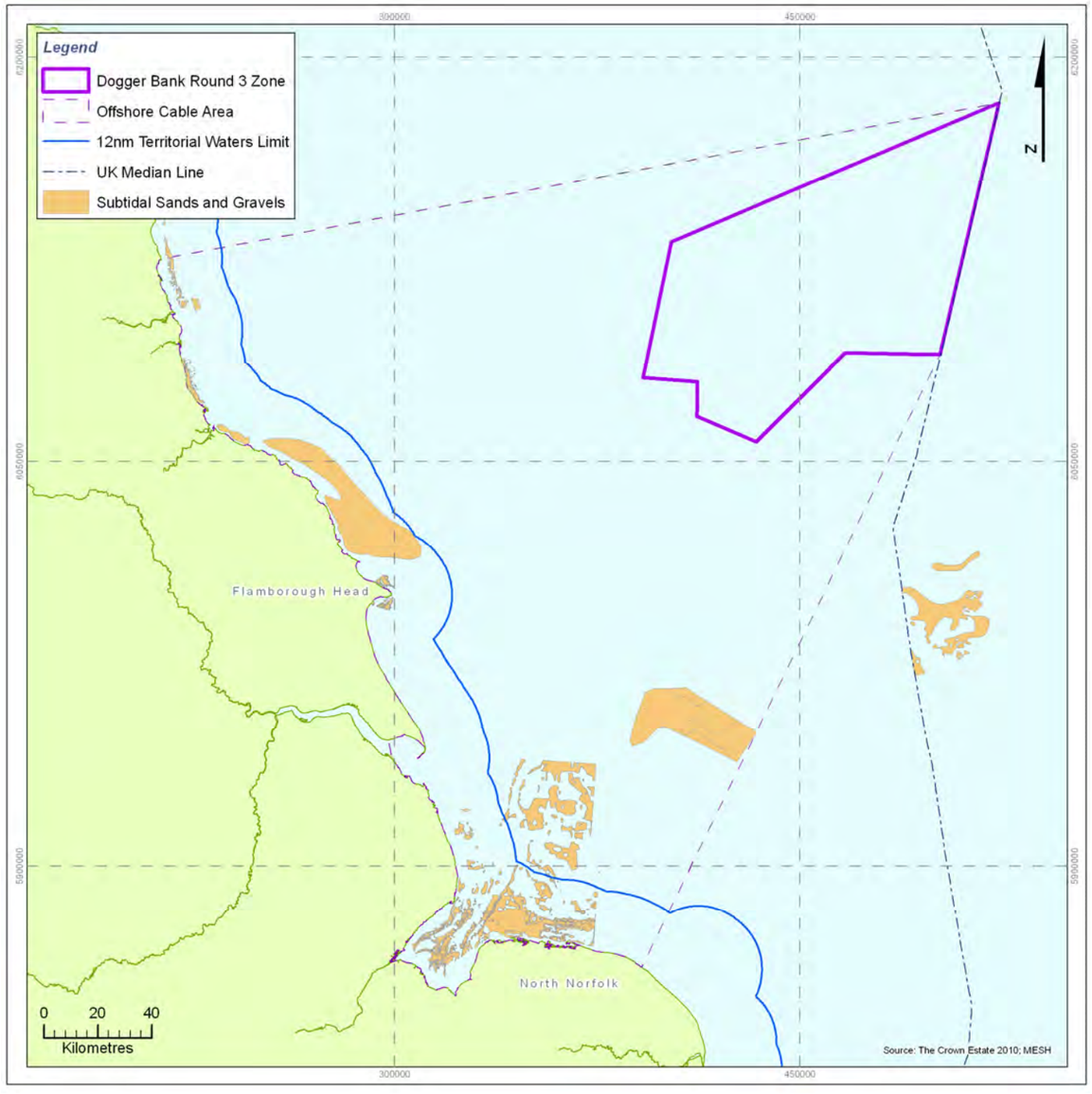


Figure 3.3: The distribution of subtidal sands and gravels as mapped from EUNIS and MCZ data sources.

in 11 places between Whitley Bay and Flamborough Head according to the JNCC MNCR database as mapped by the MCZ project (Natural England, 2010i; MCZ, 2010). Under-boulder habitat plays an important role in the life cycle of marine animals, for example the under-surfaces are an important refuge for the eggs of fish, dog whelks and sea slugs.

The sheltered gaps between and under the boulders provide security for mobile species such as larger crabs and fish, and also the juveniles of many more species (UK BAP, 2008).

No distribution map was available for intertidal under-boulder communities. Intertidal underboulder communities are a UK BAP priority habitat and may be a component part of Annex I habitats (UK BAP, 2008).

Saline lagoons in the UK are essentially bodies, natural or artificial, of saline water partially separated from the adjacent sea. They retain a proportion of their seawater at low tide and may develop as brackish, full saline or hyper-saline water bodies (UK BAP, 2008). There are saline lagoons on the Tees Estuary and elsewhere (Figure 3.2). Saline lagoons are a UK BAP priority habitat and are listed under the Habitats Directive, Annex I: Coastal lagoons (UK BAP, 2008).

Sheltered muddy gravels occur mainly in estuaries, drowned river valleys and sea lochs, in areas protected from wave action and strong tidal streams. They can be found both on the shore and in the shallows, and are probably an extension of the much more common offshore sands and gravels (Natural England, 2010k). Good quality examples of this habitat are very scarce. Polychaetes and bivalve molluscs are normally dominant and the most varied, but representatives of most marine phyla can be present (UK BAP, 2008).

The only sites within the Offshore ZDE are in northwest coastal shallows. These have been mapped, using data from the JNCC MNCR database, by Natural England to inform the Marine Conservation Zone project and are on the Blyth, Tyne and Wear, and Esk estuaries (Natural England, 2010k; MCZ, 2010). Sheltered muddy gravels are a UK BAP priority habitat (UK BAP, 2008). They occur in two Annex I habitats of the Habitats Directive, 'Sandbanks that are slightly covered by seawater all the time', and 'Estuaries' (Natural England, 2010k).

Subtidal sands and gravels are the most common sediment habitats found below the level of the lowest low tide around the coast of the United Kingdom (UK BAP, 2008). Those found in the North Sea are mainly formed from rock. They occur in a range of environmental conditions, from wave-sheltered, enclosed bays and estuaries to highly exposed open coasts. The mix of sand or gravel, and any sand waves or ripples present on the surface of the seabed, depend on factors such as the strength of the waves and tides (Natural England, 2010i). This habitat occurs extensively in the northwest coastal shallow area. The habitat has been mapped by NE for the MCZ project (MCZ, 2010) but can also be seen in Figure 3.3.

Offshore sand and gravel seascapes are important nursery grounds for the young of commercial fish species such as flatfish, bass, skates, and rays as well as sharks (Natural England, 2010i). Their distribution within the western coastal shallows area extends in an almost unbroken line which hugs the coast from the northern margin to Flamborough Head (Natural England, 2010L).

Subtidal sands and gravels are a UK BAP priority habitat (UK BAP, 2008) and are listed in Annex I of the Habitats Directive as part of sandbanks that are slightly covered by seawater all the time and Estuaries (Natural England, 2010L).

Tide-swept channels occur where the constricted coastline acts as a funnel. They are found at the entrances to fjords, lochs and lagoons, between individual islands, and between islands and the mainland. The plentiful supply of food brought in on each tide supports rich and varied communities of marine life (Natural England, 2010h).

Many of the animals that live here including soft corals, sea firs, sponges, anemones, and mussels are strongly anchored to the seabed. Common starfish, brittlestars, edible crabs, whelks and topshells are also found here. Tide-swept rocky shores that emerge between the tides support seaweeds such as kelp and sea oak, which grow to great lengths in the currents. Smaller red and brown seaweeds also occur, and animals in these plant-dominated communities include limpets, barnacles, shore crabs, whelks and winkles (Natural England, 2010h).

There are several locations within Area 3 as recorded in the JNCC MNCR database and currently mapped by the MCZ project (Natural England, 2010h; MCZ, 2010). There are two points just north and south of Tynemouth, one at Whitby, one at Filey Point and six on Flamborough Head. Tide-swept channels are a UK BAP priority habitat (UK BAP, 2008) and are listed in Annex I of the Habitats Directive: Reefs, and large shallow bays and inlets (Natural England, 2010h).

Species of Conservation Importance

Four species with some measure of protection are recorded in the Northwest coastal shallows, two molluscs and two red algae. The molluscs are the ocean quahog, dog whelk *Nucella lapillus,* and the red algae are common maërl *Phymatolithon calcareum* and the red crustose alga *Cruoria cruoriaeformis*.

The ocean quahog has been recorded from numerous locations within the northwest coastal shallows with the majority found towards the northern half of the area, particularly off the Tees estuary, Hartlepool and the Durham coast (EurOBIS, 2010).

Dog whelks are gastropod molluscs that are found on wave exposed to sheltered rocky shores. The species is widely distributed on both sides of the North Atlantic where there is suitable habitat. An assessment of the sensitivity of dog whelks, based on a literature review by the Marine Life Information Network for Britain & Ireland (MarLIN), lists this species as being highly sensitive to synthetic compound contamination, changes in nutrient levels, and substratum loss (OSPAR, 2008) (Appendix A). It is listed by OSPAR as a threatened/declining species for the greater North Sea.

Common maërl is the most widespread maërl species in Europe and is often the most abundant maërl species, with other species usually found only as minor elements of the maërl bed. Maërl is a Breton word for this unattached coralline (calcified) red alga (Birkett, 1998). It was found in a single location at Whitley Bay (distribution map from NBN Gateway available in Appendix A) just inside the Offshore ZDE south of Northumberland in 1983 (Grid Ref. NZ38). This record is for the species only and does not indicate whether or not the habitat was present here (see comment below).

Common maërl is a UK BAP priority species and as such is on the England NERC S.41 list. Section 41 of the Natural Environment and Rural Communities (NERC) Act 2006 requires the Secretary of

State to publish a list of habitats and species which are of principal importance for the conservation of biodiversity in England. The S41 list is used to guide decision-makers such as public bodies, including local and regional authorities, in implementing their duty under section 40 of the Natural Environment and Rural Communities Act 2006, to have regard to the conservation of biodiversity in England, when carrying out their normal functions. In addition, it is listed under Annex V of the directive (animal and plant species of community interest and its taking in the wild and exploitation may be the subject of management measures). Maërl biotopes are included within the Annex I Habitat 'Sandbanks slightly covered by seawater all of the time' of the European Habitats and Species Directive as well as (according to the UK BAP), 'Large shallow inlets and bays'. Furthermore, as a habitat, maërl is part of the OSPAR list of threatened/declining habitats; however the distribution map does not record this habitat as present anywhere in the Offshore ZDE. It must also be commented that an audit (JNCC, 2007) of the species for its listing in Annex V of the Habitats Directive did not indicate its presence anywhere in the Offshore ZDE. The record that currently exists at the NBN Gateway can therefore be regarded as no longer valid.

C. cruoriaeformis is a non-corralline crustose red algae often associated with maërl. A re-evaluation of the genus *Cruoria* Maggs and Guiry (1989) suggest that *C. cruoriaeformis* is more or less restricted to subtidal maërl beds in the southwestern British Isles and northern France, and possibly the Mediterranean. Whereas *C. pellita*, (the type species for the genus), is widely distributed in the northeastern Atlantic on bedrock and cobbles. EurOBIS (2010) maps the species, *C. cruoriaeformis*, as present in the Flamborough Head SAC at grid reference, TA237726 (Appendix A). The Marine Conservation Zone interactive mapper also places it here using the same data. However, no maërl exists at this same location according to JNCC (2007) so the record cannot be verified or validated. *C. cruoriaeformis* is a UK BAP priority species and as such is on the England NERC S.41 list.

3.4.4 Southern shallows (Area 4)

Habitats and Communities

The predicted EUNIS habitats recorded in this area include (*ordered by the most commonly occurring habitat to the least*):

- Circalittoral coarse sediment;
- Infralittoral coarse sediment;
- Circalittoral fine sand or circalittoral muddy sand;
- Infralittoral fine sand or infralittoral muddy sand;
- Deep circalittoral coarse sediment;
- Circalittoral mixed sediments;
- Deep circalittoral sand; and
- Infralittoral sandy mud or infralittoral fine mud.

Some of these habitats and their conservation status have previously been described above for the Southern shallows. Detailed information is also available in Appendix A. For a summary of which habitats are on the UK BAP or OSPAR list see Table 3.1.

Intertidal mudflats constitute Annex I habitat and occur as extensive areas within the Wash and the Humber SAC's where they are a primary reason for the selection of the sites. The Wash is the largest embayment in the UK with extensive areas of subtidal mixed sediment. In the tide-swept approaches to the Wash, with a high loading of suspended sand, the relatively common tube-dwelling polychaete worm *S. spinulosa* forms areas of Annex I biogenic reef. These structures are varied in nature, and include reefs which stand up to 30 cm proud of the seabed and which extend for hundreds of metres (JNCC, 2010b).

S. spinulosa reef is found extensively in the southern shallows. The Wash and North Norfolk SAC and the two possible offshore SAC's, 'Inner Dowsing, Race Bank and North Ridge' and the 'North Norfolk Sandbanks and Saturn Reef' were all selected in part because of Annex I Reef *Sabellaria spinulosa*, habitat.

Large shallow inlets and bays are another habitat for which the Wash was selected as an SAC. The Wash is the largest embayment in the UK, and represents large shallow inlets and bays on the east coast of England. It is connected via sediment transfer systems to the north Norfolk coast. Together, the Wash and North Norfolk coast form one of the most important marine areas in the UK and European North Sea coast, and include extensive areas of varying, but predominantly sandy, sediments subject to a range of conditions. Communities in the intertidal include those characterised by large numbers of polychaetes, bivalves and crustaceans. Sublittoral communities cover a diverse range from the shallow to the deeper parts of the embayments and include dense brittlestar beds and areas of *S. spinulosa*.

The account of the 'Sandbanks which are slightly covered by sea water all the time' feature for the Wash and North Norfolk SAC (JNCC, 2010b) runs as follows:

On this site sandy sediments occupy most of the subtidal area, resulting in one of the largest expanses of sublittoral sandbanks in the UK. It provides a representative example of this habitat type on the more sheltered east coast of England. The subtidal sandbanks vary in composition and include coarse sand through to mixed sediment at the mouth of the embayment. Sublittoral communities present include large dense beds of common brittlestars *Ophiothrix fragilis*. Species include the sand-mason worm *Lanice conchilega* and the tellin *Angulus tenuis*. Benthic communities on sandflats in the deeper, central part of The Wash are particularly diverse. The subtidal sandbanks provide important nursery grounds for young commercial fish species, including plaice *Pleuronectes platessa*, cod *Gadus morhua* and sole *Solea solea*'.

The North Norfolk sandbank habitat occupies a minimum area of 54,488 ha (based on the 20 m contour, LAT datum). The actual area of sandbank within the North Norfolk sandbanks SAC is larger than this minimum extent as the banks themselves extend into deeper waters. The parts of the banks in deeper waters are considered integral to the structure and functions of the banks and an integral part of the sandbank feature of conservation interest, although their precise extent is not defined.

For the Inner Dowsing, Race Bank and North Ridge SAC the evaluation of relative surface area is approximate as it is not possible to calculate an accurate total extent figure for Annex I shallow sandbank habitat for UK waters. Environmental Statements from wind farm developments in the area considered that construction activities would not have a significant impact on the sandbank habitat, and that areas of reef would be avoided during construction of turbines and routing of cables (JNCC, 2009).

Littoral chalk communities have been mapped as present just east and west of Sheringham on the North Norfolk coast by the NBN Gateway habitat mapper for OSPAR.

Zostera beds or seagrass stabilises the substratum as well as providing shelter and a substrate for many organisms. Where the habitat is well developed the leaves may be colonised by diatoms and algae, as well as stalked jellyfish and anemones. The infauna is generally similar to species occurring in shallow areas in a variety of substrata (e.g. amphipods, polychaete worms, bivalves and echinoderms), and can be rich within the bed. The shelter provided by seagrass beds makes them important nursery areas for flatfish and, in some areas, for cephalopods. The diversity of the species will depend on environmental factors such as exposure and density of the microhabitats, but it is potentially highest in the perennial, fully marine, subtidal communities and may be lowest in intertidal, estuarine, annual beds (Anon, 2000 as cited in OSPAR, 2010e). The distribution as currently available (though not complete) through the NBN OSPAR (2010) website (Appendix A) shows that the habitat has been recorded in the southern shallows area on the north Norfolk coast. *Zostera* is a UK BAP priority habitat (UK BAP, 2008) and is on the OSPAR List of Threatened and/or Declining Species and Habitats. Seagrass is also an important feature in estuary Sites of Special Scientific Interest, under the UK Wildlife and Countryside Act 1981 (Natural England, 2010e).

Blue mussel beds, as described previously, are widespread on the shore and in shallow water around the coasts of the UK and Europe (Natural England, 2010f). Within the southern shallows area it has been recorded in a total of five locations in the Wash and on the North Norfolk coast by the MCZ project (MCZ, 2010) using information from the JNCC MNCR database.

Coastal saltmarsh, as described for the previous area, is intimately associated with areas of intertidal mudflat and given the importance of mudflat in both the Humber and the Wash this habitat will have a strong presence in the southern shallows area (although no formal distribution maps could be found).

Estuarine Rocky Habitats, as has been noted, are mostly found in the north and western UK. However the marine conservation zone project (Natural England, 2010g) has also mapped the habitat near Hunstanton on the Wash.

Peat and clay exposures are sea beds formed of exposed peat or clay, or in some cases both, and are uncommon habitats. Where they do occur, they have been found between the tides as well as fully underwater. They can be buried by sand or other sediments and then exposed again on a regular basis (Natural England, 2010j). This habitat includes littoral and sublittoral examples of peat and clay exposures, both of which are soft enough to allow them to be bored by a variety of piddocks, particularly the common piddock *Pholas dactylus*, the white piddock *Barnea candida* and little piddock *Barnea parva*. Sites within the southern shallows area recorded in the JNCC MNCR database have been mapped by the MCZ project (Natural England, 2010j; MCZ, 2010). Three locations were identified near Brancaster, Norfolk and one just north of Spurn Point on the Holderness coast. Peat and clay exposures are a UK BAP priority habitat (UK BAP, 2008) and may be component parts of habitats in Annex I of the Habitats Directive (Natural England, 2010j).

Saline lagoons (Figure 3.2) can be found in North Norfolk (EA, 2009a), the Wash (EA, 2009b), Lincolnshire, North Lincolnshire, and the East Riding of Yorkshire (HECAG, 2009).

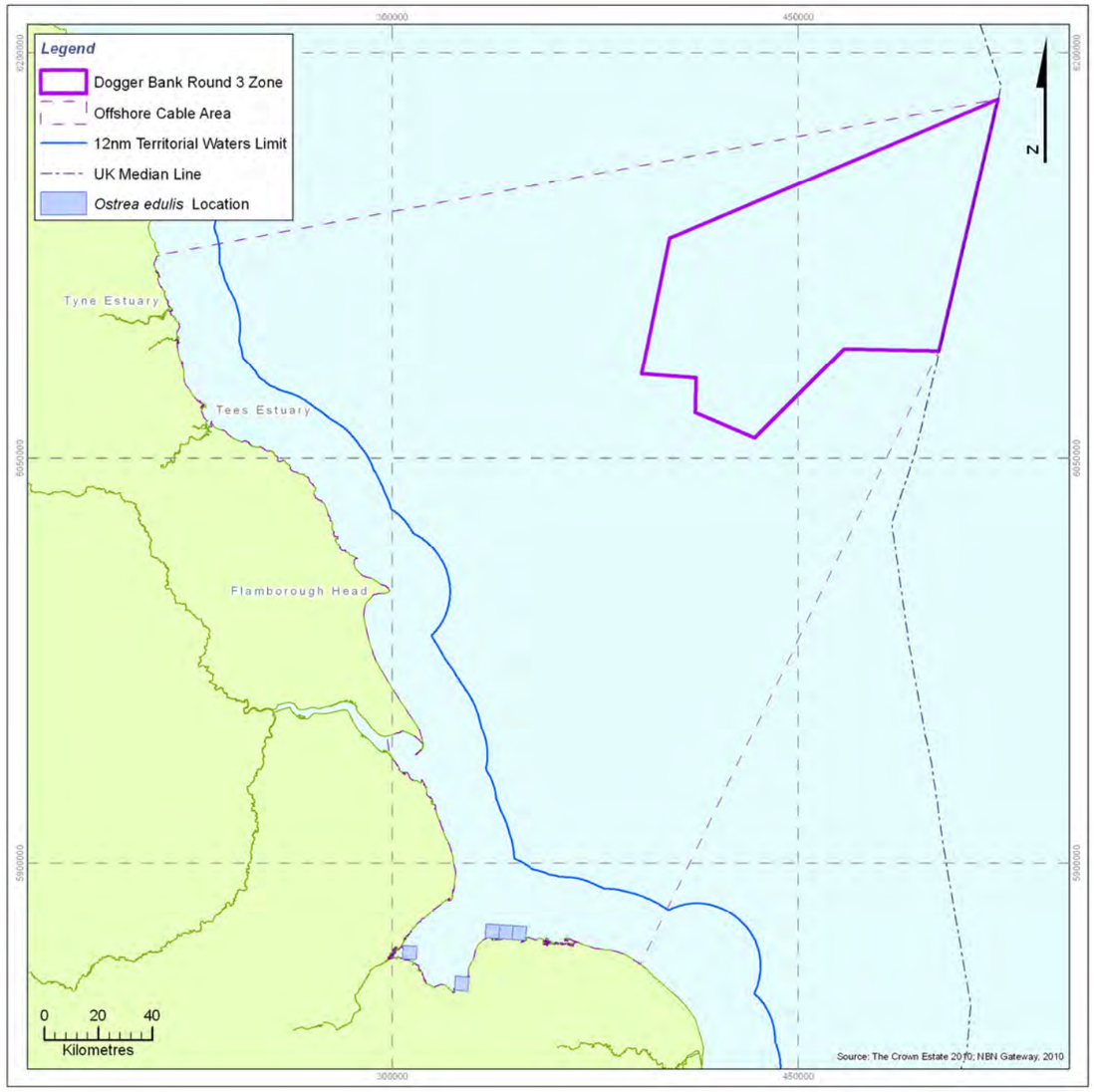


Figure 3.4: The distribution of the native oyster (*Ostrea edulis*) within the Offshore ZDE (NBN Gateway data).

Subtidal sands and gravels as in other parts of the Offshore Cable Area are found extensively in the southern shallows area (Figure 3.3) especially in The Wash and Outer Wash area as mapped by the MCZ project (Natural England, 2010i). There is a notable overlap between the area identified in the outer Wash and the map produced by Ellis *et al.* (2005) showing the location of important grounds for juvenile rajids (see Chapter 4 and Appendix A).

JNCC (Irving, 2009) have identified cobble reef areas and one of these falls within the southern shallows area of the Offshore Cable Area (Appendix A). This area of stony reef consisted of mosaics of boulder, cobble and pebble on mixed/coarse sediment though within the area a wide variety of seabed types/habitats were present. Some areas might not qualify as a stony reef on account of the small particle size. The dominant types were extensive areas of gravel, pebbles, cobbles and boulders. Cobble reefs are considered to be a sub-type of stony reefs, which also include reefs formed by boulders and some areas of iceberg ploughmarks.

To qualify as a cobble reef, 10% or more of the seabed substratum should be composed of particles greater than 64 mm across, while the remaining supporting matrix could be of smaller sized material. The reef may be consistent in its coverage or it may form patches with intervening areas of finer sediments. However, the greater the sediment component the more patchy the cobble reef is likely to be and consequently of lower 'reefiness'. The minimum size of a cobble reef has been agreed as being >25 m^2. This 25 m^2 applies to the total area of a patchy reef, rather than the minimum size for a patch (Limpenny *et al.,* 2010).

The area identified by Irving (2009) is one of three 'no trawling areas' and is off the Holderness coast extending from Skipsea in the north to Spurn in the south covering approximately 318 km^2. Within this area, a wide variety of seabed types/habitats were present, though the dominant types were extensive areas of gravel, pebbles, cobbles and boulders. A more detailed study of the area found four to five stony/cobble habitats had been distinguished, with varying degrees of 'reefiness'. Stony reef, which includes cobble reef, is a sub-habitat of Annex I 'reefs' under the Habitats Directive.

Species of Conservation Importance

Native oyster *Ostrea edulis* is a sessile, filter-feeding bivalve mollusc associated with highly productive estuarine and shallow coastal water habitats. The role of the native oyster and native oyster beds in the ecology of marine communities has led to it being considered a keystone species (e.g. Coen *et al.*, 1998 as cited in OSPAR, 2009). These functions include providing a solid surface for settlement by other species, providing a cryptic habitat

that serves as a nursery ground for, and protects, small fish and other species, stabilising sediments which may in turn provide some protection from shoreline erosion, and filtration of large quantities of water. It has been found in several locations in the Wash (Appendix A) as recorded by the NBN (2010a) Gateway (Figure 3.4):

Scolt Head Island, North Norfolk in 1998 (Grid Ref. TF813467)

- Brancaster Beach, North Norfolk in 1995 (Grid Ref. TF772453); and
- Cooden Beach to Bexhill in 1975 (Central Grid Ref. TF646278).

Ostrea edulis is a UK BAP priority species and is also on the OSPAR list of threatened/declining species both as a species and as a habitat. The habitat '*Ostrea edulis* beds' is under threat / declining wherever it occurs (OSPAR, 2009) though it is not currently mapped anywhere in the Offshore ZDE. For the species listing is it considered under threat/declining in the greater North Sea, an area which includes the entire Offshore ZDE (OSPAR, 2009).

The Ocean Quahog, as in all other areas, is found in a number of locations in Area 4, particularly in the northeast quadrant. The distribution as currently available from the NBN (2010b) Gateway can be seen in Appendix A and is also available through the EurOBIS (2010) and MCZ (2010) websites.

Dog Whelks are not as widely distributed in southern shallows as they were in the northwest coastal shallows (see Appendix A for the NBN Gateway maps). In fact, it has been recorded from two locations just north of Spurn Head and from six areas in the wash and north Norfolk.

The small amphipod crustacean, *Allomelita pellucida*, is an intertidal species which can be found in brackish waters usually living as a part of interstitial or epibenthic communities of soft sediments (Hosie, 2008). It was recorded in the Wash (Appendix A) in 1985 off Holbeach (NBN, 2010c). The species has an IUCN Red Listing based on pre 1994 guidelines according to the JNCC (2010c).

Another small amphipod crustacean, *Gitanopsis bispinosa*, is an arctic sublittoral marine species at the southern limits of its distribution in the UK and listed by the UK BAP as nationally scarce. It is usually found between 100 and 200 m. There are records of the species in the UKOOA database (v3.01) (Oil and Gas UK, 2009) from the Amethyst and Bedevere fields (Figure 3.5) in the southern shallows area of the Offshore Cable Area (from between 22 and 25 m depth). They constitute the most southerly records for the species and are in unusually shallow water.

The tentacled lagoon-worm *Alkmaria romijni* is thought to be 'scarce' within the UK (Gilliland and Sanderson, 1999) and is protected under Schedule 5 of the Wildlife and Countryside Act (WCA) 1981. It lives in mud or muddy sand and is found intertidally in the lower eulittoral and in the sublittoral fringe to a depth of just a few metres. As a brackish water species, its preferred salinity range is 5 to 20 parts per thousand (Natural England, 2010m). This species has been found in many locations in the Humber Estuary (Appendix A) in the southern shallows area of the offshore Cable Area. According to MarLIN (White, 2002) it is highly intolerant of substratum loss, increase in wave exposure and displacement.

3.5 Summary

There are benthic species and habitats of conservation importance within the Offshore ZDE.

With regard to the habitats found in the Offshore ZDE clearly some are more sensitive than others. The following summarises the habitats and communities and identifies potential sensitivities:

1. The dominant biotope of the sandbank habitat in the Dogger Bank Zone is considered to have low sensitivity to physical disturbance (Budd, 2008);

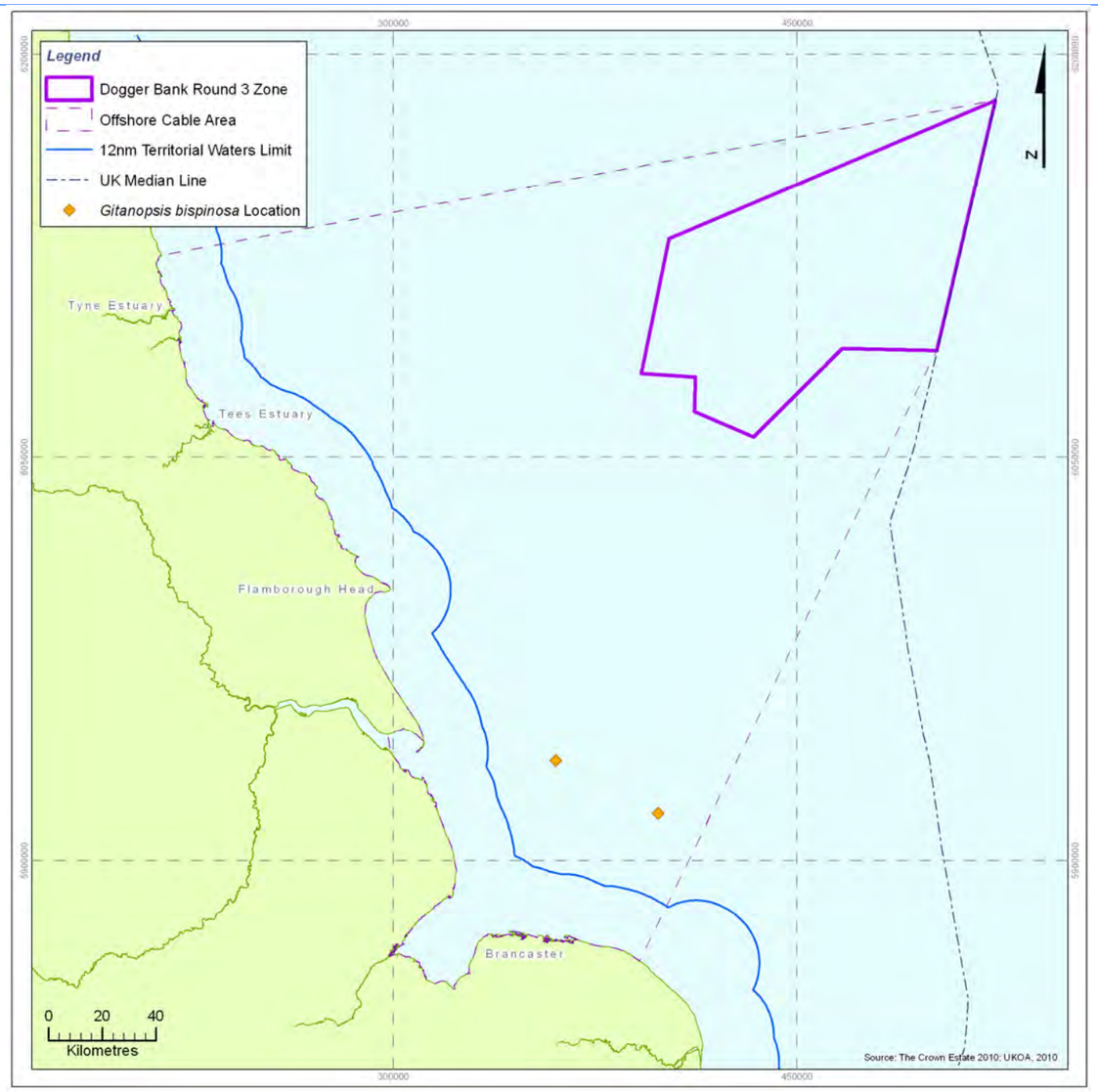


Figure 3.5: Location of the two records of the UK BAP species *Gitanopsis bispinosa* (UKOOA database v3.01).

2. Further consideration should be given to the habitat along the northern edge of the Dogger Bank Zone as this area is important to the way in which the Dogger Bank ecosystem functions. The frontal system which occurs here helps drive the high production for which the Bank is well known (see Appendix A for more detail). This deep water area off the northern edge of the Dogger Bank has habitats which may take relatively longer to recover from construction related disturbances compared to shallower water mobile sandy habitats over the main bank. The prime example of this is the sea pen and burrowing megafauna habitat, which work by Diesing *et al.* (2009) suggests is present. The results of targeted benthic surveys should enable further assessment of sensitive benthic habitats and associated communities;

3. The known cobble reef habitat off the Holderness coast identified by Irving (2009) is not thought to be continuous;

4. It is worth noting that distribution and temporal variation of *S.spinulosa* habitat can be quite variable; and

5. In the intertidal area coastal saltmarsh should be avoided as these are highly productive ecosystems supporting both intertidal and subtidal communities in addition to the fish and bird species which may use them.

With regard to the species present:

1. The large long-lived bivalve mollusc the Ocean Quahog *A. islandica* is found throughout much of the Offshore ZDE. It is on the OSPAR list of threatened / declining species. This list does not in itself confer any statutory protection except that countries party to the Convention are often required to transpose their requirements into national law. OSPAR only consider the species to be under threat/decline in the Greater North Sea (OSPAR Region II within which the Offshore ZDE is located). Despite its current lack of statutory protection in England, the fact that the species is on the OSPAR List indicates the importance with which it is regarded;

2. The Northern hatchet shell *T. gouldi* has protection under Schedule 5 of the Wildlife and Countryside Act 1981. However the most recent JNCC (2008a) review suggests that the species be removed from Schedule 5 (in England, Wales and Scotland) because it is thought to be more common and widespread than previously thought. On top of which Killeen and Oliver (2002) indicated it was unlikely to be found in the open North Sea and was confined to ‘to inlets and sea lochs’;

3. The recording of *C. cruoriaeformis* on Flamborough Head is unverified and more likely to be a mis-identification;

4. The native oyster *O. edulis* has only been recorded from north Norfolk and limited locations in the Wash;

5. Common maërl *P. calcareum* was found in a single location just inside the Offshore ZDE and was not included in a more recent distribution map for the species at that location;

6. The dog whelk *N. lapillus* currently have no statutory protection but are listed by OSPAR. This rocky shore species might be present where the cable makes it landfall;
7. The small amphipod crustacean *Allomelita pellucida* was recorded from a single location in the Wash in 1985;
8. The tentacled lagoon-worm *Alkmaria romijni* is found only in the Humber. Although it is a Schedule 5 species under the Wildlife and Countryside Act 1981, it is not as rare as first thought (Gilliland and Sanderson, 1999); and
9. The small amphipod crustacean *Gitanopsis bispinosa* was recorded from two locations in the south of the offshore Cable Area. The records are the most southerly for the species and the locations were unusually shallow for the species.

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4. Fish Resource and Ecology

4.1 Introduction

This chapter provides a characterisation of the fish resources within the proposed Offshore Zone Development Envelope (ZDE). It describes:

- The ecology of fish species typically found within the region (including commercial and other fish species);
- Conservation status and association with the wider benthic environment;
- Influences on life history; and
- Spawning, breeding and feeding behaviours.

The overall focus will concentrate on the Offshore ZDE, but, to address wider ecological issues, focus will also be placed within a North Sea context to inform local and regional spatial trends.

4.2 Data and Literature

The key data sources and literature used to compile the information in this chapter include;

- Spawning and nursery areas of some species included as features of conservation interest in Marine Protection Areas (MPAs) and Marine Conservation Zones (MCZs) (Ellis *et al*., 2010a);
- Fisheries sensitivity maps (Coull *et al*., 1998);
- International Council for the Exploration of the Sea (ICES) web resources (ICES, 2006);
- Site-specific fisheries surveys (EMU Ltd, 2008);
- Fish landings and Vessel Monitoring System data (Lee *et al*., 2009); and
- Available peer-reviewed literature.

In addition to the above specific data sources, more generic data were derived from the Centre for Environment, Fisheries and Aquaculture Sciences (Cefas) and the Joint Nature Conservation Committee (JNCC) (the latter in relation to the Dogger Bank candidate Special Area of Conservation (cSAC) have been considered, primarily in the form of web accessed data sheets.

Data for relevant species (considered to be numerically, ecologically or commercially important), their nursery and spawning areas and other sensitivities were taken from published fisheries sensitivity maps (Coull *et al.,* 1998; Cefas, 2008 and Ellis *et al*., 2010a). For species not included in these resources, adults and juvenile distributions were collated from ICES web resources (e.g. ICES, 2006).

Part of the overview of Dogger Bank fish resource is derived from surveys conducted in support of applications for aggregate extraction at two sites, Northwest Rough (northwest Dogger Bank) and Southernmost Rough (southwest Dogger Bank) (EMU Ltd, 2008). Samples were collected from the southwestern and northwest bank margins and on top of and in deeper water to the west of the bank in June and September 2007 to assess temporal variation in assemblage structure. Figure 4.1 shows the locations of the commercial trawls completed as part of this study.

Finally, a study using fish landings and Vessel Monitoring System (VMS) data to estimate the spatial distribution of fishing effort (Lee *et al.,* 2009) indicated the presence of hake, a UK BAP species, in the area of the Dogger Bank. This, when viewed in conjunction with information from the benthic ecology chapter, supported the potential presence of the seapen and burrowing megafauna habitat which is known to act as a nursery area for some fish species including European hake.

Data collated for this section are derived from databases or the most recent publications produced by ICES and Cefas. The data used are, in general, part of a historic series of studies up to 2004 (and in some cases more recent, e.g. Ellis *et al.,* 2010a), mostly including surveys carried out in the last decade, or reviews of data aiming to identify possible gaps. Maps produced by Ellis *et al*. (2010a) are currently considered to be the best available indication of the likely common spawning and nursery areas for species. Where species are not addressed by Ellis *et al*. (2010a), information provided by Coull *et al.* (1998) has been used.

4.2.1 Data limitations and gaps

The majority of the Coull *et al.* (1998) maps for individual species have been updated by Ellis *et al.* (2010a). Where this is not the case, the Coull *et al.* (1998) maps are still considered a valid reference for identification of sea areas relevant to life stages of the species included in this report. It is worth noting that some evidence has been presented of climate change affecting the distribution of important fish species (Perry *et al.,* 2005). An update to Coull *et al.* (1998) is to be released by Cefas in the near future (Cefas, 2011)[1].

The following describes identified gaps/limitations in current knowledge:

- Ellis *et al*., (2010a) reported that cod 'spawning in the North Sea may be more widespread, although the supporting data are limited'; and
- No data are available in the literature against which to make an assessment of whether there are any specific fish migration routes which could interact with the development.

4.3 Overview

Whilst this chapter goes on to explain important areas for certain species during various life stages, a study carried out by EMU Ltd (2008) did indicate that the margins and slope areas of the Dogger Bank were potentially sensitive fish and fish habitat areas (Figure 4.1). In particular the southwestern margins of the Dogger Bank and coastal areas, included in the Offshore ZDE, were considered to be potential nurseries for juvenile cod *Gadus morhua* and plaice *Pleuronectes platessa* as well as grounds for skates and rays. In fact Ellis *et al*. (2010a) have rated the rectangles immediately west and southwest of the Dogger Bank cSAC (but not overlapping with the boundary) as a high intensity nursery area for cod. Cod nursery grounds are clearly widespread and another extensive area to the north and east, a small portion of which overlaps the north-east corner of the Dogger Bank Zone, is also identified by Ellis *et al*. (2010a) as a high intensity nursery area. The same study rated the entire Offshore ZDE and the cSAC as low intensity spawning areas for cod.

The EMU Ltd (2008) study focused on the western margins of the Dogger Bank and identified some plaice spawning grounds and nursery grounds for immature cod, haddock *Melanogrammus aeglefinus* and whiting *Merlangius merlangus*. Ellis *et al.* (2010a)

[1] Also in development is the INTERREG funded Channel Integrated Approach for Marine Resource Management III project (CHARM Project, 2011). This is a cross-border European cooperation programme. The project, aiming for an ecosystem-based approach to marine resources management, will provide maps and ecological information for relevant marine species both in the English Channel and the southern North Sea.

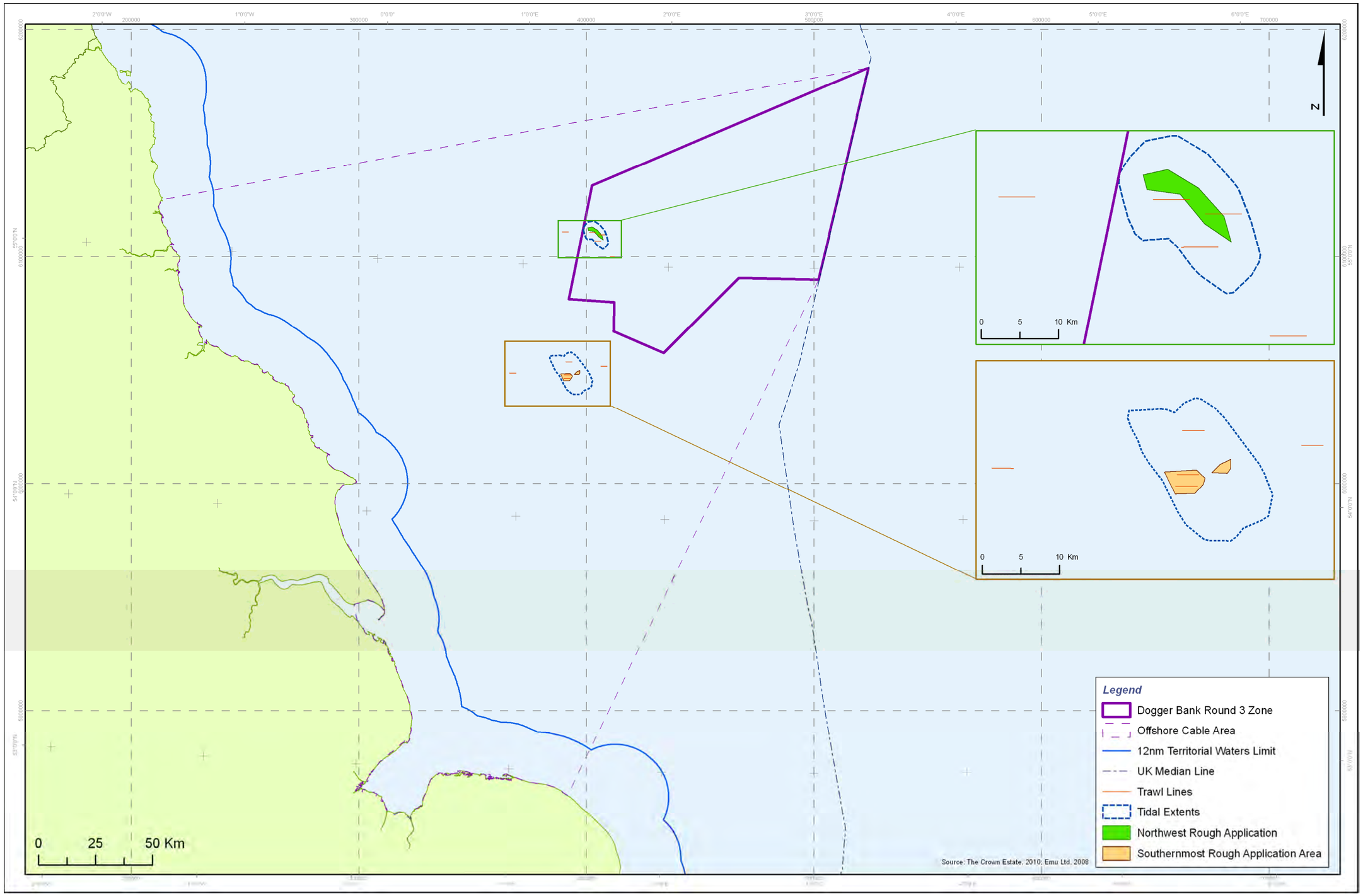


Figure 4.1: Location of previous fish sampling surveys at Dogger Bank using commercial fishing gears, with possible cod nursery area indicated (Emu Ltd, 2008).

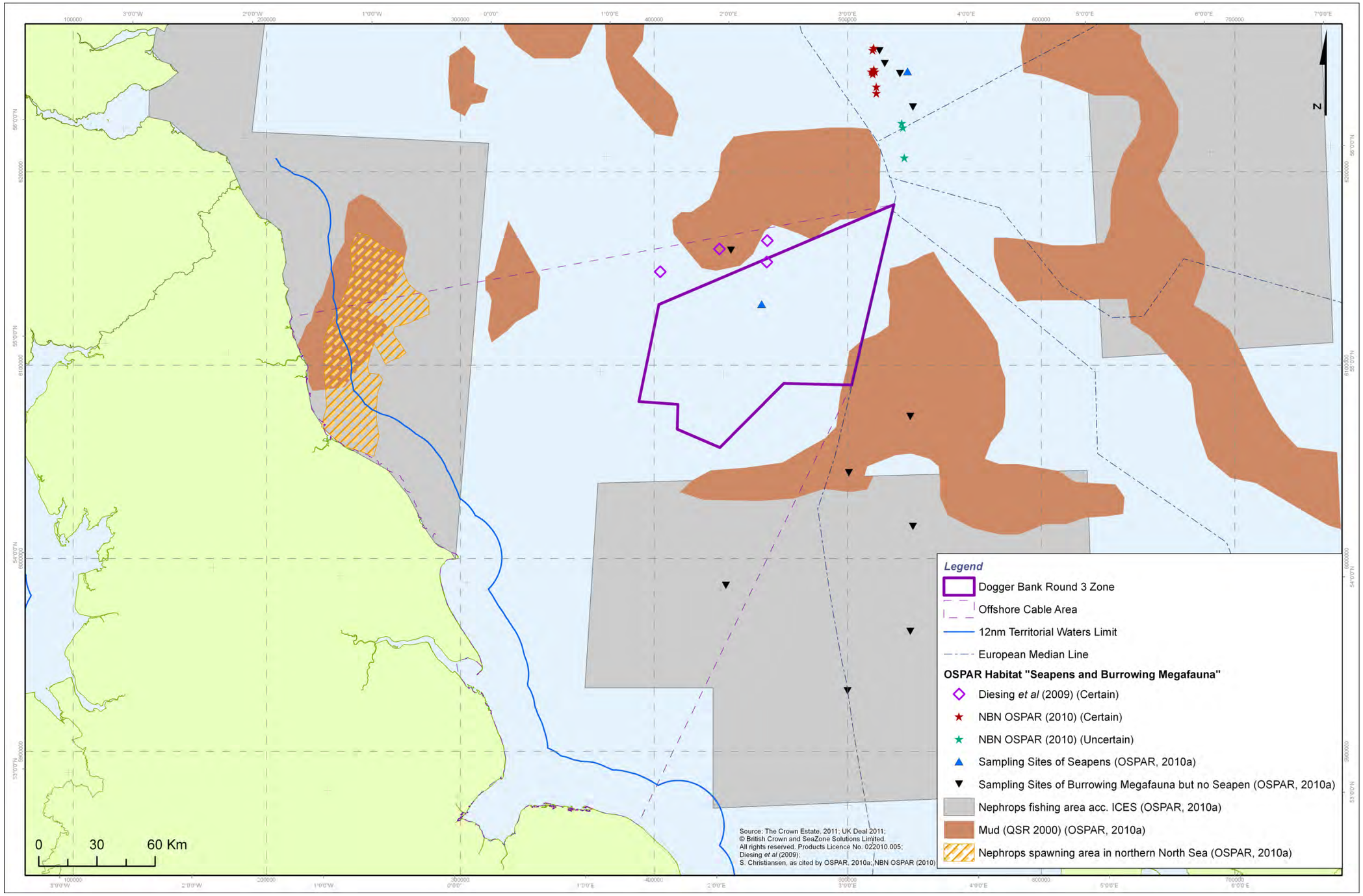


Figure 4.2: Locations of Seapen and Burrowing Megafauna in the vicinity of the Dogger Bank.

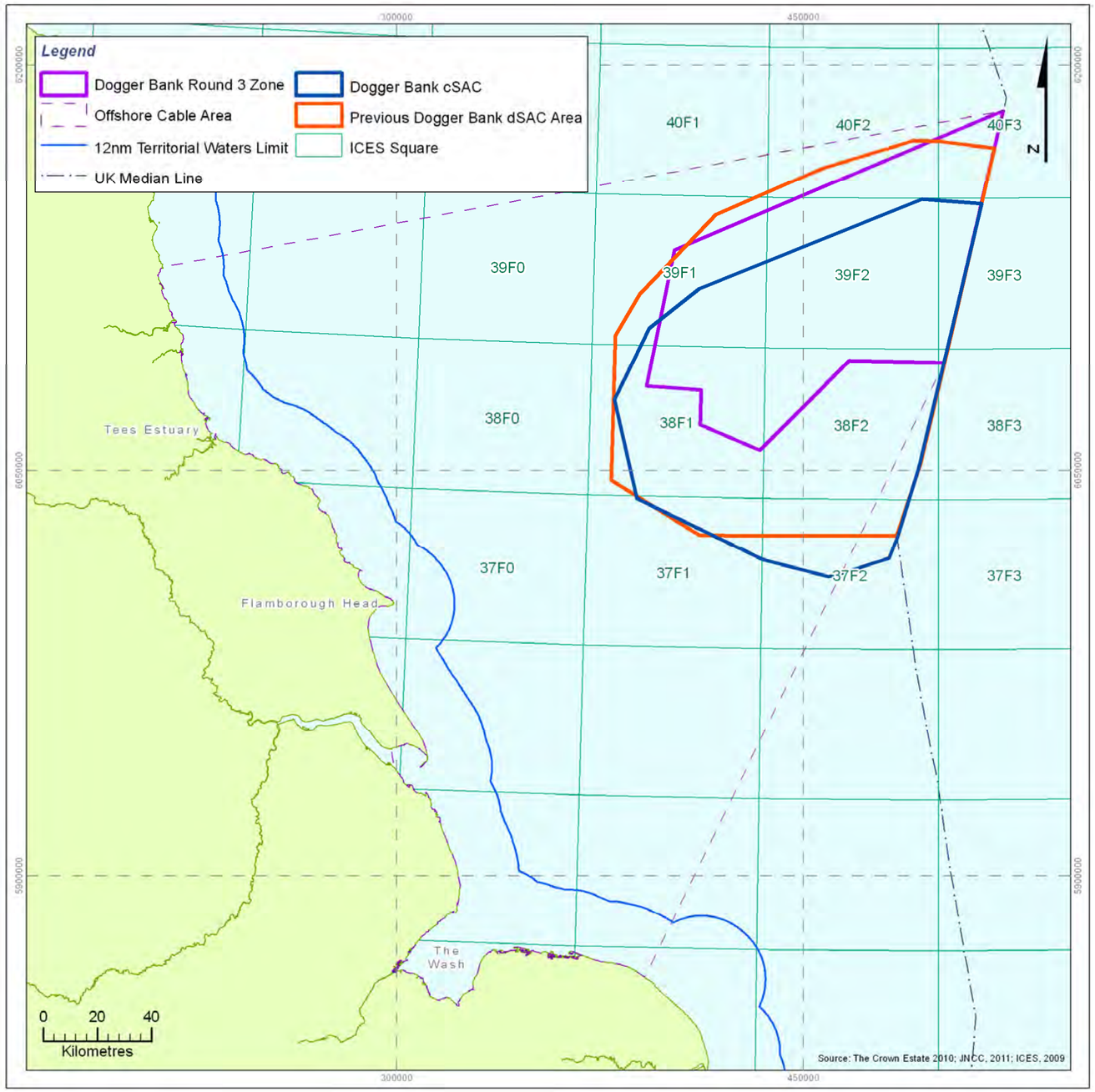


Figure 4.3: ICES rectangles present in relation to the Dogger Bank Zone, former Dogger Bank dSAC boundary and current cSAC boundary.

have indicated that these areas are low intensity plaice spawning grounds and low intensity nursery grounds for whiting. The northwestern area was also highlighted as being subject to some commercial fishing effort (EMU Ltd, 2008).

The potential for effects to seabed habitats and their possible relevance to fish ecology, especially if identified as sensitive, may include response to direct physical seabed disturbance, scour and modification to nearby seabed current regimes and predator-prey interactions. Of particular relevance are the possible "seapen and burrowing megafauna communities" on the northern margin of the Dogger Bank (Figure 4.2). These are known to be nursery areas for a number of fish species including the UK BAP priority species hake *Merluccius merluccius* (OSPAR, 2010a). Hake were considered under threat due to the stock status being below safe biological limits (JNCC, 2009) in 2003-04 for the North Sea, West Scotland, Eastern Channel, Irish Sea, Celtic Sea and West Channel areas. The northern stock, i.e. the one occurring in the North Sea as well as other northern areas, in a more recent assessment, is considered stable (European Fisheries Commission, 2011).

4.4 Fish Resource

Fish resources are highly mobile and wide ranging. Adult populations are also highly variable, temporally and spatially, as demonstrated through comparison of annual data collected under fisheries monitoring programmes (De Oliveira and Elliot, 2010). Consequently fish ecology issues are likely to be generic and relevant to the entire Offshore ZDE including the Dogger Bank Zone. The following sections, therefore, describe ecological aspects of fish and shellfish that are characteristic of the central and southern North Sea and that are relevant to both the Dogger Bank Zone and the Offshore Cable Area.

The Offshore ZDE encompasses a large part of the central and western North Sea, including part of the feature known as the Dogger Bank, which is a shallow region well known for its fisheries (Nielsen *et al.,* 1993). The Offshore ZDE includes habitats of conservation value which can have specific fish species associated with them. The Greater Wash region in the southwest of the area is characterised by shallow, turbid waters and habitats primarily ranging from estuarine muds to coarser sands and gravels further

offshore, including cobble reefs (Blyth-Skyrme, 2010).**Error! Reference source not found.**The range of habitats present on the Dogger Bank and within the Offshore ZDE (see Chapter 3, Figure 3.1) has the potential to support a variety of, generally, demersal species, with respect to preferred prey species and in relation to physically preferred habitats. Examples include occurrence of skates and rays over sandier sediments where a range of preferred crustacean species may be found; similarly sandeels have highly specific habitat preference and bury in sandy sediments for large parts of the year (FishBase, 2010).

4.4.1 Bony fish species (Osteichthyes)

All of the commercial bony fish (Osteichthyes) species relevant to the Offshore ZDE, and included in this report, have a biogeographical pattern of distribution in the North Sea (Ellis *et al.,* 2010b). Landings data from 2006 and 2007, from the ICES rectangles (**Error! Reference source not found.**), within and adjacent to the original Dogger Bank dSAC boundary (the boundary was subsequently modified to produce the present day cSAC boundary) were dominated by flatfish (Lee *et al.,* 2009). However, for the adjacent rectangles the composition differed with cod and skates (as well as Norway lobster *Nephrops norvegicus*) having a greater prominence to the south, and megrim *Lepidorhombus whiffiagonis*, hake *M. merluccius* and anglerfish *Lophius piscatorius* increasing to the north and east. This helps to illustrate the diversity of fish species available within the region. It should be noted that during 2006 and 2007 there was a ban on sandeel fishing, hence its absence from the Lee *et al.* (2009) analysis. Also noted was the fact that the majority of fishing effort deployed within this area was by Danish, Dutch and UK vessels, but at the time, Danish data were unavailable so the main focus of the Lee *et al.* (2009) study was on Dutch and UK fishing effort.

The presence of hake in the catches from the north and the east of the cSAC are of particular note. The habitat supporting the biotope "Seapens and burrowing megafauna in circalittoral fine mud" (JNCC, 2010) is reported as being a nursery ground for this species (OSPAR, 2010a). Evidence for the presence of this community on the northern edge of the Dogger Bank (Figure 4.2) was found by Diesing *et al.* (2009). This circalittoral fine mud habitat (UK BAP, 2008) is known to be impacted by bottom trawling activities and its sensitivity has been reviewed by Hughes (1998, as cited in OSPAR, 2010a). The habitat is listed by OSPAR as threatened/declining and is on the UK BAP priority list. In September 2010 OSPAR recommended furthering the protection and restoration of this habitat (OSPAR, 2010c).

The preferred habitat of the sandeel *Ammodytes* spp. is sandy sediments; therefore within the North Sea it shows a patchy distribution reflecting this preference (Macer, 1966; Scott, 1968 cited in Jensen *et al.,* 2003). The species *Ammodytes marinus* is by far the most common comprising over 90% of the sandeel catch (Jensen *et al.,* 2003). Figure 4.4 shows the sandeel catch effort at the Dogger Bank in 2008 to indicate the likely distribution of these fish within the Offshore ZDE. Sandeel play an important trophic role in the North Sea, linking zooplankton and top predators. They are considered a keystone species and are the main prey item for many birds, mammal and fish species (Frederiksen *et al.,* 2006).

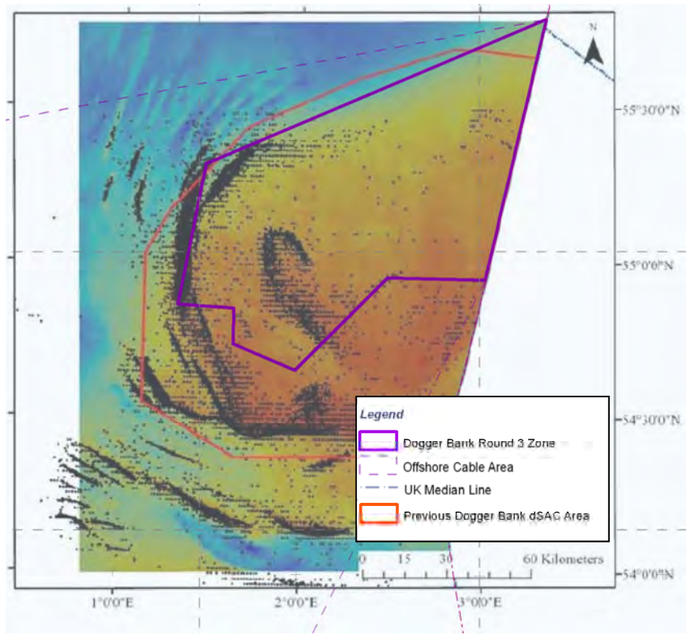


Figure 4.4: Spatial distribution of sandeel fishing effort on the Dogger Bank for 2008 (as modified from Engelhard et al., 2008, after Diesing et al., 2009).

Within the Offshore ZDE, herring and cod are widely distributed and abundance is spatially/temporally variable as indicated by annual catch rate data (see Figure 4.5 overleaf for cod). Note that the data presented in Figure 4.5 and in the following figures (Figure 4.6, Figure 4.7 and Figure 4.8) are from de Oliveira and Peach (2011) and fall within the Offshore Cable Area only. While North Sea stocks are fished throughout the year, herring landings are greatest in the third quarter of the year, predominantly from the Orkney/Shetland area, Buchan, northwest of the Dogger Bank Zone and in coastal waters of eastern England, including areas within the Offshore ZDE (Rogers and Stocks, 2001). Cod is caught throughout the North Sea (ICES, 2006).

Haddock occur throughout the northern North Sea (Albert, 1994 as cited in Rogers and Stock, 2001). An indication of the distribution of haddock abundance within and around the Offshore Cable Area is presented in Figure 4.6 as catch rate.

Whiting (Figure 4.7 and Appendix B) is widely distributed throughout the North Sea and in to Skagerrak and Kattegat, the entrance to the Baltic. High densities of both small and large whiting may be found almost everywhere, with the exception of the Dogger Bank where densities are lower (ICES, 2006). The recaptures of tagged whiting indicate that populations north and south of Dogger Bank are almost separate (Rogers and Stocks, 2001), while whiting in the North Sea and eastern Channel are assessed by ICES as one unit stock (ICES, 2006).

Sole reach their northern limit in the North Sea. The species is mainly found in the southern and eastern North Sea, south of the line from Flamborough Head (ICES, 2006), and is therefore less relevant for the Dogger Bank Zone.

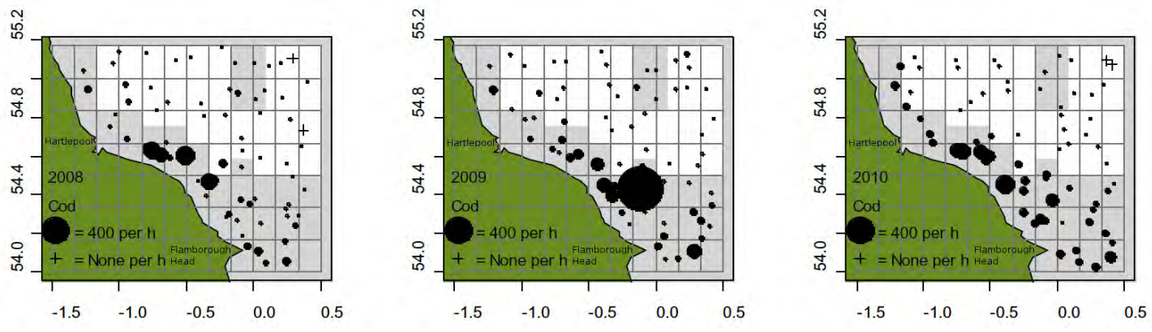


Figure 4.5: Distributions of cod within and around the offshore ZDE 2008-2010 (numbers caught per hour). Shading within the grid lines indicates area with coarse seabed type (De Oliveira and Peach, 2011). Note: Closest point of the Dogger Bank Zone is 54.854 N, 1.319W.

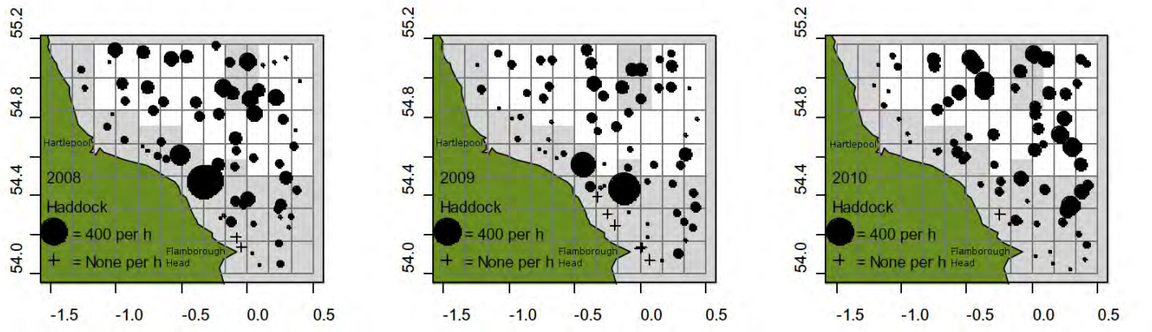


Figure 4.6: Distributions of haddock within and around the Offshore ZDE 2008-2010 (numbers caught per hour). Shading within the grid lines indicates area with coarse seabed type (De Oliveira and Peach, 2011). Note: Closest point of the Dogger Bank Zone is 54.854 N, 1.319W.

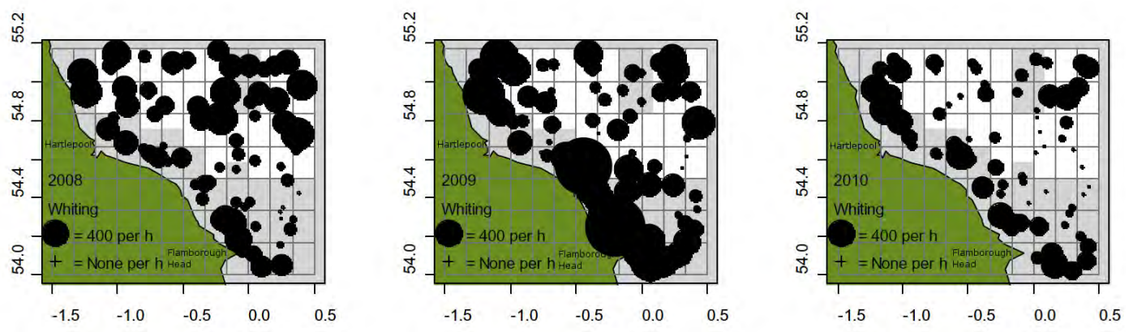


Figure 4.7: Distributions of whiting within and around the Offshore ZDE 2008-2010 (numbers caught per hour). Shading within the grid lines indicates area with coarse seabed type (De Oliveira and Peach, 2011). Note: Closest point of the Dogger Bank Zone is 54.854 N, 1.319W.

Plaice is found at its highest abundance in the southern part of the North Sea, along the east coast of the UK, and in the eastern Channel, Skagerrak and Kattegat (ICES, 2006). It is the most important flatfish of the Northern European fishing industry (Maitland and Herdson, 2009). Figure 4.8 presents annual unit catch rates for plaice as an indication of the distribution of abundance within and around the Offshore Cable Area.

In the North Sea, sprat is most abundant south of the Dogger Bank and in the Kattegat, but their distribution extends along the British coast and secondary concentrations are found in the Firth of Forth and the Moray Firth (Knijn *et al.,* 1993, as cited in ICES, 2006).

Poor cod *Trisopterus minutus* was recorded in low numbers during the site specific survey (EMU Ltd, 2008). It is widespread in the North Sea and also in the Offshore ZDE including within the Dogger Bank Zone (MarBEF, 2011). Poor cod breed in spring in deep water. Occurs mostly from 15 to 200 m in the Atlantic on sandy or muddy bottoms and large individuals occur down to 300 m (Ruiz, 2008).

Commercial marine Osteichthyes species considered to be of conservation importance that occur in the Offshore ZDE are presented in Table 4.1.

Appendix B presents summary ecological information for selected commercial species, characteristic of the Dogger Bank Zone and Offshore Cable Area.

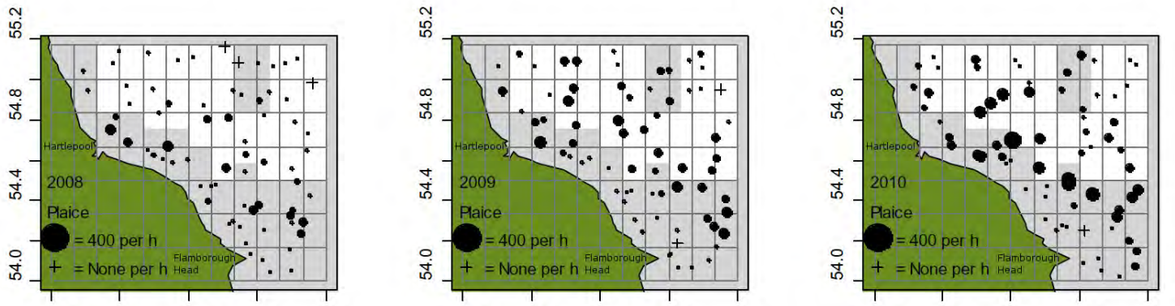


Figure 4.8: Distributions of plaice within and around the Offshore ZDE 2008-2010 (numbers caught per hour). Shading within the grid lines indicates area with coarse seabed type (De Oliveira and Peach, 2011). Note: Closest point of the Dogger Bank Zone is 54.854 N, 1.319W.

Table 4.1: Commercial Osteichthyes species with conservation importance occurring in the Offshore ZDE (JNCC, 2009).

Commercial species	Protection / Designation	Threat
Plaice *Pleuronectes platessa*	UK BAP / England NERC S.41 & Reg. 7	Unsustainable fishing mortality/International threat
Cod *Gadus morhua*	UK BAP / England NERC S.41 & Reg. 7	Outside safe biological limits/International threat
Dover sole *Solea solea*	UK BAP / England NERC S.41 & Reg. 7	Outside safe biological limits/International threat
Ling *Molva molva*	UK BAP / England NERC S.41 & Reg. 7	Outside safe biological limits (caught primarily as by-catch)
Mackerel *Scomber scombrus*	UK BAP / England NERC S.41 & Reg. 7	International threat
Horse Mackerel *Trachurus trachurus*	UK BAP / England NERC S.41 & Reg. 7	International threat
Hake *Merluccius merluccius*	UK BAP / England NERC S.41 & Reg. 7	Below safe biological limits/Marked decline in UK
Herring *Clupea harengus*	UK BAP / England NERC S.41 & Reg. 7	Nationally scarce/International threat
Lesser sandeel *Ammodytes marinus*	UK BAP / England NERC S.41 & Reg. 7	Nationally scarce/Marked decline in the UK
Whiting *Merlangius merlangus*	UK BAP / England NERC S.41 & Reg. 7	Marked as decline in the UK
Saithe *Pollachius virens*	Listed for Scotland only	UK priority species
Haddock *Melanogrammus aeglefinus*	IUCN Red List (IUCN, 2010)	Vulnerable
Norway pout *Trisopterus esmarkii*	Listed for Scotland only	25% decline
Poor cod *Trisopterus minutus*	IUCN Red List (IUCN, 2010)	Least endangered
Note: Reg. 7 refers to Regulation 7 of The Infrastructure Planning (Decisions) Regulations 2010.		

4.4.2 Elasmobranchs

Another group of species, covered under a number of protection initiatives at national level, such as the UK Biodiversity Action Plan and the Wildlife and Countryside Act (1981) (Gill and Kimber, 2005), is the elasmobranchs. Species belonging to this group are commercial fish targets, but due to their large size, many elasmobranchs are also targeted in recreational fisheries (Ellis *et al*., 2005a).

Demersal elasmobranchs are typically slow-growing and have a high age-at-maturity. No population estimates are available (although for spurdog the stock is depleted and may be in danger of collapse). Although trends in relative abundance indices from fishery-independent trawl surveys are available for many stocks, it has generally not been possible to determine whether overfishing is (or has been) occurring (ICES, 2010a; 2010b).

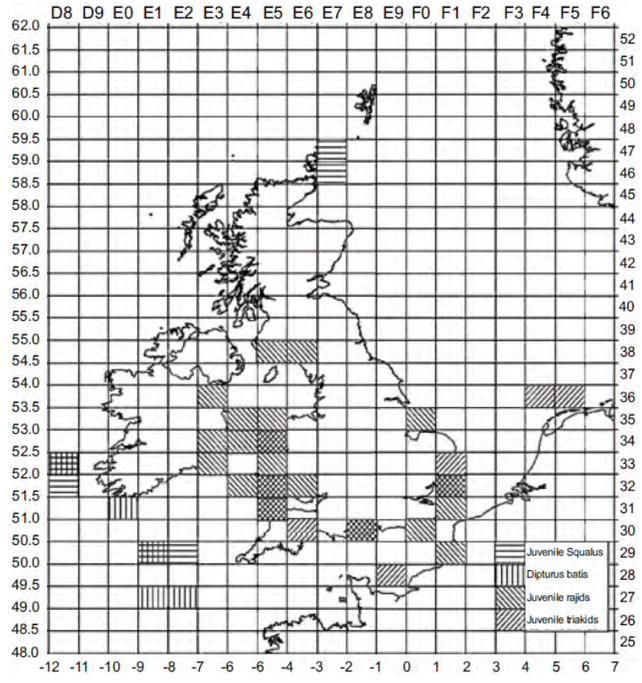


Figure 4.9: ICES rectangles that contain important grounds for the elasmobranchs species including: *Dipturus batis* (common skate) and juvenile Rajids (skates), Triakids (hound sharks) and *Squalus acanthias* (spiny dogfish). (Source: Ellis *et al*., 2005a).

Landings of skates and rays in the North Sea eco-region have generally declined, especially since the mid-1990s (ICES, 2010a). These dramatic declines in the numbers of elasmobranchs, particularly of the larger species, and the associated habitat degradation reported in the scientific literature, have been of increasing concern to fisheries and wildlife managers (Walker and Hislop, 1998; Rogers and Ellis, 2000; Meyers and Worm, 2003, as cited in Gill and Kimber, 2005).

Table 4.2 provides a summary of the status and distribution of the species stocks for which conservation designations exist with references to ICES advice for future elasmobranch stock management. Species likely to occur in the Offshore ZDE include spurdog *Squalus acanthias*, thornback ray *Raja clavata* (Figure 4.10) and spotted ray *Raja montagui* (Figure 4.11).

Suffering from fishing pressure (OSPAR, 2010b), formerly important fisheries species belonging to this group (e.g. the common skate complex *Dipturus batis*) are now absent or locally rare in UK areas (Gill and Kimber, 2005). An important ground for juvenile elasmobranchs in general has been highlighted within the Offshore ZDE (Figure 4.9) and in 2007 common skate were noted in the Humber estuary area (NBN Gateway, 2010) with additional records from the wider area identified from EurOBIS data sources (Marine Biodiversity and Ecosystem Functioning (MarBEF), 2011).

Table 4.2: Qualitative evaluation of demersal elasmobranchs stocks of relevant species for the Offshore ZDE. All species listed are UK BAP species and included in NERC S.41 List of Species of Principal Importance in England. Other designations are reported in the table.

Species	Traits and Habitat	State of the Stock	Distribution and relevance to Offshore ZDE	Conservation Designations (JNCC, 2011f)
Basking shark *Cetorhinus maximus*	Migratory and widely distributed, but only regularly seen in a few favoured coastal locations and probably never abundant (Fowler, 2005).	**VULNERABLE** (IUCN, 2010). Stock structure and dynamics unknown. The Total Allowed Catch (TAC) is zero (Fowler, 2005; ICES, 2010c).	Its distribution includes the North Sea but very few sightings have occurred here (Southall *et al.* 2005; Ellis *et al*., 2010b).	OSPAR List of threatened and/or declining species; Bern Convention (Appendix 2); Wildlife and Countryside Act 1981, Schedule 5
Kitefin shark *Dalatias licha*	Found on continental and insular shelves and slopes in warm-temperate and tropical areas. Depth range: 37 to 1,800 m. Most common between 300-600 m (Blasdale *et al*., 2006).	**NEAR THREATENED** (IUCN, 2010). Stock structure and dynamics unknown due to lack of information. The Total Allowed Catches (TAC) is zero (ICES, 2010d).	Southwest UK coast and eastern English Channel. Potential distribution within the Offshore ZDE, but no records are available (Blasdale *et al*., 2006; Ellis *et al*. 2010b; IUCN, 2010).	IUCN Red List of Threatened Species (2010).
Common skate *Dipturus batis* complex includes: *D.* cf. *flossada* *D.* cf. *intermedia* *D. nidarosiensis*	Found in shelf waters (OSPAR Commission, 2010f).	**CRITICALLY ENDANGERED** (IUCN, 2010). DEPLETED in ICES IVa (likely merging with VI &IIa) (OSPAR Commission, 2010f; IUCN, 2010)	Formerly widely distributed over much of the North Sea but is now found only rarely, and only in the northern North Sea. Juveniles off northwestern Scotland and Celtic Sea (ICES 2010e; Ellis *et al*., 2010a).	OSPAR List of threatened and/or declining species
Tope shark *Galeorhinus galeus*	Mainly coastal and bottom associated shark of temperate areas.	**DATA DEFICIENT** (IUCN, 2010). Limited biological data for Northeast Atlantic stocks (Walker *et al*., 2006; IUCN, 2010).	Single stock in all ICES areas (ICES, 2010e).	IUCN Red List of Threatened Species (2010).
Porbeagle *Lamna nasus*	Migratory and schooling species, occurring in cold, temperate waters (ICES, 2010f).	**VULNERABLE** (IUCN, 2010). Stock structure and dynamics unknown (IUCN, 2010; ICES, 2010f).	North and South Atlantic, South Pacific oceans, including the North Sea. Mostly outside the Offshore ZDE (Natanson *et al*., 2002; Stevens *et al*., 2006; MarBEF, 2011).	OSPAR List of threatened and/or declining species
Thornback ray *Raja clavata*	Mud, sand, shingle, gravel and rocky areas on the shelf and upper slope in the northeast Atlantic and all OSPAR Regions (OSPAR Commission, 2010b).	**NEAR THREATENED** (IUCN, 2010). Stable/Increasing Stocks in ICES IVc, VIId; Uncertain in ICES IVa and IVb (OSPAR, 2010b; ICES, 2010e).	All OSPAR Regions (no population estimate in Region II) Historical distribution (Figure 4.10). The distribution (Figure 4.18a) has been plotted using Defra 2010 data (OSPAR Commission, 2010b).	NERC S. 42 list of Species of Principal Importance in England; Scottish Biodiversity List of species of principal importance for biodiversity conservation; OSPAR List of threatened and/or declining species.
Spotted ray *Raja montagui*	Most common on sandy sediments in coastal and shelf seas. Depth range: 28 to 530 m. Most common 100 to 500 m (Ellis *et al*., 2007).	**LEAST CONCERN** (IUCN, 2010). Stable/increasing Stocks in IVb and IVc (ICES, 2010a).	OSPAR Area II/ICES Areas IVa,b,c and VIId,e) Historical distribution (Figure 4.11). Gaps may be due to misidentification of juveniles. (OSPAR Commission, 2010c)	OSPAR List of threatened and/or declining species; IUCN Red List of Threatened Species (2010).
Spurdog *Squalus acanthias*	Widespread on the continental shelf. Population productivity is low, with low fecundity and a protracted gestation period (ICES, 2010g).	**DEPLETED** in OSPAR Areas. Stock in danger of collapse. The Total Allowed Catch (TAC) should be set at zero and bycatches reduced at the lowest possible level (ICES, 2010g; OSPAR Commission, 2010e).	Juveniles in central/northern North Sea, northwest Scotland, northern Irish Sea and Celtic Sea (**Error! Reference source not found.**d). Data gaps in the eastern English Channel and southern North Sea may be due to reduced sampling in the area (Ellis *et al*., 2010a).	OSPAR List of threatened and/or declining species

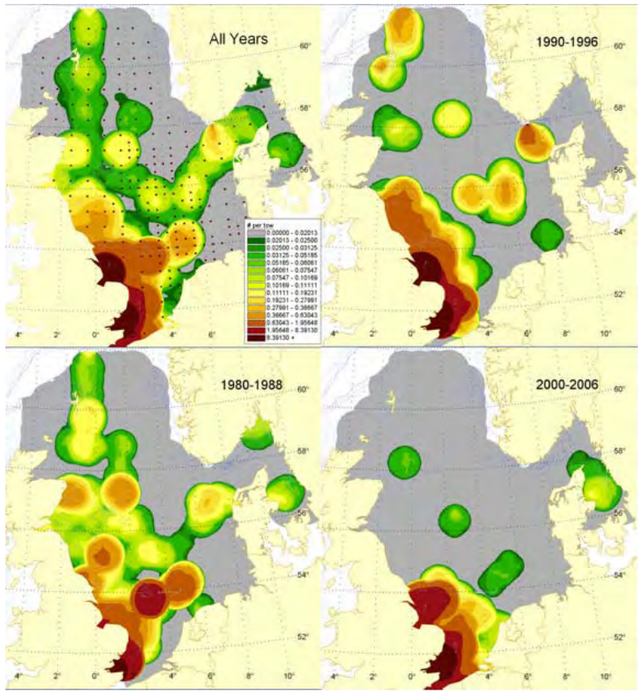


Figure 4.10: Distribution of thornback ray *Raja clavata* during three periods and averaged over the entire survey period (1980–2006) in the North Sea, Skagerrak, Kattegat and eastern English Channel. Points on "All Years" map are grid averaged survey location. Source: ICES (2007).

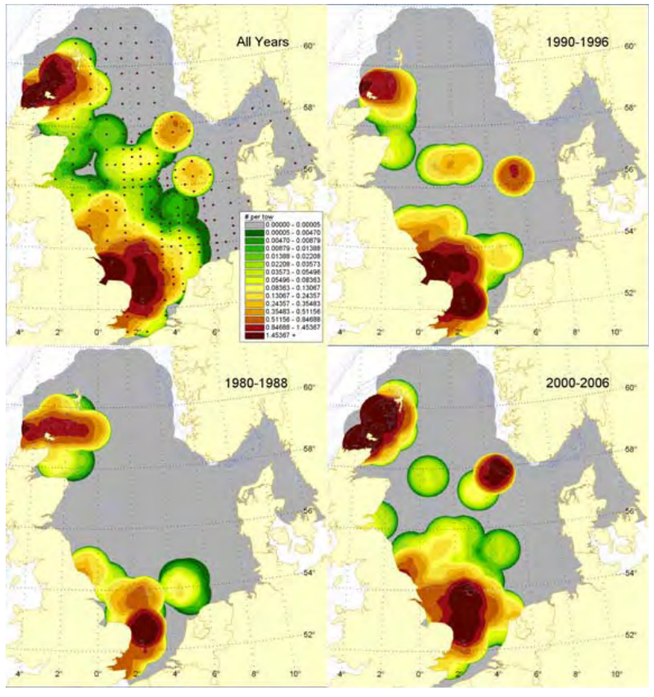


Figure 4.11: Distribution of spotted ray *Raja montagui* during three periods and averaged over the entire survey period (1980–2006) in the North Sea, Skagerrak, Kattegat and eastern English Channel. Points on "All Years"map are grid averaged survey location. Source: ICES (2007).

For most of the elasmobranch species insufficient data exist in order to delineate spawning grounds, therefore specific spawning grounds are not well established (Ellis *et al.,* 2010a). Consequently ICES (2010e) was not able to provide advice for certain species, highlighting that the lack of more precise data on the location of pupping and nursery grounds precludes spatial management for them at the present time.

The effect of climate change on elasmobranchs is only poorly understood in comparison to bony fishes (Fisheries Society of the British Isles (FSBI), 2007). Fowler *et al*. (2002) note that migratory species could be particularly vulnerable to climate change and that the distributions and abundances of individual species are unlikely to remain the same as they are seen today. Cotton *et al*. (2005) found that the major component of annual changes in relative abundance of basking sharks was correlated with short-term fluctuations in sea surface temperatures and the North Atlantic Oscillation (NAO).

Other elasmobranch species

Other species of elasmobranch with an IUCN assessment but no specific conservation status, considered during the reporting process, were the starry ray *Amblyraia radiata*; the cuckoo ray *Leucoraja noevus*; blonde ray *Raja brachyuran*; the lesser spotted dogfish *Scyliorhinus canicula* and smooth hounds *Mustelus* spp.

Species with no known distribution in the area included the leafscale gulper shark *Centrophorus squamosus*; Portuguese shark *Centroscymnus coelolepis*; gulper shark *Centrophorus granulosus*; sandy ray *Leucoraja circularis*; undulate ray *Raja undulata*; angel shark *Squatina squatina* (historic records only from the Dogger Bank); shortfin mako *Isurus oxyrinchus* and blue shark *Prionace glauca.*

4.4.3 Diadromous fish species

For many of the migratory species it is evident that there is a deficit of comprehensive and robust scientific literature available. The 'Living North Sea' project aims to focus on key issues and solutions for fish migration. It consists of fifteen partners working on reconnecting the rivers and deltas around the North Sea region (Source: www.livingnorthsea.eu). The website presents the projects which will be undertaken to fill the gap knowledge about migratory species. Of main relevance for the Offshore ZDE are activities from the Tracking and Distribution Subgroup which will undertake several projects about sea migration of sea trout and local movement of eels and lamprey species in the area of the North Sea, for which no or limited information is available. Figure 4.12 shows eel catches as recorded by the Demersal Fish Survey (DFS), an ICES-coordinated beam trawl survey in the coastal areas of the southern North Sea, during their surveys spanning the years 1970–2008 (ICES, 2009).

A diadromous fish is one which uses two habitats – specifically the sea and freshwater – during its life history (Gross, 1987). In the Offshore ZDE, seven species of diadromous fish have been recorded, namely allis shad *Alosa alosa,* twaite shad *Alosa fallax,* river lamprey *Lampetra fluviatilis*, sea lamprey *Petromyzon marinus*, Atlantic salmon *Salmo salar*, European eel *Anguilla anguilla* and European smelt *Osmerus eperlanus*. These species are all listed on Annex II of Council directive 92/43/EEC except *Anguilla anguilla* and *Osmerus eperlanus* which are features of conservation interest (FOCI) under the MCZ process.

Mapped records of their presence within the Offshore ZDE are available from MarBEF (2011). *Alosa alosa, A. fallax, L. fluvialtilis* and *P. marinus* are recorded in the Humber Estuary SAC which falls within the Offshore ZDE in the coastal area with the latter two species of lamprey listed as qualifying features for the SAC, though not a primary reason for its selection (JNCC 2011a-d). Table 4.3 summarises the distributional information for each species as well as the level of threat in European waters and the designated conservation status. More information on these species is available in Appendix B.

Table 4.3: Distribution, spawning and nursery areas and stock status for diadromous species in EU waters and their conservation designation.

Species	Distribution	Spawning/nursery areas	EU waters	Conservation Designations (JNCC, 2011f)
Allis shad *Alosa alosa*	The species are found, in the NE Atlantic along the western coastline of Europe from southern Norway to Spain.	River Humber. Estuaries are important nursery areas for both allis and twaite shad (Maitland and Hatton-Ellis, 2003).	**Status:** Classified as vulnerable in Europe (Benigno Elvira, 2000). Least Concern (IUCN, 2010). **Population trend:** unknown (IUCN, 2010).	Habitats Directive (Annex II and Va); Conservation of Habitats and Species 2010, Schedule 4; Wildlife and Countryside Act 1981, Schedule 5; Bern Convention, Appendix 3; UK BAP Priority Species; NERC Act 2006 S41 Biodiversity list species of principal importance; OSPAR List of threatened and/or declining species
Twaite shad *Alosa fallax*			**Status:** Classified as vulnerable in Europe (Benigno Elvira, 2000). Least Concern (IUCN, 2010). **Population trend:** Stable (IUCN, 2010).	Habitats Directive (Annex II and Va); Conservation of Habitats and Species 2010, Schedule 4; Wildlife and Countryside Act 1981, Schedule 5; Bern Convention, Appendix 3; UK BAP Priority Species; NERC Act 2006 S41 Biodiversity list species of principal importance
River lamprey *Lampetra fluviatilis*	Found only in Western Europe ranging from southern Norway to the western Mediterranean. UK populations are important for the conservation of the species at an EU level (JNCC, 2011)	Spawning and nursery areas for both lampreys are located in rivers adjacent to the Offshore ZDE.	**Status:** Classified as vulnerable in Europe (Benigno Elvira, 2000). Least Concern (IUCN, 2010). **Population trend:** Unknown (IUCN, 2010).	Habitats Directive (Annex II and Va); Conservation of Habitats and Species 2010, Schedule 4; Bern Convention, Appendix 3; UK BAP Priority Species; NERC Act 2006 S41 Biodiversity list species of principal importance
Sea lamprey *Petromyzon marinus*	The species is reasonably widespread in UK rivers (reviewed in Beaulaton *et al*., 2008, as cited in OSPAR, 2009).		**Status:** Classified as Lower Risk (Benigno Elvira, 2000). Least Concern (IUCN, 2010). **Population trend:** unknown (IUCN, 2010).	Habitats Directive (Annex II); Bern Convention, Appendix 3; UK BAP Priority Species; NERC Act 2006 S41 Biodiversity list species of principal importance; OSPAR List of threatened and/or declining species
Salmon *Salmo salar*	The species is widely distributed within the EU and the UK salmon population and comprises a significant proportion of the total European stock (JNCC, 2011e).	Spawning and nursery areas for both lampreys are located in rivers adjacent to the Offshore ZDE.	**Status:** Lower Risk/Least Concern (IUCN, 2010). **Population trend:** unknown (IUCN, 2010).	Habitats Directive (Annex II and Va); Conservation of Habitats and Species 2010, Schedule 4; Bern Convention, Appendix 3; UK BAP Priority Species; NERC Act 2006 S41 Biodiversity list species of principal importance; OSPAR List of threatened and/or declining species
Eel *Anguilla anguilla*	Eel stock in marine waters are thought to constitute a minor fraction of the total stock around the Southern North Sea (the majority of which is found in inland waters).	There are no data with which to identify important habitats for this species in the fully marine waters of the UK Exclusive Economic Zone (Ellis *et al*., 2010b) of the Offshore ZDE.	**Status:** Critically endangered, (Freyhof and Kottelat 2008b). **Population trend:** Decreasing (Freyhof and Kottelat, 2008b).	UK BAP Priority Species; NERC Act 2006 S41 Biodiversity list species of principal importance; OSPAR List of threatened and/or declining species; FOCI under the MCZ designation process
European smelt *Osmerus eperlanus*	Smelt are extinct in the Wansbeck, Blyth, Tyne, Wear and Tees estuaries but are present in the Humber Estuary and it is likely that this population is the basis for any stock of fish which run into the Ouse, Trent and associated waters to spawn (Maitland, 2003a). A similar pattern will be seen in the Wash.	Spawning takes place in freshwater. Estuaries are important nursery areas for smelt.	**Status:** Least Concern (Freyhof and Kottelat, 2008c). **Population trend:** Unknown (IUCN, 2010).	UK BAP Priority Species; NERC Act 2006 S41 Biodiversity list species of principal importance; FOCI under the MCZ designation process

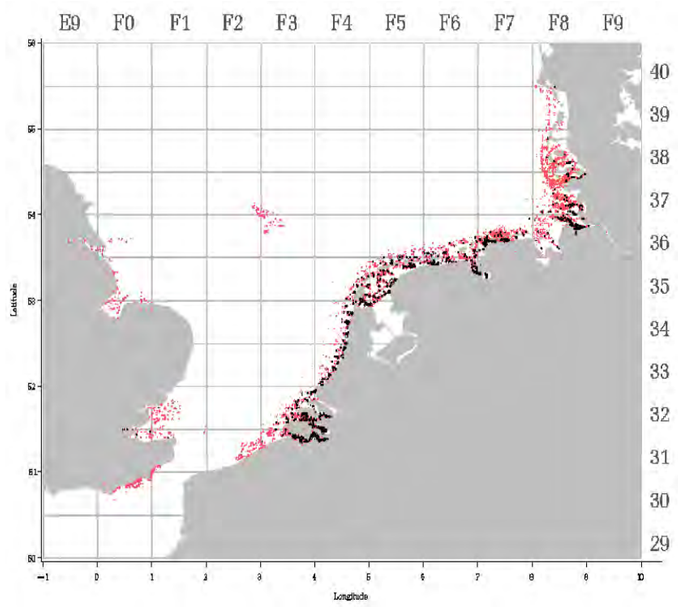


Figure 4.12: The distribution of the Demersal Fish Survey sampling in the southern North Sea from 1970 to 2008. Red dots, such as those near the Dogger Bank, indicate a zero observation; black circles are proportional to the number of eels recorded (ICES, 2009).

4.4.4 Crustacea

Norway lobster *Nephrops norvegicus* is widely distributed on muddy substrata throughout the area. This species is landed from the north and west of the Dogger Bank Zone in the central North Sea, along the northeast coast of England, the eastern coast of Scotland, and on the Fladen ground in the northern North Sea (Rogers and Stocks, 2001). Figure 4.13 shows an important *Nephrops* fishing ground in a coastal area of the Offshore ZDE at Farns Deep, off the coast of Tynemouth. Importantly, although the species itself is not protected by law, it can be present in the OSPAR and UK BAP habitat, 'sea pen and burrowing megafauna', shown previously in Figure 4.2.

Brown crab *Cancer pagurus* are widespread around the coasts of England and Scotland (Roger and Stock, 2001). Figure 4.14 shows the distribution of the catches around the British and Irish Isles in 2008 and the abundance of brown crab within the Offshore ZDE in a national context.

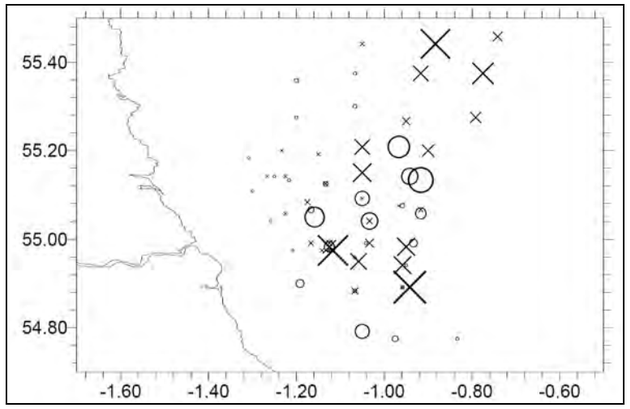


Figure 4.13: Distribution of *Nephrops* as determined during the Farn Deeps FSP survey during spring 2004. Symbols X and O represent two different fishing vessels with largest symbol equal to a catch of 5,228 per hour (Cotter *et al*., 2004).

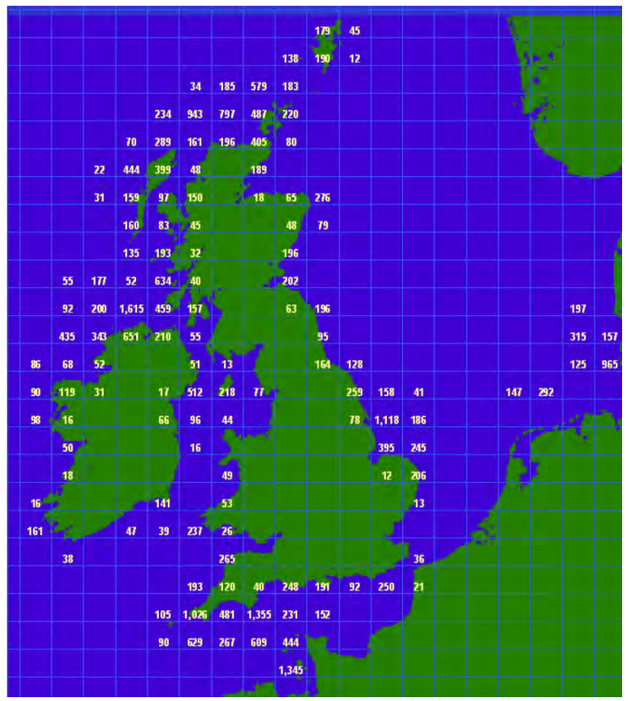


Figure 4.14: Brown crab *Cancer pagurus* catches per ICES rectangle for the UK (including Isle of Man and Channel Islands) and Republic of Ireland fleet during 2008 (tonnes, as modified in Nautilus Consultants Ltd (2009) report to Cefas.

4.4.5 Other fish species of interest

Although of only limited commercial value in the Offshore ZDE, ling *Molva molva* is considered to be of conservation importance. Appendix B provides summary ecological information for other selected species including the grey gurnard *Eutrigla gurnardus*, saithe *Pollachius virens*, and Norway pout *Trisopterus esmarkii*. Commonly encountered species during trawl fisheries surveys (EMU Ltd, 2008) included weever fish. These were found in relatively high abundance within sandy substrata on the top of the bank suggesting a particular habitat preference. Saithe, pout, dragonet *Callionymus lyra*, gurnards and pogge *Agonus cataphractus* were also frequently recorded although no discernible distribution pattern was noted.

Ling *Molva molva* lives primarily on rocky bottoms and is a UK BAP priority species which is found throughout the Offshore ZDE including within the Dogger Bank Zone (MarBEF, 2011). It spawns in deep water (100 m+) from March to July/August and the juveniles remain in coastal areas for 2-3 years (MarLIN, 2010).

Ling are considered to be 'outside safe biological limits' according to the JNCC priority species data collation report (2009).

Two species of note which usually have a more southerly distribution are also mentioned here as they are occasional visitors to the Offshore ZDE area. These are the red mullet *Mullus surmulentus* and the grey gurnard. With increasing ocean temperatures related to climate change, recordings of these species further north may be expected to become more frequent; increased landing records have been noted in the region (Walmsley and Pawson, 2007, as cited in Blyth-Skyrme, 2010).

4.4.6 Seahorse records

There are currently no records of the short-snouted seahorse *Hippocampus hippocampus* in the North Sea on the NBN Gateway. EurOBIS does record the species at a handful of coastal sites in the North Sea, principally off Belgium. The same is true for the long-snouted seahorse *H. guttulatus*.

Pinnegar *et al*. (2008) compiled records of the occurrence of the short-snouted seahorse in the North Sea. In UK waters the first confirmed record north of 54° latitude for over 100 years was in 2006 from a location within the Offshore ZDE (approximately 40 km south west of the Dogger Bank cSAC boundary). This was

a single female specimen of *H. hippocampus*. At a similar line of latitude specimens of the same species were found off Denmark between 2001 and 2007.

These species are not limited to seagrass habitats and range across micro- and macro-algae to silt, mud and rocky substrata (Garrick-Maidment and Jones, 2004 as cited in Sabatini and Ballerstedt, 2007). It is a mobile species and may move to deeper water (>70 m depth) to overwinter (Garrick-Maidment, 2998 cited in Sabatini and Ballerstedt, 2007).

Both *H. hippocampus and H. guttulatus* are protected under Schedule 5 of the Wildlife and Countryside Act 1981, the NERC Act 2006 and are listed as priority species by the UK BAP and by OSPAR as threatened and declining in the Greater North Sea area (JNCC, 2011).

Pinnegar *et al*. (2008) speculate that the lack of records for the North Sea may either be an oversight or that climate change may now be extending the range of distribution for the species northwards.

4.4.7 Site-Specific Survey Data

Characteristic fish species recorded from the Dogger Bank Zone and just south of the zone (Figure 4.1) by EMU Ltd (2008) included dab *Limanda limanda* and lemon sole *Microstomus kitt*, which were ubiquitous during commercial trawl sampling surveys suggesting no local habitat related distribution pattern. Whiting were also commonly recorded by this survey but tended to occur around the bank margins and in deeper water west of the Dogger Bank; on top of the bank it was not found or only recorded in very low numbers. Other conspicuous species included mackerel *Scomber scombrus* and squid Loliginidae. These species were associated with areas of the Dogger Bank Zone with a slope and were only present in low numbers/absent from the shallower and flatter sandy seabed areas on top of the bank. Plaice, in contrast, were distributed over sandy habitat areas over the top of the bank suggesting a preference for comparatively simpler sandy and shallower water habitats.

Commercial fish		Commercial shellfish		Other fish species	
Species name	**Common name**	**Species name**	**Common name**	**Species name**	**Common name**
Gadus morhua	Cod	*Homarus gammarus*	Lobster (f)	*Molva molva*	Ling
Merlangius merlangus	Whiting	*Cancer pagurus*	Brown crab	*Trisopterus luscus*	Bib/Pouting
Melanogrammus aeglefinus	Haddock	*Maja (squinado) brachydactyla*	Spider crab	*Zoarces viviparous*	Eelpout
Pollachius pollachius	Pollack	*Sepia officinalis*	Cuttlefish	Syngnathidae	Snake pipefish
Trisopterus minutus	Poor cod	Loliginidae	Squid	Triglidae	Gurnards
Mullus surmuletus	Red mullet	*Buccinum undatum*	Common whelk	Cottidae	Sea scorpions
Trachurus trachurus	Horse mackerel	*Pecten maximus*	King scallop	*Agonus cataphractus*	Pogge
Scomber scombrus	Mackerel	*Aequipecten opercularis*	Queen scallop	Liparidae	Seasnails
Clupea harengus	Herring			Trachinidae	Weevers
Pleuronectes platessa	Plaice			Callionymidae	Dragonet
Limanda limanda	Dab				
Arnoglossus laterna	Scaldfish				
Microstomus kitt	Lemon sole				
Ammodytidae	Sandeels				
Pollachius virens	Saithe/Colay				

Table 4.4: Conspicuous fish, shellfish and other fish species identified during surveys at Dogger Bank (Emu Ltd, 2008).

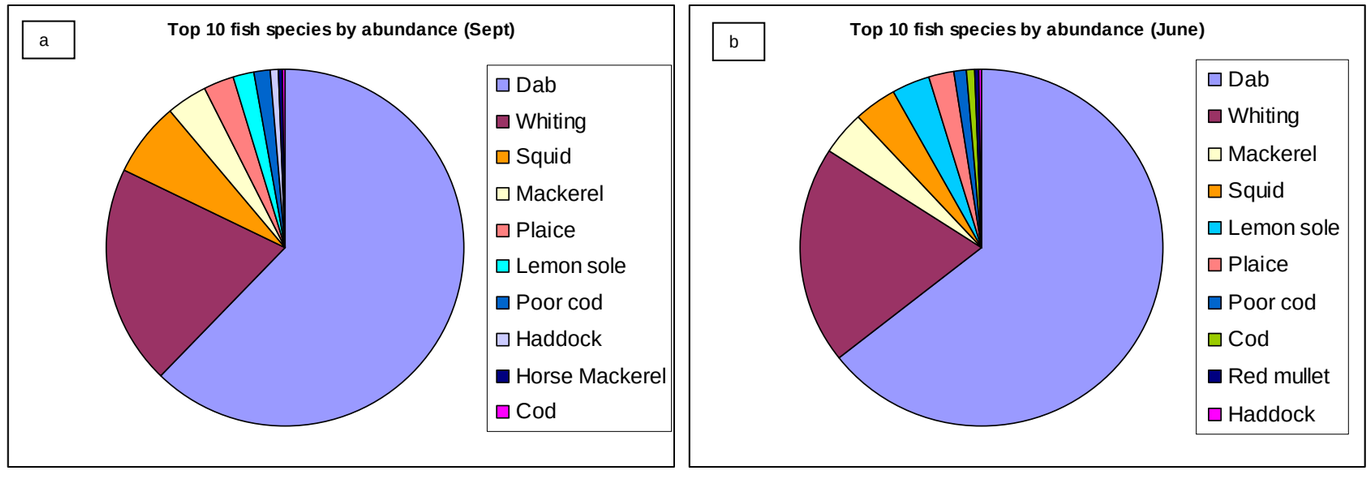


Figure 4.15: Relative abundance of conspicuous fish species as detected during the a) June and b) September 2007 surveys (Emu Ltd, 2008).

Table 4.5: Key prey items of the main fish and shellfish species (various sources cited in Rogers and Stocks, 2001 and ICES, 2006).

Predator	Prey
Sandeel	Feed on planktonic prey such as copepods and crustacean larvae as well as polychaete worms, amphipods and small fish (including sandeels).
Herring	Larvae feed on copepods and other small planktonic organisms. Larger Herring feed on small fish, arrow worms and ctenophores.
Grey gurnard	Small individuals: feed on small crustaceans (e.g. brown shrimp *Crangon crangon*) and small crabs. Larger individuals: juveniles of cod, whiting, sandeel and Dover sole.
Cod	Feed on crustacean (shrimps and small crabs), worms, brittlestars, fish (including herring, sprats, sandeels, smaller gadoids, juvenile flatfish).
Haddock	Pelagic post-larvae predate on euphausids, appendicularians, decapod larvae, copepods and small fish. Larger haddock feed on benthic invertebrates and fish such as sandeel, Norway pout, long rough dab, gobies, sprat, and herring.
Whiting	Immature whiting (< 20 cm) feed on crustaceans such as euphausids, mysids and crangonid shrimps. Larger whiting feed almost entirely on small species of fish like Norway pout, sprat, and sandeel, and juveniles of larger species such as herring, cod, and haddock.
Striped red mullet	Mainly feed on benthic organisms such as shrimps, amphipods, polychaete worms, molluscs, and benthic fish.
Norway lobster	Scavengers feeding on worms, crustacean, and other small invertebrates.
Plaice	Feed on seabed species such as molluscs, crustaceans, amphipods and worms and occasionally on brittlestars and sandeels.
Saithe	Young saithe feed on planktonic organisms, including copepods and euphausiids. Adults feed on a range of demersal prey, including crustaceans, invertebrates and fish species such as sandeel, Norway pout, and haddock.
Thornback ray	Young specimens feed on amphipod, mysids and crangonid shrimps. Adults feed on bottom living invertebrates especially crustaceans (prawns, shrimp and crab) as well as fish (sandeels, small gadoids and dragonets).
Mackerel	Mackerel principally prey on small pelagic crustaceans and fish such as herring, sprat, sandeel and Norway pout.
Dover sole	Feed on small crustacean and polychaete worms, occasionally small molluscs, echinoderms and small fish.
European sprat	Immature individuals feed on diatoms, copepods and crustacean larvae as well as bivalve larvae and mysids. Larger fish feed on larger plankton including cladocerans, Oikopleura, bivalve larvae, mysids, and euphausids.
Spurdog	Opportunistic feeders, predominantly fish eaters preying upon pelagic stocks including herring, sprats, pilchards, garfish, sandeels, flatfish and gadoids as well as crustaceans, cephalopods and ctenophores.
Horse mackerel	Pelagic feeders that predate on planktonic organisms such as euphausids and copepods. Larger individuals feed increasingly on demersal species, and small fish becoming more important in their diet such as 0-group herring, cod, and whiting (5-7 cm long).
Norway pout	Young individuals are pelagic feeder, preying on planktonic crustaceans (copepods, euphausids, shrimps, amphipods). Adult fish feed on benthic crustaceans, small fish and various eggs and larvae.
Brown/ edible crab	Edible crab feed on living food, including marine worms, shellfish, molluscs, fish and smaller individuals of its own species.

A list of conspicuous commercial fish, shellfish and other fish species caught during fisheries surveys at the Dogger Bank (EMU Ltd, 2008) is presented in Table 4.4. These surveys recorded a total of some 50 fish species, nine commercial shellfish species and approximately 20 benthic invertebrate species.

Figure 4.15 (a and b) present a summary of Dogger Bank fish assemblages and show relative abundances of conspicuous fish species found during the 2007 commercial trawl sampling surveys carried out by EMU Ltd and demonstrated the numerical dominance of dab and whiting.

4.5 Fish Habitats

Appendix B provides summaries of selected fish species and their typical habitats. In general the greatest variety and abundance of commercial fish and shellfish species have been found in association with the Dogger Bank margins. This may relate to the presence of greater seabed heterogeneity and presence of more complex coarse habitats and associated erect epifauna e.g. Dead Man's Fingers *Alcyonium digitatum* or seapens, which may be favoured by particular species compared to simpler homogenous finer grained sediment habitats on top of the bank as favoured by species such as flatfish.

4.6 Predator-Prey Relationships

Most fish and shellfish species have a wide range of prey items but the benthic fauna are considered to be of prime importance in their diet. It is therefore necessary to consider the benthic fauna of the Dogger Bank. Further information can be found in Chapter 3 – *Benthic Ecology*. Table 4.5 summarises the main preferred prey items of some of the fish and shellfish species predominantly found in the study area, based on a review of the scientific literature (see Appendix B for more details).

4.7 Spawning and Migration

A number of fish species are known to utilise the Dogger Bank Zone and Offshore Cable Area for spawning. Full details of relevant species are included in Table 4.6 and Appendix B, with some illustrated examples included in Figure 4.16 (mackerel, herring, cod and spurdog), Figure 4.17 (whiting, sandeel, sole and plaice) and Figure 4.18 (thornback ray, tope shark, sprat and *Nephrops*).

Work undertaken by Coull *et al.* (1998) to investigate the sensitivity of fish species within British waters provided indicative areas of spawning for a number of commercially important fish species.

These data are based on surveys targeted at the distribution of eggs, larvae and young and commercially sized fish in addition to samples of the sea floor sediments and surveys using acoustic techniques. Further work by Cefas (2008) also determined areas likely to be utilised for spawning by herring. A recent work by Ellis *et al*. (2010a) carrying out ichthyoplankton surveys, allowed an update of the original nominal maps (by Coull *et al*., 1998) mapping them as rectangles, as the original polygons were often viewed as exact boundaries (Ellis *et al*., 2010a). Spawning areas are in fact indicative, as they are likely to be subject to significant variation from year to year, dependent on a wide range of environmental conditions e.g. sea temperature.

Data included in Figure 4.16 to Figure 4.18 are drawn from Ellis *et al*. (2010a), if updated data were available, and refer to Coull *et al.* (1998) or Cefas (2008) otherwise. Based on Coull *et al.* (1998) as updates for the North Sea area were not available, mackerel are shown to utilise the entire Dogger Bank Zone and the Offshore Cable Area beyond approximately 60 km of the coast for spawning (Figure 4.16a). Similarly, sprat spawning occurs across the Dogger Bank Zone and much of the Offshore Cable Area, excluding coastal areas (< ~25 km of the coast) and near to The Wash (Figure 4.18c). Whiting spawning areas are more widespread than previously considered and extend into the Dogger Bank Zone (Figure 4.17a).

Plaice, herring and sandeel spawning occurs over wide areas of the Offshore ZDE. Higher concentrations of plaice eggs and larvae are recorded in the Offshore Cable Area and marginally in the Dogger Bank Zone, but a wider range is recognised as suitable for spawning of this species (Figure 4.17d). Sandeel have been noted to spawn mainly on the west of the Dogger Bank Zone although a wider area across the Offshore ZDE is considered suitable as spawning ground. Also juvenile stages tend to remain in the same areas (Figure 4.17b). Spawning of sole occurs in the south of the Offshore Cable Area within approximately 50 km of the shore but are not thought to spawn within the Dogger Bank Zone (Figure 4.17c). Cod eggs have been found to be widespread in the North Sea suggesting that spawning may also be more widespread than was indicated by Coull *et al*. 1998 (Ellis *et al*., 2010). Figure 4.16c based on Ellis *et al*. (2010a) illustrates this, showing that the Offshore ZDE, like the rest of the North Sea, is considered a low

Table 4.6: This table includes spawning times and migration behaviour of species which are relevant to the ecology of the Offshore ZDE. The cells highlighted in yellow indicate the spawning times for each species, while the darker cells indicate peaks in the spawning periods where the information is available.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sandeel *Ammodytes marinus*	**Spawning:** There are no comprehensive data on the demersal spawning grounds of sandeels *per se*; given the demersal egg stage and sediment preferences of the species, the presence of larvae and juveniles will likely overlap the spawning grounds (Ellis *et al*., 2010a). Spawning is known to occur throughout much of the southern and central North Sea, especially near sandy sediments off the coasts of Denmark, northeastern England (including all the Offshore ZDE area), eastern Scotland, and the Orkney Islands. For the North Sea spawning areas differ very little from the ones described by Coull *et al*. (1998). The larvae of *Ammodytes marinus* are the most abundant of the sandeel larvae in the North Sea (Reay, 1970; Proctor, *et al.,* 1998, as cited in Rogers and Stocks, 2001). Tagging experiments have shown that there is little movement between spawning and feeding grounds, indicating that fishing and spawning grounds may coincide (Rogers and Stocks, 2001).											
	Migration: It is observed only during planktonic phase, while post-settlement sandeels do not move far from their habitat (Gauld, 1990; Macer, 1966, as cited in Jensen *et al*., 2003). Spawning and fishing grounds are believed to coincide (Kunzlik*et al.,* 1986, as in Rogers and Stocks, 2001).											
Herring *Clupea harengus*	**Spawning:** It has been suggested that the importance of spawning grounds is related to the overall health of the stock of autumn-spawning herring (see Schmidt *et al.*, 2009, as cited in Ellis *et al*., 2010a).The fish congregate on traditional spawning grounds in shallow water (15-40 m) where the females produce a single batch of eggs per year, released as a ribbon that adheres to gravel and similar habitats (e.g. coarse sand, maerl, shell) where there is a low proportion of fine sediment and well-oxygenated water available (e.g. Bowers, 1980; de Groot, 1980; Rankine, 1986; Aneer, 1989; Stratoudakis *et al.*, 1998; Maravelias *et al.*, 2000, as cited in Ellis *et al.*, 2010a). Hatching is driven by sea bottom temperature (Russel, 1976, as cited in ICES, 2006). An update (Cefas, 2008) to the map of the spawning area for this species in the central North Sea compared with Coull *et al.* (1998) highlighted some movement of the spawning areas, some of which were highly relevant to the Dogger Bank Zone and the Offshore Cable Area. However, it has subsequently been noticed that some historic spawning grounds (e.g. parts of the Dogger Bank) currently have none, or very little spawning activity, but that, in an MCZ context, appropriate management measures should ensure that the physical nature of these grounds does not restrict future re-colonisation (Ellis *et al*., 2010a).											
	Migration: Diurnal vertical movement (Harden-Jones, 1968). Move offshore after two years in coastal spawning grounds (MacKenzie, 1985, as in ICES, 2006).											
Cod *Gadus morhua*	**Spawning:** Cod eggs are widespread in the North Sea, and although data are limited, recent updates (as shown in **Error! Reference source not found.**) highlighted that spawning may be more widespread than indicated by Coull *et al.* (1998) (Ellis *et al*., 2010a). Recent studies applying DNA-techniques for species identification (Fox *et al.,* 2008) showed that the most important concentration of stage I cod eggs was found around the southern and eastern edges of the Dogger Bank, outside the Dogger Bank Zone but partially within the Offshore ZDE (though as indicated data are limited).											
	Migration: Species can travel 200 miles or possibly more (Rogers and Stock, 2001). Older cod do not disperse at random throughout the North Sea. Based on tagging studies, the average annual feeding and spawning movements are usually limited to distances between 20 and 120 nm, depending on tagging location (ICES, 2006). Especially south of the Dogger Bank, cod migrate southwards for spawning during autumn, and north again to their feeding grounds during spring (ICES, 2006). The juveniles aggregate in the shallow coastal areas during the winter period and disperse in a northwesterly direction over deeper parts of the central North Sea in summer (Heessen, 1983, as cited in ICES, 2006).											
Whiting *Merlangius merlangus*	**Spawning:** Whiting eggs are widespread in the North Sea, and although limited data, recent update (as shown in **Error! Reference source not found.**) highlighted that spawning may be more widespread than indicated by Coull *et al.* (1998) (Ellis et al., 2010a). Two main areas of high abundances of spawning adults are identified in the North Sea. One to the north of the Dogger Bank along the east coast of Scotland, from south of the Shetlands Islands to the Flamborough Head region; the other to the south of the Dogger Bank in the Southern Bight and in front of the Flamborough Head region. Very low abundances were located in the central and eastern parts of the North Sea. At the end of the 2000's, abundances were much lower and spawning adults were distributed in narrower areas than at the beginning of the nineties (Loots *et al*., 2010). Spawning takes place from January in the southern North Sea to July in the northern North Sea (Coull *et al.,* 1998 and ICES 2006).											
	Migration: Movements are mainly along the Scottish coast and from the Skagerak to the North Sea for spawning (Knudsen, 1964, as cited in Rogers and Stocks, 2001). Movements also occur between the southern North Sea and the eastern Channel (ICES, 2005).											
Grey gurnard *Eutrigla gurnardus*	**Spawning:** The population is concentrated in the central western North Sea during winter and spreads into the southeastern part during spring to spawn (ICES, 2006). It occurs in moderately deep waters (Maitland and Herdson, 2009).											
	Migration: It is considered a Lusitanian-Boreal species that is widespread in the Eastern Atlantic. During winter, Grey gurnards are concentrated to the northwest of the Dogger Bank at depths of 50-100 m. The distribution pattern changes substantially in the spring and becomes more widespread during the summer.											
Sole *Solea solea*	**Spawning:** There are five major spawning areas, one, the Norfolk banks, falls within the Offshore ZDE with the Humber area being the northern limit on the East Coast. The relative importance of these nursery grounds to the whole North Sea Sole stock varies from year to year (Beek *et al.,* 1989 as cited in ICES, 2006).											

	Migration: The species migrates inshore in spring to spawn. In autumn when temperatures fall, they migrate from the shallow coastal areas to warmer, deeper offshore grounds. The pelagic eggs and larvae are transported by residual currents along the coast (Riley, 1974). After two years the juveniles move to deeper water to join the adult stock (ICES, 2006).
Plaice *Pleuronectes platessa*	**Spawning:** Generally occurs in coastal area, but tending to be concentrated in depths of 20-40m (Maitland and Herdson, 2009). Data from ichthyoplankton surveys confirms the importance of parts of the North Sea (including the Southern Bight; Coombs *et al.* (1990), as cited in Ellis *et al*., 2010a), eastern English Channel and other areas around the UK coasts, with eggs and larvae also more widely distributed in these areas, as shown in **Error! Reference source not found.** (Ellis *et al*.. 2010a). **Migration:** Plaice make selective use of tidal currents in various stages of their life: the planktonic larvae use semi active tidal transport to move from the spawning areas to the inshore nursery areas, while as juveniles mature they use tidal currents to move offshore to deeper waters (ICES, 2005).
Norway lobster *Nephrops norvegicus*	**Spawning:** There is a tendency for *Nephrops* located in more northerly waters to spawn later in the year (Farmer 1975, as cited in Rogers and Stocks, 2001). **Migration:** This species do not migrate, and spends its life in the area in which they settle as larvae (Rogers and Stocks, 2001).
Brown crab *Cancer pagurus*	**Spawning:** In the North Sea English waters, the area of maximum spawning activity for the edible crab is the western central area. Spawning and larval development in the brown crab are dependent on temperature and neither of them can be triggered below 7-8°C. Spawning females are generally restricted to the shallow waters south of the Dogger Bank and along the coastal zone to the north (Eaton *et al.,* 2003). **Migration:** Females have been observed migrating north along the east coast of England and Scotland. Mature females have also been observed moving into deeper waters in autumn before spawning, followed by an inshore movement in spring when the eggs are hatched (Eaton *et al.,* 2003)
Mackerel *Scomber scomber*	**Spawning:** Important spawning areas have been localized off the western coasts of the British Isles, but data for examining mackerel spawning in the North Sea were unavailable for updating the Coull *et al*., maps (Ellis *et al*., 2010a). However, the pelagic eggs can be found in the central North Sea at depths to 60 m below the surface, but the majority are found in the upper mixed layer above 26 m (Coombs *et al*., 1981, as cited in Rogers and Stocks, 2001). **Migration:** This species undertakes long migrations. North Sea mackerel overwinter in the deep water to the east and north of the Shetland Islands, and on the edge of the Norwegian Deeps (Lockwood, 1978; Dawson, 1991, as cited in Rogers and Stocks, 2001). In the spring, adult mackerel migrate south to spawning areas in the central North Sea (Rogers and Stocks, 2001).
Red mullet *Mulluss urmuletus*	**Spawning:** Occurs in May and June off the southern coast of Brittany (N Da and Deniel 1993, as cited in ICES, 2006) and from May to July off Plymouth (Russell, 1976, as cited in ICES, 2006). During extensive egg-surveys in 1989 in the southern North Sea, no eggs of this species were reported (Land, van der 1990, as cited in ICES, 2006). However, in recent years, the presence of first year (0 – group) juveniles suggests that spawning may take place in the southern North Sea (ICES, 2006). **Migration:** The species enters the southern North Sea in spring and migrates along the continental coast as far north as the Skagerrak and Kattegat. In autumn these fish return to the Channel. It is not completely clear from where the fish found in the northwestern North Sea originate. They might be an overspill of the southern North Sea (Beare *et al.,* 2004, as cited in ICES, 2006) but they might also have come from the northwest. In 1997, juvenile striped red mullet were observed on the west coast of Scotland (Gibson and Rob 1997, as cited in ICES, 2006).
Haddock *Melanogrammus aeglefinus*	**Spawning:** Generally occurs at depths of 100 – 150 m (ICES, 2006). The main spawning area is in the central northern North Sea between the Shetland Islands and the Norwegian Deep and southwards towards the Fladen Ground (ICES, 2001; Knijn *et al.,* 1993, as cited in Rogers and Stocks, 2001). **Migration:** Judging from the North Sea Benthic Trawl survey data, haddock does not appear to display seasonal long-distance migrations. However, the haddock of the Norwegian Deeps shows a seasonal migration between relatively shallow areas in summer and deeper parts in winter. Mature specimens are even found migrating out of the area in winter (Albert, 1991, as cited in ICES, 2006). After spawning, adult haddock disperse and migrate westward toward the Orkney and Shetland Islands and into the central part of the North Sea to feed (Rogers and Stocks, 2001).
Horse mackerel *Trachurus trachurus*	**Spawning:** A batch spawner; females releasing 5 to 16 batches of eggs over a period of several months (Abaunza*et al.,* 2008, as cited in ICES, 2006) and spawning in the North Sea has been reported to occur mainly off the coasts of Belgium, the Netherlands, Germany, and Denmark. Macer (1974 as cited in ICES 2006) found eggs in the North Sea from May to late August. Quarterly surveys indicate clearly that North Sea horse mackerel are most abundant in the southern North Sea during the spring and summer, although juveniles stay somewhat longer than the adults (ICES, 2006). Spawning areas occur mainly outside the Offshore ZDE, however the data were limited for the North Sea. Nursery grounds are widespread throughout UK waters (Ellis *et al.,* 2010a).

	Migration: From October onwards the species leaves the North Sea through the Dover Strait to overwinter in the warmer waters of the Channel and Celtic Sea (ICES 1990, as cited in ICES, 2006). The western stock after spawning in the Celtic Sea in June, makes a northerly feeding migration along the western edge of the British Isles. Return migrations occur in late autumn (October-November), to the overwintering area off southwest Ireland (Macer, 1977, as cited in ICES, 2006, Eaton, 1983). Vertical migrations also occur, but their range decreases during the winter, when activity is lower (Nazarov, 1989, as cited in ICES, 2006).
Saithe *Pollachius virens*	**Spawning:** The main spawning areas are in the northern North Sea east of the Shetland Islands and along the edge of the Norwegian Deep. It generally occurs along the edge of the continental shelf (Reinsch, 1976, as cited in ICES, 2006) from January to May (further north). **Migration:** Little is known about its migrations, but older tagging experiments have shown recaptures over considerable areas, indicating at least some exchange between the Norwegian coast, Faroer and Iceland (Reinsch, 1976, as cited in ICES, 2006).
Thornback ray *Raya clavata*	**Spawning:** Thornback rays are oviparous, mature females laying between 48-74 eggs (mermaids' purses). The eggs are deposited individually and take 4-6 months to hatch, dependent on water temperature (ICES, 2006). Spawning migrations have been suggested for several species and, for example, Holden (1975 as cited in ICES 2006) described parts of the Wash as grounds where female *R. clavata* would congregate (Ellis *et al*., 2005b). **Migration:** Adult Thornbacks undertake seasonal breeding migrations, moving into shallow inshore waters in the spring/summer and to deeper waters when winter approaches. Juveniles are not thought to be migratory, remaining on their inshore nursery grounds (ICES, 2006).
Common Skate *Dipturus batis*	**Spawning:** There are insufficient data on the occurrence of the egg-cases or egg-bearing females with which to delineate spawning grounds, although these should broadly overlap with nursery grounds (Ellis et al., 2010a). The Celtic Sea has been highlighted as an area where relevant grounds for this species occur (Ellis *et al.,* 2005b) and egg-cases have been reported from undisclosed locations in Scottish waters (Ellis *et al*., 2010a). **Migration:** A recent study (Wearmouth and Sims, 2009) has highlighted that individual skate may associate with specific sites for long periods. Large scale migrations appear rare for Common Skate (Wearmouth and Sims, 2009).
Spurdog *Squalus acanthias*	**Spawning:** Locations and temporal stability of specific parturition grounds are not well established (Ellis *et al*., 2010a). Mating takes place in the winter months with gestation lasting 22-24 months, the longest for any vertebrate. Reproduction is aplacental viviparous (live bearing) (Hisaw and Albert, 1947). The main pupping season off Plymouth is from August to December (ICES, 2006). Nursery grounds are mostly in soft sediment bays and estuaries (Kay and Dipper, 2009) and probably due to sampling artefacts, juveniles seems to be absent from the North Sea (Ellis *et al*., 2010a). **Migration:** It may migrate all around the British Isles (ICES, 2006). This species in the area is believed to exist in a single northeast Atlantic stock, thus the North Sea component is considered to represent part of a much larger stock (ICES, 2006)
Norway pout *Trisopterus esmarkii*	**Spawning:** The southern distribution border extends from northeast England, along the northern edge of the Dogger Bank, with occasional specimens caught as far south as the English Channel. However this species does not have a specific nursery ground and in the North Sea they remain near their spawning grounds (ICES, 2006). The data indicate that spawning grounds are not within the Offshore ZDE, however they encompass an area where this species is important commercially (ICES, 2006). **Migration:** Norway pout migrates between the Shetland Islands and Norway and out of Skagerrak, to spawn. Pelagic juveniles, undertake diurnal migrations, spending the day at depth and moving towards the surface during the night (ICES, 2006).

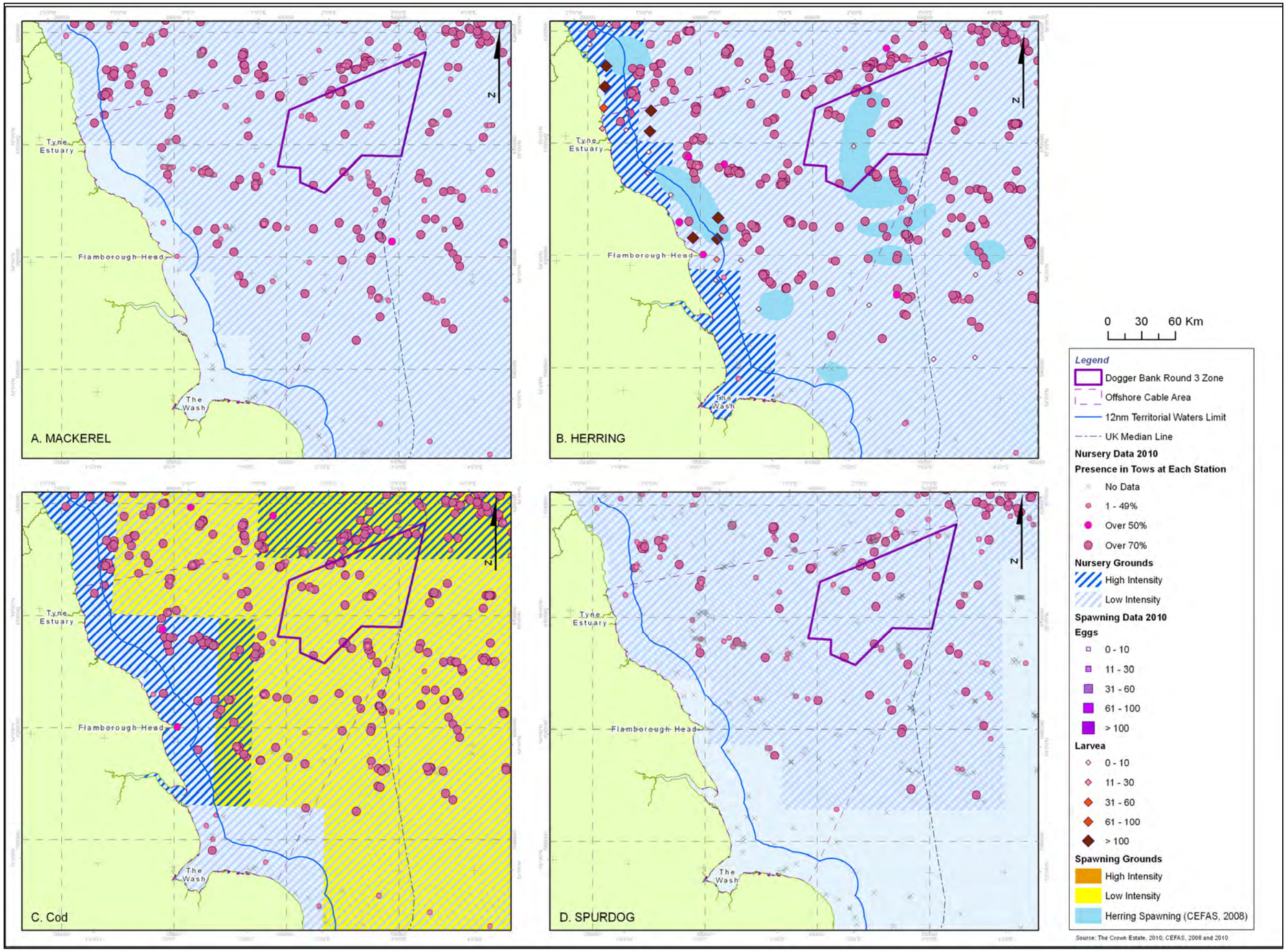


Figure 4.16: Spawning and nursery areas for mackerel, herring, cod and spurdog, within the Offshore ZDE (Ellis *et al*., 2010a; Cefas, 2008).

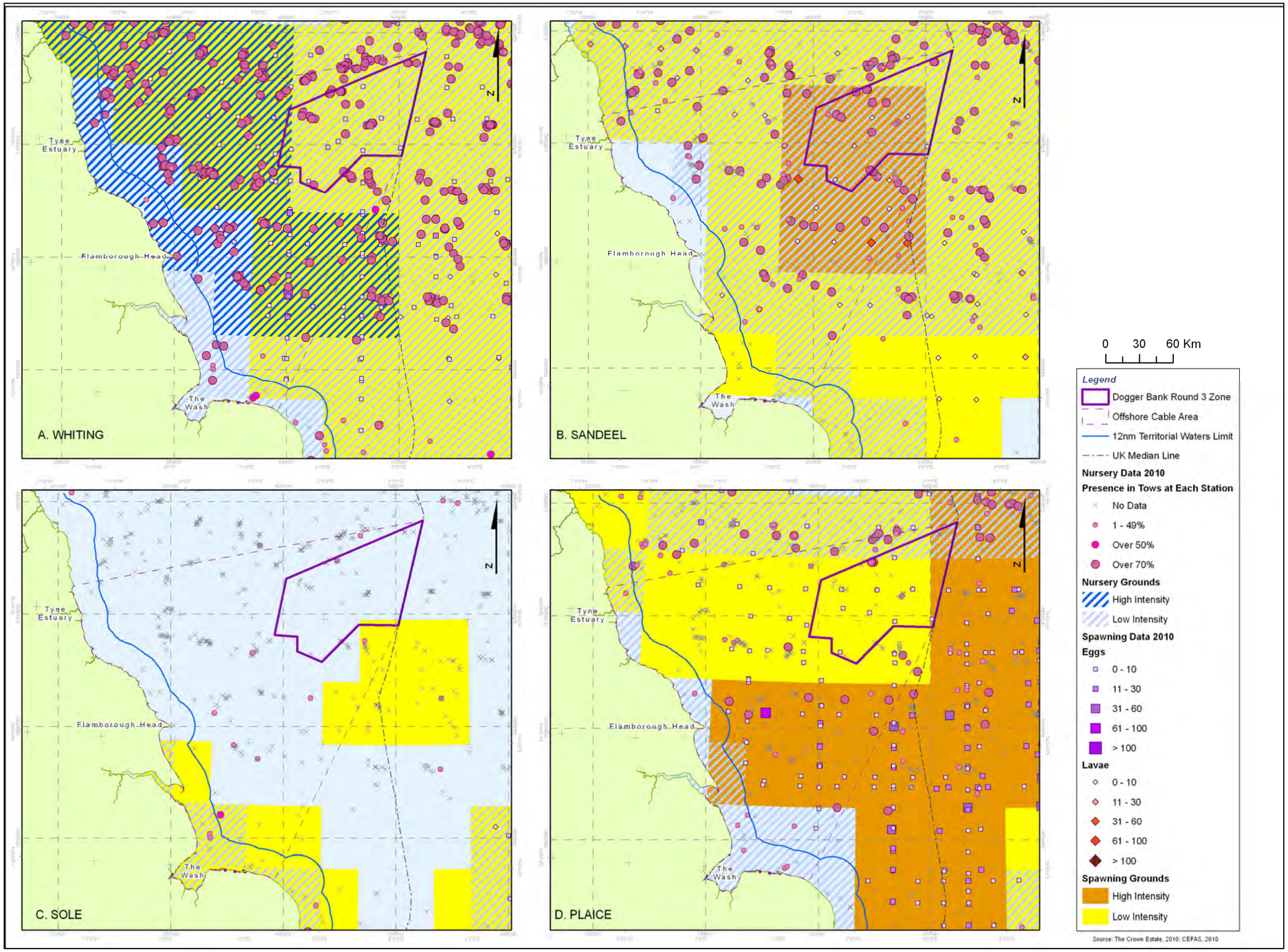


Figure 4.17: Spawning and nursery and spawning areas for whiting, sandeel, sole and plaice, within the Offshore ZDE (Ellis *et al*., 2010a).

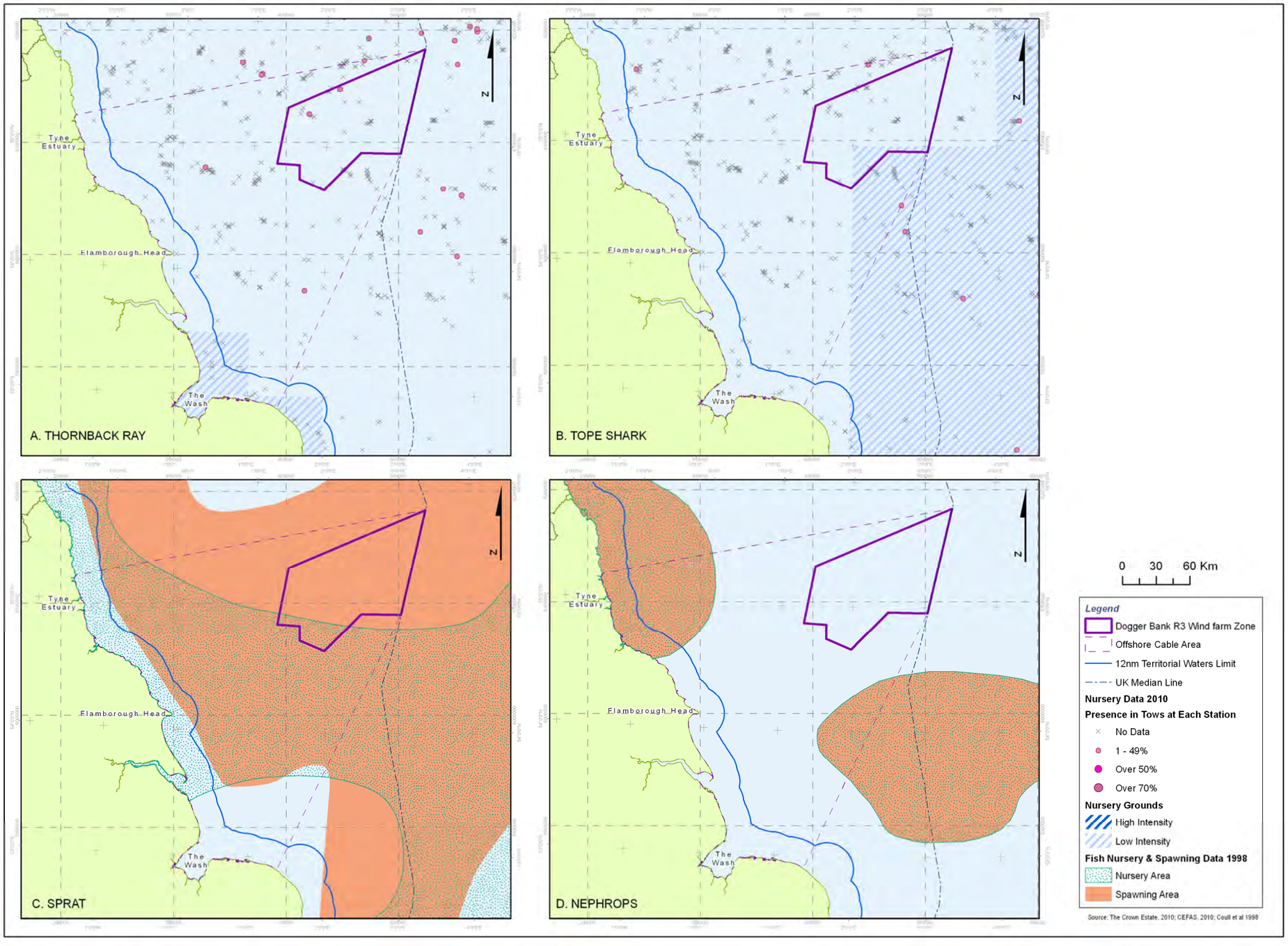


Figure 4.18: Spawning and nursery areas for thornback ray, tope shark, sprat and *Nephrops*, within the Offshore ZDE (Ellis *et al*., 2010a; Coull *et al*., 1998).

intensity spawning area for cod. Haddock spawning is considered to be absent from the Dogger Bank Zone and the Offshore Cable Area, according to Coull *et al*. (1998) (Figure 4.19) and no additional updates were available for this species.
Nephrops are shown to spawn in discrete areas to the northwest of the Offshore ZDE and to the south of the Dogger Bank Zone (Figure 4.18d).

In general, the Offshore ZDE includes grounds which have been described as spawning grounds for various finfish species (e.g. cod, haddock and whiting) (Figure 4.19).

Table 4.6 presents summary data on spawning times and migratory behaviour of fish species, which occur within the Offshore ZDE.

It is not currently known if there are any specific migration routes which might occur within the Offshore ZDE. However, the activities of the Tracking and Distribution Subgroup of the Living North Sea project (www.livingnorthsea.eu) are expected to undertake studies about sea migration of sea trout and local movement of eels and lamprey species in the area of the North Sea.

Figure 4.20 summarises observations of brown crab *C. pagurus* spawning within the Offshore ZDE and shows the concentration of larval stage zoea 1 (considered a spawning indicator) for this species. Numbers have been very high in the central North Sea since the first survey carried out in 1976 (Edwards, 1979, as cited in Eaton *et al.,* 2003).

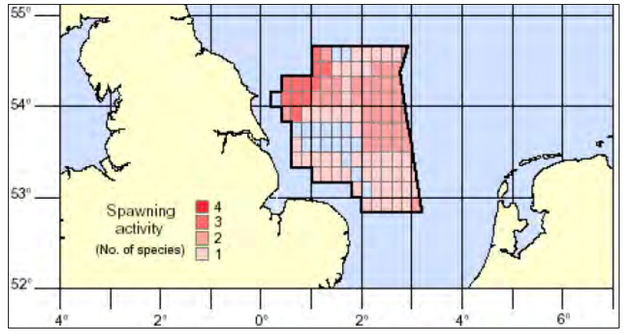


Figure 4.19: Spawning intensities of finfish (cod, haddock, whiting, saithe, Norway pout, plaice, sole and mackerel) by licence block, during February to June (adapted from Rogers and Stocks (Cefas, 2001)).

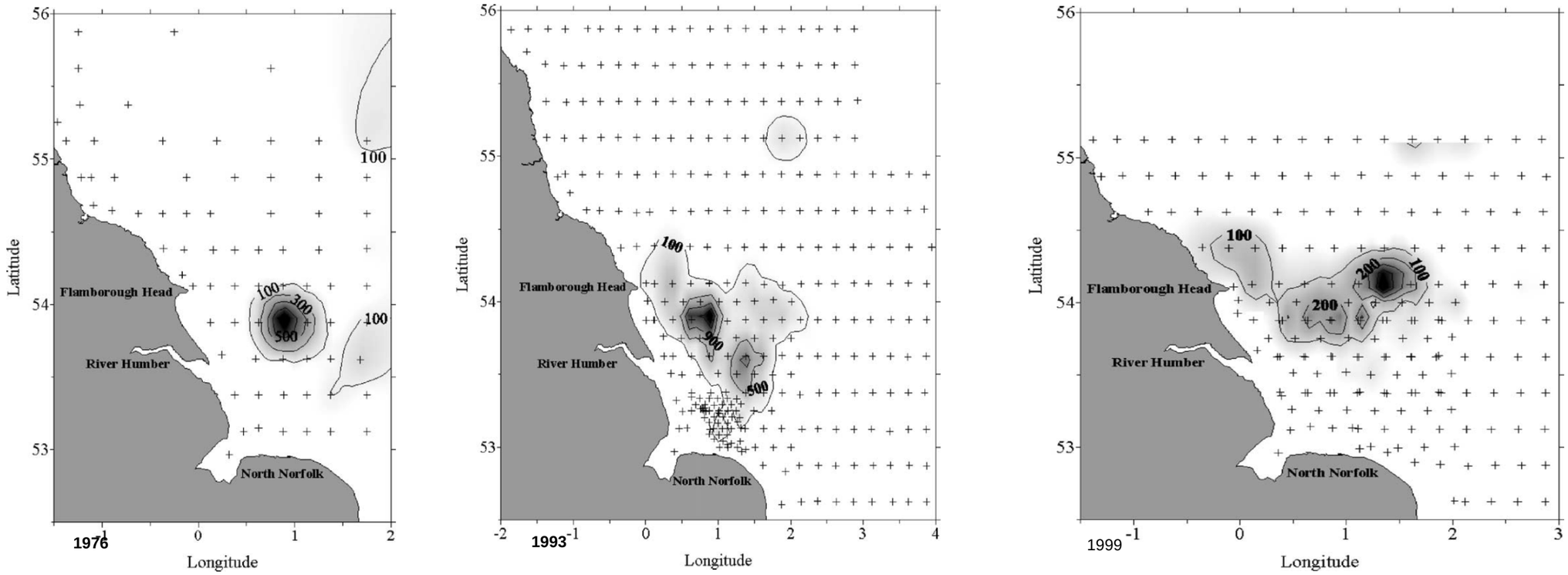


Figure 4.20: Sampling positions (+) (as processed in Eaton *et al*., 2003) and distribution of the Edible crab zoea I stage *Cancer pagurus* larval stage in 1976, 1993 and 1999. (Eaton *et al*., 2003).

Eaton *et al.* (2003) suggested that the main spawning may be localised at the Offshore site 54°N, 1°E, extending towards the southeast. This epicentre of brown crab spawning lies within the Offshore Cable Area. Eaton *et al.* (2003) go on to state, 'if the distribution of zoea 1 can be assumed to be indicative of the distribution of spawning females, then it can be hypothesised that, in the area studied at least, spawning female crabs are generally restricted to the shallower waters south of the Dogger Bank Zone and along the coastal zone to the north'. This area is characterised by coarse sand and gravels and is thus suitable for overwintering and egg incubation.

This distribution appears to be supported by the areas' hydrographical characteristics (Figure 4.21), which also indicate that the western central North Sea population could be effectively isolated, whilst at the same time providing recruitment for adult crabs to the northern areas by the adult females' migration; however further studies are required (Eaton *et al*., 2003).

Ellis *et al*. (2010a) have suggested that cod spawning in the North Sea is more widespread than indicated previously. In fact they report that there is no recent evidence of cod spawning activity being confined to the patchy areas suggested by Coull *et al*. (1998). Fox *et al*. (2008) carried out the first ichthyoplankton survey to cover the whole North Sea in 2004 and employed DNA-techniques to unambiguously identify stage I cod eggs. The work included a map of the historic distribution of cod eggs throughout the North Sea (Figure 4.22a). The blank areas shown on the historic map are due to areas not being surveyed.

The spring 2004 survey (Fox *et al*., 2008) showed that the most important cod egg concentration was found in a limited area, only partially within the Offshore Cable Area (Figure 4.22b). In fact the main concentrations of stage I cod eggs were found around the southern and eastern edges of the Dogger Bank (which was in agreement with the more historical data). This distribution was confirmed by trawl survey data for the same year which showed concentrations of mature cod in an arc from the south to the northeast of the Dogger Bank (Fox *et al*., 2008).

Active spawning as confirmed by the plankton surveys in these areas showed that the highest concentrations of eggs were closer to the edge of the Dogger Bank than suggested by the trawl data. From this study the authors concluded that the spawning grounds as shown in Figure 4.22b were still active in 2004. Updated spawning grounds from Ellis *et al*. (2010a) are shown in Figure 4.16c.

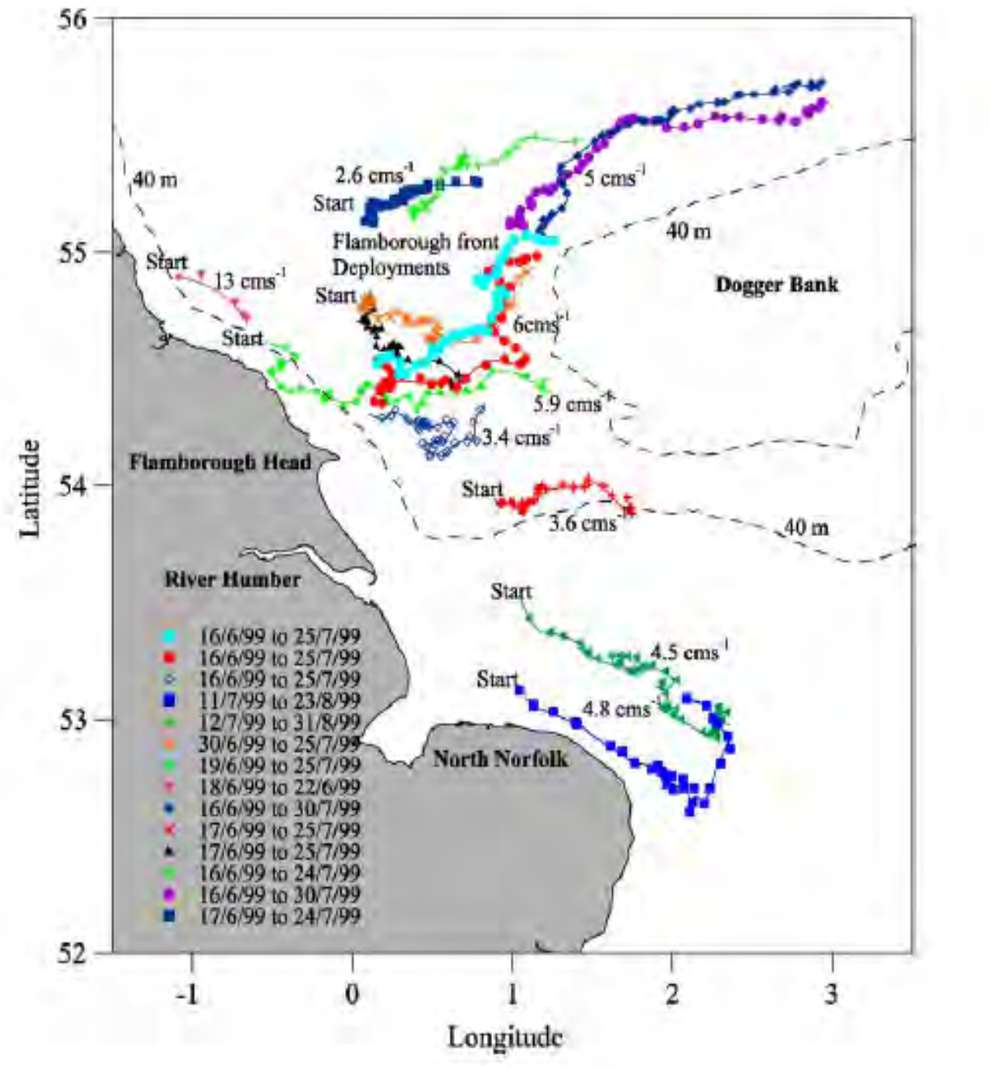


Figure 4.21: Tidally filtered trajectories of satellite-tracked Argos buoys in 1999. The daily positions at 00:00 GMT are plotted, together with the mean velocity for each trajectory (Eaton *et al.,* 2003).

4.8 Nursery Areas

Fish hatch quickly from their eggs and many species remain in the water column as larvae, consuming microscopic organisms and gradually developing the body shape and behaviour patterns of adults. At this stage of the life cycle, many species occupy discrete areas, either in the water column or on the seabed, where opportunities for feeding, and for protection from predators are greatest. These are known as nursery areas. For example, juvenile flatfish will tend to converge on shallow coastal waters and feed on the abundant worms and crustaceans in these productive areas.

Other fish, such as juvenile cod, can occupy coastal reef environments as well as deeper offshore regions. Juvenile fish can often be found in nursery areas together with slightly older individuals, and occasionally adults, and the prevailing water temperature and availability of food can also alter the position of these nursery grounds from year to year. As a result of these factors it is difficult to precisely define the limits of nurseries (Coull *et al.,* 1998).

Juveniles of a number of commercially important fish species are known to utilise the Dogger Bank Zone and Offshore Cable Area as nursery areas. Ellis *et al.* (2010a), based on Coull *et al*. (1998) and recent ichthyoplankton surveys, provide updated maps of nursery areas for many commercial species around the UK waters, as illustrated in Figure 4.16, Figure 4.17 and Figure 4.18.

The coastal regions of the Offshore Cable Area are used as nursery areas by cod (Figure 4.16), herring (Figure 4.16), plaice (Figure 4.17) and sole (Figure 4.17). As shown, plaice and cod utilise almost the entire coastal region of the Offshore Cable Area, as well as, for the cod, an offshore area to the northeast of the Dogger Bank. Herring utilise the northern and southern coasts and sole are limited to the southern coastal areas. However, the entire Offshore ZDE is marked as low intensity, but active nursery areas.

Sprat (Figure 4.18) and whiting (Figure 4.17) use much of the northern Offshore ZDE including the Dogger Bank Zone as a high density nursery area, although the area to the southwest, near to The Wash is not used.

Mackerel (Figure 4.16) nursery areas are shown to occur within the Dogger Bank Zone and Offshore Cable Area. The northern part of the Offshore Cable Area is known to be a nursery area for haddock, but this does not include Dogger Bank Zone itself. Sandeel nursery areas demonstrate a close association with their spawning areas, though Ellis *et al*. (2010a) show that low intensity nursery areas occur across the whole Offshore ZDE (Figure 4.17).

Nephrops (Figure 4.18) utilise an area offshore from the Northumberland Coast and an area to the south of the Dogger Bank Zone.

Potential nursery areas for those fish, for which insufficient data are available, are identified by the distribution of juvenile stages (0 -<1 years) (ICES, 2006) and are presented in Figure 4.23 a-d. These show the relative importance of the northern flanks of the Dogger Bank Zone with regard to juvenile haddock and Norway pout with the southern margin being comparatively important for juvenile sprat. Clearly, however, juvenile fish are distributed across the wider North Sea and it is unlikely fish nursery habitat is restricted solely to the Offshore Cable Area and Dogger Bank Zone.

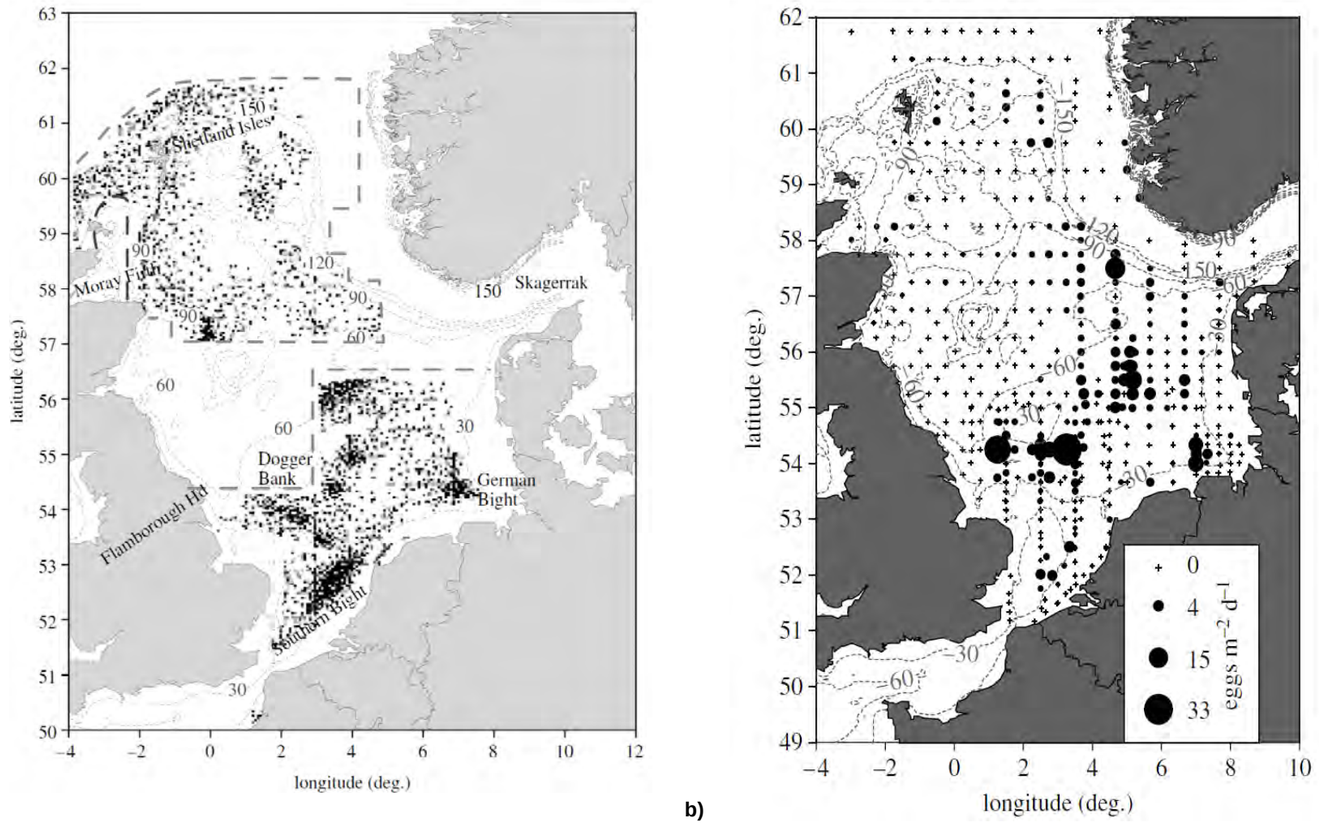


Figure 4.22: Distribution of cod eggs stage 1 in the North Sea from 1945 ('A') and 2004 ('B'). The scale ('B') indicates no. of eggs per m^2 of sea surface and crosses indicate where a plankton sample was collected but no stage 1 cod eggs were found (Fox *et al.*, 2008).

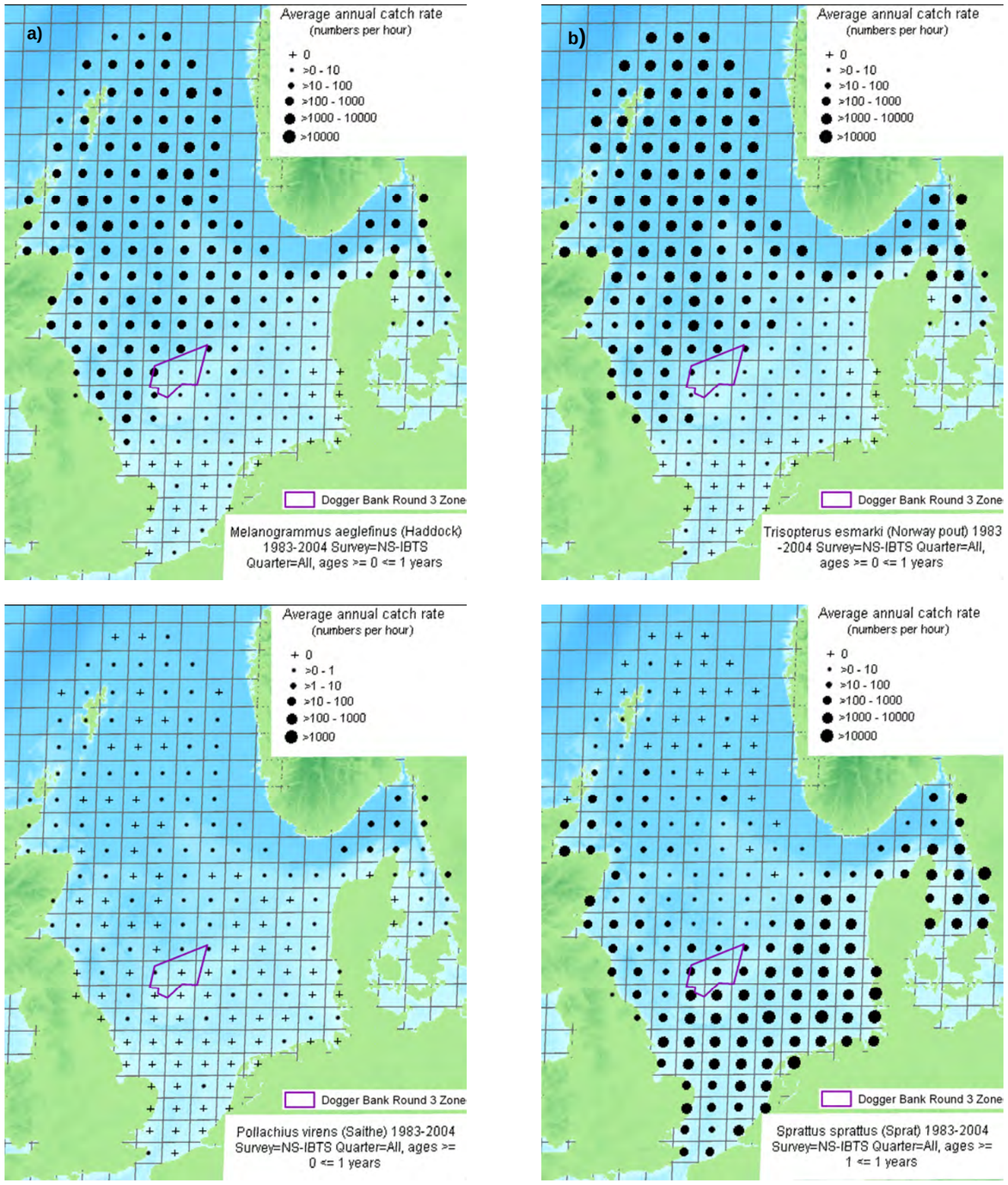


Figure 4.23: Distribution of juvenile stages of a) haddock; b) Norway pout; c) saithe; and d) sprat (ICES, 2006).

'Seapen and burrowing megafauna communities' suspected to occur on the northern margin of the Dogger Bank Zone, just on the northern edge of the Dogger Bank Zone (Diesing *et al.,* 2009) (see Figure 4.2 previously) are considered to be nursery areas for a number of fish species including the UK BAP priority species hake (OSPAR, 2010a).

4.9 Summary

The fact that fisheries resources can be highly mobile and wide-ranging was noted with adult populations showing large variability, temporally and spatially. Details have been provided here and in Appendix B on a variety of fish relevant to the ecology of the area including 12 priority species as identified by the UK BAP, three of which, cod, common skate and the spurdog, are also listed by OSPAR (not including diadromous species). Spawning and nursery areas for relevant species have been shown as indicated in Ellis *et al*. (2010a). For other species for which an update for spawning and nursery area was not available the grounds shown were taken from Coull *et al.* (1998) and Cefas (2008).

Herring and sole primarily utilise coastal areas for nursery grounds, though the entire Offshore ZDE is marked as a low intensity nursery area for Herring. Herring spawning occurs over wide areas of the Offshore ZDE and a wider range is also recognised as suitable. Low intensity spawning of sole occurs in the south of the Offshore Cable Area within approximately 50 km of the shore and a patch of similarly low intensity spawning offshore occurs on the southeast boundary of the Dogger Bank Zone (Ellis *et al*., 2010a).

Work by Fox *et al*. (2008) showed cod spawning areas just south of the Dogger Bank and in an arc, stretching largely outside the Offshore ZDE, to the northeast.

The wide range of seabed habitats encountered within the Offshore ZDE supports a variety of demersal fish species as well as important shellfisheries. Of particular note were the following:

1. Grounds supporting important elasmobranch species exist in the southwest of the Offshore Cable Area. These species are highlighted as endangered through impacts of overfishing and climate change. Furthermore these species are able to detect electrical and magnetic fields generated by some types of cables which could influence the activities of elasmobranchs (Gill and Kimber, 2005).

2. The possible presence of the UK BAP habitat, ‘Seapen and burrowing megafauna’ within the northern areas of the Dogger Bank Zone and its relative importance as nursery habitat for various species of fish was noted.
3. There is a stable epicentre of brown crab spawning, in the shallower waters south of the Dogger Bank Zone and along the coastal zone to the north, within the Offshore Cable Area.
4. Important sandeel fishing grounds are found in an arc from the western edge of the Dogger Bank Zone to the south and east of this in the Offshore Cable Area. Furthermore isolated concentrations are found to either side of this arc, within the Dogger Bank Zone and outside of the cSAC boundary.
5. The regional coastal environment north of the Humber estuary hosts a variety of different habitats and the coastal waters are important fishing grounds for the UK fishing industry. Commercial species with additional conservation importance such as Norway lobster *Nephrops norvegicus* are also found near to the coast and in the sea pen and burrowing mega fauna habitats.
6. Ling *Molva molva*, a UK BAP species, is present within the Offshore ZDE. Despite having a deep water spawning habitat, they remain in shallow inshore water nursery areas.

Data gaps noted included a lack of specific information on fish migration movements which may occur in the Offshore ZDE. However, this desk study has also highlighted that more information on spawning and nursery areas is likely to become available and will possibly be relevant for the Offshore ZDE.

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5. Birds

5.1 Introduction

This chapter presents a high level review of the distribution and abundance of seabirds[1] and movements of other birds in the Offshore Zone Development Envelope (ZDE) comprising the Dogger Bank Zone itself and the Offshore Cable Area.

This Zonal Characterisation for birds aims to:

- Summarise information from recent surveys and other sources on the distribution and abundance of seabirds and movements of other birds within the Offshore ZDE;
- Summarise important breeding colony and passage / wintering site protected areas or migration routes within the Offshore ZDE;
- Flag the limitations of current knowledge of seabird distribution and abundance in the Offshore ZDE, and identify data gaps to be addressed; and
- Within the constraints of the available data, assess the importance of seabird distribution and abundance and movements of other birds within the Offshore ZDE.

The ZAP process will help to provide an early characterisation of the distribution and abundance of seabirds and other birds in the Dogger Bank Zone and the Offshore Cable Area and so help inform the subsequent Environmental Impact Assessment (EIA) process.

Although there are gaps in existing knowledge, there is sufficient information available to provide an overview of the likely distribution and abundance of seabirds within the Offshore ZDE. Information on non-seabirds migrating through the Offshore ZDE is less detailed.

Dedicated monthly boat-based surveys of the Dogger Bank Zone commenced in January 2010 and are on-going. High definition video camera aerial surveys are also undertaken monthly. Data collected thus far by these surveys are summarised in this chapter and adds to the existing knowledge of the distribution and abundance of seabirds and other bird species within the Zone.

[1] Note, for the purposes of this report, the term seabirds is used to include all bird species that frequent the marine environment, thus including divers, grebes and seaduck, as well as species more typically considered as seabirds, i.e. petrels, gannets, skuas, gulls, terns and auks. The (overlapping) term waterbirds is here used to refer to those species such as divers, grebes, cormorants, herons, swans, geese, ducks, rails, waders, gulls and terns that may be passage or wintering features of coastal and wetland Special Protection Areas (SPAs).

5.2 Data and Literature

5.2.1 Key publications

Several sources of information on the distribution and abundance of seabirds and other bird species in the North Sea (including the Offshore ZDE) have been used to produce this chapter.

Breeding seabirds

- *Seabird Populations of Britain and Ireland* (Mitchell *et al.,* 2004) reporting the results of *Seabird 2000*, the latest census of breeding seabirds in Britain and Ireland conducted between 1998 and 2002;
- Information on SPAs designated under the EC Birds Directive (2009/147/EC) and their features (taken from Stroud *et al.* (2001), which provides the definitive list of qualifying species and their numbers at the SPAs concerned; see http://jncc.defra.gov.uk/page-5485); and
- *Seabird Foraging Ranges as a Tool for Identifying Candidate Marine Protected Areas* (Thaxter *et al*., in review). Foraging distances of seabird feature species of SPAs are further discussed in Chapter 7 – *Nature Conservation*.

Seabirds at sea

- *Important Bird Areas for Seabirds in the North Sea* (Skov *et al.,* 1995). This report summarised European Seabirds at Sea (ESAS) datasets collected between 1980 and 1994. The report contains contour maps showing density and seasonal distribution for individual species and species groups across the North Sea, as well as highlighting areas of the North Sea where internationally important numbers of seabirds at sea were recorded;
- *An Atlas of Seabird Distribution in Northwest European Waters* (Stone *et al.,* 1995). This report also utilised the ESAS database, with data collected between 1980 and 1993;
- *Seabird and Marine Mammal Surveys in the North Sea between February 2008 and March 2009* (Cork Ecology, 2009). A report to the Department of Energy and Climate Change (DECC);
- *An Analysis of the Numbers and Distribution of Seabirds within the British Fishery Limit aimed at Identifying Areas that Qualify as Possible Marine Special Protection Areas (SPAs)* (Kober *et al.,* 2010). This analysis utilised ESAS data from 1980 to 2004 to identify the most suitable areas for the protection of seabirds within the British Fishery Limit, including the North Sea;
- Appendix A3a.7 of the recent Offshore Energy SEA (DECC, 2011), which contains baseline descriptions of breeding seabirds and the distribution of seabirds at sea, as well as information on migrating waterbirds and terrestrial birds; and
- *Offshore Wind farms and Birds: Round 3 Zones, Extensions to Round 1 and Round 2 Sites and Scottish Territorial Waters* (Langston, 2010). This report identified species which are most likely to be priorities for data collation and collection as part of the planned further development of offshore wind projects, including the Dogger Bank Zone.

5.2.2 Recent survey work in the Dogger Bank Zone

DECC funded a series of boat-based surveys in the North Sea between February 2008 and March 2009. The March 2008 survey provided good coverage of the south of the Dogger Bank Zone, while the August 2008 survey achieved moderate coverage in the southeast of the Dogger Bank Zone. A dedicated charter survey in September 2008 obtained good survey coverage throughout the Dogger Bank Zone (Cork Ecology, 2009).

Monthly boat-based seabird and marine mammal surveys of the Dogger Bank Zone commenced in January 2010 and are on-going. The January 2010 survey only obtained limited coverage of the Zone over two days. However coverage of the Dogger Bank Zone has been more complete in most months since, with the exception of September 2010, when coverage was limited by weather conditions.

Aerial surveys of the Dogger Bank Zone were conducted at the request of The Crown Estate (TCE) between May 2009 and April 2010. The first four surveys (May 2009 to August 2009) were visual aerial surveys carried out by the Wildfowl and Wetlands Trust (WWT). The following six surveys (November 2009 to

April 2010) were high definition video camera aerial surveys carried out by HiDef Limited. Visual aerial survey coverage in May to August 2009 was not complete across the whole Dogger Bank Zone, and there were no surveys in September and October 2009. Observations of some of the key bird species sighted during these surveys have been plotted and are provided for reference in Appendix C. The programme of monthly high definition video camera aerial surveys has been continued across the Dogger Bank Zone since the completion of TCE surveys in April 2010.

Raw data from the boat-based surveys are summarised here to provide an overview of the numbers and relative abundance of birds recorded in the Dogger Bank Zone across the first complete year of surveys, i.e. between January and December 2010, and up to March 2011 (Note, as these raw numbers of birds have not been corrected for distance in calculating relative abundance, the latter should be treated as indicative only).

5.2.3 Population estimates

"Population" estimates for February to May 2010 produced by combining data from the boat-based surveys on the proportions of different species in species groups with the counts of birds from the high definition aerial surveys, as presented in Austin *et al.* (2011) are also presented here. Note, it is assumed that 100% of birds within the transect strips are detected by the aerial surveys and thus that they provide a more reliable dataset than the boat-based surveys to estimate the populations that occur in the Dogger Bank Zone. However, as identification to species level is not always possible from the aerial surveys, information on the proportions of different species in species groups is used from the boat surveys so that counts of birds from the aerial surveys that are presently assigned to species groups can be apportioned to species. At the time of writing, population estimates were not available for subsequent months up to March 2011.

These population estimates for the Zone are compared to the species' Great Britain and biogeographic population sizes (Table 5.1) to determine if they surpass the respective 1% thresholds for identifying sites of national or international importance.

Both the boat and aerial survey data are also used to indicate the distributions of birds across the Dogger Bank Zone.

Table 5.1: Great Britain and biogeographic population estimates for species considered in this chapter.

Species	Season	GB population [1, 2]	GB 1% threshold [2]	Biogeographic population [1, 3]	Biogeographic 1% threshold [3]
White-billed diver	Winter	-	-	-	100
	Summer	N/A	N/A	-	100
Fulmar	Winter	-	-	-	102,000
	Summer	498,764 P	15,000	2,700,000-4,100,000 P	102,000
Gannet	Winter	-	-	-	11,700
	Summer	218,546 N	6,600	390,000 P	11,700
Great skua	Winter	-	-	-	480
	Summer	9,634 P	280	16,000 P	480
Kittiwake	Winter	914,000 I	9,100	-	82,500
	Summer	366,832 P	11,000	2,500,000-3,000,000 P	82,500
Little gull	Winter	-	-	72,000-174,000	1,230
	Summer	N/A	N/A	-	-
Lesser black-backed gull [4]	Winter	124,654 I	1,200	530,000-570,000 (*graellsii*) 325,000-440,000 (*intermedius*)	5,500
	Summer	110,101 P	3,300	530,000-570,000 (*graellsii*) 325,000-440,000 (*intermedius*)	5,500
Herring gull [5]	Winter	729,801 I	7,300	1,700,000-3,600,000 (*argentatus*) 560,000-620,000 (*argenteus*)	5,900
	Summer	131,469 P	3,900	1,700,000-3,600,000 (*argentatus*) 560,000-620,000 (*argenteus*)	5,900
Great black-backed gull	Winter	75,860 I	760	330,000-540,000	4,400
	Summer	17,084 P	510	330,000-540,000	4,400
Guillemot	Winter	-	-	-	85,500
	Summer	1,322,354 I	13,200	2,800,000-2,900,000 P	85,500
Razorbill	Winter	-	-	-	15,900
	Summer	164,492 I	1,600	530,000 P	15,900
Little auk	Winter	-	-	-	-
	Summer	N/A	N/A	-	-
Puffin	Winter	-	-	-	181,500
	Summer	579,189 I	5,800	5,500,000-6,600,000	181,500

[1] I = individuals; P = pairs; N = nests;

[2] GB populations and thresholds for wintering gulls are taken from Musgrove *et al*. (in prep.), following Banks *et al* (2007). For seabirds recorded during the summer months, population estimates are taken from Baker et al. (2006); where GB populations are given as numbers of individuals, thresholds are taken as 1% of these values; where GB populations are given as numbers of pairs or nests, it is assumed that the overall number of individuals in the population is three times this and the 1% threshold calculated accordingly (following the protocol used in Stroud *et al*. 2004). Rounding protocols follow Stroud et al. (2004);

[3] Biogeographic populations and thresholds for white-billed diver and gulls are taken from Wetlands International (2006). For seabirds, biogeographic populations are taken from Mitchell *et al*. (2004) and (following the protocol used in Stroud *et al.* 2004) it is assumed that the overall number of individuals in the population is three times the number of pairs and the 1% threshold calculated accordingly. Rounding protocols also follow Stroud *et al*. (2004);

[4] Threshold for *Larus fuscus graellsii* used here following Calbrade *et al*. (2010);

[5] Threshold for *Larus argentatus argenteus* used here following Calbrade *et al*. (2010).

5.2.4 Other bird species

Other bird species that might occur within the Offshore ZDE include migrant waterbirds and other migrant, terrestrial species.

The Wetland Bird Survey (WeBS)[2] monitors non-breeding waterbirds in the UK, using monthly land-based counts to annually identify population sizes, trends in numbers and to identify important sites for waterbirds. Information on the numbers of waterbirds supported by SPAs on the east coast of Britain is taken from Stroud *et al.* (2001). More recent information from WeBS is taken from Calbrade *et al.* (2010).

5.2.5 Data limitations and gaps

Although at-sea surveys of seabirds began in the North Sea in the 1980s and continued into the 1990s, survey work in the North Sea in recent years has been limited. It should be borne in mind that data presented from Skov *et al.* (1995) and Stone *et al.* (2005) were collected between 1980 and 1994, and that patterns of seabird distribution and abundance may have since changed.

A gap analysis study for the Department of Energy and Climate Change (DECC) reviewed ESAS seabird and marine mammal survey data in UK waters and highlighted areas which have not yet been covered or required further surveys (Pollock and Barton, 2006). Several criteria were used to define gaps, including age of data, number of years of survey required, number of months and overall amount of data required. Monthly survey coverage was considered adequate if survey coverage exceeded 20 km^2 per quarter ICES rectangle.

Monthly survey coverage in the Dogger Bank Zone between 1984 and 2003 is summarised in Appendix D. Overall, monthly ESAS survey coverage in the Zone was limited, particularly in January, March and December, when very little coverage was recorded. These gaps are being addressed by the on-going monthly boat-based and aerial seabird and marine mammal surveys in the Dogger Bank Zone.

[2] WeBS is a partnership scheme of the British Trust for Ornithology (BTO), Royal Society for the Protection of Birds (RSPB) and the Joint Nature Conservation Committee (JNCC) (on behalf of the Council for Nature Conservation and the Countryside), the Countryside Council for Wales (CCW), Natural England (NE) and Scottish Natural Heritage (SNH)), in association with Wildfowl & Wetlands Trust.

5.3 Overview

This overview considers a list of focal seabird species that should provisionally be considered as of Very High or High Sensitivity to development of the Dogger Bank Zone as either their numbers in the Zone are of national or international importance, or which as interest features of SPAs or transnational Natura 2000 sites might be affected by the proposed development.

A review of survey design used for the Dogger Bank Zone (Austin *et al.,* 2011) used information from recent surveys to derive a provisional list of ten focal species: white-billed diver, fulmar, gannet, kittiwake, lesser black-backed gull, great black-backed gull, guillemot, razorbill, little auk and puffin. At this stage, it is unclear as to whether numbers of great skua, little gull and herring gull occurring in the Dogger Bank Zone might also be of importance and thus these species are also considered in detail here.

Included in the accounts for each of these focal seabird species are tables providing information on:

i. The densities (birds/km^2) recorded by ESAS surveys between 1980 and 1994 in the area of the Dogger Bank (after Skov *et al.,* 1995);

ii. The raw monthly numbers of birds recorded by boat-based surveys between January 2010 and March 2011 Gardline Environmental Ltd (2010a-l, 2011a-c);

iii. These boat-based survey numbers expressed as a relative abundance (birds/km surveyed); and

iv. Population estimates for February to May 2010 (after Austin *et al.*, 2011).

Densities from the ESAS surveys are categorised in these tables as very low (VL: <0.1 birds/km^2), low (L: 0.1 – 0.9 birds/km^2), moderate (M: 1.0 – 9.9 birds/km^2) or high (H: ≥ 10.0 birds/km^2). In relation to the numbers of birds recorded by boat surveys, it should be noted that coverage was low in January and September 2010. Population estimates shown in red type exceed the national 1% threshold.

For each of these species, maps are also provided showing their distributions in the Dogger Bank Zone based upon the first complete year of boat-based surveys, i.e. between January and December 2010, and seasonally, for spring (April to July), autumn (August to October) and winter (November to March) using boat-based survey data from April 2010 and March 2011.

While the overview focuses on these species, the numbers of other seabird species occurring in the Offshore ZDE are also discussed. The main factors affecting seabird distribution is the availability of their food and location of breeding areas (Skov *et al.,* 1995). Seabirds are discussed in detail in Section 5.4.

In addition to seabirds, many different species of other birds cross the North Sea every year from Europe and Scandinavia to Britain during spring and autumn migration (Hüppop *et al.,* 2006). The main species groups include both waterbirds (that may be features of SPAs) and terrestrial birds including raptors, owls, pigeons and doves, swallows and martins, larks, pipits, wagtails, chats, thrushes, warblers and finches. Many of these migrants are likely to pass over the Offshore ZDE during these periods. There is a general movement northwards or northeastwards in spring and south or southwestwards in autumn, but the scale of movement through the Zone at these times is often dependent on weather patterns. These species are discussed in detail in Section 5.5.

5.4 Seabirds

A brief outline of the breeding numbers, at-sea densities and distributions of the regularly occurring seabird species within the Offshore ZDE throughout the year is given below. These accounts are based on information presented in Skov *et al*. (1995), as well as other more recent surveys (Cork Ecology, 2009; Gardline Environmental Ltd, 2010a-l, 2011a-c).

Table 5.2 and Figure 5.1 provide a summary of important coastal breeding seabird colony SPAs on the east coast of England bordering Offshore ZDE, while Table 5.3 summarises the species' diet and feeding behaviour.

5.4.1 Seaduck

In the Offshore ZDE, the high densities of common eider are recorded in inshore waters north of the Tees Estuary in winter with moderate densities recorded in other months. Common scoter are also recorded in moderate densities in inshore waters off the east coast of England, including The Wash and Humber Estuary. Other species of seaduck are recorded in very low densities in the Offshore ZDE (Skov *et al.,* 1995).

Table 5.2: Summary of important coastal breeding seabird colony SPAs on the east coast of England bordering Offshore ZDE (see also Figure 5.1).

SPA	Main Species [1]	SPA total [1]	Percentage of GB breeding population[1]
Teesmouth and Cleveland Coast	Little tern	37 pairs	1.5%
Flamborough Head and Bempton Cliffs	Gannet	2,501 pairs	1.2%
	Herring gull	1,110 pairs	0.7%
	Kittiwake	83,370 pairs	17.0%
	Guillemot	16,150 pairs	2.3%
	Razorbill	5,133 pairs	5.2%
	Puffin	3,473 pairs	0.8%
Humber Estuary [2]	Little tern	51 pairs[2]	2.1%[2]
Gibraltar Point	Little tern	23 pairs	1.0%
The Wash	Little tern	33 pairs	1.4%
	Common tern	152 pairs	1.2%
North Norfolk coast	Mediterranean gull	2 pairs	20.0%
	Sandwich tern	3,457 pairs	24.7%
	Little tern	377 pairs	15.7%
	Common tern	460 pairs	3.7%
	Roseate tern	2 pairs	3.3%

[1] Data represent the numbers of seabird features of SPAs and percentages of the GB population as provided in Stroud *et al.* (2001), which provides the definitive list of qualifying species and their numbers at the SPAs concerned.

[2] Site classified in 2007 (superseding previous Humber Flats, Marshes and Coast SPA) and data thus taken from citation document (http://jncc.defra.gov.uk/pdf/SPA/UK9006111.pdf).

Table 5.3: Summary of diet, feeding behaviour and foraging ranges of key seabird species within the Dogger Bank Zone. Sources: Snow and Perrins (1998), Camphuysen *et al*., (2005), Thaxter *et al*. (in review), Furness & Tasker (2000).

Species	Diet	Feeding behaviour
White-billed diver	Fish	Dives from surface
Fulmar	Sandeels, sprat, zooplankton, squid, fish discards and offal	Feeds on surface and occasionally shallow plunge dives to c. 4m. Mean foraging range of 48 km, a mean maximum of 400 km and a maximum of 580 km
Gannet	Mackerel, haddock, sandeels, fish discards	Plunge dives from heights up to 40m. Mean foraging range of 126 km, a mean maximum of 282 km and a maximum of 590 km
Great skua	Fish including discards, seabirds, offal, eggs, carrion, mammalian prey	Feeds primarily on surface and kleptoparasitises seabirds including guillemots, razorbills, puffins and gannets
Kittiwake	Sandeels, sprats, young herring, discards	Feeds on surface or shallow plunge dives. Mean foraging range of 27 km, a mean maximum of 62 km and a maximum of 120 km
Little gull	Insects, small fish and aquatic invertebrates, including zooplankton	Feeds on surface or shallow plunge dives
Lesser black-backed gull	Omnivorous, fish, discards, offal	Feeds on surface or shallow plunge dives. Mean foraging range of 65 km, a mean maximum of 132 km and a maximum of 181 km
Herring gull	Omnivorous, fish, discards, offal	Feeds on surface or shallow plunge dives. Mean foraging range of 11 km, a mean maximum of 61 km and a maximum of 92 km
Great black-backed gull	Fish, discards, seabirds	Feeds on surface. Indicative foraging range of approximately 10 km
Guillemot	Sprats, herring, gobies, whiting, haddock, sandeels	Dives from surface to depths of c. 60 m. Mean foraging range of 20 km, a mean maximum of 71 km and a maximum of 135 km
Razorbill	Sandeels, herring, sprats, molluscs, crustaceans	Dives from surface to depths of c. 15 m. Mean foraging range of 24 km, a mean maximum of 58 km and a maximum of 100 km
Little auk	Planktonic crustaceans and fish fry	Dives from surface

Table 5.4: Monthly totals of seaduck recorded on boat-based surveys within the Dogger Bank Zone between January 2010 and March 2011 (Gardline, 2010a-l, 2011a-c).

Seaduck Species	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Long-tailed duck	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Common scoter	0	0	4	28	0	0	3	51	0	9	18	4	0	0	0
Velvet scoter	0	0	0	0	0	0	0	0	0	8	0	0	0	0	1
Goldeneye	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0
Goosander	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0

Very low densities of scaup, eider, common scoter, velvet scoter, goldeneye and red-breasted merganser were recorded on ESAS surveys in the Dogger Bank Zone throughout the year (Skov *et al.,* 1995), and no seaduck were recorded in the Dogger Bank Zone during the 2008 surveys (Cork Ecology, 2009).

Recent boat-based surveys in the Dogger Bank Zone have similarly recorded only low numbers of seaduck species (Table 5.4). Based on these results, it is likely that only small groups of common scoter may pass through the Dogger Bank Zone, primarily on migration, but not in significant numbers.

5.4.2 White-billed diver

ESAS surveys between 1980 and 1994 recorded very low densities of divers in the Dogger Bank Zone and Offshore Cable Area between October and May (Skov *et al.,* 1995).

A total of 29 white-billed divers were recorded by boat-based surveys in 2010, with all records in winter or early spring and a peak of 11 birds in December (Table 5.5). A further 10 birds were seen between January and March 2011. The white-billed diver is a rare bird in UK waters, with between 10 and 20 records annually (BBRC, 2010), although the majority of records involve birds seen from land, so the species may be under-recorded.

The species breeds within the Arctic Circle, with birds from the western Siberian population wintering off the northern coast of Norway, and returning to breeding areas during May and June. Some birds may winter off the Dutch coast (BirdGuides, 2010).

There is no national population estimate for white-billed diver. However, the peak winter population estimate for the Zone of 79 in March 2010 (Figure 5.2) produced from boat surveys for this species is close to the 1% threshold of 100 for the species' biogeographic population, and thus it is reasonable to conclude that the Zone may also be of international importance for this species.

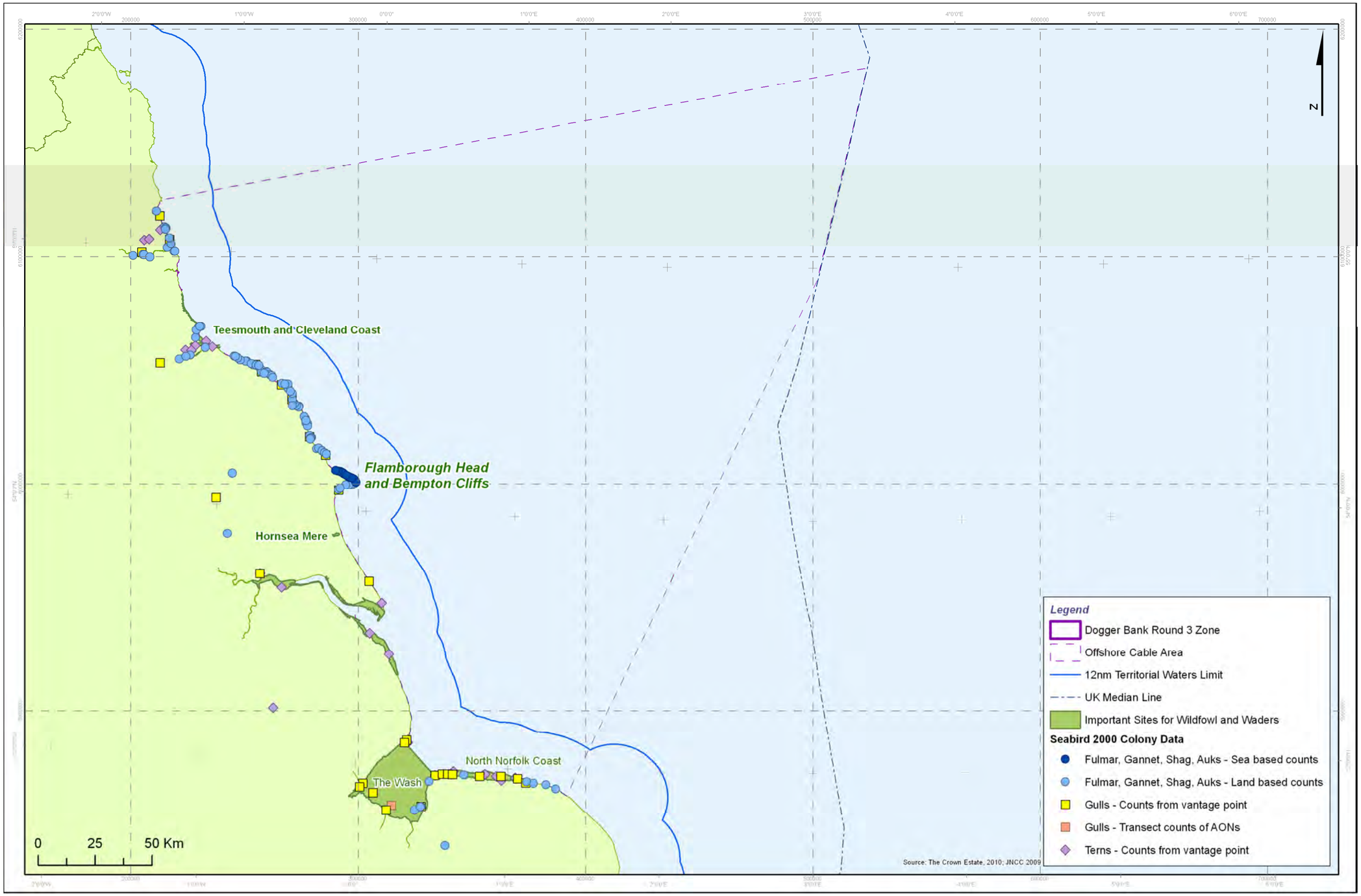


Figure 5.1: Seabird colonies within the Offshore ZDE (JNCC, 2009).

Table 5.5: Monthly totals of white-billed divers recorded on boat-based surveys within the Dogger Bank Zone between January 2010 and March 2011 (Gardline Environmental Ltd, 2010a-l, 2011a-c) and associated population estimates derived from boat-based survey data (Austin *et al.*, 2011).

	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Boat survey numbers	0	1	9	6	0	0	0	0	0	0	2	11	6	0	4
Population estimates	-	23	79	21	0	-	-	-	-	-	-	-	-	-	-

Table 5.6: Numbers of other divers recorded on surveys in the Dogger Bank Zone between January 2010 and March 2011.

	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Red-throated diver	0	0	2	1	0	0	0	0	0	7	1	0	0	0	0
Black-throated diver	0	0	0	2	0	0	0	0	0	0	1	0	0	0	1
Great Northern Diver	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
Unidentified divers	0	0	0	0	3	0	0	0	0	1	0	0	0	0	1

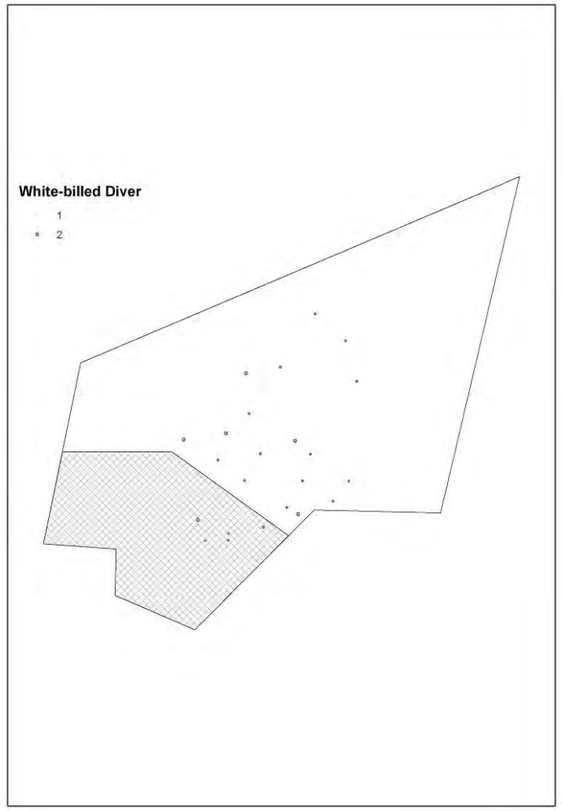


Figure 5.2: Distribution of white-billed divers in the Dogger Bank Zone based upon boat-based survey observations between January 2010 and December 2010.

5.4.3 Other divers

ESAS surveys between 1980 and 1994 recorded very low densities of other divers in the Dogger Bank Zone (Table 5.6) and Offshore Cable Area between October and May (Skov *et al.,* 1995).

Boat-based surveys between January 2010 and March 2011 have also recorded only low numbers of red-throated diver, black throated diver and great northern diver in the Dogger Bank Zone (Table 5.6).

5.4.4 Fulmar

Fulmars are one of the commonest species of seabird in the North Atlantic, and are widely distributed throughout the North Sea in all months (Tasker *et al.,* 1987). The species is a feature of several SPAs, although none within the Offshore ZDE (Table 5.2; Stroud *et al.*, 2001). However, the species' foraging range means that some fulmars that are features of other SPAs in Scotland may potentially forage within the Zone during the breeding season (see Chapter 7 – *Nature Conservation*). Other closer, but smaller colonies include Flamborough Head and Bempton Cliffs which contains the largest fulmar colony in the Offshore ZDE, with 878 apparently occupied sites (AOS) in 2008 (http://www.jncc.gov.uk/smp).

Fulmars have a wide-ranging diet including fish and offal and can forage up to 580 km from colonies, although 400 km is the mean maximum distance (Table 5.3), meaning that the Dogger Bank Zone and Offshore Cable Area are within the potential foraging range of birds from the Troup, Pennan and Lion's Heads, Fowlsheugh, Forth Islands and Buchan Ness to Collieston Coast SPAs (all in Aberdeenshire except the Forth Island which are in Fife).

In the Offshore ZDE, the highest density of fulmars (28.7 birds/km^2) was recorded off the east coast of England between the months of November and February (Skov *et al.,* 1995).

ESAS surveys recorded fulmars in moderate densities in all months in the Dogger Bank Zone (Table 5.7), with the highest average density (2.7 birds/km^2) recorded between August and October over the whole Dogger Bank Zone (Skov *et al.,* 1995). Similarly, low to moderate densities were recorded on surveys in the Dogger Bank Zone in March, August and September 2008 (Cork Ecology, 2009).

Surveys between January 2010 and March 2011 recorded a peak of 2,608 fulmars in May 2010 (Table 5.7) (Gardline Environmental Ltd, 2010a-l, 2011a-c). When related to survey effort, this gave a relative abundance of 1.9 birds/km travelled for May (Table 5.7). The population estimate for May 2010 exceeded the 1% national threshold for the species.

The relative abundance of fulmars recorded on aerial surveys of the Dogger Bank Zone between May 2009 and April 2010 was very low (<0.5 birds/km) (Appendix C) (TCE, 2010).

The 2010 boat-surveys indicate that the largest concentrations of fulmars appear along the western edge of the Dogger Bank Zone (Figure 5.3), but otherwise a relatively even distribution across the Zone at moderate densities. Figure 5.4 indicates that this concentration occurred in the summer (April-July).

Table 5.7: Monthly mean densities of fulmars from ESAS surveys and totals of fulmars recorded on boat-based surveys within the Dogger Bank Zone between January 2010 and March 2011 (Gardline Environmental Ltd, 2010a-l, 2011a-c) and associated population estimates derived from boat-based survey data (Austin *et al*., 2011). Note: Population estimates shown in red type exceed the national 1% threshold.

	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
ESAS Density (birds/km^2)	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Boat survey number	11	640	800	508	2,608	1,638	619	248	17	266	307	649	248	59	519
Boat survey relative abundance (birds/km)	< 0.1	0.6	0.5	0.2	1.9	1.5	0.5	0.2	0.1	0.1	0.3	0.5	0.2	0.1	0.2
Population estimates	-	2,428	808	1,736	18,953	-	-	-	-	-	-	-	-	-	-

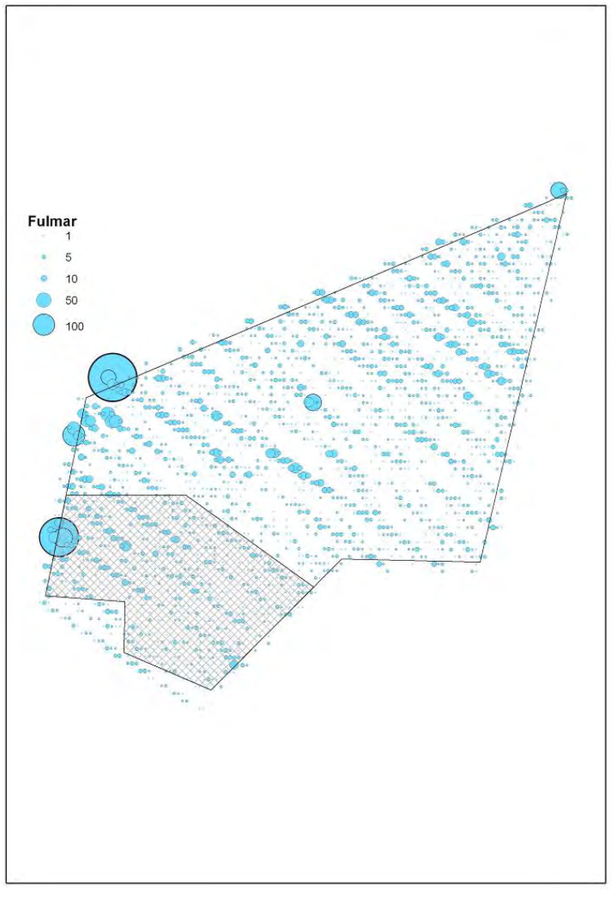


Figure 5.3: Distribution of fulmars in the Dogger Bank Zone based upon boat-based survey observations between January 2010 and December 2010.

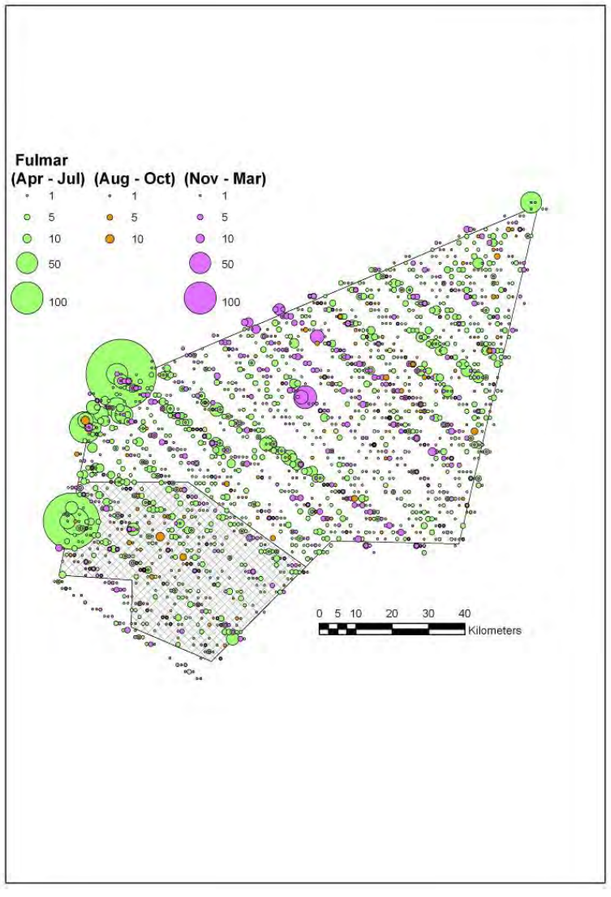


Figure 5.4: Seasonal distribution of fulmars in the Dogger Bank Zone based upon boat-based survey observations between April 2010 and March 2011.

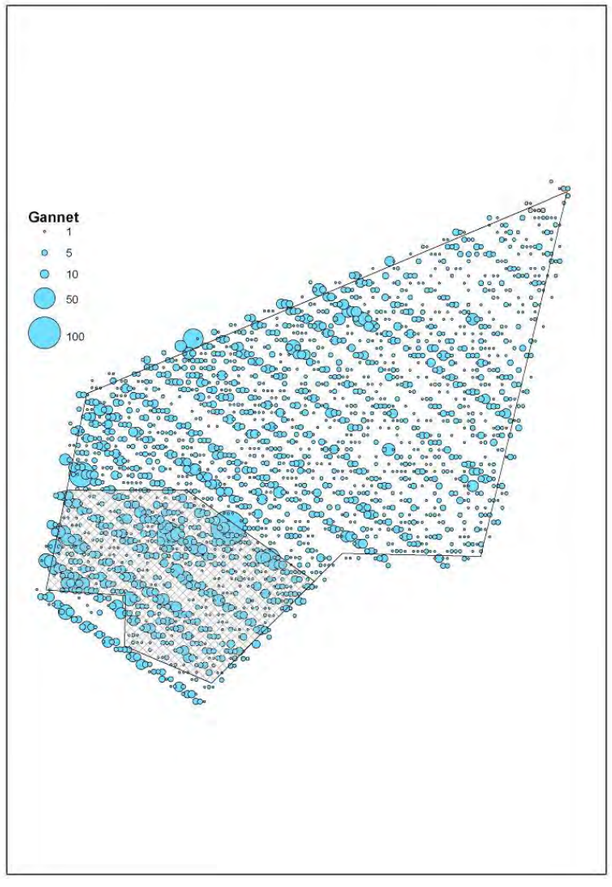


Figure 5.5: Distribution of gannets in the Dogger Bank Zone based upon boat-based survey observations between January 2010 and December 2010.

Table 5.8: Monthly mean densities of gannets from ESAS surveys and totals of fulmars recorded on boat-based surveys within the Dogger Bank Zone between January 2010 and March 2011 (Gardline Environmental Ltd, 2010a-l, 2011a-c) and associated population estimates derived from boat-based survey data (Austin *et al.*, 2011).

	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
ESAS Density (birds/km^2)	L	L	VL	VL	M	M	M	M	L	L	L	L	L	L	VL
Boat survey number	26	518	2,261	2,063	174	343	471	614	137	1,530	338	299	390	745	3,726
Boat survey relative abundance (birds/km)	0.2	0.4	1.3	0.9	0.1	0.3	0.4	0.5	1.1	0.8	0.3	0.2	0.3	0.9	1.5
Population estimates	-	329	704	549	62	-	-	-	-	-	-	-	-	-	-

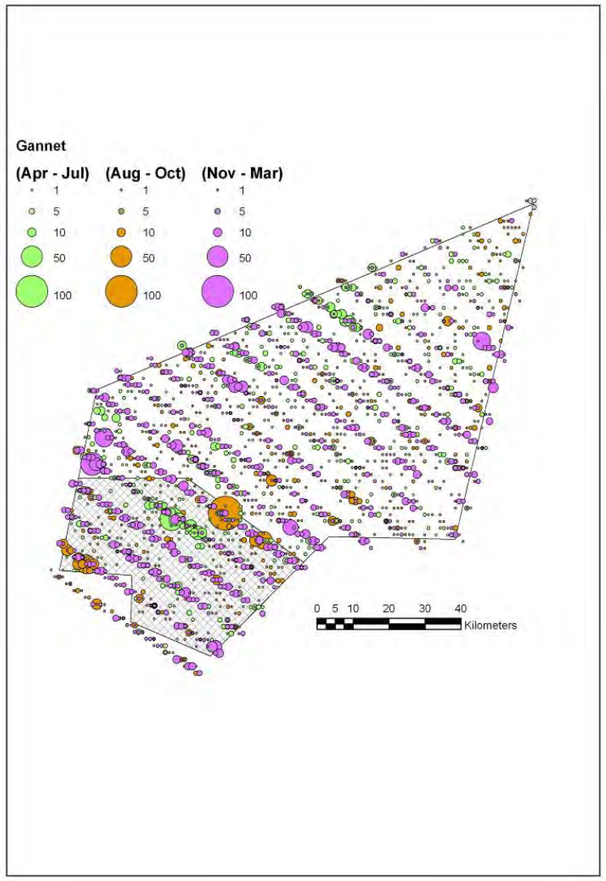


Figure 5.6: Seasonal distribution of gannets in the Dogger Bank Zone based upon boat-based survey observations between April 2010 and March 2011.

5.4.5 Gannet

Gannets are widespread throughout the North Sea in all months, with most adults remaining all year. Younger birds generally move south in the winter, with some individuals having been recorded off the west coast of Africa at this time (Camphuysen, 2005). There is one breeding colony of gannets within the Offshore ZDE at the Flamborough Head and Bempton Cliffs SPA, with 2,501 pairs (1.2% of the GB breeding population) listed by Stroud *et al.* (2001) (Table 5.2), although numbers have risen more recently (http://www.jncc.gov.uk/smp). This site is the only SPA for breeding gannets in the Offshore ZDE (Stroud *et al.*, 2001).

Gannets eat a wide variety of fish, including discards from fishing vessels, and can forage up to 590 km from colonies, although 282 km is the mean maximum distance (Table 5.3). Recent tagging studies indicate that gannets from the Flamborough Head and Bempton Cliffs SPA can forage within the Dogger Bank Zone (http://www.rspb.org.uk/ourwork/projects/details/273898-tracking-gannets-from-bempton-cliffs#results). The species' foraging range means that some gannets from the Forth Islands SPA could also potentially forage within the Zone during the breeding season (see Chapter 7 – *Nature Conservation*).

In the Offshore ZDE, the highest gannet density (4.3 birds/km^2) was recorded off the Yorkshire coast between November and February on ESAS surveys (Skov *et al.,* 1995). Numbers of gannets in this area of the North Sea at this time of year were estimated as being of international importance by Skov *et al.* (1995).

ESAS surveys in the Dogger Bank Zone recorded gannets at moderate mean densities between May and August (Table 5.8), when the highest average density was 1.0 birds/km^2 in the southwest of the Dogger Bank Zone (Skov *et al.,* 1995). Mean density was lower in all other months. Surveys in March, August and September 2008 recorded gannets at very low to moderate density across the Dogger Bank Zone (Cork Ecology, 2009).

Surveys between January 2010 and March 2011 recorded peaks of 2,261 and 3,726 gannets just prior to the breeding season, in March 2010 and March 2011 respectively (Table 5.8) (Gardline Environmental Ltd, 2010a-l, 2011a-c). When related to survey effort, these figures give relative abundances of 1.3 and 1.5 birds/km respectively (Table 5.8), which may indicate that higher numbers of gannets may occur in the Dogger Bank Zone at this time of year than was reported in Skov *et al.* (1995). The relative abundance of gannets recorded on aerial surveys of the Dogger Bank Zone between May 2009 and April 2010 was very low (<0.5 birds/km) (Appendix C) (TCE, 2010).

The 2010 boat-surveys indicate that the distribution of gannets is more concentrated in the centre and west of the Dogger Bank Zone (Figure 5.5), though that the species occurred throughout the Zone at moderate densities. Figure 5.6 indicates that this distributional bias is most apparent in summer (April-July) and autumn (August-October).

5.4.6 Great Skua

As almost two thirds of the world population of great skuas breeds in Orkney and Shetland (Mitchell *et al.,* 2004) and the North Sea is of great importance to this species. In summer, birds are concentrated at their breeding colonies, however, in autumn, birds move down the east coast of Britain, through the English Channel and to the Atlantic, where they spend the winter.

ESAS surveys in the Dogger Offshore ZDE between 1980 and 1994 recorded low great skua densities (0.6 birds/km^2) offshore from Flamborough Head in September and October (Skov *et al.,* 1995). Despite the low densities, numbers of great skuas in this area of the North Sea at this time of year were estimated to be of international importance by Skov *et al.* (1995). Recorded densities were very low in all other months.

Table 5.9: Monthly mean densities of great skuas from ESAS surveys and totals of fulmars recorded on boat-based surveys within the Dogger Bank Zone between January 2010 and March 2011 (Gardline Environmental Ltd, 2010a-l, 2011a-c) and associated population estimates derived from boat-based survey data (Austin *et al*., 2011).

	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
ESAS Density (birds/km^2)	VL	VL	VL	VL	VL	VL	VL	VL	L	L	VL	VL	VL	VL	VL
Boat survey number	0	1	0	8	1	6	12	20	12	29	5	1	4	2	1
Boat survey relative abundance (birds/km)	0	< 0.1	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

Low densities (0.1 birds/km^2) of great skuas were also recorded in September and October over the Outer Dowsing Shoal, (including the southwest corner of the Dogger Bank Zone). Again, numbers of great skuas in this area of the North Sea at this time of year were estimated to be of international importance by Skov *et al.,* (1995). Great skuas were recorded at very low densities elsewhere in the Dogger Bank Zone at this time and in very low densities throughout the Dogger Bank Zone in all other months (Skov *et al.,* 1995). Surveys in August and September 2008 recorded great skuas scattered throughout the Dogger Bank Zone at very low to low densities (Cork Ecology, 2009).

Recent boat-based surveys in the Dogger Bank Zone have recorded low numbers of great skuas in most months between January 2010 and March 2011, with the greatest numbers in autumn and a peak of 29 birds in October (Table 5.9) (Gardline Environmental Ltd, 2010a-l, 2011a-c).

Figure 5.7 indicates that great skuas were recorded relatively evenly across the Dogger Bank Zone in 2010.

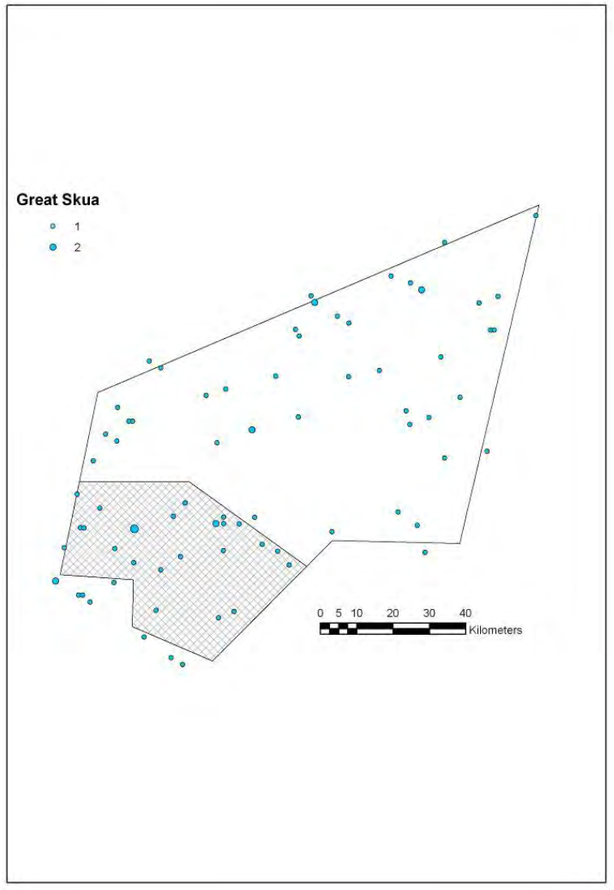


Figure 5.7: Distribution of great skuas in the Dogger Bank Zone based upon boat-based survey observations between January 2010 and December 2010.

5.4.7 Kittiwake

Kittiwakes are widespread throughout the North Sea in all months, with largest numbers occurring in winter (Tasker *et al.,* 1987). The largest breeding colony of kittiwakes within the Offshore ZDE is at the Flamborough Head and Bempton Cliffs SPA, with 83,370 pairs (17.0% of the GB breeding population) listed by Stroud *et al.* (2001) (Table 5.2), though numbers have fallen more recently (http://www.jncc.gov.uk/smp). This colony is the only designated SPA for the species in the Offshore ZDE (Stroud *et al.*, 2001).

Kittiwakes eat a variety of fish, and can forage up to 120 km from colonies, although 62 km is the estimated mean maximum range (Table 5.3). Tagging studies of kittiwakes are on-going at the Flamborough Head and Bempton Cliffs SPA and this work should show whether kittiwakes from this SPA may forage within the Dogger Bank Zone (http://www.rspb.org.uk/ourwork/projects/details.aspx?view=print&id=tcm:9-255106).

Low to moderate kittiwake densities were recorded on ESAS surveys in the Offshore ZDE in all months (Skov *et al.,* 1995).

ESAS surveys recorded kittiwakes in the Dogger Bank Zone at moderate densities in all months (Table 5.10), with a peak mean density of 1.1 birds/km^2 recorded between April and September, and 1.6 birds/km^2 recorded between October and March (Skov *et al.,* 1995). Surveys in March 2008 recorded kittiwakes at high densities (between 20.0 – 49.9 birds/km^2) in the southwest of the Dogger Bank Zone, while surveys in August and September 2008, recorded kittiwakes at very low to moderate densities over the southern half of the Dogger Bank Zone, and more sporadically in the northern half (Cork Ecology, 2009).

Kittiwakes were regularly recorded on boat-based surveys between January 2010 and March 2011, with a peak of 7,793 birds in March 2011 (Table 5.10) (Gardline Environmental Ltd, 2010a-l, 2011a-c). When related to survey effort, this gives a relative abundance of 3.2 birds/km (Table 5.10). The population estimates for February to April 2010 exceeded the 1% national thresholds for the species.

The relative abundance of kittiwakes recorded on aerial surveys of the Dogger Bank Zone between May 2009 and April 2010 was mostly low, with a maximum of 2.51 to 5.00 birds/km recorded in December 2009 and February 2010 (Appendix C) (TCE, 2010).

The 2010 boat-surveys indicate that the distribution of kittiwakes is concentrated towards the centre and the western edge of the Dogger Bank Zone (Figure 5.8), though that the species occurs throughout the Zone. Although published information suggests that the Dogger Bank Zone would be at the foraging range limit for birds from the nearest significant colony, i.e. the Flamborough Head and Bempton Cliffs SPA, Figure 5.9 indicates that this distributional bias is most apparent in summer (April-July).

Table 5.10: Monthly mean densities of kittiwakes from ESAS surveys and totals of fulmars recorded on boat-based surveys within the Dogger Bank Zone between January 2010 and March 2011 (Gardline Environmental Ltd, 2010a-l, 2011a-c) and associated population estimates derived from boat-based survey data (Austin *et al.*, 2011). Note: Population estimates shown in red type exceed the national 1% threshold.

	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
ESAS Density (birds/km^2)	M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
Boat survey number	100	2,164	3,180	3,099	854	1,879	3,742	720	123	2,631	1,055	2,163	1,379	1,512	7,793
Boat survey relative abundance (birds/km)	0.6	1.9	1.8	1.4	0.6	1.7	3.3	0.6	1.0	1.3	0.9	1.5	1.1	1.8	3.2
Population estimates	-	11,937	10,455	18,031	9,659	-	-	-	-	-	-	-	-	-	-

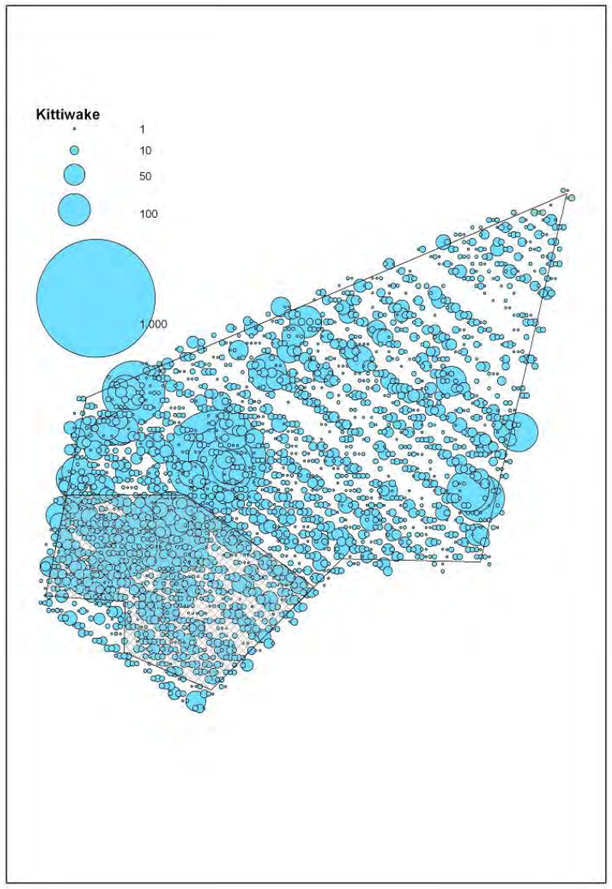


Figure 5.8: Distribution of kittiwakes in the Dogger Bank Zone based upon boat-based survey observations between January 2010 and December 2010.

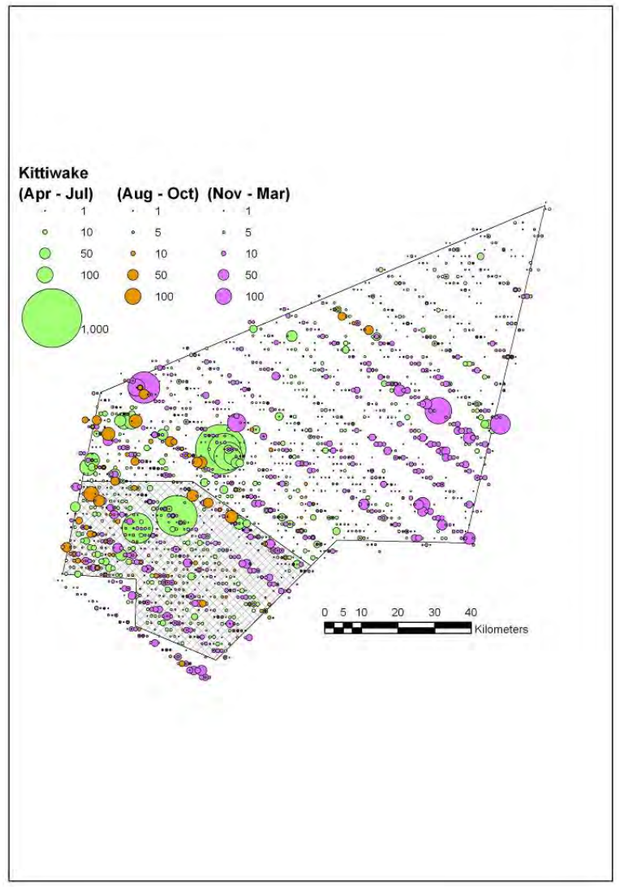


Figure 5.9: Seasonal distribution of kittiwakes in the Dogger Bank Zone based upon boat-based survey observations between April 2010 and March 2011.

5.4.8 Little gull

In the Offshore ZDE, little gulls were recorded at low densities off the North Yorkshire coast and off Flamborough Head between August and November, with very low densities recorded in other months (Skov *et al.,* 1995).

A recent JNCC statistical analysis of ESAS data investigating possible marine SPAs, highlighted the southwest of the Dogger Bank Zone as part of an area categorised as "near-qualifying" for little gulls in winter (Kober *et al.,* 2010). However, ESAS data between 1980 and 1994 showed that very low densities of little gulls were recorded in the Dogger Bank Zone in all months except June and July, when no birds were recorded (Skov *et al.,* 1995).

In addition, no little gulls were recorded in the Dogger Bank Zone on 2008 surveys (Cork Ecology, 2009). On boat-based surveys in the Dogger Bank Zone between January 2010 and March 2001 a single bird was recorded in July 2010 and a total of 121 little gulls in October 2010 (Gardline Environmental Ltd, 2010a-l, 2011a-c). The latter figure suggests that numbers of national or perhaps international importance might occur in the Dogger Bank Zone.

Hornsea Mere is the only site in the UK that is classified as internationally important for little gull. Large numbers of little gulls are regularly recorded at the site in August, e.g. 21,500 birds in August 2007 (Calbrade *et al.*, 2010).

5.4.9 Lesser black-backed gull

Highest numbers of lesser black-backed gulls occur in the North Sea in spring and summer as the species is a partial summer migrant to the area (Tasker *et al.,* 1987). The largest breeding colony of lesser black-backed gulls within the Offshore ZDE is on Outer Trial Bank in The Wash, with 1,378 apparently occupied nests (AONs) recorded during Seabird 2000 (Mitchell *et al.*, 2004), although as numbers at the site were previously lower, the species is not included as a feature of The Wash SPA (Stroud *et al.*, 2001).

There are no designated SPAs for the species in the Offshore ZDE (Stroud *et al.*, 2001). Lesser black-backed gulls eat a wide variety of fish, including discards and offal from fishing vessels, and are mainly coastal during the breeding season (Table 5.3).

Table 5.11: Monthly mean densities of lesser black-backed gulls from ESAS surveys and totals of fulmars recorded on boat-based surveys within the Dogger Bank Zone between January 2010 and March 2011 (Gardline Environmental Ltd, 2010a-l, 2011a-c) and associated population estimates derived from boat-based survey data (Austin *et al.*, 2011).

	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
ESAS Density (birds/km^2)	VL	VL	L	L	L	L	VL	VL	VL	VL	VL	VL	VL	VL	L
Boat survey number	0	3	17	606	215	386	112	67	1	9	33	3	2	0	14
Boat survey relative abundance (birds/km)	0	< 0.1	< 0.1	0.3	0.2	0.4	0.1	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0	< 0.1
Population estimates	-	125	375	709	330	-	-	-	-	-	-	-	-	-	-

The species can forage up to 181 km from colonies, although 132 km is the estimated mean maximum range (Table 5.3), meaning that the Offshore Cable Area is within the potential foraging range of birds from the Ribble and Alt Estuaries and Bowland Fell SPAs (see Chapter 7 – *Nature Conservation*), though it is unlikely that birds from these west coast sites would cross the country to forage during the breeding season.

In the Offshore ZDE, lesser black-backed gulls were recorded at low densities off the North Yorkshire coast in September and October, and in the central and southern North Sea between March and June (Skov *et al.,* 1995).

ESAS surveys in the Dogger Bank Zone recorded birds at low densities from March to June (Table 5.11), with a peak average density of 0.75 birds/km^2 (Skov *et al.,* 1995). Very low densities were recorded between July and February. Surveys in August and September 2008, recorded birds at very low to moderate densities occasionally throughout the Dogger Bank Zone (Cork Ecology, 2009).

Results from the boat-based surveys of the Dogger Bank Zone between January 2010 and March 2011 also followed this pattern, with the greatest numbers of the species recorded in April 2010 (when birds are still returning to the breeding colonies) with a decline through the summer (Table 5.11) (Gardline Environmental Ltd, 2010a-l, 2011a-c). When related to survey effort, the peak of 606 birds recorded in April 2010 gives a relative abundance of 0.3 birds/km travelled (Table 5.11).

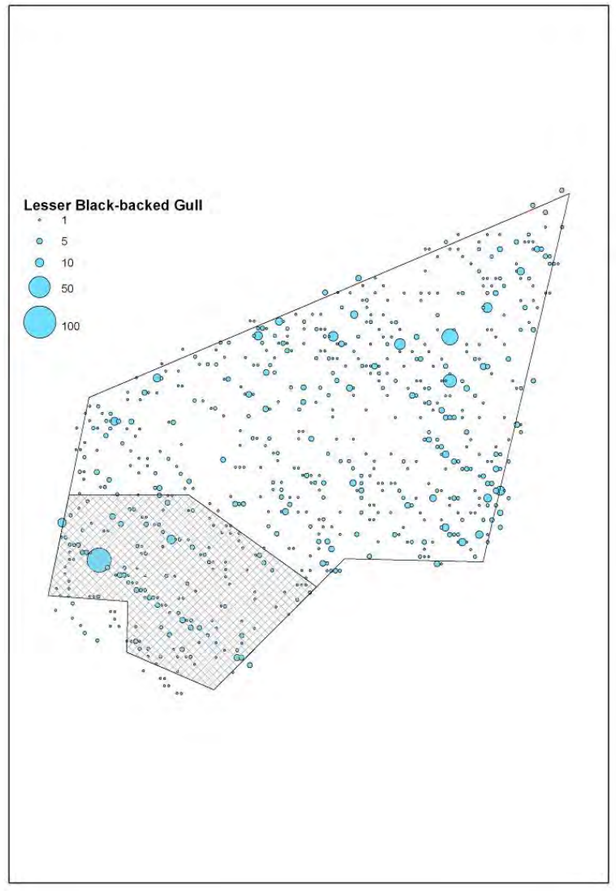


Figure 5.10: Distribution of lesser black-backed gulls in the Dogger Bank Zone based upon boat-based survey observations between January 2010 and December 2010.

The 2010 boat-surveys indicate that the distribution of lesser black-backed gulls is relatively even across the Dogger Bank Zone (Figure 5.10). Figure 5.11 clearly shows that the greatest numbers occur in the summer period, with no obvious distributional differences between seasons.

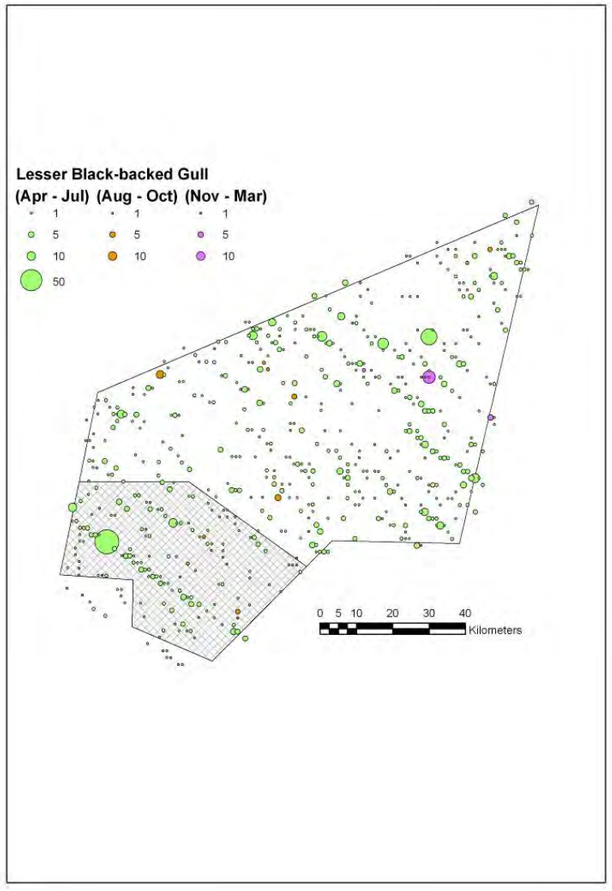


Figure 5.11: Seasonal distribution of lesser black-backed gulls in the Dogger Bank Zone based upon boat-based survey observations between April 2010 and March 2011.

5.4.10 Herring gull

Numbers of herring gulls in the North Sea are highest during winter, when birds are widely dispersed. The species is a feature of the Flamborough Head and Bempton Cliffs SPA, with 1,110 pairs (0.1% of the GB breeding population) listed by Stroud *et al.*

(2001) (Table 5.2). A total of 1,003 AONs on the Outer Trial Bank in The Wash was recorded during Seabird 2000 (Mitchell *et al.*, 2004), although as numbers at the site were previously lower, the species is not included as a feature of The Wash SPA (Stroud *et al.*, 2001).

Herring gulls eat a wide variety of fish, including discards and offal from fishing vessels, and are mainly coastal during the breeding season (Table 5.3). The species can forage up to 92 km from colonies, although 61 km is the estimated mean maximum range (Table 5.3) meaning that the Offshore Cable Area is within the potential foraging range of birds from the Flamborough Head and Bempton Cliffs SPA (see Chapter 7 – *Nature Conservation*).

ESAS surveys in the Offshore ZDE recorded highest herring gull density (12.8 birds/km^2) off the coast of Newcastle between November and February (Skov *et al.,* 1995). Numbers of herring gulls in this area of the North Sea at this time of year were highlighted as being of international importance by Skov *et al.,* (1995).

ESAS surveys recorded moderate densities in the Dogger Bank Zone between November and February (Table 5.12), with highest average density of 1.7 birds/km^2 recorded in the southwest corner of the Dogger Bank Zone (Skov *et al.,* 1995). Low densities were recorded in March and April, with very low densities recorded between May and October. Surveys in the Dogger Bank Zone in August and September 2008, recorded birds occasionally at very low to moderate densities (Cork Ecology, 2009).

Recent boat-based surveys of the Dogger Bank Zone between January 2010 and March 2011 recorded generally low numbers of herring gulls with a peak of 225 birds in February 2010 (Table 5.12) (Gardline Environmental Ltd, 2010a-l, 2011a-c). When related to survey effort, this gives a relative abundance of 0.2 birds/km for February (Table 5.12).

The 2010 boat-surveys indicate that the distribution of herring gulls is relatively even across the Dogger Bank Zone (Figure 5.12). Figure 5.13 clearly shows that the greatest numbers occur in the winter period, with no obvious distributional differences between seasons.

Table 5.12: Monthly mean densities of herring gulls from ESAS surveys and totals of great black-backed gulls recorded on boat-based surveys within the Dogger Bank Zone between January 2010 and March 2011 (Gardline Environmental Ltd, 2010a-l, 2011a-c) and associated population estimates derived from boat-based survey data (Austin *et al*., 2011).

	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
ESAS Density (birds/km^2)	M	M	L	L	VL	VL	VL	VL	VL	VL	M	M	M	M	L
Boat survey number	48	225	49	32	54	18	2	2	2	17	37	146	29	8	31
Boat survey relative abundance (birds/km)	0.3	0.2	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1
Population estimates	-	422	201	64	661	-	-	-	-	-	-	-	-	-	-

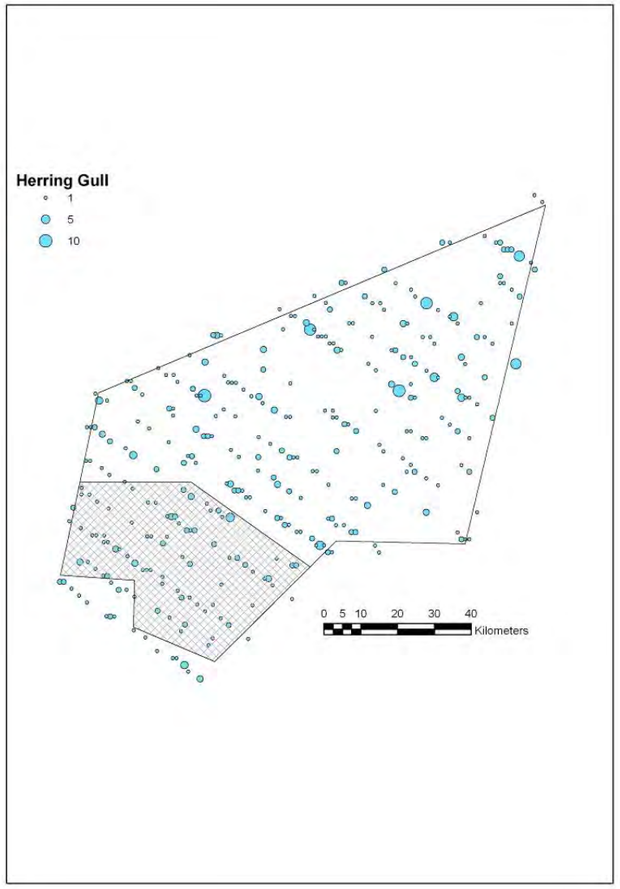


Figure 5.12: Distribution of herring gulls in the Dogger Bank Zone based upon boat-based survey observations between January 2010 and December 2010.

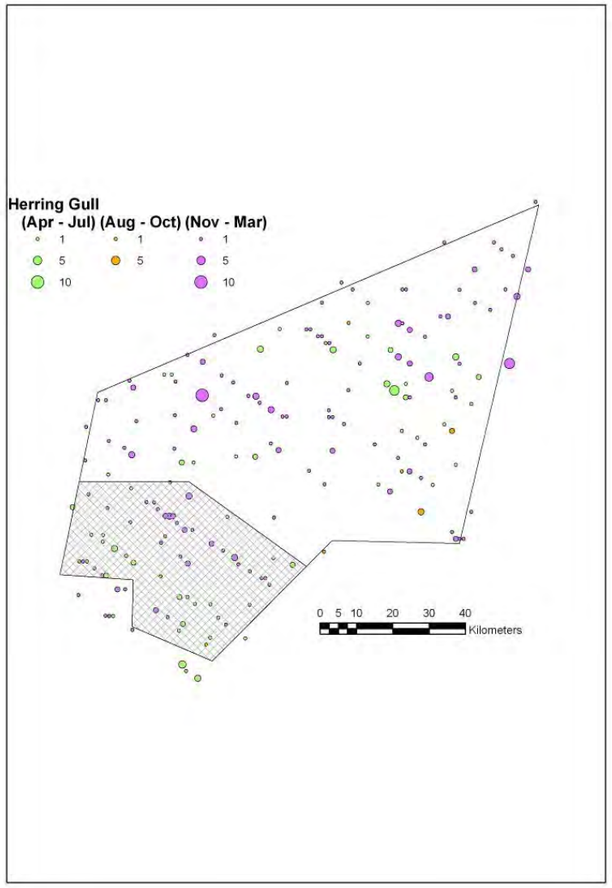


Figure 5.13: Seasonal distribution of herring gulls in the Dogger Bank Zone based upon boat-based survey observations between April 2010 and March 2011.

5.4.11 Great black-backed gull

The North Sea is of global importance for great black-backed gulls in winter (Skov *et al.,* 1995). There are no large breeding colonies of great black-backed gulls within the Offshore ZDE and no designated SPAs for the species in the Offshore ZDE (Mitchell *et al.,* 2004; Stroud *et al.*, 2001). Great black-backed gulls eat a wide variety of fish, including discards and offal, and seabirds, and are mainly coastal during the breeding season (Table 5.3).

In the Offshore ZDE, the highest densities of great black-backed gulls (7.8 birds/km^2) were recorded on ESAS surveys offshore from Flamborough Head between November and February (Skov *et al.,* 1995). Numbers of great black-backed gulls in this area of the North Sea at this time of year were estimated to be of international importance by Skov *et al.,* (1995).

ESAS surveys in the Dogger Bank Zone recorded great black-backed gulls at low densities between August and October and at very low densities in all other months (Table 5.13) (Skov *et al.,* 1995). Surveys in August and September 2008 recorded birds at very low to moderate densities in the southwest of the Dogger Bank Zone and occasionally elsewhere in the Offshore ZDE (Cork Ecology, 2009).

Recent boat-based surveys of the Dogger Bank Zone between January 2010 and March 2011 recorded a peak of 416 great black-backed gulls in February 2010 (Table 5.13) (Gardline Environmental Ltd, 2010a-l, 2011a-c). When related to survey effort, this gives a relative abundance of 0.4 birds/km^2 travelled (Table 5.13). The population estimate for February 2010 exceeded the 1% (winter) national threshold for the species.

The 2010 boat-surveys indicate that the distribution of great black-backed gulls is relatively even across the Dogger Bank Zone (Figure 5.14). Figure 5.15 clearly shows that the greatest numbers occur in the winter period, with no obvious distributional differences between seasons.

Table 5.13: Monthly mean densities of great black-backed gulls from ESAS surveys and totals of great black-backed gulls recorded on boat-based surveys within the Dogger Bank Zone between January 2010 and March 2011 (Gardline Environmental Ltd, 2010a-l, 2011a-c) and associated population estimates derived from boat-based survey data (Austin *et al.*, 2011). Note: Population estimates shown in red type exceed the national 1% threshold.

	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
ESAS Density (birds/km^2)	VL	VL	VL	VL	VL	VL	VL	L	L	L	VL	VL	VL	VL	VL
Boat survey number	26	416	249	136	64	26	25	35	8	57	66	266	297	120	176
Boat survey relative abundance (birds/km)	0.2	0.4	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	0.1	0.2	0.2	0.1	0.1
Population estimates	-	1,201	65	11	118	-	-	-	-	-	-	-			

ESAS surveys recorded black-headed gulls in very low densities in the Dogger Bank Zone in all months except May and June, when no birds were recorded (Stone *et al.,* 1995). Surveys within the Dogger Bank Zone in August and September 2008 also recorded black-headed gulls at low densities (Cork Ecology, 2009). Recent boat-based surveys in the Dogger Bank Zone recorded low numbers of black-headed gulls between January 2010 and March 2001, with a peak of 67 birds in July (Gardline Environmental Ltd, 2010a-l, 2011a-c).

Highest numbers of common gulls occur in the North Sea during winter, although the species is predominantly coastal in distribution (Tasker *et al.,* 1987). In the Offshore ZDE, ESAS surveys recorded common gulls at low densities between Flamborough Head and The Wash from December to February, with very low densities recorded in all other months (Skov *et al.,* 1995).

Very low densities of common gulls were recorded on ESAS surveys in the Dogger Bank Zone throughout the year (Skov *et al.,* 1995). Surveys in August and September 2008 recorded common gulls scattered at very low to low densities across the Dogger Bank Zone (Cork Ecology, 2009). Recent boat-based surveys in the Dogger Bank Zone recorded low numbers of black-headed gulls between January 2010 and March 2001, with a peak of 84 birds in October (Gardline Environmental Ltd, 2010a-l, 2011a-c).

A single Sabine's gull was also recorded by boat-based surveys in October 2010.

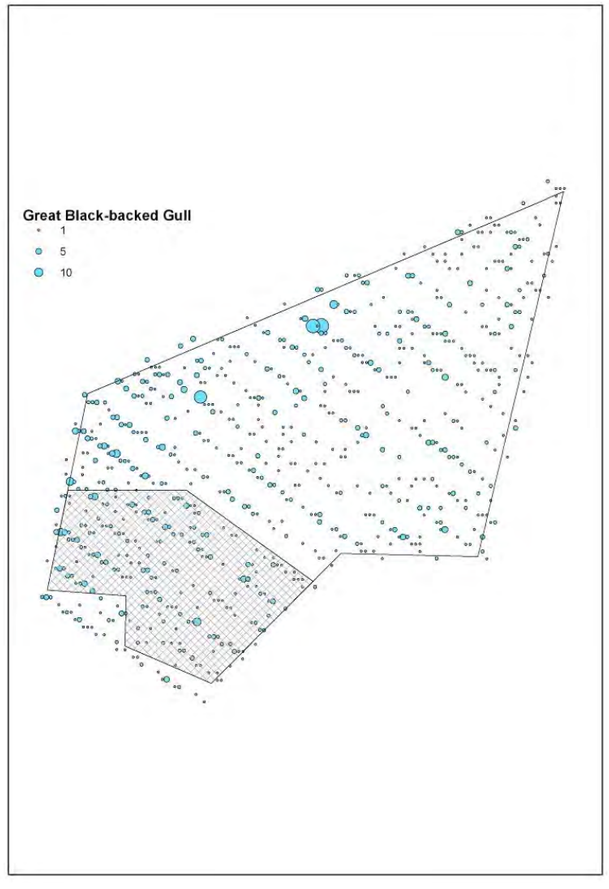


Figure 5.14: Distribution of great black-backed gulls in the Dogger Bank Zone based upon boat-based survey observations between January 2010 and December 2010.

5.4.12 Other gulls

Black-headed gulls are a predominantly coastal species (Tasker *et al.,* 1987), recorded in low densities between July and February in coastal waters off Flamborough Head and North Yorkshire on ESAS surveys in the Offshore ZDE between 1980 and 1993 (Stone *et al.,* 1995).

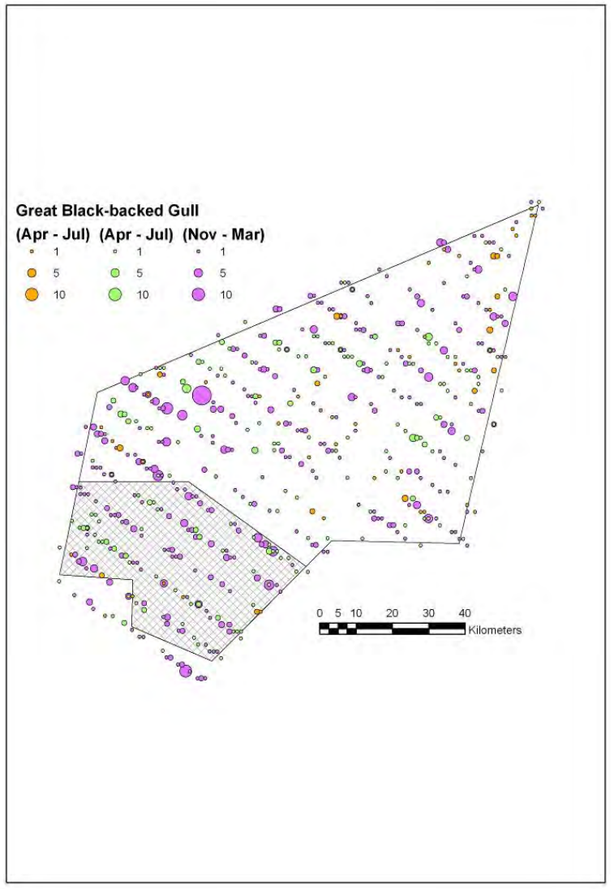


Figure 5.15: Seasonal distribution of great black-backed gulls in the Dogger Bank Zone based upon boat-based survey observations between April 2010 and March 2011.

5.4.13 Terns

Terns are summer visitors to the North Sea (Tasker *et al.,* 1987). Little terns are breeding features of five SPAs within the Offshore ZDE (Table 5.2; Stroud *et al.*, 2001). Common terns are also features of two of these sites, while sandwich tern and roseate tern are each a feature of a single SPA in the Offshore ZDE (Table 5.2; Stroud *et al.*, 2001). Very low numbers of Arctic terns also breed within these colonies each year (Mitchell *et al.,* 2004).

Three species (sandwich tern, common tern and Arctic tern) were regularly recorded between April and September on ESAS surveys in the Offshore ZDE, mostly in inshore waters, close to breeding colonies (Skov *et al.,* 1995).

Very low densities of sandwich terns and common terns were recorded in the Dogger Bank Zone between April and September on ESAS surveys (Skov *et al.,* 1995). Stone *et al.* (1995) analysed ESAS data for Arctic terns together with common terns due to the similarity of the two species, and recorded birds at low densities in the southwest of the Dogger Bank Zone between July and September. Neither species were recorded on surveys in the Dogger Bank Zone in August and September 2008 (Cork Ecology, 2009). Recent boat-based surveys in the Dogger Bank Zone between January 2010 and March 2001 typically recorded low numbers (less than 10 birds) of common and Arctic terns between April and October 2010, with a peak of 28 Arctic terns in July (Gardline Environmental Ltd, 2010a-l, 2011a-c).

Based on the above, it is likely that low numbers of common and Arctic terns pass through the Dogger Bank Zone during spring and autumn migration between their breeding colonies and wintering grounds off Africa and further south.

5.4.14 Guillemot

Guillemots are found throughout the North Sea in all months, with late summer generally being the most important period, when an estimated 1.8 million birds are in the North Sea, including recently fledged juveniles, moulting adults and non-breeding birds (Skov *et al.,* 1995). The most important area lies off the east coast of Scotland and northeast England in July and August. The largest guillemot breeding colony within the Offshore ZDE is at the Flamborough Head and Bempton Cliffs SPA, with 16,150 pairs (2.3% of the GB breeding population) listed by Stroud *et al.* (2001) (Table 5.2). This colony is the only designated SPA for the species in the Offshore ZDE (Stroud *et al.*, 2001).

Guillemots eat a variety of fish, and can forage up to 135 km from colonies, although 71 km is the estimated mean maximum range (Table 5.3), meaning that the Offshore Cable Area and possibly the Dogger Bank Zone are within the potential foraging range of birds from the Flamborough Head and Bempton Cliffs SPA.

In the Dogger Offshore ZDE, the highest density of guillemots (34.7 birds/km^2) on ESAS surveys was recorded offshore from Teesside in September and October. Numbers of guillemots in this area of the North Sea at this time of year were estimated to be of international importance by Skov *et al.* (1995). In addition, high densities of guillemots were also recorded around Flamborough Head from March to June (Skov *et al.,* 1995).

On ESAS surveys in the Dogger Bank Zone, the highest guillemot density was recorded between November and February in the southwest of the Dogger Bank Zone (Table 5.14), with a peak mean density of 10.9 birds/km^2 in the southwest of the Dogger Bank Zone. A recent JNCC statistical analysis investigating possible marine SPAs included this area as part of another area which was categorised as “near-qualifying” for guillemots in winter (Kober *et al.,* 2010).

Moderate densities were recorded in the south of the Dogger Bank Zone between March and July and in September and October (Skov *et al.,* 1995). In March 2008 guillemots were recorded at high densities (20.0 – 49.9 birds/km^2) in the southwest of the Dogger Bank Zone, while very low to moderate densities of guillemots were recorded sporadically across the Dogger Bank Zone in August and September 2008 (Cork Ecology, 2009).

Table 5.14: Monthly mean densities of guillemots from ESAS surveys and totals of guillemots recorded on boat-based surveys within the Dogger Bank Zone between January 2010 and March 2011 (Gardline Environmental Ltd, 2010a-l, 2011a-c) and associated population estimates derived from boat-based survey data (Austin *et al.*, 2011). Note: Population estimates shown in red type exceed the national 1% threshold.

	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
ESAS Density (birds/km^2)	H	H	M	M	M	M	M	L	M	M	H	H	H	H	M
Boat survey number	145	2,134	4,389	1,045	468	236	2,958	940	135	4,496	1,854	2,980	1,701	3,071	7,359
Boat survey relative abundance (birds/km)	0.9	1.8	2.5	0.5	0.3	0.2	2.6	0.8	1.1	2.3	1.6	2.1	1.4	3.6	3.0
Population estimates	-	63,335	82,621	17,882	4,246	-	-	-	-	-	-	-	-	-	-

Peak guillemot numbers on boat-based surveys of the Dogger Bank Zone between January 2010 and March 2001 occurred just prior to the breeding season, in March 2010 and March 2011, when 4,389 and 7,359 birds were recorded respectively (Table 5.14) (Gardline Environmental Ltd, 2010a-l, 2011a-c). When related to survey effort, these figures give relative abundances of 2.5 and 3.0 birds/km^2 respectively (Table 5.14). Guillemot relative abundance was slightly lower in February, but was clearly lower in other months, which is similar to the pattern recorded from ESAS surveys. The population estimates for February to April 2010 exceeded the 1% national thresholds for the species.

Aerial surveys of the Dogger Bank Zone between May 2009 and April 2010 indicate a similar distribution pattern. Auks were widespread across the Dogger Bank Zone at moderate abundance (5.01 to 10.0 birds/km^2) in January 2010, while highest abundance was recorded in February 2010 in the southwest corner (>15 birds/km^2) (Appendix C) (TCE, 2010).

The 2010 boat-surveys indicate that the species occurs throughout the Dogger Bank Zone, though are most concentrated at the western edge and fewest birds are found in the north (Figure 5.16). Figure 5.17 indicates that this concentration was most pronounced in the summer (April-July) and autumn (August-October).

Although it is not possible to identify individual auks to species on aerial surveys, it is likely that the majority of auks recorded on aerial surveys were guillemots, as this species has been consistently recorded in higher numbers than razorbill or puffin on boat-based surveys between January 2010 and March 2011 (Gardline Environmental Ltd 2010a-l, 2011a-c).

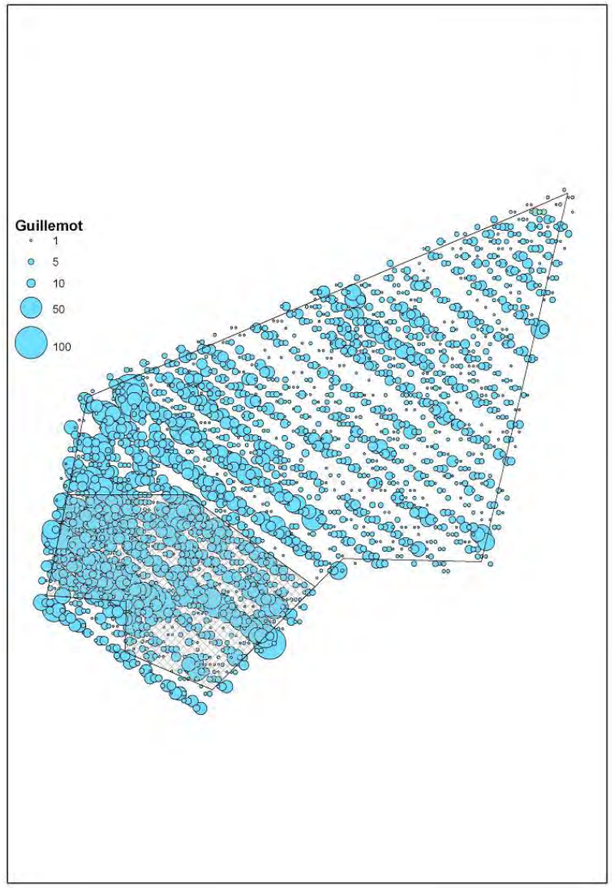


Figure 5.16: Distribution of guillemots in the Dogger Bank Zone based upon boat-based survey observations between January 2010 and December 2010.

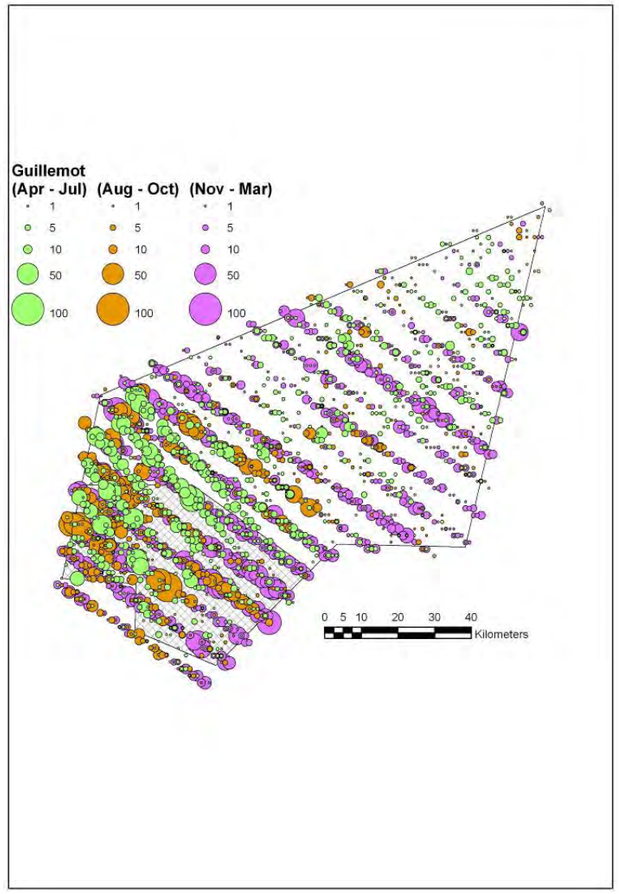


Figure 5.17: Seasonal distribution of guillemots in the Dogger Bank Zone based upon boat-based survey observations between April 2010 and March 2011.

5.4.15 Razorbill

Razorbills are widely distributed in the North Sea throughout the year, with peak numbers occurring in the winter months (Skov *et al.,* 1995). The largest razorbill breeding colony within the Offshore ZDE is at the Flamborough Head and Bempton Cliffs SPA, with 5,133 pairs (5.2% of the GB breeding population) listed by Stroud *et al.* (2001) (Table 5.2). This colony is the only designated SPA for the species in the Offshore ZDE (Stroud *et al.*, 2001).

Razorbills eat a variety of fish, and can forage up to around 100 km from colonies, although 58 km is the estimated mean maximum range (Table 5.3), meaning that the Offshore Cable Area and possibly the Dogger Bank Zone are within the potential foraging range of birds from the Flamborough Head and Bempton Cliffs SPA.

In the Offshore ZDE, the highest density of razorbills (6.35 birds/km2) on ESAS surveys was recorded between Teesside and Flamborough Head, between July and September. Numbers of razorbills in this area of the North Sea at this time of year were highlighted as being of international importance by Skov et al., (1995).

ESAS surveys in the Dogger Bank Zone recorded razorbills at very low to low densities throughout the year (Table 5.15) (Skov et al., 1995). In March 2008 razorbills were recorded at high densities (10.0 – 19.9 birds/km^2) in the southwest of the Dogger Bank Zone, while very low to moderate densities of razorbills was recorded in August and September 2008 (Cork Ecology, 2009).

Peak razorbill numbers on boat-based surveys of the Dogger Bank Zone between January 2010 and March 2001 occurred in March 2010, October 2010 and March 2011, when 1,319, 3,502 and 2,532 birds were recorded respectively (Table 5.15) (Gardline Environmental Ltd, 2010a-l, 2011a-c). When related to survey effort, the October peak gives a relative abundance of 1.8 birds/km^2 (Table 5.15).

The 2010 boat-surveys indicate that the species occurs throughout the Dogger Bank Zone, though are most concentrated in the western part with fewer birds found in the northeast (Figure 5.18). Figure 5.19 indicates that this concentration was most pronounced in the autumn (August-October), i.e. when numbers peaked following the breeding period.

5.4.16 Little auk

Little auks are winter visitors to the North Sea, breeding in the high Arctic (Tasker *et al.,* 1987). On ESAS surveys in the Offshore ZDE, little auks were recorded in moderate densities inshore of the Dogger Bank Zone between December and February (Skov et al., 1995).

ESAS surveys in the Dogger Bank Zone recorded moderate densities of little auks between October and February (Table 5.16), with a peak average density of 3.8 birds/km^2 in the southern half of the Dogger Bank Zone between December and February (Skov *et al.,* 1995). A recent JNCC statistical analysis investigating possible marine SPAs highlighted the southwest corner of the Dogger Bank Zone as part of an area categorised as "near-qualifying" for little auks in winter (Kober *et al.,* 2010).

Little auks were recorded at very low to low densities in the southwest of the Dogger Bank Zone in March 2008 (Cork Ecology, 2009).

Table 5.15: Monthly mean densities of razorbills from ESAS surveys and totals of guillemots recorded on boat-based surveys within the Dogger Bank Zone between January 2010 and March 2011 (Gardline Environmental Ltd, 2010a-l, 2011a-c) and associated population estimates derived from boat-based survey data (Austin *et al.*, 2011). Note: Population estimates shown in red type exceed the national 1% threshold.

	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
ESAS Density (birds/km^2)	VL	VL	L	L	L	L	VL	VL	VL	L	L	VL	VL	VL	VL
Boat survey number	234	750	1,317	465	58	39	225	5	53	3,502	610	400	964	479	2,352
Boat survey relative abundance (birds/km)	1.5	0.6	0.8	0.2	< 0.1	< 0.1	0.2	< 0.1	0.4	1.8	0.5	0.3	0.8	0.6	1.0
Population estimates	-	12,261	18,230	6,974	192	-	-	-	-	-	-	-	-	-	-

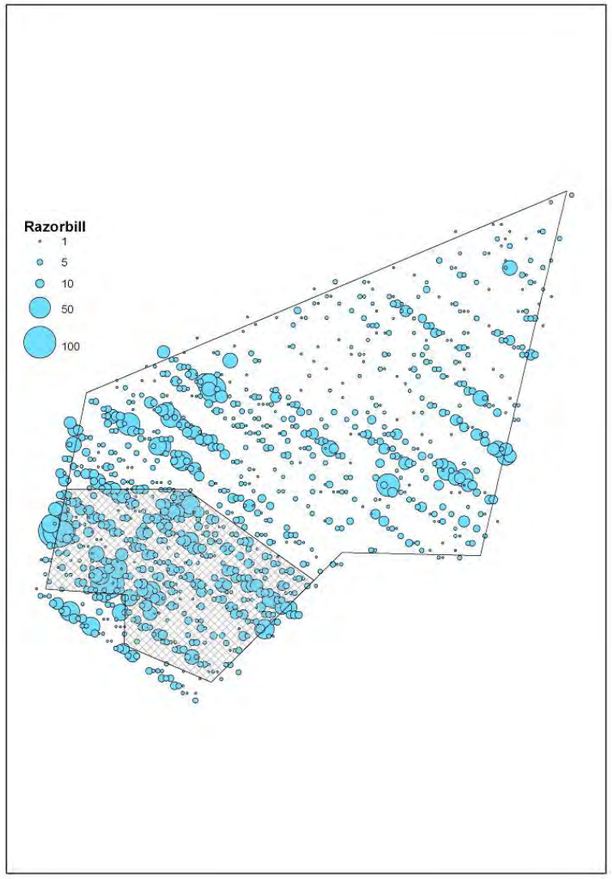


Figure 5.18: Distribution of razorbills in the Dogger Bank Zone based upon boat-based survey observations between January 2010 and December 2010.

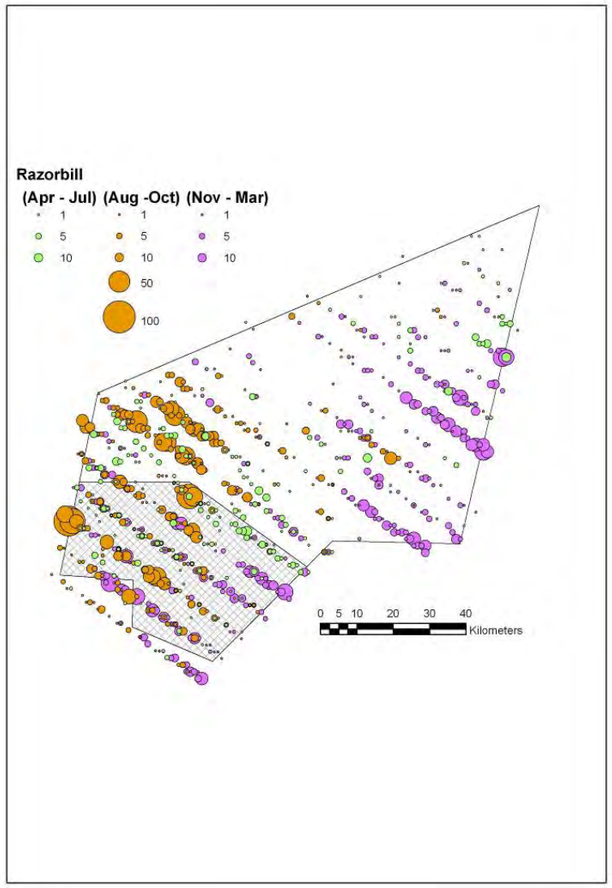


Figure 5.19: Seasonal distribution of razorbills in the Dogger Bank Zone based upon boat-based survey observations between April 2010 and March 2011.

Recent boat-based surveys in the Dogger Bank Zone between January 2010 and March 2001 recorded a peak of 917 little auks in November (Table 5.16) (Gardline Environmental Ltd, 2010a-l, 2011a-c). When related to survey effort, this gives a relative abundance of 0.8 birds/km (Table 5.16).

The 2010 boat-surveys indicate that the distribution of little auks is relatively even across the Dogger Bank Zone (Figure 5.20).

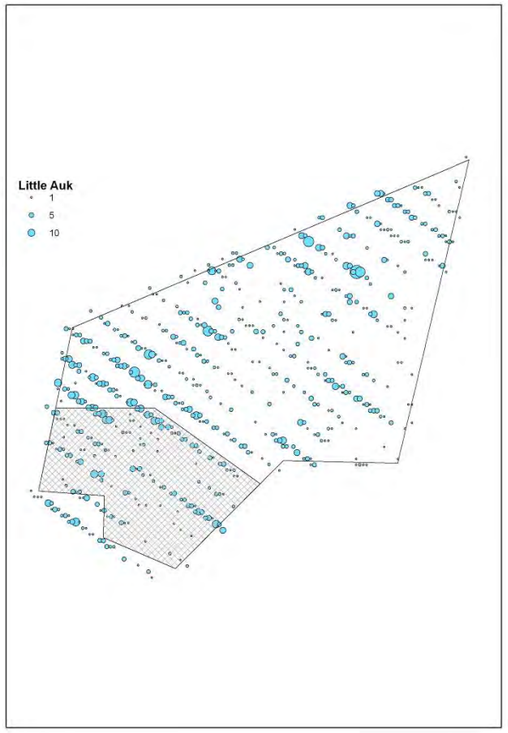


Figure 5.20: Distribution of little auks in the Dogger Bank Zone based upon boat-based survey observations between January 2010 and December 2010.

5.4.17 Puffin

Puffins are recorded in the North Sea throughout the year, with highest numbers recorded around the main breeding colonies in summer. In winter months, birds disperse to offshore waters (Tasker *et al.,* 1987). The largest puffin breeding colony within the Offshore ZDE is at the Flamborough Head and Bempton Cliffs SPA, with 3,473 pairs (0.8% of the GB breeding population) listed by Stroud *et al.* (2001) (Table 5.2). This colony is the only designated SPA for the species in the Offshore ZDE (Stroud *et al.*, 2001).

Puffins eat a variety of fish, and can forage up to 200 km from colonies, although 87 km is the estimated mean maximum distance (Table 5.3), meaning that the Offshore Cable Area and possibly the Dogger Bank Zone are within the potential foraging range of birds from the Flamborough Head and Bempton Cliffs SPA.

On ESAS surveys in the Offshore ZDE, puffins were recorded in moderate densities off Flamborough Head in August and September, with lower densities recorded in other months (Skov *et al*., 1995).

ESAS surveys in the Dogger Bank Zone recorded low densities of puffins in all months (Table 5.17) (Skov *et al*., 1995). Surveys in March, August and September 2008 recorded very low to low densities of puffins in the Dogger Bank Zone (Cork Ecology, 2009).

Recent boat-based surveys in the Dogger Bank Zone between January 2010 and March 2001 recorded puffins throughout the year, though with fewest during summer and a peak of 351 in October (Table 5.17) (Gardline Environmental Ltd, 2010a-l, 2011a-c).

When related to survey effort, this gives a relative abundance of 0.2 birds/km^2 (Table 5.17).

The 2010 boat-surveys indicate that the distribution of puffins is relatively even across the Dogger Bank Zone over the year as a whole (Figure 5.21). Figure 5.22 suggests a slight concentration to the western edge of the Zone in the autumn (August-October), i.e. when numbers peaked following the breeding period.

5.4.18 Other seabird species

A number of other seabird species have also been recorded in the Dogger Bank Zone, though typically in low numbers. In the Offshore ZDE, ESAS surveys between 1980 and 1994 recorded low densities of cormorants in the Humber Estuary, and moderate densities off the Durham coast and inshore waters of the Wash throughout the year. Shags were recorded at moderate densities around Flamborough Head in all months (Skov *et al.,* 1995).

ESAS surveys in the Dogger Bank Zone recorded very low densities of cormorants and shags throughout the year (Skov *et al.,* 1995). Neither species were recorded in the Dogger Bank Zone during 2008 surveys (Cork Ecology, 2009). Boat-based surveys in the Dogger Bank Zone between January 2010 and March 2011 recorded one cormorant in October 2010, one in November 2010 and two in March 2011 and just one shag, in March 2010 (Gardline Environmental Ltd, 2010a-l, 2011a-c).

Other seabird species recorded occasionally or in low numbers by boat-based surveys between January 2010 and March 2011 have included European storm-petrel, sooty shearwater, Manx shearwater, pomarine skua and Arctic skua.

Table 5.16: Monthly mean densities of little auks from ESAS surveys and totals of guillemots recorded on boat-based surveys within the Dogger Bank Zone between January 2010 and March 2011 (Gardline Environmental Ltd, 2010a-l, 2011a-c) and associated population estimates derived from boat-based survey data (Austin *et al*., 2011).

	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
ESAS Density (birds/km^2)	M	M	VL	VL	VL	VL	VL	VL	VL	M	M	M	M	M	VL
Boat survey number	0	157	3	0	0	0	0	0	0	32	917	865	173	117	187
Boat survey relative abundance (birds/km)	0	0.1	< 0.1	0	0	0	0	0	0	< 0.1	0.8	0.6	0.1	0.1	0.1
Population estimates	-	1,761	0	0	0	-	-	-	-	-	-	-	-	-	-

Table 5.17: Monthly mean densities of puffins from ESAS surveys and totals of guillemots recorded on boat-based surveys within the Dogger Bank Zone between January 2010 and March 2011 (Gardline Environmental Ltd, 2010a-l, 2011a-c) and associated population estimates derived from boat-based survey data (Austin *et al.*, 2011).

	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
ESAS Density (birds/km^2)	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L
Boat survey number	4	153	106	112	40	113	3	3	24	352	121	141	152	116	343
Boat survey relative abundance (birds/km)	< 0.1	0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	< 0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Population estimates	-	4,934	5,879	1,599	447	-	-	-	-	-	-	-	-	-	-

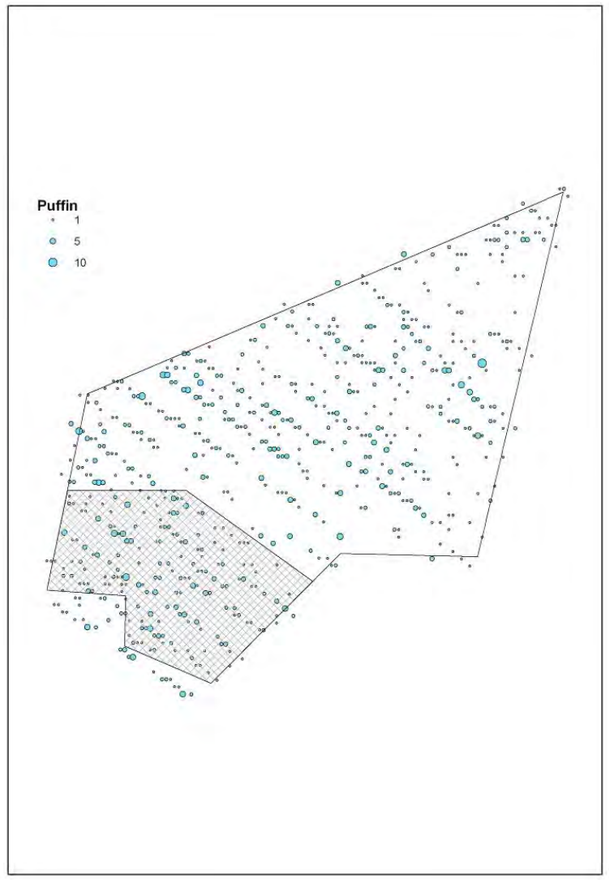


Figure 5.21: Distribution of puffins in the Dogger Bank Zone based upon boat-based survey observations between January 2010 and December 2010.

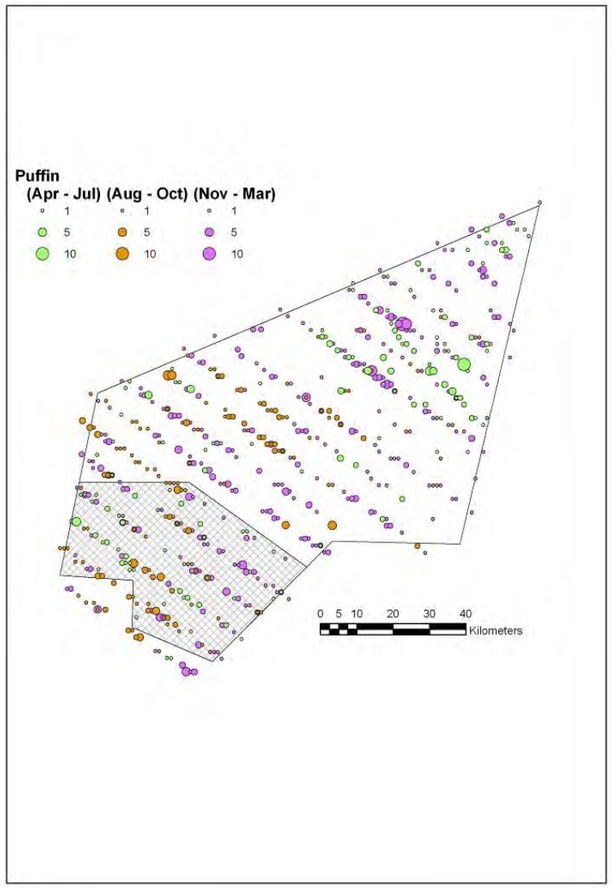


Figure 5.22: Seasonal distribution of puffins in the Dogger Bank Zone based upon boat-based survey observations between April 2010 and March 2011.

5.5 Other species

In addition to seabirds, there are many other bird species that are likely to occur in the Offshore ZDE. These include waterbirds and terrestrial (or land) birds.

5.5.1 Important sites for waterbirds

Within the Offshore ZDE, there are four SPAs on the east coast of England that regularly hold important numbers of waterbirds (Table 5.18). All five sites are counted as part of the UK-wide Wetland Bird Survey (WeBS), and three of these sites (The Wash, North Norfolk Coast and the Humber Estuary) are listed in the top six WeBS sites in the UK (Calbrade *et al.*, 2010). Several species are qualifying interest features for these SPAs (see also Chapter 7 – *Nature Conservation*).

Waterbirds generally migrate between their breeding, staging (areas where they rest and feed up during migration) and wintering areas along regular routes or "flyways". Research into wader migration has found that there are eight global flyways. Waders moving up and down the east coast of England (including through the Offshore ZDE) are considered part of the East Atlantic Flyway (Delaney *et al.,* 2009). Both The Wash and the Humber Estuary are considered key sites of this flyway, as they are listed as regularly supporting more than five wader species recorded in internationally important numbers (Delaney *et al.,* 2009). While the features of these sites are in close proximity to the development of the Dogger Bank Zone, the features of other SPAs (and Ramsar sites) outside of the Offshore ZDE may potentially also pass through the Zone.

5.5.2 Bird migration across the North Sea

Several hundred million birds of many different species cross the North Sea every year from Europe and Scandinavia to Britain during spring and autumn migration (Hüppop *et al.,* 2006). Many of these birds are likely to pass over the Dogger Bank Zone during these periods. The main species groups include waterbirds (that may be features of SPAs) and terrestrial birds including raptors, owls, pigeons, swallows and martins, larks, wagtails, pipits, chats, thrushes, warblers, crows, starlings, finches and buntings. There is a general movement northwards in spring and south in autumn, but the scale of movement is often dependent on prevailing weather conditions and the time of year.

Table 5.18: Summary of important coastal SPAs for wintering or passage waterbirds within the Offshore ZDE.

SPA	Waterbird assemblage [1]	SPA qualifying interest [1]	WeBS 2004/05 – 2008/09 [2]
The Wash	400,273	Black-tailed godwit avocet, golden plover, bar-tailed godwit, pink-footed goose, dark-bellied brent goose, shelduck, pintail, oystercatcher, grey plover, whooper swan, dunlin, sanderling, curlew, redshank turnstone, little grebe, cormorant, white-fronted goose, wigeon, mallard, ringed plover, lapwing, knot, whimbrel	372,964
North Norfolk Coast	91,249	Shelduck, avocet, golden plover, ruff, bar-tailed godwit, pink-footed goose, dark-bellied brent goose, wigeon, pintail, knot, redshank, bittern, white-fronted goose, dunlin, gadwall, teal, shoveler, common scoter, velvet scoter, oystercatcher, ringed plover, grey plover, lapwing, sanderling, cormorant	205,571
Humber Estuary [3]	153,934[3]	Teal, wigeon, mallard, turnstone, pochard, tufted duck, bittern, dark-bellied brent goose, goldeneye, sanderling, dunlin, knot, ringed plover, oystercatcher, bar-tailed godwit, black-tailed godwit, curlew, whimbrel, ruff, golden plover, grey plover, avocet, shelduck, greenshank, redshank, lapwing.	157,785
Teesmouth and Cleveland Coast	21,406	Sanderling, lapwing, shelduck cormorant, redshank, knot	21,322

[1] Winter / passage features as given in Stroud *et al.* (2001), which provides the definitive list of qualifying species and their numbers at the SPAs concerned.

[2] Mean of peaks for most recent five-year period (Calbrade *et al.,* 2010).

[3] Humber Estuary SPA classified in 2007 (superseding previous Humber Flats, Marshes and Coast SPA) and data thus taken from citation document (http://jncc.defra.gov.uk/pdf/SPA/UK9006111.pdf).

Table 5.20: Numbers of waterbirds recorded during boat surveys in the Dogger Bank Zone between January 2010 and March 2011 (excluding species considered as seabirds above) (Gardline Environmental Ltd, 2010a-l, 2011a-c).

Species	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Swan sp.	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0
Bean Goose	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Greylag Goose	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Goose sp.	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0
Teal	0	0	0	0	0	0	0	0	0	0	4	3	0	0	1
Mallard	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Pintail	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Pochard	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Tufted Duck	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Aythya duck sp.	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Goldeneye	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0
Goosander	0	0	0	2	0	0	0	0	0	0	0	3	0	0	0
Grey Heron	0	0	0	0	0	0	3	0	0	1	0	0	0	0	2
Oystercatcher	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2
Ringed Plover	0	0	0	0	0	0	1	3	0	0	0	0	0	1	0
Golden Plover	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Lapwing	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3
Knot	0	0	0	0	0	0	6	2	0	0	0	0	0	0	0
Sanderling	0	0	0	0	0	0	2	3	1	0	0	0	0	0	0
Dunlin	0	0	0	0	0	0	3	12	0	2	0	0	0	1	1
Jack Snipe	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Woodcock	0	1	0	0	0	0	0	0	0	0	1	0	0	0	3
Whimbrel	0	0	0	1	3	1	1	1	0	0	0	0	0	0	0
Curlew	0	0	0	9	1	0	36	5	0	0	0	0	0	0	2
Common Sandpiper	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Redshank	0	0	0	0	0	0	1	6	0	0	0	0	0	0	0
Turnstone	0	0	0	0	0	0	5	2	0	0	0	0	0	0	0
Wader sp.	0	0	0	0	0	0	0	0	0	0	37	1	0	0	1
Grey phalarope	0	0	0	0	0	0	0	0	0	1	2	1	1	0	3
Total birds	**2**	**17**	**2**	**15**	**5**	**2**	**58**	**35**	**1**	**4**	**43**	**13**	**2**	**6**	**18**
Total spp.	**1**	**2**	**1**	**5**	**3**	**2**	**9**	**9**	**1**	**3**	**3**	**2**	**0**	**4**	**8**

Table 5.19: Terrestrial birds recorded during boat surveys in the Dogger Bank Zone between January 2010 and March 2011 (Gardline Environmental Ltd, 2010a-l, 2011a-c).

Species	2010												2011		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Sparrowhawk	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Osprey	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Kestrel	0	0	1	0	0	1	0	0	2	2	0	0	0	0	0
Woodpigeon	0	1	1	2	4	0	0	0	0	0	0	0	0	0	1
Collaredd	0	0	0	1	3	1	0	0	0	0	0	0	0	0	0
Short-eared owl	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Swift	0	0	0	0	1	0	1	2	0	0	0	0	0	0	0
Carrion crow	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0
Goldcrest	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0
Skylark	0	0	0	1	0	0	0	0	0	2	1	0	0	0	0
Swallow	0	0	0	4	10	7	0	0	0	1	0	0	0	0	1
House martin	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0
Chiffchaff	0	0	4	7	0	0	0	0	0	12	0	0	0	0	0
Willow warbler	0	0	0	2	1	0	0	0	0	1	0	0	0	0	0
Blackcap	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0
Garden warbler	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Lesser whitethroat	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Grasshopper warbler	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0
Sedge warbler	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Marsh warbler	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Reed warbler	0	0	0	0	0	2	0	0	0	5	0	0	0	0	0
Locustella	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Warbler sp.	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0
Waxwing	0	1	0	0	0	0	0	0	0	0	50	0	2	0	0
Wren	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
Starling	1	0	152	0	0	0	1	0	0	276	243	3	0	87	0
Ring ouzel	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Blackbird	0	2	6	1	0	0	0	0	0	5	1	1	1	4	23
Fieldfare	3	6	3	0	0	0	0	0	0	0	1	4	3	0	1
Song thrush	0	1	1	0	0	0	0	0	0	28	1	0	0	0	1
Redwing	8	0	7	0	0	0	0	0	0	245	1	0	0	0	0
Thrush sp.	0	1	0	0	0	0	0	0	0	5	0	0	0	2	20
Robin	0	0	0	0	0	0	0	0	0	10	0	0	1	2	1
Bluethroat	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Black redstart	0	0	5	0	0	0	2	0	0	1	1	0	0	0	0
Common redstart	0	0	0	0	0	0	0	0	1	5	0	0	0	0	0
Wheatear	0	0	0	3	0	0	0	2	0	0	0	0	0	0	0
Yellow wagtail	0	0	0	1	0	0	0	0	0	2	0	0	0	0	0
Grey wagtail	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Pied/white wagtail	0	1	2	1	1	1	0	1	1	1	1	0	0	0	1
Meadow pipit	0	0	4	7	0	0	0	0	8	133	1	0	0	1	3
Pipit sp.	0	0	0	0	1	0	0	0	0	0	0	0	0	1	5+
Chaffinch	0	0	1	0	0	0	0	0	0	77	0	0	0	0	0
Brambling	0	0	0	0	0	0	0	0	0	8	0	0	0	0	0
Greenfinch	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Siskin	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Linnet	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Finch sp.	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Snow bunting	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
Lapland bunting	0	0	0	0	0	0	0	0	0	5	1	0	0	0	0
Dark-eyed junco	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Reed bunting	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Pallas's reed bunting	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Bunting sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Total birds	**12**	**13**	**188**	**49**	**24**	**16**	**4**	**5**	**14**	**847**	**306**	**8**	**7**	**98**	**52**
Total spp.	**3**	**6**	**12**	**18**	**9**	**8**	**3**	**3**	**5**	**29**	**15**	**3**	**4**	**4**	**8**

On-going boat-based surveys in the Dogger Bank Zone recorded 25 different species of waterbirds (excluding species considered as seabirds above) and 48 different terrestrial (or land) bird species between January 2010 and March 2011 (Table 5.19 and Table 5.20).

Most waterbirds were recorded in low numbers, with curlew being the commonest species recorded, with a peak of 36 in July (Table 5.20). Grey phalaropes winter at sea and primarily occurred in the Dogger Bank Zone during the winter rather than passage periods.

The commonest terrestrial birds recorded were starling, redwing and meadow pipit, with respective peaks of 276, 245 and 133 in October 2010 (Table 5.19).

There is some existing information on the movement of these species over the North Sea from sources such as the North Sea Bird Club, who produce annual reports of bird species and numbers recorded on oil rigs and support vessels in the North Sea (e.g. Thorpe, 2001).

5.6 Likely key species in the Dogger Bank Zone

A recent report by Langston (2010) highlighted the species of most particular concern in relation to the construction of offshore wind farms. That report also listed species likely to be of concern in each Round 3 Zone including the Dogger Bank Zone. More recently, a review of survey design used for the Dogger Bank Zone (Austin *et al*., 2011) used information from recent surveys to provide a provisional list of ten focal seabird species:

- White-billed diver;
- Fulmar;
- Gannet;
- Kittiwake;
- Lesser black-backed gull;
- Great black-backed gull; and
- Auks - guillemot, razorbill, little auk and puffin.

At this stage, it is unclear as to whether numbers of great skua, little gull and herring gull occurring in the Dogger Bank Zone might also be of importance.

Appraisal of the BTO Migration Atlas (Wernham *et al*. 2002) also indicates that the following species might potentially pass through the Zone in significant numbers on migration from wintering site SPAs to their breeding grounds in Scandinavia or the Arctic, or other sites used on passage: light-bellied brent goose, shelduck, pintail, wigeon, oystercatcher, ringed plover, golden plover, grey plover, knot, sanderling, dunlin, ruff, bar-tailed godwit, curlew and turnstone. Several of these species have been recorded by the boat-based surveys of the Dogger Bank Zone to date.

Of those listed above, the following were assessed by Langston (2010) as being of moderate or high risk to effects and thus can be considered sensitive to:

i. Collision risk: light-bellied brent goose, gannet, Arctic skua, great skua, kittiwake, lesser black-backed gull, herring gull, great black-backed gull, common tern and Arctic tern;

ii. Displacement: red-throated diver, black-throated diver, great northern diver, common scoter, guillemot, razorbill, little auk and puffin;

iii. Barrier effects: red-throated diver, black-throated diver, great northern diver, common scoter, guillemot, razorbill, little auk and puffin;

iv. Habitat / prey effects: red throated diver, black-throated diver, great northern diver, fulmar, common scoter, common tern, Arctic tern, guillemot, razorbill, little auk and puffin.

5.6.1 White-billed diver

White-billed diver was not considered by Langston (2010) but, as with other diver species, should also be considered at high risk from displacement and moderate risk to barrier effects and changes in habitat affecting prey availability.

Based on ESAS surveys (Skov *et al.,* 1995) and more recent surveys (Gardline Environmental Ltd, 2010a-l, 2011a-c), white-billed divers are only likely to occur in the Dogger Bank Zone in winter and in low densities.

There is no national population estimate for white-billed diver. However, population estimates for the Zone are likely to be close to the 1% threshold of 100 for the species' biogeographic population, and thus the Zone may be of international importance for this species.

5.6.2 Fulmar

Fulmars are considered to be at low risk of possible collision impacts, displacement issues and barrier effects of offshore wind farms, but of moderate risk of impacts from changes in habitat affecting prey availability (Langston, 2010). Based on ESAS surveys (Skov *et al.,* 1995) and more recent surveys (Gardline Environmental Ltd, 2010a-l, 2011a-c), fulmars are likely to occur in the Dogger Bank Zone throughout the year at moderate densities.

Although fulmars do breed at coastal colonies within the Offshore ZDE, there are no designated SPAs for the species within the Offshore ZDE. However, the species' foraging range means that some fulmars that are features of other SPAs in Scotland may potentially forage within the Zone during the breeding season (see Chapter 7 – *Nature Conservation*). Further research would be required to ascertain the degree that this occurs.

5.6.3 Gannet

Gannets are considered to be at moderate risk of possible collision impacts, and low risk of displacement issues, barrier effects of offshore wind farms, and changes in habitat affecting prey availability (Langston, 2010). Based on ESAS surveys (Skov *et al.,* 1995) and more recent surveys (Gardline Environmental Ltd, 2010a-l, 2011a-c), gannets are likely to occur at low to moderate densities in the Dogger Bank Zone throughout the year.

There is one designated SPA for gannets (Flamborough Head and Bempton Cliffs) (Stroud *et al.*, 2001) within the Offshore ZDE. Gannets can forage up to 590 km from colonies, and have a mean maximum range of 282 km, and recent tagging studies indicate that gannets from the Flamborough Head and Bempton Cliffs SPA can forage within the Dogger Bank Zone (http://www.rspb.org.uk/ourwork/projects/details/273898-tracking-gannets-from-bempton-cliffs#results). The species' foraging range means that some gannets from the Forth Islands SPA could also potentially forage within the Zone during the breeding season (see Chapter 7 – *Nature Conservation*).

5.6.4 Kittiwake

Kittiwakes are considered to be at moderate risk of possible collision impacts, and low risk of displacement issues, barrier

effects of offshore wind farms, and changes in habitat affecting prey availability (Langston ,2010). Based on ESAS surveys (Skov *et al.,* 1995) and more recent surveys (Gardline Environmental Ltd, 2010a-l, 2011a-c), kittiwakes are likely to occur at moderate to occasionally high densities in the Dogger Bank Zone throughout the year.

There is one designated SPA (Flamborough Head and Bempton Cliffs) for breeding kittiwakes within the Offshore ZDE (Stroud *et al.*, 2001). Although published information suggests that the Dogger Bank Zone would be at the foraging range limit (120 km) for birds from the nearest significant colony, i.e. the Flamborough Head and Bempton Cliffs SPA, Figure 5.9 indicates a distributional bias towards the western end of the Dogger Bank Zone in summer.

5.6.5 Large gulls

Gulls are listed by Langston (2010) as being at risk of possible collision impacts in the Dogger Bank Zone. Based on species densities and numbers recorded on ESAS surveys and recent boat-based surveys in the Dogger Bank Zone, it is considered that the larger gulls (lesser black-backed gull, herring gull and greater black-backed gull) are at a greater potential risk than more coastal species such as common gull and black-headed gull that are likely to occur much less frequently in the Dogger Bank Zone. All three species are considered to be moderate risk of possible collision impacts, and low risk of displacement issues, barrier effects of offshore wind farms, and changes in habitat affecting prey availability (Langston, 2010). Based on ESAS surveys (Skov *et al.,* 1995) and more recent surveys (Gardline Environmental Ltd, 2010a-l, 2011a-c), lesser black-backed gulls are likely to occur in the Dogger Bank Zone at low densities in spring and summer months, while herring gull and great black backed gulls are likely to occur at moderate densities in the winter months, with lower densities likely at other times of year.

Although lesser black-backed gulls breed at colonies within the Dogger Offshore ZDE, there are no designated SPAs for the species in the Offshore ZDE. There is one designated SPA (Flamborough Head and Bempton Cliffs) for herring gulls within the Offshore ZDE (Stroud *et al.*, 2001). Great black-backed gulls do not breed in the Offshore ZDE (Mitchell *et al.,* 2004). All three species tend to remain in coastal waters during the breeding season (Stone *et al.,* 1995), and so breeding birds from these SPAs would not be expected to forage in the Dogger Bank Zone during the breeding season.

5.6.6 Auks

Four auk species (guillemot, razorbill, puffin and little auk) are considered to be at low risk of possible collision impacts, but moderate risk of displacement issues, barrier effects of offshore wind farms, and changes in habitat affecting prey availability (Langston, 2010). However, based on the higher densities and numbers of guillemots recorded in the Dogger Bank Zone on ESAS and more recent surveys (Skov *et al.,* 1995; Gardline Environmental Ltd, 2010a-l, 2011a-c) compared to numbers and densities of razorbills, puffins and little auks, it is considered that guillemot is most likely to be at risk of these potential impacts in the Dogger Bank Zone. Guillemots are likely to occur at high densities in mid to late winter, and in moderate densities in other months, while razorbills are likely to occur in generally low densities throughout the year, with a possible peak in density in mid to late winter. Little auks are likely to occur in low to moderate densities in winter months, peaking in February, while low densities of puffins are likely throughout the year.

While the little auk does not breed in the UK, there is one designated SPA within the Offshore ZDE (Flamborough Head and Bempton Cliffs) for guillemots, razorbills and puffins (Stroud *et al.*, 2001). Guillemots, razorbills and puffins can forage up to 135 km, 100 km and 200 km from their colonies respectively, though have mean maximum foraging ranges of 71 km, 58 km and 87 km respectively. Recent surveys (Gardline Environmental Ltd, 2010a-l, 2011a-c) indicate that the distribution of guillemot is concentrated towards the western end of the Dogger Bank Zone in summer and autumn, while similar biases in concentrations occur for razorbill and puffin in autumn, i.e. when numbers peaked following the breeding period.

5.6.7 Little gull

Based on ESAS surveys (Skov *et al.,* 1995) and more recent surveys (Gardline Environmental Ltd, 2010a-l, 2011a-c), little gulls are only occasionally recorded in the Dogger Bank Zone. However, the total of 121 little gulls in October 2010 suggests that numbers of national or perhaps international importance might occur in the Zone. A recent JNCC statistical analysis of ESAS data investigating possible marine SPAs, highlighted the southwest corner of the Dogger Bank Zone as part of an area categorised as "near-qualifying" for little gulls in winter (Kober *et al.,* 2010).

5.6.8 Great skua

Great skuas are considered to be at moderate risk of possible collision impacts, and low risk of displacement issues, barrier effects of offshore wind farms, and changes in habitat affecting prey availability (Langston, 2010).

Based on ESAS surveys (Skov *et al.,* 1995) and more recent surveys (Gardline Environmental Ltd, 2010a-l, 2011a-c), great skuas are likely to occur in greatest numbers in the Dogger Bank Zone in the autumn when their numbers are potentially of national importance.

5.6.9 Waterbirds

Migrating waterbirds were also highlighted by Langston (2010) as being likely to require an assessment of potential collision risk in the Dogger Bank Zone.

5.6.10 Marine SPAs

A recent JNCC statistical analysis investigating possible marine SPAs using a series of qualifying features, included part of the southwest of the Dogger Bank Zone as part of a larger area that is "near-qualifying" for guillemots, little auks and little gulls in winter (Kober *et al.,* 2010). This was defined as "meeting the criterion of minimum numbers, but failing narrowly to meet the criterion of regularity". The study analysed ESAS data collected between 1980 and 2004, which includes the ESAS data from 1980 to 1994 that was used by Skov *et al.* (1995).

At the time of publication (March 2010), JNCC stated that "JNCC is not in a position to confirm which areas will be further considered for SPA status or classified". Final recommendations for the consideration of possible SPAs will be given in a separate further paper.

5.7 Summary

It can be seen from this review that at least ten species of seabirds might be considered as of Very High or High Sensitivity to development of the Dogger Bank Zone as either their numbers in the Zone are of national or international importance, or which as interest features of SPAs or transnational Natura 2000 sites might be affected by the proposed development. The distribution and

abundance of these species varies throughout the year. Due to the highly mobile nature of seabirds and their food sources, any areas of high density are likely to change between seasons and years.

In addition to seabirds, there are many other bird species that are likely to occur in the Dogger Offshore ZDE. These include waterbirds and terrestrial (or land) birds.

On-going monthly surveys within the Dogger Bank Zone will provide up to date information on the distribution and abundance of these key seabird species. These surveys will also provide additional information for other seabirds in the area, as well as information on the occurrence and distribution of other species groups including waterbirds and terrestrial birds.

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6. Marine Mammals

6.1 Introduction

This chapter presents a high level review of the distribution and abundance of marine mammals in the Offshore Zone Development Envelope (ZDE). Two species of seal and at least three species of cetacean regularly occur in the Dogger Bank Zone and Offshore Cable Area, although the distribution and abundance of these species vary throughout the year. The main factors affecting marine mammal distribution are the availability of their food and location of breeding areas (DECC, 2009; 2011).

This marine mammal Zonal Characterisation aims to:

- Address the extent to which the distribution and abundance of marine mammals within the Dogger Bank Zone and Offshore Cable Area is known and understood;
- Map Special Areas of Conservation (SACs)/Sites of Community Importance (SCIs) relevant to marine mammal species in the North Sea region;
- Map known breeding and haul-out sites of seals within the Offshore ZDE;
- Flag the limitations of current knowledge of marine mammal distribution and abundance in the Dogger Bank Zone and Offshore Cable Area, and identify data gaps to be addressed; and
- Within the constraints of the available data, assess the importance of known marine mammal distribution within the Offshore ZDE.

The early assessment of the distribution and abundance of marine mammals as part of the ZAP process and subsequent Environmental Impact Assessments (EIA) for the Dogger Bank Zone will identify potential constraints on development and, coupled with the implementation of appropriate mitigation measures, will greatly reduce risk to both marine mammals and the development.

There is sufficient existing information available to provide an overview of the potential distribution and abundance of marine mammals within the Dogger Bank Zone and Offshore Cable Area. Dedicated monthly boat-based surveys of the Dogger Bank Zone commenced in January 2010 and are ongoing, together with monthly high definition video camera aerial surveys. Data from these surveys will add to the existing knowledge of marine mammal distribution within the Dogger Bank Zone.

6.2 Data and Literature

6.2.1 Key publications

This Zonal Characterisation used several sources of information on the distribution and abundance of marine mammals in the North Sea (including the Dogger Bank Zone and Offshore Cable Area), namely:

- "*Atlas of cetacean distribution in northwest European waters*", by Reid *et al.* (2003), hereafter referred to as the JNCC Cetacean Atlas. This report contains marine mammal data from the JNCC Seabirds at Sea Team, together with sightings data from the UK Mammal Society Cetacean Group, Sea Watch and data from the first Small Cetaceans of the Atlantic and North Sea (SCANS) survey (Hammond *et al.,* 1995);
- Final Report of the 2005 SCANS II project, which surveyed the North Sea for cetaceans in July 2005 (SCANS II, 2008);
- Appendix A3a.8 of the recent Offshore Energy SEA2 (DECC, 2011) and Appendix A3a.7 of the preceding Offshore Energy SEA (DECC, 2009), which contain baseline descriptions of the distribution and abundance of marine mammals in UK waters;
- Information on the distribution and movements of common seals around the UK (Sharples *et al.,* 2005; Special Committee on Seals (SCOS), 2010) and on movements and foraging areas of grey seals in the North Sea (McConnell *et al.,* 1999);
- Final report on seabird and marine mammal boat surveys in the North Sea between February 2008 and March 2009 for DECC (Cork Ecology, 2009);
- Data and summary reports from monthly boat-based surveys of the Dogger Bank Zone conducted by Gardline on behalf of Forewind. Boat-based surveys commenced in January 2010 and are on-going; and
- Data from aerial surveys of the Dogger Bank Zone. The first four aerial surveys (May 2009 to August 2009) were visual surveys carried out by the Wildfowl & Wetlands Trust (WWT) at the request of the Crown Estate. Subsequent aerial surveys (November 2009 to June 2011) were high definition video camera aerial surveys carried out by HiDef Limited (on behalf of TCE from November 2009 to March 2010 and on behalf of Forewind from April 2010 to June 2011 and on-going). In addition to survey coverage of the Dogger Bank Zone, surveys from January 2011 have covered the southwestern part of the Zone (Tranche A) in greater detail (Figure 6.1).

The Gardline boat survey and HiDef aerial survey data are currently being analysed to determine relative and absolute abundance of key marine mammal species and to produce distribution and population estimates within the Dogger Bank Zone. Observations made during these surveys are summarised in Table 6.3 and Table 6.4, later in this chapter.



Figure 6.1: Typical flight tracks taken during the HiDef aerial surveys of the Dogger Bank Zone and Tranche A.

Various sources of new data have now become available since the publication of the Joint Cetacean Atlas. The JNCC is leading a collaborative project, called the Joint Cetacean Protocol, to produce an updated atlas of cetacean distribution within the northeast Atlantic (JNCC, 2011a). The updated Joint Cetacean Protocol has also been identified as a potential future data source for the characterisation of the Dogger Bank Zone.

6.2.2 Data limitations and gaps

The JNCC Cetacean Atlas (Reid *et al.,* 2003) utilised data from the European Seabirds at Sea (ESAS) database, SCANS I and the Sea Watch Foundation. Overall, ESAS coverage within the North Sea has been conducted over many years and is very widespread. Although much of the data are now relatively old, they are still useful to provide an overview of marine mammal distribution and abundance. While the data from SCANS I are more recent than some of the ESAS data, and were analysed using Distance software to produce population estimates, they were limited to surveys during July only, and so do not take seasonal variation into account. Data from the Sea Watch Foundation were mostly collected from land, and so are predominantly focused on inshore areas. All three surveys collected data using different methods, but the JNCC Cetacean Atlas attempted to present the results in a compatible form.

The adequacy of existing ESAS monthly survey coverage within the Dogger Bank Zone has been assessed by Pollock and Barton (2006), with the results summarised in Section 5.2.5 of Chapter 5 – *Birds* and in Appendix D; ESAS survey coverage is limited during the autumn and winter months, although some adequate coverage of the southern and western parts of the Dogger Bank Zone is available during the spring and summer months.

The programme of boat-based surveys undertaken in the North Sea on behalf of DECC between February 2008 and March 2009 provided good coverage of the southern end of the Dogger Bank Zone in March 2008, while the August 2008 survey on board FRS Scotia achieved moderate coverage in the southeast corner of the Dogger Bank Zone. A dedicated charter survey in September 2008 obtained good survey coverage throughout the Dogger Bank Zone (Cork Ecology, 2009).

Recent Gardline boat-based surveys of the Dogger Bank Zone did not record any marine mammals in January 2010; however, this survey was only conducted over a two day period. Coverage over the Dogger Bank Zone between February 2010 and June 2011, undertaken by Gardline, has been more complete, so totals for these months give a better indication of the numbers of each species present.

6.3 Overview

Within the Dogger Bank Zone and Offshore Cable Area, three species of cetacean (minke whale, white-beaked dolphin and harbour porpoise) are likely to occur regularly. In addition, bottlenose dolphin, common dolphin, Atlantic white-sided dolphin and Risso's dolphin may occur occasionally (Reid *et al.,* 2003), though limited or no sightings have been recorded during surveys of the Zone.

Although both grey seal and common (or harbour) seal occur regularly in the Offshore Cable Area, common seal is less likely than grey seal to occur in the Dogger Bank Zone, as it is typically a more coastal species (Sharples *et al.,* 2005; McConnell *et al.,* 1999).

A summary of the potential occurrence of marine mammal species within the Dogger Bank Zone and Offshore ZDE is shown in Table 6.1. A summary of the typical diet, distribution and breeding seasons for the marine mammal species likely to occur regularly in the Dogger Bank Zone and Offshore ZDE is presented in Table 6.2.

6.4 Species Accounts

A brief outline of the at-sea density and distribution of the regularly occurring marine mammal species within the Dogger Bank Zone and Offshore Cable Area throughout the year is given in the following section. These accounts are based on information presented in Reid *et al.,* (2003) and SCANS II (2008), as well as other more recent surveys, including Cork Ecology (2009), on-going boat-based surveys (Table 6.3), and high definition aerial surveys (Table 6.4) undertaken on behalf of Forewind by Gardline and HiDef Limited.

Table 6.1: Summary of potential occurrence of marine mammals in the Offshore ZDE (Sources: Reid *et al*., 2003; Sharples *et al*., 2005; McConnell *et al*., 1999).

Species	Offshore ZDE	Dogger Bank Zone
Minke whale	Regular, occurs throughout the year, mainly between May and September	
White-beaked dolphin	Common, occurs throughout the year, mainly between June and October	
Bottlenose dolphin	Occasional	
Common dolphin	Occasional	
Atlantic white-sided dolphin	Occasional	
Risso's dolphin	Occasional	
Harbour porpoise	Common, occurs throughout the year, with peak numbers between June and October	
Grey seal	Regular, all year	
Common seal	Regular, all year	Occasional

Table 6.2: Summary of diet, distribution and breeding seasons of regular marine mammal species within the Dogger Bank Zone and Offshore Cable Area (Sources: Reid *et al*., 2003; Hayden and Harrington, 2000; Evans, 1987; SCOS, 2010).

Species	Diet	Distribution	Breeding season
Minke whale	Wide variety of fish including herring, cod, capelin, haddock, saithe & sandeel	Mainly over the continental shelf in water depths of 200 m or less	Conception – February peak Birth – December peak
White-beaked dolphin	Fish including mackerel, herring, cod, capelin, whiting, haddock, hake, sandeels, gobies & flatfish	Usually over the continental shelf in waters of 50 – 100 m depth	Conception – July to October Birth – May to August
Harbour porpoise	Small fish including whiting, poor cod, Norway pout, herring, sandeels & gobies	Mainly over the continental shelf	Conception – June to August Birth – May to July
Grey seal	Fish including poor cod, whiting, cod, ling, sandeels, flatfish, salmon, mackerel & herring	Mainly coastal waters and occasional further offshore	September to December
Common seal	Fish including sandeels, herring, whiting, flatfish and saithe	Mainly coastal waters and occasional further offshore	Conception – August to October Birth – June to July

Table 6.3: Summary of survey effort and species counts for boat-based surveys of the Dogger Bank Zone between January 2010 and June 2011.

		January 2010	February 2010	March 2010	April 2010	May 2010	June 2010	July 2010	August 2010	Sept 2010	October 2010	Nov 2010	Dec 2010	January 2011	February 2011	March 2011	April 2011	May 2011	June 2011
Total hours effort		12.6	94.7	141.2	194.7	116.7	112.2	108.1	111.9	8.3	107.9	58.7	75.8	64.75	45.8	129.6	129.4	96.2	126.8
Total distance effort (km)		157.65	1,164.78	1,734.23	2,252.79	1,368.22	1,097.9	1,147.36	1,235.52	127.19	1,992.55	1,156.93	1,433.8	1,244.12	856.52	2,445.34	2,431.82	1771.21	2,430.70
Survey effort recorded in Sea States 0-3		57%	52%	65%	91%	91%	95%	78%	84%	-	56%	52%	61%	61%	50%	82%	71%	44%	75%
Number of marine mammal species seen		0	5	4	4	4	3	3	1	0	2	3	3	4	2	5	4	6	5
Minke whale	Number of animals	0	0	0	0	20	48+	1	1	0	3	0	1	0	0	7	22	5	12
	Animals/hour	0	0	0	0	0.2	0.4	< 0.1	< 0.1	0	< 0.1	0	< 0.1	0	0	< 0.1	0.17	< 0.1	< 0.1
	Animals/km	0	0	0	0	< 0.1	< 0.1	< 0.1	< 0.1	0	< 0.1	0	< 0.1	0	0	< 0.1	< 0.1	< 0.1	< 0.1
White-beaked dolphin	Number of animals	0	18	14	38	141	45	0	0	0	0	2	5	5	0	29	34	54	44
	Animals/hour	0	0.2	0.1	0.2	1.2	0.4	0	0	0	0	< 0.1	< 0.1	< 0.1	0	0	0.26	0.57	0.35
	Animals/km	0	< 0.1	< 0.1	< 0.1	0.1	< 0.1	0	0	0	0	< 0.1	< 0.1	< 0.1	0	0	< 0.1		< 0.1
Atlantic white-sided dolphin	Number of animals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
	Animals/hour	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	< 0.1	0
	Animals/km	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	< 0.1	0
Harbour porpoise	Number of animals	0	3	9	2	58	6	1	0	0	12	3	37	22	5	18	80	6	13
	Animals/hour	0	< 0.1	< 0.1	< 0.1	0.5	< 0.1	< 0.1	0	0	0.11	< 0.1	0.49	0.34	0.11	0.14	0.62	< 0.1	0.1
	Animals/km	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Humpback whale	Number of animals	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	1
	Animals/hour	0	0	0	0	0	0	0	0	0	0	0	0	< 0.1	0	0	0	< 0.1	< 0.1
	Animals/km	0	0	0	0	0	0	0	0	0	0	0	0	< 0.1	0	0	0	< 0.1	< 0.1
Grey seal	Number of animals	0	6	15	6	15	1	1	0	0	0	6	28	16	37	19	10	9	3
	Animals/hour	0	< 0.1	0.1	< 0.1	0.1	< 0.1	< 0.1	0	0	0	0.1	0.37	0.25	0.81	0.15	< 0.1	< 0.1	< 0.1
	Animals/km	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0	0	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Common seal	Number of animals	0	7	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	Animals/hour	0	< 0.1	0	0	0	0	0	0	0	0	0	0	0	0	< 0.1	0	0	0
	Animals/km	0	< 0.1	0	0	0	0	0	0	0	0	0	0	0	0	< 0.1	0	0	0
Lagenorhynchus dolphin species	Number of animals	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Animals/hour	0	0	< 0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Animals/km	0	0	< 0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Unidentified dolphin species	Number of animals	0	4	9	10	3	8	0	0	0	0	0	0	0	0	8	9	0	0
	Animals/hour	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0	0	0	0	0	0	0	0	< 0.1	< 0.1	0	0
	Animals/km	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0	0	0	0	0	0	0	0	< 0.1	< 0.1	0	0
Unidentified whale species	Number of animals	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0
	Animals/hour	0	0	0	0	< 0.1	0	0	0	0	< 0.1	0	0	0	0	0	< 0.1	0	0
	Animals/km	0	0	0	0	< 0.1	0	0	0	0	< 0.1	0	0	0	0	0	< 0.1	0	0
Unidentified seal species	Number of animals	0	1	1	0	1	0	0	0	0	0	0	2	0	0	2	1	0	1
	Animals/hour	0	< 0.1	< 0.1	0	< 0.1	0	0	0	0	0	0	< 0.1	0	0	< 0.1	< 0.1	0	< 0.1
	Animals/km	0	< 0.1	< 0.1	0	< 0.1	0	0	0	0	0	0	< 0.1	0	0	< 0.1	< 0.1	0	< 0.1
Key to coloured scales:					No animals seen			< 0.1 animals/hour				0.10 to 0.99 animals/hour					≥1 animals/hour		

Table 6.4: Summary of survey effort and species counts for high definition video camera aerial surveys of the Dogger Bank Zone between November 2009 and June 2011.

		Nov 2009	Dec[1] 2009	January 2010	Feb 2010	March 2010	April 2010	May 2010	June 2010	July 2010	August 2010	Sept 2010	October 2010	Nov 2010	Dec 2010	January 2011	Feb[2] 2011	March 2011	April 2011	May 2011	June 2011
Hours surveyed[3]	Zone	272	745	721	1383	891	-	114	969	1,032	989	1,023	990	1,025	957	759	-	1,335	656	518	1,153
	Tranche A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	689	-	1,091	630	1,877	1,126
Distance surveyed per month (km)	Zone	-	2,774	2,247	6,055	8,813	3,662	-	4,008	-	3,685	4,040	3,695	3,494	3,109	2,639	-	4,871	2,649	2,595	2,641
	Tranche A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,520	-	4,162	2,446	2,429	2,571
Transect spacing (km)	Zone	3	3	3	3	3	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	3	3	3	3	3	3
	Tranche A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1	1	1	1	1	1
Total recorded swathe width (m)		300	300	300	300	300	300	300	300	300	300	300	300	300	300	175	175	175	175	175	175
No. of marine mammal species seen		1	2	3	3	2	2	4	4	1	1	4	2	2	2	4	2	4	3	4	4
Minke whale	Number of animals	0	0	0	0	0	0	1	9	0	0	1	0	0	0	0	0	1	0	1	5
	Animals/km	0	0	0	0	0	0	< 0.1	< 0.1	0	0	< 0.1	0	0	0	0	0	< 0.1	0	< 0.1	< 0.1
Orca	Number of animals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Animals/km	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	< 0.1
White-beaked dolphin	Number of animals	0	0	8	1	0	0	13	5	0	0	0	0	0	0	5	5	16	5	5	0
	Animals/km	0	0	< 0.1	< 0.1	0	0	-	< 0.1	0	0	0	0	0	0	< 0.1	-	< 0.1	< 0.1	< 0.1	0
Harbour porpoise	Number of animals	0	10	28	115	23	15	389	552	39	28	253	20	31	7	104	371	486	371	930	470
	Animals/km	0	< 0.1	0.10	0.12	< 0.1	< 0.1	-	0.14	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	-	< 0.1	< 0.1	0.19	< 0.1
Grey seal	Number of animals	0	1	0	2	1	1	1	1	0	0	1	0	0	0	4	4	4	4	1	0
	Animals/km	0	< 0.1	0	< 0.1	< 0.1	< 0.1	-	0	0	0	< 0.1	0	0	0	< 0.1	-	< 0.1	< 0.1	< 0.1	0
Common seal	Number of animals	1	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	0	3	0
	Animals/km	-	0	0	0	0	0	0	0	0	0	< 0.1	0	0	0	< 0.1	0	0	0	< 0.1	0
Unidentified dolphin species	Number of animals	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	12	5	1	0
	Animals/km	0	0	0	0	0	0	-	< 0.1	0	0	0	0	0	0	0	0	< 0.1	< 0.1	< 0.1	0
Unidentified small cetacean species	Number of animals	0	3	8	17	9	3	70	132	7	4	33	0	8	1	21	23	21	23	14	8
	Animals/km	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1	0	< 0.1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1
Unidentified large cetacean species	Number of animals	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	1	1
	Animals/km	0	0	0	0	0	0	0	0	0	0	< 0.1	0	< 0.1	0	0	0	0	0	< 0.1	0
Unidentified seal species	Number of animals	3	6	8	25	1	3	20	3	0	0	3	2	4	1	27	4	9	4	12	6
	Animals/km	-	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	-	< 0.1	0	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	< 0.1
Unidentified small cetacean or seal species	Number of animals	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	20	20	13	5
	Animals/km	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	< 0.1	< 0.1	< 0.1	< 0.1
Unidentified cetacean, seal or shark species	Number of animals	0	2	3	24	8	11	42	32	0	0	16	2	12	2	18	4	3	4	2	0
	Animals/km	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	-	< 0.1	0	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	-	< 0.1	< 0.1	< 0.1	0

Key to coloured scales: No animals seen | < 0.1 animals/km | 0.10 to 0.99 animals/km | ≥1 animals/km

[1] Due to adverse weather conditions and a camera fault, only 43% of the Dec 2009 survey could be completed

[2] Due to adverse weather conditions, the survey scheduled for February 2011 was undertaken in early March 2011

[3] Time spent surveying is approximate

- Indicates where data is currently unavailable

6.4.1 Minke whale *Balaenoptera acutorostrata*

Within the Offshore Cable Area, the JNCC Cetacean Atlas indicates that minke whales are regular to the north of Humberside, but are comparatively scarce in the southern North Sea. Animals are present throughout the year, but most sightings are between May and September. Most sightings were in the south and west of the Dogger Bank Zone, with fewer sightings elsewhere in the Dogger Bank Zone (Reid *et al.,* 2003).

Minke whales were not recorded in the Dogger Bank Zone on surveys undertaken during March, August and September 2008, although single animals were seen to the north and south of the Dogger Bank Zone (Cork Ecology, 2009).

No minke whales were recorded on boat-based surveys in the Dogger Bank Zone between January and April 2010, however 20 animals were recorded in May 2010 and a minimum of 48 animals were recorded in June 2010 (Table 6.3). Three of the May sightings involved adults and juvenile animals. Lower numbers were identified throughout the rest of 2010, increasing again in April 2011, indicating that minke whales are present during the summer months (Table 6.3) though sea state and weather may have an influence on survey yields.

The aerial surveys detected fewer minke whales; with most monthly surveys detecting no, or single, individuals except in both June 2010 and June 2011 where nine and five individuals were identified respectively (Table 6.4).

The hourly encounter rate (number of animals divided by number of hours of survey effort) for the boat-based surveys peaked at 0.4 animals/hour (or 0.04 animals/km) in June 2010, although this included data recorded in all sea states (Table 6.3: Summary of survey effort and species counts for boat-based surveys of the Dogger Bank Zone between January 2010 and June 2011).

Based on the above, highest numbers of minke whales are likely to occur within the Dogger Bank Zone over the summer months.

6.4.2 White-beaked dolphin *Lagenorhynchus albirostris*

White-beaked dolphin is one of the most regular cetaceans in the central and northern North Sea, and is frequently encountered in coastal and offshore waters in the region throughout the year, with most sightings between June and October, although survey effort was less in winter months (Reid *et al.,* 2003).

Within the Dogger Bank Zone, the JNCC Cetacean Atlas indicates that the majority of white-beaked dolphin sightings were in the north-western corner of the Dogger Bank Zone, with fewer sightings to the east and south (Reid *et al.,* 2003). White-beaked dolphin density on the SCANS II survey in 2005 was estimated at 0.003 animals/km^2 in the UK southern Central North Sea, which includes the Dogger Bank Zone (SCANS II, 2008). White-beaked dolphins were not recorded in the Dogger Bank Zone on surveys in March, August and September 2008 (Cork Ecology, 2009).

Recent 2010 boat-based surveys in the Dogger Bank Zone recorded low numbers between February and April, with an increase in activity in May, when a minimum of 141 animals were recorded. Very few sightings were recorded for the months July 2010 to February 2011; totalling 12 individuals throughout those eight months, with no sightings for July to October 2010 or February 2011. The peak number of sightings for the first half of 2011 was, again, in May (Table 6.3).

The hourly encounter rate for May 2010 was 1.2 animals/hour (and 0.57 animals/hour for May 2011) (Table 6.3), although this included data recorded in all sea states.

The HiDef aerial camera surveys detected fewer white-beaked dolphins (Table 6.3). Sightings were exclusively between January and June, for both 2010 and 2011, and no more than 16 individuals were recorded in a single month. Possible attraction of white-beaked dolphin to the boats may account for the differences in sightings between the boat-based and aerial surveys, though this may not always be the case.

Based on these results, it is likely that white-beaked dolphins occur regularly in the Dogger Bank Zone, in varying numbers with peak occurrences more likely between March and May.

6.4.3 Harbour porpoise *Phocoena phocoena*

Harbour porpoise is the most common cetacean species in UK waters, including the Dogger Bank Zone and Offshore Cable Area. Although present in the Offshore ZDE throughout the year, peak numbers are generally recorded from June to October (Reid *et al.,* 2003).

The JNCC Cetacean Atlas regularly recorded sightings of harbour porpoise throughout the Dogger Bank Zone. Most sightings occurred between May and September, although survey effort was less in winter months (Reid *et al.,* 2003). Harbour porpoise density on the SCANS II survey in 2005 was estimated at 0.56 animals/km^2 in the UK southern Central North Sea, which includes the Dogger Bank Zone (SCANS II, 2008).

Comparing results from the two July SCANS surveys highlighted apparent changes in distribution with the North Sea between the two surveys. Results from SCANS I in 1994 suggested high densities of animals north of Scotland and in the western central and northern North Sea. However, in 2005, harbour porpoise were observed in relatively high densities throughout much of the UK part of the southern North Sea (including the Dogger Bank Zone), where they were largely absent in 1994 (SCANS II, 2008). This southerly shift in distribution is confirmed in a study by Jung *et al.* (2009).

Surveys in the southern end of the Dogger Bank Zone in March 2008 recorded harbour porpoise in low abundance, while surveys in August and September 2008, when coverage in the Dogger Bank Zone was complete, recorded harbour porpoise at low to moderate abundance (less than 1 animal/km) sporadically within the Dogger Bank Zone (Cork Ecology, 2009).

Relative abundance of harbour porpoise recorded on visual aerial surveys of the Dogger Bank Zone between May 2009 and August 2009 was very low, although coverage of the Dogger Bank Zone was not complete in these months. Surveys of the entire Dogger Bank Zone, using high definition video cameras, between November 2009 and June 2011 show harbour porpoise to be very abundant, occurring mostly in May and June. The highest number of individuals identified in a month was 930, in May 2011.

Recent monthly boat-based surveys also recorded low numbers of harbour porpoise in the Dogger Bank Zone between February and April, with an increase in activity in May 2010. Numbers dropped again in June and remained fairly low until the end of the year. Occurrence was highest in April 2011 when 80 individuals were identified (Table 6.3).

The hourly encounter rate in May 2010 was 0.5 animals/hour, or less than 0.1 animals/km, although this included data recorded in all sea states (Table 6.3). Detection rate per km in May 2010 was lower than that recorded in the Dogger Bank Zone in August and September 2008 (Cork Ecology, 2009).

As sea state increases, it becomes increasingly difficult to detect small cetaceans such as harbour porpoises. Camphuysen *et al.* (2004) recommended that only observations of marine mammals recorded in sea states of Beaufort scale 0 to 3 should be used in subsequent analysis. Although a detailed analysis of weather conditions during survey was beyond the scope of this review, more than 90% of surveys between April and June 2010 were conducted in sea states of 0 to 3, though 44-84% of other surveys were in sea states of Beaufort scale 0 to 3 (Table 6.3).

These results indicate that, generally, high numbers of harbour porpoises may be present in the Dogger Bank Zone, especially during periods May and June.

6.4.4 Atlantic white-sided dolphin *Lagenorhynchus acutus*

Within the Dogger Bank Zone and Offshore Cable Area, the JNCC Cetacean Atlas indicates low numbers of sightings of Atlantic white-sided dolphins. Most sightings occurred between May and August, although survey effort was less in winter months (Reid *et al.,* 2003). Too few Atlantic white-sided dolphins were recorded on the SCANS II survey in 2005 to allow abundance estimates to be calculated (SCANS II, 2008).

Atlantic white-sided dolphins were not recorded in the Dogger Bank Zone on surveys during March, August and September 2008 (Cork Ecology, 2009). During the boat-based 2010-11 surveys, two Atlantic white-sided dolphins were encountered in a single sighting in the Dogger Bank Zone, this sighting occurred in May 2011. Three animals, which were probably this species, were also seen at distance during the March 2010 survey. All other months had no positive identifications of this species. Atlantic white-sided dolphin were not detected in the aerial camera surveys undertaken by HiDef Limited.

Based on existing published data and results from recent surveys, it appears that this species is likely to be occasional in the Dogger Bank Zone.

6.4.5 Other cetaceans

Other cetacean species that may occur occasionally within the Dogger Bank Zone include bottlenose dolphin *Tursiops truncatus*, common dolphin *Delphinus delphis*, and Risso's dolphin *Grampus griseus* (Reid et al., 2003).

The JNCC Cetacean Atlas does not identify humpback whales *Megaptera novaeangliae* as present in the Dogger Bank Zone; most sightings are made off the continental shelf and north of Scotland between May and September (Reid et al., 2003). However, three of the eighteen boat-based surveys recorded humpback whales within the Dogger Bank Zone during 2011; these were the January, May and June surveys, totalling four individuals. The January sighting included two humpback whales associating with white-beaked dolphins, other sightings involved solitary animals, likely to be passing through the area.

A single orca *Orcinus orca* was identified during the HiDef aerial surveys in June 2011 (Table 6.4). It was observed moving northwards through the Dogger Bank Zone. Orcas are usually observed foraging cooperatively in pods, especially when chasing prey (Reid *et al*., 2003), making it unlikely that this animal was feeding in the area.

A number of animals that were encountered during the Gardline boat-based surveys could not be identified to species level. For definite sightings of cetaceans, these encounters were recorded as either whale or dolphin species. Unidentified dolphin occurrences were generally throughout the spring and summer months (Table 6.3), with no more than ten individuals recorded in each month. Whales that could not be further identified to species level were less common, with only three sightings throughout January 2010 to June 2011 (Table 6.3).

Unidentified dolphin species were also recorded during the HiDef aerial surveys, occurring throughout the same period as those not identified to species level in the boat-based surveys (March to June) (Table 6.4). Unidentified cetaceans were also classed into other categories given in Table 6.4.

6.4.6 Grey seal *Halichoerus grypus*

Over 90% of the UK grey seal population breeds in Scotland, largely in the Hebrides, Orkney, and Shetland. Within the Offshore ZDE, there is a large colony at Donna Nook at the mouth of the Humber, where 1,437 grey seal pups were raised in 2006 (DECC, 2009) (Figure 6.2).

The majority of grey seals will be on land for several weeks during the breeding season (October to December), and also during the annual moult (February and March). Densities at sea are therefore likely to be lower during this period than at other times of the year (DECC, 2009).

Tagging studies of 14 grey seals caught in the Farne Islands have found that they regularly travel long distances from one haul-out site to another, often hundreds of kilometres apart. In addition, animals also make shorter, more local foraging trips to offshore areas (McConnell *et al.,* 1999).

Although grey seals were not recorded in the Dogger Bank Zone on surveys in March, August and September 2008 (Cork Ecology, 2009), recent boat-based surveys have recorded low numbers (typically below 15) of grey seals in the Dogger Bank Zone throughout the year, except during December 2010 to March 2011 where numbers increased to between 16 and 37 (Table 6.3). No grey seals were recorded during boat-based surveys undertaken in August, September or October. Aerial camera surveys detected even fewer grey seals, with maximums of four seals for each month of January to April 2011. Most winter surveys encountered no grey seals, with other monthly surveys identifying one or two individuals (Table 6.4**Error! Reference source not found.**).

The hourly encounter rate during boat-based surveys peaked at 0.81 animals/hour in February 2011, although this included data recorded in all sea states (Table 6.3).

Based on these results, grey seals are likely to occur in the Dogger Bank Zone regularly in low numbers throughout the year. Numbers are likely to be lowest during the breeding season (October to December) when most animals are on land; this is confirmed by data from the aerial surveys, which did not include any grey seals from October to December (Table 6.4).

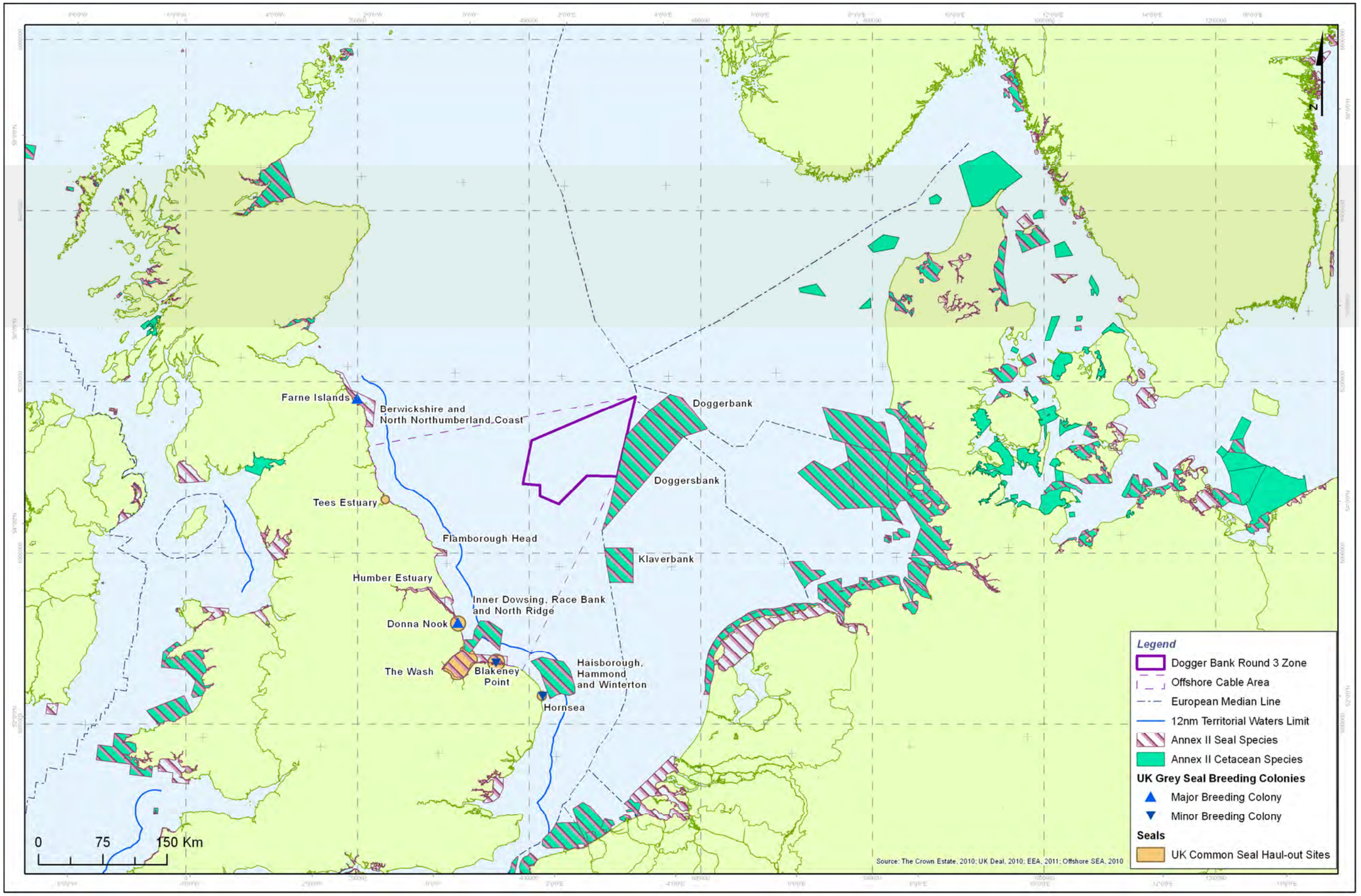


Figure 6.2: Grey seal breeding colonies, common seal haul-out sites, and European designated sites supporting Annex II Habitats Directive marine mammal species.

6.4.7 Common seal *Phoca vitulina*

Common seals occur regularly within the Dogger Offshore ZDE. Their distribution at sea is constrained by the need to return periodically to land. Large numbers of common seals are recorded at regular haul-out sites on the English east coast. Minimum counts from aerial surveys in 2006 estimated 1,695 common seals in the Wash, with a further 719 animals at Blakeney Point on the north Norfolk coast and 299 at Donna Nook (DECC, 2009). Common seals are widespread in the coastal waters around these colonies and haul-out sites (DECC, 2009, 2011).

Common seals are ashore more often from June to September, as their pups are born on land in June and July, while adults undergo moult in August and September (SCOS, 2010). Densities at sea are therefore likely to be lower during this period than at other times of the year (DECC, 2009, 2011).

Tagging studies of common seals caught in The Wash have found that animals undergo long journeys at sea, with seals travelling repeatedly to between 75 and 120 km offshore (Sharples *et al.,* 2005). As such, the Dogger Bank Zone would be at the further edge of their likely range. This is reflected in the findings of recent surveys in the Dogger Bank Zone. One common seal was recorded in the Dogger Bank Zone on surveys in March 2008 (Cork Ecology, 2009), while Gardline boat-based surveys recorded seven common seals in the Dogger Bank Zone in February 2011 and one common seal in March 2011, but there were no other sightings throughout the entire survey period.

The HiDef aerial surveys detected common seals in four of the twenty survey months. These amounted to eight individuals throughout the year (Table 6.4).

From the above, it is likely that common seals occur occasionally in the Dogger Bank Zone. It appears that they are less likely than grey seals to occur regularly in the Dogger Bank Zone, due to the Dogger Bank Zone being close to their maximum likely offshore range.

6.4.8 Unidentified Seals

The Gardline boat-based and HiDef aerial surveys both detected seal species that could not be identified to species level. The boat-based surveys found nine such instances in seven of the surveys between December and June (see Table 6.3).

The aerial surveys grouped unidentified seal-like animals into 'unidentified seal' species or 'unidentified small cetacean or seal species'. Unidentified seal species were present regularly throughout the 18 months with up to 27 animals a month not being categorised to species level (Table 6.4). Animals were classed into 'unidentified small cetacean or seal species' from February 2011, and comprised between 5 and 20 individuals a month (Table 6.4).

6.5 Important Sites for Marine Mammals

Special Areas of Conservation (SACs) and Sites of Community Importance are designated in the North Sea and include Annex II Habitats Directive cetacean species (harbour porpoise and bottlenose dolphin) and seal species (grey and common). Several sites that are important to marine mammals are included in the Offshore ZDE and the adjacent areas (Figure 6.2). The Dogger Bank candidate SAC (cSAC) overlaps the Dogger Bank Zone boundary. The non-qualifying interest features for this site include harbour porpoise, grey seal and common seal for their presence in the area. No other designated sites fall within the Dogger Bank Zone.

There is one SAC (The Wash and North Norfolk Coast) within the Offshore ZDE for which common seal is a primary qualifying feature (JNCC, 2010). This site is the largest colony of common seals in the UK and contains approximately 7% of the total UK population.

The Humber Estuary SAC, within the Offshore ZDE, lists grey seal as a qualifying feature but it is not a primary reason for site selection, meaning the population is not significantly above the threshold for national importance (JNCC, 2010).

In addition, Flamborough Head SAC, the Wash and North Norfolk Coast SAC, the Inner Dowsing, Race Bank and North Ride SAC, and the Haisborough, Hammond and Winterton SAC all list grey seal as a non-qualifying feature.

Both grey and common seals are also listed as resident on the Dutch Dogger Bank SCI, and on the Dutch Klaverbank SCI (Natura 2000, 2006, 2008a & 2008b) shown in Figure 6.2.

There are currently no designated SACs for harbour porpoise in the UK, though harbour porpoise is listed as a non-qualifying feature of the Dogger Bank cSAC. In addition, the species also qualifies as resident at the Dutch and German Dogger Bank SCIs, and at the Dutch Klaverbank SCI (Natura 2000, 2006, 2008a and 2008b).

Other areas within the Offshore ZDE, which are not designated, include Donna Nook which is in the outer southern Humber Estuary. This is the UK's most southeasterly grey seal breeding colony, and the largest colony in England. Donna Nook is also an important haul-out site for common seals, where they sleep or give birth in safety. Other common seal haul-out sites within the ZDE are Blakeney Point, The Wash and the Tees estuary (Figure 6.2).

Important marine mammal sites that are adjacent to the ZDE include the Berwickshire and North Northumberland Coast SAC/SCI (which includes the Farne Islands) (Figure 6.2). This site represents a major grey seal breeding colony and accounts for up to 2.5% of grey seal pup production (JNCC, 2011b).

While Figure 6.2 broadly identifies all the SACs/SCIs in the North Sea supporting Annex II (Habitats Directive) cetacean and seal species, Chapter 7 - *Nature Conservation* discusses these sites further and highlights those that have been screened in during Habitats Regulations Assessment as potentially being affected by the Round 3 plan.

6.6 Summary

Based on current available data, the review shows that, within the Dogger Bank Zone and Offshore Cable Area, four species of marine mammal (minke whale, white-beaked dolphin, harbour porpoise and grey seal) are likely to occur regularly. In addition, humpback whale, orca, bottlenose dolphin, common dolphin, Atlantic white-sided dolphin, Risso's dolphin and common seal may occur occasionally.

The Gardline boat survey and HiDef aerial survey data are currently being analysed to determine relative and absolute abundance of key marine mammal species and to produce distribution and population estimates within the Dogger Bank Zone. Due to the highly mobile nature of marine mammals and their food sources, any areas of high density are likely to change between seasons and years. For this reason, two years' dedicated survey is required to generate sufficient data for an effective assessment.

On-going monthly surveys within the Dogger Bank Zone will provide up to date information on the distribution and abundance of these key marine mammals. These surveys will also provide additional information for other marine mammal species in the area.

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7. Nature Conservation

7.1 Introduction

This chapter provides background information on designated sites for nature conservation from within, and where relevant, beyond the boundaries of the Offshore Zonal Development Envelope (ZDE). Designated sites and the habitats and species features they support are an important consenting consideration for development and as such this chapter therefore includes relevant information on appropriate conventions and legislation related to marine nature conservation. It also provides a description of relevant designated sites in UK and other coastal North Sea nations' waters as determined from international, national and local legislation.

Designated sites which have a marine element and which fall within the Dogger Bank Zone and Offshore Cable Area have all been considered within this chapter. Consideration has also been given to legislative requirements and transboundary issues.

In addition to the suite of designated sites that fall within the Offshore ZDE, sites beyond the ZDE that support mobile species (e.g. seabirds and marine mammals) that may be present in the Dogger Bank Zone are also considered. For seabirds, consideration is also given to species that may be present in the Zone due to migration or foraging activity.

An overview of coastal and onshore sites is provided in Chapter 16 – *Onshore Zone Development Envelope*, and sites pertinent to potential future terrestrial development are captured in substation-specific chapters (e.g. Chapter 17 – *Creyke Beck Substation Study Area*).

7.2 Data and Literature

Data on the spatial distribution and qualifying features of European designated and candidate sites of nature conservation interest (Special Areas of Conservation (SAC), Special Protection Areas (SPA) and Sites of Community Importance (SCI)) were sourced from the Joint Nature Conservation Committee (JNCC) and the European Environment Agency (EEA) and have been interpreted using GIS.

Additional data and literature from specific designated European sites have been sourced from the JNCC and other nations' conservation bodies. Strategic documents, including the Department for Energy and Climate Change (DECC) Offshore Energy Strategic Environmental Assessment (SEA) and the updated Offshore Energy SEA2, as well as TCE's Habitat Regulations Assessment (undertaken in accordance with the requirements of the EC Habitats Directive as transposed into domestic UK regulations, as described below) have also been used (see DECC, 2011; 2009; Entec, 2009).

As well as these, information from the documents that are specific to the Dogger Bank have also been considered in this chapter, namely those relating to JNCC characterisation and recommendations for a designation as a SAC (JNCC, 2011a; 2011b).

Spatial data and details of the UK's initiative to identify draft Marine Conservation Zones (dMCZs) were acquired for the North Sea in July 2011 from the regional MCZ project known as Net Gain.

Further, to inform the Environmental Impact Assessment (EIA) process for development of individual projects within Tranches, surveys are being undertaken by Forewind on a zone-wide basis for geophysical, bird and marine mammal aspects. These will be complemented by additional ecological surveys undertaken on a Tranche basis. The results of these are addressed as necessary in their respective ZoC chapters as interpreted data become available.

7.3 Overview

The Dogger Bank feature itself is an area of raised seabed that extends into Dutch, German, British and Danish areas of the North Sea. The bank is characterised by sandbanks and qualifies as a designated habitat under European legislation, as it is classed as '*sandbanks which are slightly covered by sea water all the time'*.

The Dogger Bank Zone overlaps with an area of this qualifying habitat on the sandbank feature and there are a number of international and national nature conservation sites located within the Zone and surrounding area, both in UK waters and in the adjoining Danish, Dutch, Belgian and German waters. Additionally there are a number of sites designated at an international level that support marine species within the Offshore Cable Area. There are also numerous sites along the coast, including local, national and international sites supporting a range of nature conservation features.

In particular, the Dogger Bank Zone overlaps with the defined boundary of a site identified by the JNCC and recommended to the European Commission (EC) as a candidate SAC (cSAC), a site status implemented as part of the UK's designation process under the EC Habitats Directive and transposing UK regulations. The site, known as the Dogger Bank cSAC, has gone through a stage of formal consultation, recommendation of the site to the UK Government, and the Governments submission of the site to the EC on the 26th August 2011 for approval as a SCI and then as a fully designated SAC.

7.4 Conventions and Legislation

7.4.1 International

There are a number of key international agreements and measures to promote conservation of marine habitats and species that the UK and European Union and non-EU nations such as Norway have signed up to. These include:

- The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention);
- The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention or CMS);
- The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention or Wetlands Convention);
- Convention on Environmental Impact Assessment in a Trans-boundary Context (the 'Espoo (EIA) Convention');
- The Convention on Biological Diversity (Biodiversity Convention or CBD); and
- The Convention for the protection of the Marine Environment of the North East Atlantic (OSPAR).

These conventions all include commitments to the protection of certain rare habitats and species that are found in the marine environment, and are implemented through regional and national policy and legislative frameworks. More detailed information on each of these is provided in Appendix E.

Within the European Union the key international legislative measures driving protection of specific rare and at-risk habitats and species are the EC Birds Directive (2009/147/EC) and the EC Habitats Directive (92/43/EC). These two Directives provide a framework for the designation of a network of protected sites for species and features (as listed in the Directives' Annexes) within member states known as the 'Natura 2000 network', and fulfils the European Union's commitment to the Convention on Biological Diversity and other international conventions. Species listed in the Directives' Annexes are known as European Protected Species (EPS).

An additional European measure applicable to the marine environment is the EC Marine Strategy Framework Directive (2008/56/EC), which provides a legislative framework for marine biodiversity and sets out a target of achieving or maintaining a 'good environmental status', which is outlined by several indicators, by 2020.

7.4.2 National

Within British waters, the transposing UK national legislation for the EC Habitats Directive is the Conservation (Natural Habitats & c.) Regulations 1994 (as amended) and the Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007 for sites beyond 12 nm, which allow for the designation of SACs. The provisions of the EC Birds Directive are implemented in the UK through the Wildlife & Countryside Act 1981 (as amended), the Conservation (Natural Habitats, & c.) Regulations 1994 (as amended); and the Offshore Marine Conservation (Natural Habitats & c.) Regulations 2007, which allow for the designation of SPAs. Under these regulations, the JNCC is responsible for the designation of SACs and SPAs beyond 12 nm and Natural England responsible within 12 nm. These regulations also implement protection for EPS through a licensing system, whereby a licence is required for undertaking any activities which could result in disturbance of these species. Further information on the process for designation of offshore SACs and SPAs and the features for which they are designated is provided in Appendix E.

The EC Marine Strategy Framework Directive (MSFD) is transposed through the UK Marine Strategy Regulations 2010. This commits the UK Government to produce an assessment of the current state and a description of what Good Environmental Status means for UK waters and associated targets and indicators, to establish monitoring programmes to measure the number of deadlines, beginning in 2012.

The UK Government is also implementing a number of domestic measures related to the management of the marine environment. The Marine and Coastal Access Act 2009 allows for the development of a marine spatial planning system, which will provide a policy background for future marine development, and is allowing the creation of further marine protected areas for nationally and regionally important marine species and habitats, known as MCZs. These measures help fulfil the Government's international commitments to protection of habitats and species and contribute to some of the requirements of the MSFD.

For intertidal (and terrestrial) areas further domestic legislation and policy applies with respect to nature conservation. This allows species, habitats and features that are important and national, regional and local levels to be afforded statutory protection. The Wildlife and Countryside Act 1981 (as amended by the Countryside and Rights of Way Act 2000) allows for the creation of protected sites for nationally important features and the National Parks and Access to the Countryside Act 1949 and Environment and Rural Communities Act 2006 allows for the designation of sites of local importance.

7.5 Internationally Protected Sites

There are a number of sites in the Offshore ZDE and wider North Sea area that are designated as protected areas for nature conservation or biodiversity purposes. The vast majority of these are designated under EU Directives and other international agreements and are described below.

7.5.1 OSPAR and Ramsar sites

Some international conventions allow for the creation of protected sites; OSPAR signatory countries have identified OSPAR Marine Protected Areas (MPAs) and signatories to the Ramsar convention have identified Ramsar sites (wetlands of international importance). For EU member states, these sites are also protected under the Birds and Habitats Directive.

Norway, however, is not a member of the European Union and as such does not comply with the Birds and Habitats Directives. Nevertheless, it is a signatory to the OSPAR Convention. Norway is in the process of identifying and legislating for marine protected areas to fulfil its OSPAR commitments, however limited information is available on these sites at present, which are exclusively in inshore and coastal areas and so not in close proximity to the ZDE (Norwegian Ministry of Fisheries and Coastal Affairs, 2011).

7.5.2 Special Areas of Conservation / Sites of Community Importance

The Habitats Directive (and transposing regulations) allows protected sites to be designated for habitats listed under Annex I and species listed under Annex II. The Habitats Directive is built around two pillars: a network of protected sites; and species protection. Sites containing habitats and species listed in the Annexes are identified by EU member states as potential SCIs and recommended to the EC for designation. The exact process to identify pSCIs varies between individual countries. In the UK, sites are first identified as draft sites (dSAC), then as possible sites (pSAC), and then as candidate sites (cSAC) which are recommended to the EC for designation and are therefore equivalent to pSCI at the European level. However, in all cases the EC considers pSCIs within biogeographic regions before formally adopting them as SCIs. The SCIs must then have appropriate management measures defined and be formally designated as SACs by individual member states within six years (McLeod *et al.,* 2005; EC Habitats Directive).

The wider Dogger Bank seabed feature is characterised by the Annex I habitat 'sandbanks which are slightly covered by sea water all the time'. In UK waters the Dogger Bank Zone and part of the Offshore Cable Area overlap the Dogger Bank cSAC, recommended to the EC by the UK Government on 26th August 2011. The surface area of the site proposed for designation is 12,338 km^2 (JNCC, 2011b), of which 6,140 km^2 overlaps the 8,660 km^2 Dogger Bank Zone. In considering the impact of TCE's Round 3 Plan to lease areas for offshore wind farm zones on Natura 2000 sites (known as Habitats Regulation Assessment or HRA), Entec (2009) concluded that there was the potential for an interaction to occur between developments within the Dogger Bank Zone and the Dogger Bank cSAC sandbank feature.

The Dogger Bank feature overlaps several international boundaries, and so under the Espoo (EIA) Convention (which

provides obligations related to trans-boundary notification and co-operation for projects that are likely to have a significant adverse environmental impact across boundaries), consideration must be given to the wider sandbank feature in terms of characterisation. Approximately 1,698.95 km^2 of the sandbank has been designated as a SCI in German waters, and 4,717.5 km^2 as a pSCI in Dutch waters (Bundesamt für Naturschutz (BfN), 2011; EEA, 2011; Ministerie van Economische Zaken, Landbouw en Innovatie, 2011a; 2011b).

In addition to the Dogger Bank sites, there are several other offshore and coastal SACs that fall directly within the Offshore ZDE that are designated for a number of habitat features including reefs, coastal lagoons, large shallow inlets, bays and mudflats and sandflats not covered by seawater at low tide. These SACs are described in Table 7.1 and illustrated in Figure 7.1.

There are also a number of internationally designated sites beyond the boundaries of the ZDE and the Dogger Bank sandbank itself, both in UK and other nation's waters. These include SAC or SCI sites that fall under the jurisdiction of the Netherlands, Germany, Denmark and Belgium, and these are also described in Table 7.1 and illustrated in Figure 7.1.

For example, many of the sites in the North Sea region surrounding the ZDE are designated for species listed under Annex II of the Habitats Directive, such as marine mammal species and diadromous fish, which although not a designated feature of the Dogger Bank cSAC or of other SACs/SCIs within the Offshore ZDE, could be present in the area and may constitute qualifying species of other SACs/SCIs beyond the limits of the Offshore ZDE.

Marine mammal species, such as the harbour porpoise *Phocoena phocoena*, bottlenose dolphin *Tursiops truncatus*, grey seal *Halichoerus grypus* and common seal *Phoca vitulina*, are all expected to occur within the boundary of the Dogger Bank cSAC (JNCC, 2011b) and are also qualifying species for a number of SACs/SCIs in the North Sea region, as detailed in Table 7.1. Further information on the occurrence of these species in the Offshore ZDE is provided in Chapter 6 – *Marine Mammals*.

In the plan level HRA for TCE, Entec identified SACs/SCIs and associated designated features that had potential to be affected by offshore wind development associated with the Dogger Bank Zone and other Round 3 developments and assessed whether further consideration would be needed on an individual zone and project level. Figure 7.1 and in Table 7.1 summarise all sites within or immediately adjacent to the Offshore ZDE, as well as:

- Transboundary sites identified by Entec (2009) that are unlikely to be significantly or adversely affected by the Round 3 plan, assuming that certain plan-level mitigation measures will be employed by developers at zone and project level; and
- Transboundary sites identified by Entec (2009) that require project-level assessment and HRA to determine if an interaction or impact on site integrity will occur.

Entec (2009) also identified sites where it was concluded that significant or adverse impacts on the sites are unlikely to occur from the Round 3 plan. For this reason, these sites are not individually labelled or summarised in Figure 7.1 and Table 7.1.

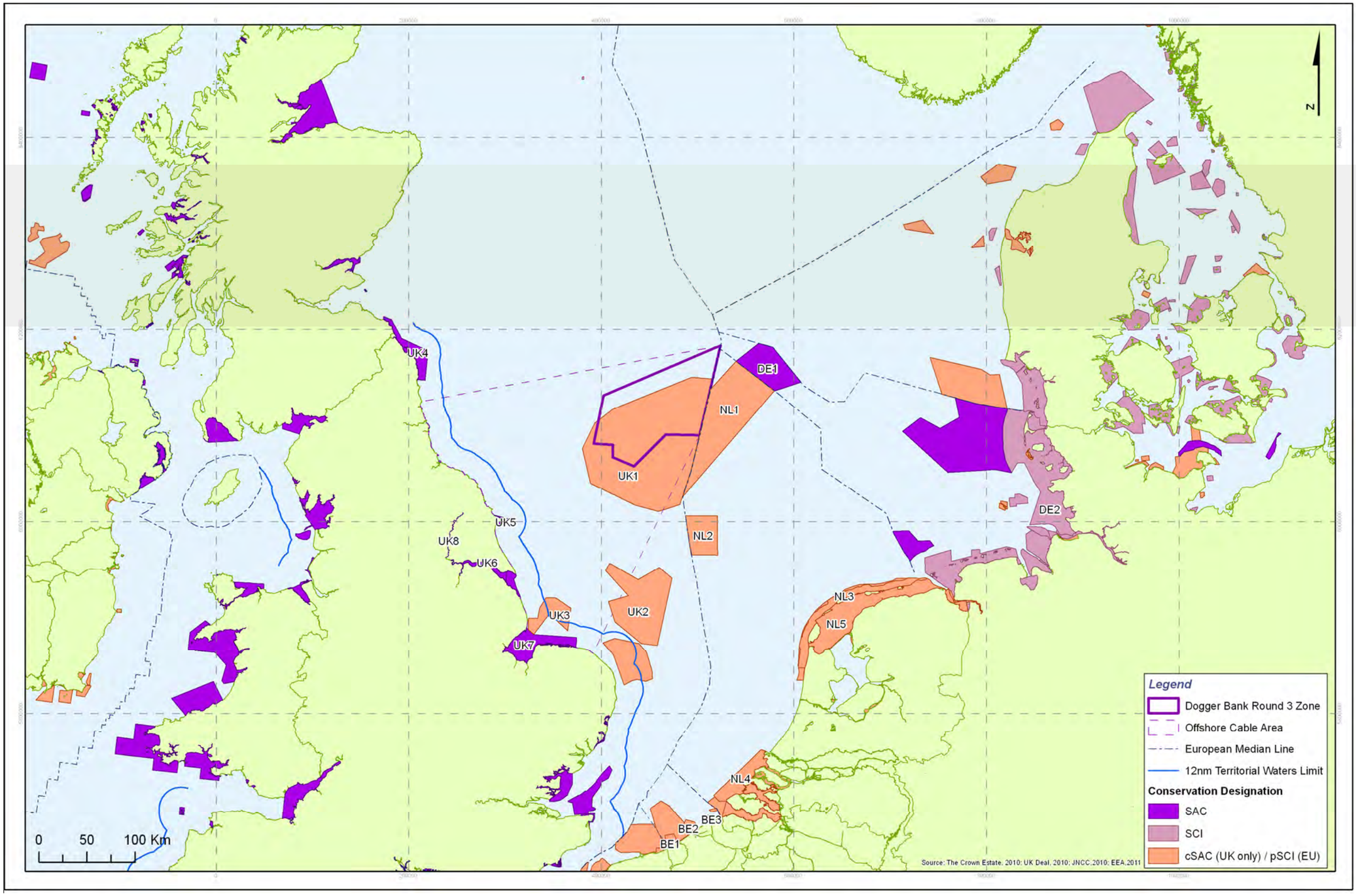


Figure 7.1: UK and European SACs/SCIs in relation to the Offshore ZDE. The sites labelled are SACs/SCIs within or adjacent to the Offshore ZDE and other sites with the potential to be impacted through future development in the ZDE, as interpreted from Entec (2009). The labelled sites are described in Table 7.1 below. Source: Entec, 2009, The Crown Estate, 2010; JNCC, 2011b; European Environment Agency (EEA), 2011.

Table 7.1: UK and European SACs/SCIs within or adjacent to the Offshore ZDE and sites with potential to be impacted through future development in the ZDE as interpreted from Entec (2009). Note that for some non-UK sites information on qualifying and non-qualifying features is limited. Sources: BfN, 2011; EEA, 2011; Ministerie van Economische Zaken, Landbouw en Innovatie, 2011a; 2011b; JNCC, 2011a, 2011b, Entec, 2009.

Site reference (see Figure 7.1)	Site (Natura 2000 site reference)	Primary reasons for designation	Additional qualifying features	Other, non-qualifying Features and characteristics	Notes on siteand features with connectivity to future development, as adapted from Entec, 2009.
UK waters					
UK1	**Dogger Bank cSAC (submitted to the EC for approval, equivalent to pSCI) (UK0030352)**	Sandbanks which are slightly covered by sea water all the time		Harbour porpoise *Phocoena phocoena* Common seal *Phoca vitulina* Grey seal *Halichoerus grypus*	• Situated within the ZDE; and • Sandbank habitat feature of particular relevance and highlighted at plan level
UK2	**North Norfolk Sandbanks and Saturn Reef cSAC/pSCI (UK0030358)**	Sandbanks which are slightly covered by sea water all the time Reefs			• Situated within the ZDE.
UK3	**Inner Dowsing, Race Bank and North Ridges cSAC/pSCI (UK0030370)**	Sandbanks which are slightly covered by sea water all the time Reefs (characterised by species *Sabellaria spinulosa*) Grey seal *Halichoerus grypus* Harbour porpoise *Phocoena phocoena*		Harbour porpoise *Phocoena phocoena* Grey seal *Halichoerus grypus*	• Situated within the ZDE.
UK4	**Berwickshire and North Northumberland Coast SAC (UK0017072)**	Mudflats and sandflats not covered by sea water at low tide Large shallow inlets and bays Reefs Submerged or partially submerged sea caves Grey seal *Halichoerus grypus*		Atlantic salt meadows Sandbanks which are slightly covered by sea water all the time Estuaries Otter *Lutra lutra*	• Potential interaction for grey seals highlighted at a plan level (Entec identify plan level mitigation measures that can be applied to manage future impacts on the species)
UK5	**Flamborough Head SAC (UK0013036)**	Reefs Vegetated sea cliffs of the Atlantic and Baltic coasts Submerged or partially submerged sea caves		Sandbanks which are slightly covered by sea water all the time Grey seal *Halichoerus grypus*	• Reefs highlighted at plan level as features of relevance and highlighted at plan level.
UK6	**Humber Estuary SAC (UK0030170)**	Estuaries Mudflats and sandflats not covered by sea water at low tide	Sandbanks which are slightly covered by sea water all the time Coastal lagoons *Salicornia* and other annuals colonising mud and sand Atlantic salt meadows *Glauco-Puccinellietalia maritimae* Embryonic shifting dunes Shifting dunes along the shoreline with *Ammophila arenaria* (`white dunes`) Fixed dunes with herbaceous vegetation (`grey dunes`) Dunes with *Hippophae rhamnoides* River lamprey *Lampetra fluviatilis* Sea lamprey *Petromyzon marinus* Grey seal *Halichoerus grypus*	Annual vegetation of drift lines *Spartina* swards Common seal *Phoca vitulina* Allis shad *Alosa alosa* Twaite shad *Alosa fallax*	• Estuaries, Mudflats and sandflats, sandbanks and Grey seal features highlighted as features of relevance and highlighted at plan level; and • Diadromous fish highlighted as features of relevance and highlighted at plan level. (Entec identify plan level mitigation measures that can be applied to manage impacts on the species). leve.

UK7	**The Wash and North Norfolk Coast SAC (UK0017075)**	Sandbanks which are slightly covered by sea water all the time Mudflats and sandflats not covered by sea water at low tide Large shallow inlets and bays Reefs *Salicornia* and other annuals colonising mud and sand Atlantic salt meadows *Glauco-Puccinellietalia maritimae* Mediterranean and thermo-Atlantic halophilous scrubs *Sarcocornetea fruticosi* Common seal *Phoca vitulina*	Coastal lagoons Grey seal *Phoca vitulina* Otter *Lutra lutra*		• Grey seal highlighted as feature of relevance and highlighted at plan level(Entec identify plan level mitigation measures that need to be applied)
UK8	**River Derwent SAC (UK0030253)**	Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation River lamprey *Lampetra fluviatilis*	Sea lamprey *Petromyzon marinus* Bullhead *Cottus gobio* Otter *Lutra lutra*	Crayfish *Austropotamobius pallipes* Brook lamprey *Lampetra planeri* Atlantic salmon *Salmo salar*	• Diadromous fish highlighted as feature of relevance and highlighted at plan leve(Entec identify plan level mitigation measures that need to be applied) .l.
Site reference (see Figure 7.1)	**Site (Natura 2000 site reference)**	**Designated features**			**Notes on site and features with connectivity to future development, as adapted from Entec, 2009.**
Non-UK waters					
DE1	**Doggerbank SAC (DE1003301) (Germany)**	Sandbanks which are slightly covered by sea water all the time Common seal *Phoca vitulina* Harbour porpoise *Phocoena phocoena*			• Situated adjacent to the Dogger Bank Zone; • Harbour porpoise and common seal of particular relevance and highlighted at plan level (Entec identify plan level mitigation measures that need to be applied)
DE2	**NTP S-H Wattenmeer und angrenzende Kustengebiete SCI (DE0916391) (Germany)**	Sandbanks slightly covered by water all the time Estuaries Mudflats and sandflats not covered by water all the time Coastal algoons Large shallow inlets and bays Reefs Several further terrestrial and coastal habitats including salt meadows and dunes Bottlenose dolphin *Tursiops truncatus* – Common seal *Phoca vitulina* Harbour porpoise *Phocoena phocoena* Grey seal *Halichoerus grypus*			• Bottlenose dolphin highlighted as feature of relevance and highlighted at plan level (Entec identify plan level mitigation measures that need to be applied)
NL1	**Doggersbank pSCI (NL2008001) (the Netherlands)**	Sandbanks which are slightly covered by sea water all the time Common seal *Phoca vitulina* Harbour porpoise *Phocoena phocoena* Grey seal *Halichoerus grypus*			• Adjacent to the Dogger Bank Zone;
NL2	**Klaverbank pSCI (NL2008002) (Cleaverbank) (the Netherlands)**	Reefs Common seal *Phoca vitulina* Harbour porpoise *Phocoena phocoena* Grey seal *Halichoerus grypus*			• In close proximity to the Dogger Bank Zone; and • Not assessed at a plan level, however given proximity to ZDE and presence of marine mammal features, listed here.
NL3	**Noordzeekustzone pSCI (NL2003062) (the Netherlands)**	Sandbanks which are slightly covered by sea water all the time Bottlenose dolphin *Tursiops truncatus* Common seal *Phoca vitulina* Harbour porpoise *Phocoena phocoena* Grey seal *Halichoerus grypus* River lamprey *Lampetra fluviatilis* Sea lamprey *Petromyzon marinus*			• Bottlenose dolphin highlighted as feature of relevance and highlighted at plan level (Entec identify plan level mitigation measures that need to be applied)

NL4	**Voordelta pSCI (NL4000017) (the Netherlands)**	Bottlenose dolphin *Tursiops truncatus* Common seal *Phoca vitulina*	• Bottlenose dolphin highlighted as feature of relevance and highlighted at plan level (Entec identify plan level mitigation measures that need to be applied)
NL5	**Waddenzee pSCI (NL1000001) (the Netherlands)**	Sandbanks which are slightly covered by sea water all the time Estuaries Mudflats and sandflats not covered by seawater at low tide *Salicornia* and other annuals colonizing mud and sand Spartina swards *(Spartinion maritimae)* Atlantic salt meadows *(Glauco-Puccinellietalia maritimae)* Embryonic shifting dunes Shifting dunes along the shoreline with *Ammophila arenaria (*'white dunes') Fixed coastal dunes with herbaceous vegetation ('grey dunes') Grey seal *Halichoerus grypus* Bottlenose dolphin *Tursiops truncatus*	• Bottlenose dolphin highlighted as feature of relevance and highlighted at plan level.
BE1, BE2, BE3	**SBZ 1 / ZPS 1, SBZ 2 / ZPS 2 and SBZ 3 / ZPS 3 pSCIs (3 combined sites) (BEMNZ0002-BEMNZ0004). (Belgium).** **Note that all 3 sites are also SPAs.**	Sandbanks which are slightly covered by sea water all the time Harbour porpoise *Phocoena phocoena* Grey seal *Halichoerus grypus* Common seal *Phoca vitulina*	• Harbour porpoise highlighted as feature of relevance and highlighted at plan level (though Entec suggest no adverse effects from future development).

7.5.3 Special Protection Areas

The Birds Directive (through domestic transposing regulations in EU member states) creates a comprehensive scheme of protection for all wild bird species naturally occurring in the European Union.

The Directive emphasises the protection of habitats for endangered as well as migratory species (listed in Annex I), through the establishment of a coherent network of SPAs comprising all the most suitable territories for these species. Since 1994 all SPAs form an integral part of the Natura 2000 network when combined with SCIs/SACs designated under the Habitats Directive.

SPAs have been considered both within and outside of the ZDE to take account of the mobile foraging and migratory behaviour of birds. Sites which support migratory birds and breeding seabirds are of particular relevance.

Survey data collected by Forewind and results of work by Langston (2010) suggest a number of key species recorded within the Offshore ZDE which may be impacted by future development. For the Dogger Bank Zone, a provisional list of focal seabird species has been identified and is summarised in Chapter 5 - *Birds* which includes: fulmar, gannet, kittiwake, lesser black-backed gull, great black-backed gull, guillemot, razorbill, little auk, puffin and white-billed diver. At this stage, it is unclear as to whether numbers of great skua, little gull and herring gull occurring in the Dogger Bank Zone might also be of importance. Consideration was then given to the mean maximum foraging ranges for these key species with a view to identifying designated sites within the North Sea region that support them and may require further assessment.

The known mean and maximum foraging ranges of breeding seabird species are summarised within Chapter 5 – *Birds,* and in Table 7.2 below.

Table 7.2: Key seabird species and indicative foraging ranges (Sources: Thaxter *et al.,* (in review) and Furness and Tasker, 2000).

Species	Foraging range
Fulmar	Mean foraging range of 48 km, a mean maximum of 400 km and a maximum of 580 km
Gannet	Mean foraging range of 126 km, a mean maximum of 282 km and a maximum of 590 km
Kittiwake	Mean foraging range of 27 km, a mean maximum of 62 km and a maximum of 120 km
Lesser black-backed gull	Mean foraging range of 65 km, a mean maximum of 132 km and a maximum of 181 km
Herring gull	Mean foraging range of 11 km, a mean maximum of 61 km and a maximum of 92 km
Great black-backed gull	Indicative foraging range of approximately 10 km
Guillemot	Mean foraging range of 20 km, a mean maximum of 71 km and a maximum of 135 km
Razorbill	Mean foraging range of 24 km, a mean maximum of 58 km and a maximum of 100 km
Puffin	Mean foraging range of 4 km, a mean maximum of 87 km and a maximum of 200 km

Given these indicative foraging ranges, SPAs outside of UK waters have been considered that have such species as qualifying features. For example the Dutch, German and Danish Wadden Sea areas are designated SPAs for such key breeding species for an area extending from Dan Helder in Holland to just north of Esbjerg in Denmark (Ministerie van Economische Zaken, Landbouw en Innovatie, 2011b).

The range of SPAs found in the North Sea region which are considered significant through their proximity to the Offshore ZDE or their species designations is illustrated in Figure 7.2.

It should be noted that Figure 7.2 presents foraging ranges extending from the Dogger Bank Zone boundary purely for the purpose of identifying the SPAs that may be most pertinent in relation to the Dogger Bank Zone. The figure is therefore a conceptual one and, in reality, "central place foraging" extends from the breeding colonies themselves.

The SPAs labelled in Figure 7.2 are considered significant, either because they occur within the Offshore ZDE or because they occur within the indicative foraging ranges and support breeding populations of the focal seabird species identified above as qualifying site features. Details of these labelled sites are provided in Table 7.3.

Labelled SPAs are considered significant because they occur within the Offshore ZDE or are otherwise SPAs

It should also be noted that the JNCC has identified areas which might be considered for extensions for current SPAs or new SPAs. These are referred to as Areas of Search (AoS), and currently encompass an area of coastline stretching from Hornsea Mere to the North Norfolk coast, encompassing a breeding tern colony SPA within the Humber Estuary and an important seabird concentration that incorporates the Dogger Bank (Kober *et al*., 2010).

Further information on pertinent bird species is provided in Chapter 5 – *Birds*.

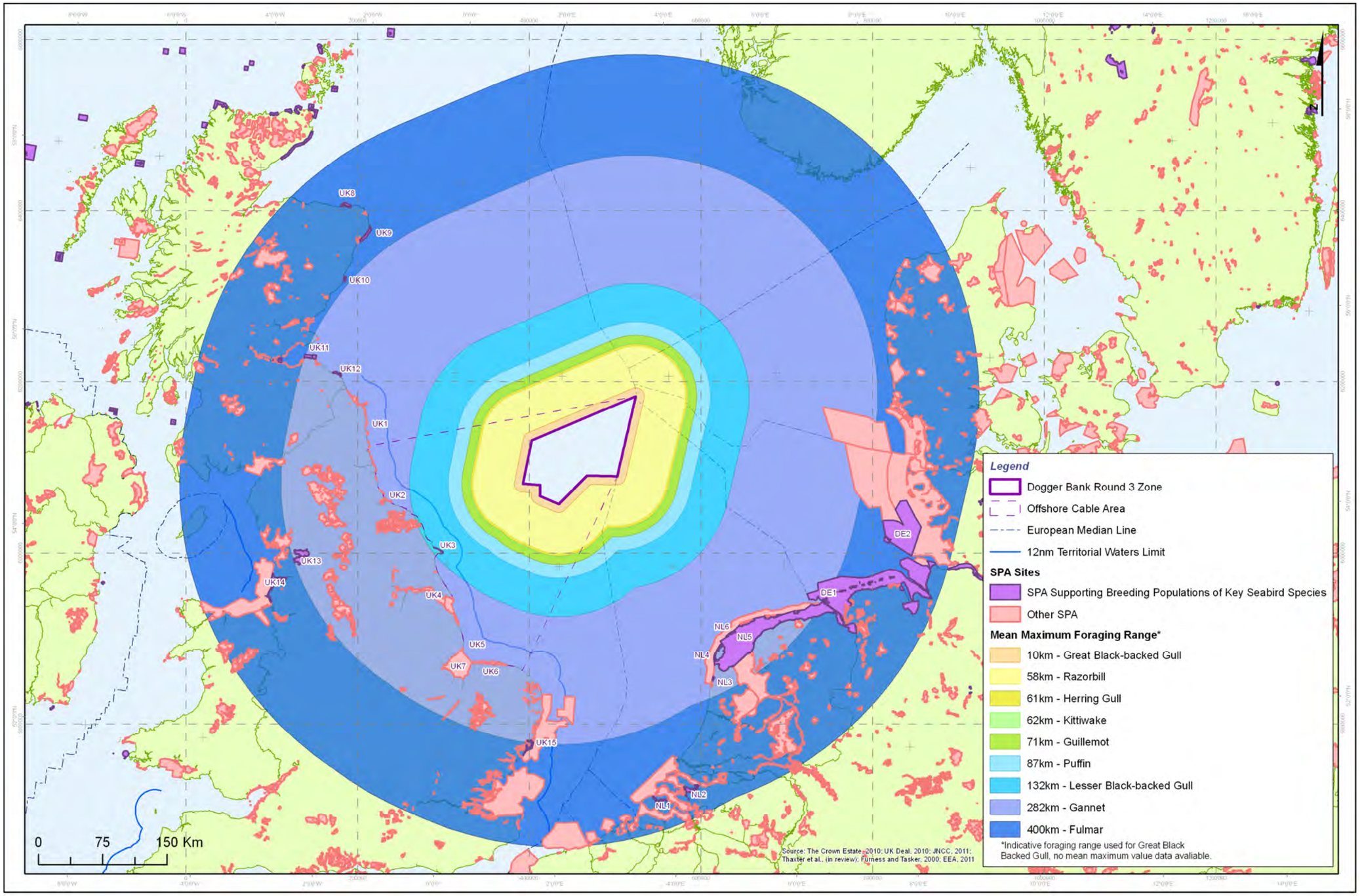


Figure 7.2: SPAs and foraging distances relevant to the Dogger Bank Zone. Labelled SPAs are considered significant because they occur within the Offshore ZDE or because they occur within the indicative foraging ranges and support breeding populations of the focal seabird species identified above as qualifying site features. Sites are described in Table 7.3 below. Sources: The Crown Estate, 2010; JNCC, 2011a; 2011b; Thaxter *et al*., (in review); Furness and Tasker, 2000; EEA, 2011, Entec, 2009.

Table 7.3: SPAs and their qualifying features in the Offshore ZDE, and outside the Offshore ZDE where breeding populations of focal seabird species are qualifying features. Note for SPAs outside the UK only information concerning key species (as identified above) is included. Sources: EEA, 2011, JNCC, 2011c, Stroud *et al.*, 2001.

Site number (refer to Figure 7.2)	Site (Natura 2000 site reference)	Qualifying Features			
		During the breeding season	Staging (on passage)	Over winter:	Assemblage
UK sites					
UK1	**Northumbria Coast SPA (UK9006131)**	Little tern *Sterna albifrons*		Purple sandpiper *Calidris maritima* Turnstone *Arenaria interpres*	
UK2	**Teesmouth and Cleveland Coast SPA (UK11068)**	Little tern *Sterna albifrons*	Sandwich tern *Sterna sandvicensis* Redshank *Tringa totanus*	Knot *Calidris canutus*	Sanderling *Calidris alba* Lapwing *Vanellus vanellus* Shelduck *Tadorna tadorna* Cormorant *Phalacrocorax carbo* Redshank *Tringa totanus* Knot *Calidris canutus*
UK3	**Flamborough Head and Bempton Cliffs SPA (UK9006101)**	Kittiwake *Rissa tridactyla*			Puffin *Fratercula arctica* Razorbill *Alca torda* Guillemot *Uria aalge* Herring gull *Larus argentatus* Gannet *Morus bassanus* Kittiwake *Rissa tridactyla*
UK4	**Humber Estuary SPA (UK11031)**	Bittern *Botaurus stellaris* Little tern *Sterna albifrons* Marsh harrier *Circus aeruginosus* Pied avocet *Recurvirostra avosetta*	Redshank *Tringa tetanus* Sanderling *Calidris alba* Ruff *Philomachus pugnax* Dunlin *Calidris alpina alpina* Knot *Calidris canutus* Black-tailed godwit *Limosa limosa islandica* Redshank *Tringa totanus*	Bar-tailed godwit *Limosa lapponica* Black-tailed godwit *Limosa limosa islandica* Bittern *Botaurus stellaris* Golden plover *Pluvialis apricaria* Hen harrier *Circus cyaneus* Dunlin *Calidris alpina alpina* Knot *Calidris canutus* Redshank *Tringa totanus* Shelduck *Tadorna tadorna* Pied avocet *Recurvirostra avosetta*	Mallard *Anas platyrhynchos* Golden plover *Pluvialis apricaria* Bar-tailed godwit *Limosa lapponica* Shelduck *Tadorna tadorna* Knot *Calidris canutus* Dunlin *Calidris alpina alpina* Redshank *Tringa totanus* Cormorant *Phalacrocorax carbo* Dark-bellied brent goose *Branta bernicla bernicla* Bittern *Botaurus stellaris* Teal *Anas crecca* Curlew *Numenius arquata* Pochard *Aythya ferina* Goldeneye *Bucephala clangula* Oystercatcher *Haematopus ostralegus* Ringed plover *Charadrius hiaticula* Grey plover *Pluvialis squatarola* Lapwing *Vanellus vanellus* Sanderling *Calidris alba* Black-tailed godwit *Limosa limosa islandica* Wigeon *Anas penelope* Whimbrel *Numenius phaeopus*
UK5	**Gibraltar Point SPA (UK9008022)**	Little tern *Sterna albifrons*		Bar-tailed godwit *Limosa lapponica* Grey plover *Pluvialis squatarola* Knot *Calidris canutus* Sanderling *Calidris alba*	Oystercatcher *Haematopus ostralegus* Knot *Calidris canutus* Grey plover *Pluvialis squatarola* Bar-tailed godwit *Limosa lapponica*

Site number (refer to Figure 7.2)	Site (Natura 2000 site reference)	Qualifying Features			
		During the breeding season	Staging (on passage)	Over winter:	Assemblage
UK6	**North Norfolk Coast SPA (UK9009031)**	Avocet *Recurvirostra avosetta* Bittern *Botaurus stellaris* Marsh harrier *Circus aeruginosus* Common tern *Sterna hirundo* Little tern *Sterna albifrons* Roseate tern *Sterna dougallii* Sandwich tern *Sterna sandvicensis*	Ringed plover *Charadrius hiaticula*	Avocet *Recurvirostra avosetta* Bar-tailed godwit *Limosa lapponica* Bittern *Botaurus stellaris* Golden plover *Pluvialis apricaria* Hen harrier *Circus cyaneus* Ruff *Philomachus pugnax* Dark-bellied brent goose *Branta bernicla bernicla* Knot *Calidris canutus* Pink-footed goose *Anser brachyrhynchus* Pintail *Anas acuta* Redshank *Tringa totanus* Wigeon *Anas penelope*	Shelduck *Tadorna tadorna* Avocet *Recurvirostra avosetta* Golden plover *Pluvialis apricaria* Ruff *Philomachus pugnax* Bar-tailed godwit *Limosa lapponica* Pink-footed goose *Anser brachyrhynchus* Dark-bellied brent goose *Branta bernicla bernicla* Wigeon *Anas penelope* Pintail *Anas acuta* Knot *Calidris canutus* Redshank *Tringa totanus* Bittern *Botaurus stellaris* White-fronted goose *Anser albifrons albifrons* Dunlin *Calidris alpina alpina* Gadwall *Anas strepera* Teal *Anas crecca* Shoveler *Anas clypeata* Common scoter *Melanitta nigra* Velvet scoter *Melanitta fusca* Oystercatcher *Haematopus ostralegus* Ringed plover *Charadrius hiaticula* Grey plover *Pluvialis squatarola* Lapwing *Vanellus vanellus* Sanderling *Calidris alba* Cormorant *Phalacrocorax carbo*
UK7	**The Wash SPA (UK11072)**	Common tern *Sterna hirundo* Little tern *Sterna albifrons*	Ringed plover *Charadrius hiaticula* Sanderling *Calidris alba*	Avocet *Recurvirostra avosetta* Bar-tailed godwit *Limosa lapponica* Golden plover *Pluvialis apricaria* Whooper swan *Cygnus cygnus* Black-tailed godwit *Limosa limosa islandica* Curlew *Numenius arquata* Dark-bellied brent goose *Branta bernicla bernicla* Dunlin *Calidris alpina alpina* Grey plover *Pluvialis squatarola* Knot *Calidris canutus* Oystercatcher *Haematopus ostralegus* Pink-footed goose *Anser brachyrhynchus* Pintail *Anas acuta* Redshank *Tringa totanus* Shelduck *Tadorna tadorna* Turnstone *Arenaria interpres*	Black-tailed godwit *Limosa limosa islandica* Avocet *Recurvirostra avosetta* Golden plover *Pluvialis apricaria* Bar-tailed godwit *Limosa lapponica* Pink-footed goose *Anser brachyrhynchus* Dark-bellied brent goose *Branta bernicla bernicla* Shelduck *Tadorna tadorna* Pintail *Anas acuta* Oystercatcher *Haematopus ostralegus* Grey plover *Pluvialis squatarola* Whooper swan *Cygnus cygnus* Dunlin *Calidris alpina alpina* Sanderling *Calidris alba* Curlew *Numenius arquata* Redshank *Tringa totanus* Turnstone *Arenaria interpres* Little grebe *Tachybaptus ruficollis* Cormorant *Phalacrocorax carbo* White-fronted goose *Anser albifrons albifrons* Wigeon *Anas penelope* Mallard *Anas platyrhynchos* Ringed plover *Charadrius hiaticula* Lapwing *Vanellus vanellus* Knot *Calidris canutus* Whimbrel *Numenius phaeopus*

Site number (refer to Figure 7.2)	Site (Natura 2000 site reference)	Qualifying Features			
		During the breeding season	Staging (on passage)	Over winter:	Assemblage
UK8	**Troup, Pennan And Lion's Heads SPA (UK9002471)**	Kittiwake *Rissa tridactyla* Guillemot *Uria aalge*			Razorbill *Alca torda* Fulmar *Fulmarus glacialis* Herring gull *Larus argentatus* Kittiwake *Rissa tridactyla* Guillemot *Uria aalge*
UK9	**Buchan Ness To Collieston Coast SPA (UK9002491)**	Herring gull *Larus argentatus* Fulmar *Fulmarus glacialis* European shag *Phalacrocorax aristotelis* Kittewake *Rissa tridactyla* Guillemot *Uria aalge*			
UK10	**Fowlsheugh SPA (UK9002271)**	Razorbill *Alca torda* Fulmar *Fulmarus glacialis* Herring gull *Larus argentatus* Kittiwake *Rissa tridactyla* Guillemot *Uria aalge*			
UK11	**Forth Islands SPA (UK9004171)**	Razorbill *Alca torda* Atlantic puffin *Fratercula arctica* Fulmar *Fulmarus glacialis* Herring gull *Larus argentatus* Lesser black-backed gull *Larus fuscus* Gannet *Morus bassanus* European shag *Phalacrocorax aristotelis* Cormorant *Phalacrocorax carbo* Kittewake *Rissa tridactyla* Common tern *Sterna hirundo* Arctic tern *Sterna paradisaea* Roseate tern *Sterna dougallii* Sandwich tern *Sterna sandvicensis* Guillemot *Uria aalge*			
UK12	**St Abb's Head to Fast Castle SPA (UK9004271)**	Razorbill *Alca torda* Herring gull *Larus argentatus* European shag *Phalacrocorax aristotelis* Kittewake *Rissa tridactyla* Guillemot *Uria aalge*			
UK13	**Bowland Fells SPA (UK9005151)**	Lesser black-backed gull *Larus fuscus* Hen harrier *Circus cyaneus* Merlin *Falco columbarius*			

Site number (refer to Figure 7.2)	Site (Natura 2000 site reference)	Qualifying Features			
		During the breeding season	Staging (on passage)	Over winter:	Assemblage
UK14	**Ribble and Alt Estuaries SPA (UK9005103)**	Lesser black-backed gull *Larus fuscus* Black-headed gull *Larus ridibundus* Common gern *Sterna hirundo* Ruff *Philomachus pugnax*	Sanderling *Calidris alba* Ringed plover *Charadrius hiaticula* Whimbrel *Numenius phaeopus* Redshank *Tringa totanus*	Bewick's swan *Cygnus columbianus bewickii* Whooper swan *Cygnus cygnus* Bar-tailed godwit *Limosa lapponica* Golden plover *Pluvialis apricaria* Northern pintail *Anas acuta* Common teal *Anas crecca* Wigeon *Anas penelope* Pink-footed goose *Anser brachyrhynchus* Greater scaup *Aythya marila* Sanderling *Calidris alba* Dunlin *Calidris alpina alpina* Red knot *Calidris canutus* Oystercatcher *Haematopus ostralegus* Black-tailed godwit *Limosa limosa islandica* Black scoter *Melanitta nigra* Eurasian curlew *Numenius arquata* Great cormorant *Phalacrocorax carbo* Grey plover *Pluvialis squatarola* Common shelduck *Tadorna tadorna* Redshank *Tringa totanus* Northern lapwing *Vanellus vanellus*	
UK15	**Alde–Ore Estuary SPA (UK9009112)**	Lesser black-backed gull *Larus fuscus* Little tern *Sterna albifrons* Sandwich tern *Sterna sandvicensis* Pied avocet *Recurvirostra avosetta* Marsh harrier *Circus aeruginosus*		Redshank *Tringa totanus* Ruff *Philomachus pugnax* Pied avocet *Recurvirostra avosetta*	
German sites					
DE1	**Niedersächsisches Wattenmeer und angrenzendes Küstenmeer SPA (DE2210401)**	Lesser black-backed gull *Larus fuscus* Great black-backed gull Herring gull *Larus argentatus*			
DE2	**Seevogelschutzgebiet Helgoland SPA (DE1813491)**	Fulmar *Fulmarus glacialis* Gannet *Morus bassanus* Guillemot *Uria aalge* Razorbill *Alca torda* Lesser black-backed gull *Larus fuscus* Herring gull *Larus argentatus*			
Dutch Sites					
NL1	**Veerse Meer SPA (NL9802025)**	Lesser black-backed gull *Larus fuscus*			
NL2	**Krammer-Volkerak SPA(NL1000021)**	Lesser black-backed gull *Larus fuscus*			
NL3	**Zwanenwater SPA(NL9910002)**	Lesser black-backed gull *Larus fuscus*			
NL4	**Duinen Texel SPA (NL3009008)**	Lesser black-backed gull *Larus fuscus*			
NL5	**Waddenzee SPA (NL9801001)**	Lesser black-backed gull *Larus fuscus*			
NL6	**Duinen Vlieland SPA (NL3009009)**	Lesser black-backed gull *Larus fuscus*			

7.6 Nationally and Locally Protected Sites

There are a number of sites in the ZDE that are designated or undergoing the process of designation under domestic UK legislation as being important for nature conservation.

As outlined above, sites designated under the EU Birds and Habitats Directives are implemented through domestic legislation in the UK, and the same is true for other EU member states.

7.6.1 UK Intertidal and Terrestrial Sites

Under the Wildlife and Countryside Act there is a network of Sites of Special Scientific Interest (SSSI) and National Nature Reserves (NNR) in the UK. These are protected species and habitats of national importance, however they are largely terrestrial and do not extend below the low water mark. Similarly, under the National Parks and Access to the Countryside Act 1949 and amended by the Natural Environment and Rural Communities Act 2006 (and others) there is a network of Local Nature Reserves (LNRs) designated for locally important habitats and features. All sites afforded a designation under the Natura 2000 network or other international conventions such as Ramsar sites are also designated at a national and/or local level. Given the location of the Dogger Bank Zone there is unlikely to be interaction with such onshore sites, however migratory species (such as birds) could potentially be found in the Offshore ZDE. Interactions between land based designations and key bird species are considered in Chapter 5 – *Birds.* Additionally further information on terrestrial sites such as National Parks, SSSI, NNR and LNR can be found in Chapter 16 – *Onshore Zone Development Envelope* and Chapter 17 – *Creyke Beck Substation Study Area*.

7.6.2 UK Marine Sites – Marine Conservation Zones

Under UK legislation there is currently very little of the UK's marine environment afforded protection outside of those sites designated at an international level, apart from a handful of local or voluntary areas, none of which fall within the Offshore ZDE. However, the Marine and Coastal Access Act has allowed for the creation of a network of MCZs. MCZs will protect nationally and regionally important marine wildlife, habitats, geology and geomorphology and can be designated anywhere in English offshore waters. The sites are being identified through an iterative, stakeholder based process in regional projects, and designation is expected in 2012.

The ZDE falls within the boundary of the regional MCZ project known as Net Gain (The North Sea MCZ Project). Net Gain has been established to work with stakeholders to identify and recommend MCZs as well as management measures to be developed for each site in the English North Sea.

Potential sites have been identified by Net Gain through a process of stakeholder consultation (including consultation with Forewind) and under national guidance issued from the JNCC and Natural England, which highlights those features (referred to as 'features of conservation interest', or FOCI) that qualify an area for designation as a MCZ and the requirements for site connectivity and ecological coherence of the network. Management measures are yet to be defined for MCZs, however a proportion of MCZs in each region will be reference areas. Within these areas activities that can be carried out may be restricted. A suite of draft MCZs (dMCZs) and reference areas has been agreed by the Net Gain project and submission of these sites to the UK Government for a formal consultation and designation process is expected in early 2012.

The dMCZs and reference areas identified through the Net Gain project area that fall within the Offshore ZDE and those that are close to the Dogger Bank Zone itself and their interest features are summarised in Figure 7.3 and Table 7.4. There are no dMCZs or reference areas within the Dogger Bank Zone however several fall within the ZDE (Net Gain, 2011).

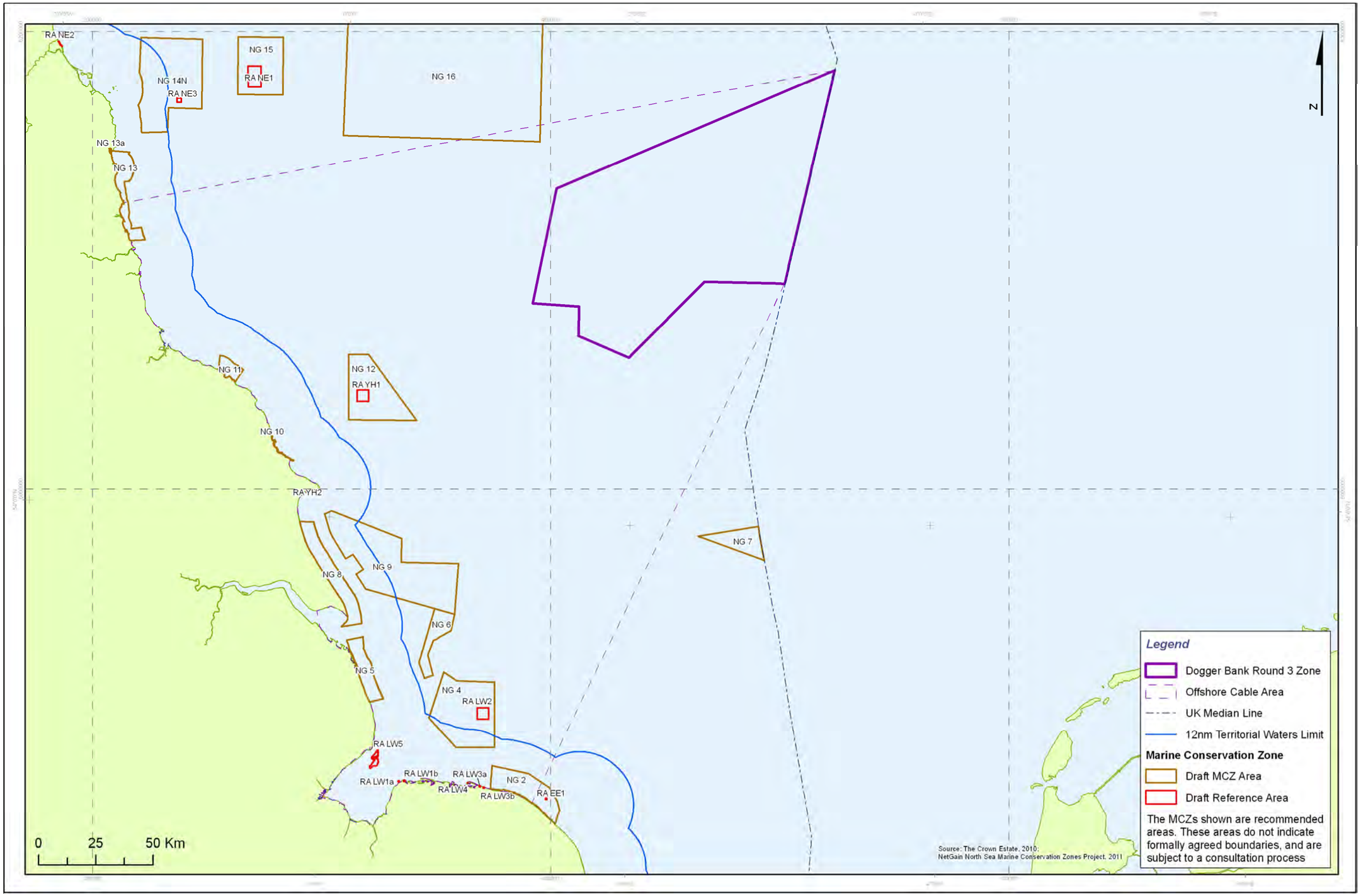


Figure 7.3: Draft Marine Conservation Zones and Reference Areas for the Net Gain region in relation to the ZDE. Source: The Crown Estate, 2010; Net Gain, 2011.

Table 7.4: Draft Marine Conservation Zones (dMCZs) and Reference Areas (dRA) for the Net Gain region and the site designated and other features. Source: Net Gain, 2011.

Key to table

Feature for which site is designated	
Additional feature in site	

	Broad scale habitats																			Habitats of conservation importance															Species of conservation importance												
	High energy intertidal rock	Moderate energy intertidal rock	Low energy intertidal rock	Intertidal coarse sediment	Intertidal sand and muddy sand	Intertidal mud	Intertidal mixed sediments	Coastal saltmarshes and saline reed beds	Intertidal biogenic reefs	High energy infralittoral rock	Moderate energy infralittoral rock	High energy circalittoral rock	Moderate energy circalittoral rock	Low energy circalittoral rock	Subtidal coarse sediment	Subtidal sand	Subtidal mud	Subtidal mixed sediments	Subtidal biogenic reefs	Littoral chalk communities	Subtidal chalk (model)	Estuarine rocky habitats	Subtidal sands and gravels (model)	Peat and clay exposures	Subtidal chalk (modelled)	Subtidal sands and gravels	Subtidal chalk	Sheltered muddy gravels (model)	Intertidal underboulder communities	Tide swept channels	Blue Mussel Beds	Seagrass beds	*anemone Nematostella vectensis*	Ross worm (*Sabellaria spinulosa*) reefs	Ocean quahog *Arctica islandica*	Horse mussel beds	Common maerl *Phymatolithon calcareum*	Amphipod shrimp *Gitanopsis bispinosa*	Native oyster*Ostrea edulis*	Smelt *Osmerus eperlaus*	European Eel *Anguilla anguilla*	Undulate Ray *Raja undalata*	Tentacled lagoon-worm *Alkmaria romijini*	Geological features
dMCZ NG 1b Fishermen's Friend																																												
dMCZ NG 1c Alde Ore Estuary																																												
dMCZ NG2 Cromer Shoal Chalk Beds																																												
dMCZ NG4 Wash Approach																																												
dMCZ NG5 Lincs Belt																																												
dMCZ NG6 Silver Pit																																												
dMCZ NG7 Markham's Triangle																																												
dMCZ NG8 Holderness Inshore																																												
dMCZ NG9 Damnation Ally																																												
dMCZ NG10 Castle Ground																																												
dMCZ NG11 Boulby Zone																																												
dMCZ NG12 Compass Rose																																												
dMCZ NG13 Coquet - St Mary's																																												
dMCZ NG13a Aln Estuary																																												
dMCZ NG14 Farnes East																																												
dMCZ NG15 Rock Unique																																												
dMCZ NG16 Swallow Sand																																												
dMCZ NG17 Fulmar																																												
dRA EE1 Blue Mussel beds																																												
dRA LW 1a																																												
dRA LW 1b																																												
dRA LW2																																												
dRA LW 3a and 3b																																												
dRA LW 4																																												
dRA LW 5																																												
dRA YH 1																																												
dRA YH 2, Kirk's Own																																												
dRA NE 1																																												
dRA NE 2																																												
dRA NE 3																																												

7.7 Summary

The Dogger Bank Zone and Offshore ZDE support a number of internationally and nationally designated sites for marine nature conservation that cover a wide range of habitats and species. In addition to these, sites outside of the ZDE that support mobile species, birds and marine mammals that may be affected by the development have been noted where possible.

The Dogger Bank Zone overlaps with the Dogger Bank cSAC, a site submitted to the EC for consideration and approval to become a SCI and then SAC. The Dogger Bank cSAC is designated for its sandbank feature, and the underlying sandbank extends into German, Dutch and Danish waters. Some of these areas of the feature have been similarly designated at SCIs by the different countries, also under the Habitats Directive requirements.

A number of designated sites are located within the wider Offshore ZDE, supporting habitat and species interest features and are identified in Figure 7.1 to Figure 7.2 and Table 7.1 and Table 7.3. At a domestic level there is a process underway to identify and designate sites for species and habitats of national and regional importance in the UK as MCZs and many of these potential sites, currently in draft form, fall within the Offshore ZDE. These are shown in Figure 7.3; however they are still subject to change. Final MCZ site designation is expected in 2012 (Net Gain, 2011).

Additionally there are a number of national and local sites that lie within the intertidal zone (SSSIs, NNR, LNR and National Parks). As it is unlikely that any interaction will arise between these coastal sites and offshore development associated with the Dogger Bank Zone and future Tranches these have not been explicitly detailed here in this chapter. Relevant intertidal and coastal sites are detailed in Chapter 16 – *Onshore Zone Development Envelope* and Chapter 17 – *Creyke Beck Substation Study Area*.

Consideration has also been given to wider North Sea sites in relation to mobile species such as marine mammals and key seabird species. Figures 7.1 and Figure 7.2 show that there are a number of coastal and offshore designated sites where these species can occur.

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8. Archaeology and Cultural Heritage

8.1 Introduction

In line with the ZAP process, this chapter constitutes a high level review of the range of archaeological potential in the Offshore Zone Development Envelope (Offshore ZDE).

This review has been informed by the following best practice and guidance documents:

- Code of Practice for Seabed Developers (Joint Nautical Archaeology Policy Committee, 1998);
- Military Aircraft Crash Sites (English Heritage, 2002);
- England's coastal heritage (English Heritage, 1996);
- Department of Energy and Climate Change (2009);
- Identifying and Protecting Palaeolithic Remains (English Heritage, 1998); and
- North Sea Prehistory Research and Management Framework 2009 (Peeters *et al*., 2009).

Archaeological remains in the Offshore ZDE will comprise shipwrecks, aircraft crash sites and prehistoric archaeological sites and materials. Additionally, the Dogger Bank area has a high potential for the discovery of submerged prehistoric landscapes and associated deposits.

Archaeological sites and materials are a non-renewable receptor (i.e. one that is finite and cannot be replaced or regenerated) which may be impacted by the infrastructure and activities associated with offshore renewable energy development. However, the early assessment of the archaeology as part of the ZAP process and subsequent Environmental Impact Assessments (EIA) for the Zone will identify the archaeological issues relevant to development and, coupled with the implementation of appropriate mitigation measures, will greatly reduce risk to both the archaeological record and the development.

This chapter aims to:

- Define the nature of the archaeological potential within the Offshore ZDE by considering the prehistory and maritime and aviation histories of the wider area;
- Address the extent to which the archaeological resource within the Offshore ZDE is known and understood;
- Map known and potential archaeological sites, findspots and palaeolandscapes across the Offshore ZDE;
- Flag the limitations of current knowledge of the archaeological record in the Offshore ZDE and identify data gaps to be addressed;
- Within the constraints of the available data, assess the importance of known and potential archaeology within the Offshore ZDE; and
- Highlight areas within the Offshore ZDE to be avoided by development.

This chapter also includes a high level review of the potential for encountering unexploded ordnance (UXO) in the Offshore ZDE - primarily sea mines, torpedoes, depth charges and projectiles.

8.2 Data and Literature

This chapter is based on a high level, desk-based appraisal of a range of data sources for the Offshore ZDE. These include United Kingdom Hydrographic Office (UKHO) wreck data supplied by SeaZone, the *Aircraft Crash Sites at Sea* project report (Wessex Archaeology, 2008) and the University of Birmingham's *North Sea Palaeolandscapes Project* (NSPP) archive (Fitch *et al*., 2005; Gaffney *et al*., 2007, 2009), and some limited geophysical survey data collected by Gardline. In addition, relevant literature sources were consulted and are listed in the reference section at the end of the chapter.

UKHO wreck data and shapefiles generated from NSPP data were overlaid on the footprint of the Offshore ZDE, and the spatial distribution of sites and features represented in these datasets was used to inform this chapter.

It is important to note that because of the nature of the archaeological record (particularly the prehistoric record and pre-modern maritime record) it is unlikely that it will ever be possible to quantify the full range and extent of sites and materials within the Dogger Bank Zone and Offshore Cable Area. Archaeological sites are by definition usually buried and are often small, discrete and ephemeral, particularly when viewed at the landscape scale. Their occurrence within the maritime context of the Offshore ZDE further complicates prospecting and site identification.

However, by using available records it is possible to assess what is known and what the further potential is for archaeological remains on and below the seabed.

Furthermore, desk-based research on a Tranche specific basis, combined with archaeological assessment of geophysical and geotechnical data will enhance our knowledge of the archaeology of the Offshore ZDE as the Zonal Characterisation proceeds. This will ensure that informed decisions can be made in relation to the potential impact of the development on the archaeological record.

The UXO review drew on material from the UKHO and from a variety of published sources. It is important to note that the accuracy and comprehensiveness of wartime records is frequently difficult or impossible to verify. As a result, conclusions as to the exact location, quantity and nature of the ordnance threat can never be definitive.

8.3 Overview

This chapter characterises the historical environment of the Offshore ZDE within the wider setting of the North Sea.

In broad terms offshore archaeological sites and material can be divided into three categories, each of which is addressed individually below. These are:

- Submerged prehistoric archaeology and palaeolandscapes;
- Maritime or shipwreck archaeology; and
- Aviation or aircraft archaeology.

Evidence for submerged prehistoric archaeology and palaeolandscapes of the southern North Sea is presented, based on the local geology and the effects of glaciation and sea level change since the first known hominin occupation of the UK *c*.700,000 years ago (Parfitt *et al*., 2005).

The maritime and aviation archaeological potential of the Offshore ZDE is described, based on records of known marine casualties and the wider maritime history of the North Sea.

The potential sources of UXO include:

- Wrecks of military vessels, merchant vessels carrying munitions as cargo, and aircraft;
- Defensive or offensive minefields;
- Official and unofficial weapon ranges;
- Torpedoes and depth charges;
- Evidence of aerial bombing; and
- Official and unofficial munitions dumping sites.

8.4 Submerged Prehistory and Palaeolandscapes

Please refer the Chapter 2 for updated information from the BGS. As implied by its name the Dogger Bank is a vast raised platform or bank, consisting of Devensian pro-glacial lake deposits resting on earlier, Middle Pleistocene sediments (Flemming, 2002).

Quaternary sediments in the Offshore ZDE consist of a variable thickness of Dogger Bank Formation, overlain by Holocene and modern seabed sediments. Several layers of peat have been identified within sediments on the Dogger Bank and these have the potential to contain valuable palaeo-environmental information. Archaeological sites and material may be present in the sediments of the Offshore ZDE, either in primary, undisturbed contexts (i.e. where they were originally deposited), or in derived or secondary contexts, which imply that they have been moved, usually by natural agents like water or ice (Flemming, 2002).

The submerged prehistoric archaeological potential of the Dogger Bank is closely related to glacial activity and sea level change over time. For long periods since the first recorded hominin (i.e. a human or a human ancestor) occupation of the UK, *c*. 840,000 to 950,000 years before the present (BP) (Parfitt *et al.,* 2010), much of the southern North Sea, including the Offshore ZDE, would have been dry land and open to occupation and exploitation by hominins. Until the end of the Mesolithic (*c.* 4,500 years BP) the area covered by the Offshore ZDE was subject to geological processes ranging from Pleistocene glaciations and associated sub aerial erosion to repeated marine transgressions and regressions. Most recently, post-Devensian glaciation sea level rise led to the area's latest submergence. An archaeological and geological chronology for the UK is presented in Table 8.1

These processes dictated the potential for prehistoric hominin activity in the Offshore ZDE and have influenced the preservation of the archaeological evidence of this activity.

The seabed of the southern North Sea basin remains one of the most intriguing palaeolandscapes in northwest Europe and it is believed that instead of merely serving as a land bridge between the UK and mainland Europe, the area would also have been inhabited at various stages by hominin settlers, most recently during the Mesolithic.

Although archaeological artefactual evidence recovered in the area is currently limited, the Dogger Bank Zone and parts of the Offshore Cable Area lie within the so-called 'Doggerland' region of the southern North Sea (Coles, 1998). This region is an internationally recognised submerged prehistoric landscape which is believed to have been the heartland of an early Mesolithic culture in north-western Europe (Clark, 1936; Wymer, 1991).

The periods when there is greatest potential for hominin occupation of the area can be summarised as follows:

- Lower Palaeolithic hominin occupation during the Cromerian period (*c*. at least 840,000 to 478,000 years BP);
- Lower Palaeolithic hominin occupation during the Wolstonian period (*c*. 350,000 to 170,000 years BP);
- Middle and Upper Palaeolithic modern human occupation during the Devensian (*c*. 40,000 BP and 24,000 years BP); and
- Late Upper Palaeolithic and Mesolithic modern human occupation during the Devensian late-glacial and early Holocene (*c*. 13,000 BP and 5,500 years BP).

Each is now discussed in turn.

8.4.1 The Cromerian Period and Anglian Glaciation

The earliest current evidence for a hominin presence in the UK dates to *c.* 840,000 to 950,000 years BP during the Cromerian interglacial and comes from a site at Happisburgh in Norfolk (Parfitt *et al.,* 2010). Other evidence from around this time has been found at Pakefield in Suffolk (Parfitt *et al.,* 2005), Boxgrove in Suffolk and at Waverley Wood (Keen *et al*., 2006; Stringer, 2006). It has been announced in the press that the recent find of stone tools at Happisburgh suggests that the earliest date for a hominin occupation of the UK will need to be revised backwards to *c.*840,000 to 950,000 years BP (Sample, 2010). Together these finds suggest that a hominin presence in the Offshore ZDE was possible during the Cromerian.

The Offshore ZDE was subsequently affected by the major ice incursion associated with the Anglian glaciation (*c*. 478,000 to 424,000 years BP) during which a hominin presence is highly unlikely. Resultant high levels of erosion and sediment reworking mean that any archaeological remains in the Offshore ZDE from this period are likely to be in secondary contexts, but this material can still be of great value, as demonstrated by the artefacts associated with glaciotectonised sediments at High Lodge in Suffolk (Ashton and Lewis, 2002).

8.4.2 The Hoxnian and Ipswichian Interglacials and the post-Anglian/pre-Devensian Glaciation

During the Hoxnian interglacial (*c.* 424,000 to 374,000 years BP) the climate was warm and there is concrete archaeological evidence, such as the Swanscombe Skull (Stringer, 2006), for hominin occupation of the present UK mainland. There is thus also the potential for hominin occupation in the Offshore ZDE during those periods of the Hoxnian when the area was exposed above sea level. As already observed, in relation to Cromerian period archaeological material, some archaeologically significant material from the Hoxnian can be expected in derived or secondary contexts, as a result of subsequent glacial erosion and sediment reworking. If primary context sites and occupation surfaces are found within buried sediments in the Offshore ZDE this material will be highly significant and of high archaeological importance.

The period following the Hoxnian, which from terrestrial river terrace signatures includes evidence of major, multiple glaciations between *c.* 330,000 and 135,000 years BP (Sumbler, 1995; Gibbard *et al*., 1992, 2009; White *et al*., 2010) has varying archaeological potential. During the cold, glacial periods the Offshore ZDE would have been covered by ice and a hominin presence is unlikely.

However, sites such as those at Purfleet (dated to *c.* 350,000 years BP) (Schreve *et al*., 2002) and Stanton Harcourt (dated to between *c*. 170,000 and 180,000 years BP) (Buckingham *et al.*, 1996) show evidence of a hominin presence and activity during the intervening, warm periods of the interglacial. In the case of these intervening interglacials, the nature and pattern of glaciation will have affected whether and to what extent archaeological material can be expected to be preserved in either a primary or secondary context.

Current evidence suggests that hominins were largely absent from the UK from the end of the Purfleet to the end of the Ipswichian interglacial, even though climatic conditions during the Ipswichian (*c.* 135,000 to 73,000 years BP) appear to have been suitable for occupation (Wymer, 1999; Stringer, 2006). The reasons for this absence are unclear, but may be linked to the breaching of the land bridge with Europe and the formation of the Dover Straits (Ashton and Lewis, 2002). On the basis of current knowledge, therefore, the potential for recovering archaeological material in the Offshore ZDE from this period is regarded as low.

8.4.3 The Devensian Glaciation

During the last (Devensian) glaciation (*c*. 110,000 to 13,000 years BP) much of the Offshore Cable Area was covered by ice. It has been argued, however, that much of what comprises the Dogger Bank Zone may have been ice free and located in a postulated gap between Devensian (British) and Weichselian (Scandinavian) ice sheets (Coles, 1998). Sea level was as much as 120 m lower than today and, where not covered by ice, the Offshore ZDE would have been exposed, terrestrial landscapes. Despite this, the harsh periglacial conditions likely in the Offshore ZDE through this period probably discouraged a human presence.

Modern human habitation of the Offshore ZDE probably remained limited until *c*. 13,000 to 11,000 years BP when the climate had ameliorated sufficiently, although there is evidence of at least some level of human presence in the UK between *c*. 40,000 and 24,000 years BP. At sites like Lynford in East Anglia, for example, *in situ* artefacts in association with large vertebrate remains are evidence for human butchery activities (Boismier, 2003). More generally, however, much of the archaeological evidence for this period is ephemeral

Table 8.1: Archaeological and Geological Chronology.

Age in years BP	British Stages	Climate	Archaeological Period	Relative Sea Level
Present day	Holocene	Warm		0m
c. 7,500 BP			Mesolithic	-5m
				-10m
				-15m
				-20m
				-25m
c. 9,500 BP			Early Mesolithic	-30m
c. 10,000 BP	Younger Dryas (Loch Lomond Stadial)	Cold		-35m
			Upper Palaeolithic	-40m
				-50m
				-60m
c. 11,000 BP	Windemere Interstadial	Warm		
c. 13,000 BP	Dimlington Stadial	Cold		
c. 16,000 BP	Devensian	Mainly cold		-120m
c. 18,000 BP				
c. 25,000 BP				-50m
c. 50,000 BP			Middle Palaeolithic	
c. 70,000 BP				
c. 110,000 BP	Ipswichian	Warm		+5m
c. 130,000 BP	Wolstonian	Cold		Low?
c. 186,000 BP		Warm		High?
c. 245,000 BP		Cold	Lower Palaeolithic	Low?
c. 303,000 BP		Warm		High?
c. 339,000 BP		Cold		
c. 380,000 BP	Hoxnian	Warm		High?
c. 423,000 BP	Anglian	Cold		-120m+?
c. 478,000 BP	Cromerian Complex	Warm		Varying
c. 500,000 BP				
c. 860,000 BP				

or by association. For example, a mammoth tusk dating to *c*.44,000 years BP recovered from glacial tills in aggregate extraction licence area 408 off the Humber (Dellino-Musgrave *et al*., 2009) suggests that these mammals were present in the North Sea basin at this time, and as a prey item for modern humans, can be used as a proxy to suggest that humans were also present in the landscape. In general, however, the likelihood for the presence of archaeological material dating to the period *c*. 35,000 to 18,000 years BP in the Offshore ZDE is low.

8.4.4 The Late-glacial and Holocene

Environmental changes in the Offshore ZDE between the Devensian glacial maximum (*c.* 18,000 years BP) and the Holocene marine transgression (*c*. 6,000 years BP) are much better understood than those during the periods described above. Sea level curves generated by Shennan (2000, 2002) indicate that most of the Offshore ZDE was emergent from the beginning of the glacial retreat at *c.* 16,000 BP (Late Upper Palaeolithic) to around 7,000 years BP (Late Mesolithic). Until about 13,000 years BP, however, large areas of the Offshore ZDE were probably still under the influence of the glacial ice sheets, with concomitant limits on the potential for human occupation of the region.

At the start of the Mesolithic (*c*.10,000 years BP) the sea level in the North Sea was still approximately 65 m below its present level and substantial areas of the current seabed, including the Offshore ZDE would still have been terrestrial. Continued rises in sea level resulted in the inundation of the entire North Sea basin by *c*. 7,000 years BP (Coles, 1998). The effects of Holocene sea level rise would have first been felt in the Offshore Cable Area after *c*. 8,000 years BP. The inundation of the palaeo-Ouse River valley, the Inner Silver Pit off Lincolnshire, and the Outer Silver Pit Lake south of the Dogger Bank meant that much of the Offshore Cable Area was subject to marine transgression well before the Dogger Bank itself. Reconstructions based on the present-day bathymetry of the North Sea indicate that the Dogger Bank would have been one of the last areas to be inundated, and was for some substantial period part of a peninsula extending into the North Sea from north Norfolk, before becoming a large island *c*. 7,500 years BP (Coles, 1998; Van de Noort, 2011).

Evidence from peat deposits and pollen samples suggests that following the retreat of the Devensian ice sheet the Offshore ZDE would have been a rich environment, bisected by large rivers systems, including the Ouse and the Elbe and was an environment attractive to modern humans (Coles, 1998). A large inland lake is thought to have occupied the Outer Silver Pit Lake, just to the south of the Dogger Bank (Coles, 1998), portions of which lie within the Offshore Cable Area. In the period between the retreat of the ice and the mid-Holocene marine transgression, the lake shores and adjacent hills, palaeo-river valleys and plains would have been abundant in plant and animal life, and provided a rich diet for human groups. Evidence of fauna in the area during the late Devensian suggests populations of mammoth, red deer, elk, horse, fox, beaver and wolf (Coles, 1998).

The Offshore ZDE is unlikely to have been occupied by modern humans until around 13,000 years BP, with early indications of human occupation elsewhere in the UK during the Late-glacial found at Creswell Crags in Nottinghamshire and dated to *c.* 12,300 years BP (Smith, 1992; Mithen, 2003). The emergence of the land bridge to Europe, represented by the North Sea basin palaeolandscape, during the early Holocene is highly significant, since re-colonisation of the UK would have been via this emergent landscape, often referred to as 'Doggerland' (Coles, 1998), of which the Offshore ZDE is a part. The archaeological evidence suggests that modern human groups tracked the retreating ice from as early as the 12th millennium BC following these animals, which they had hunted during the preceding millennia (Van de Noort, 2011).

Our understanding of the morphology of this landscape has recently been greatly increased through the work of the North Sea Palaeolandscape Project (NSPP) (Fitch *et al*., 2005; Gaffney *et al*., 2007, 2009) and the Humber Regional Environmental Characterisation (REC) project (Ben Gearey, pers. comm.), which both overlap with the Offshore ZDE (Figure 8.1). For more information about REC see http://www.alsf-mepf.org.uk/projects/rec-projects.aspx.

The archaeological potential of this landscape is hinted at in the many hundreds of submerged Upper Palaeolithic and Mesolithic sites that have been found amongst the islands of the Danish archipelago (see Andersen, 1980; Pedersen *et al*., 1997; Van de Noort, 2011). The extraordinary complexity and the density of particularly the Mesolithic sites in Denmark suggests that other parts of the North Sea coast, including the area immediately south of the Dogger Bank, would have had similar human occupation at the same date (Flemming, 2002).

Using 2D and 3D seismic data gathered by the oil and gas industry, the NSPP has identified a number of landscape features of possible archaeological interest within the Offshore ZDE, including several major palaeochannel systems, which trend from southwest – northeast across the Offshore ZDE and apparently originate from Holderness and the Lincolnshire Marsh (Fitch *et al*., 2005; Gaffney *et al*., 2007, 2009). The southern eastern portion of the Offshore ZDE overlaps with the Outer Silver Pit, which probably formed a lake during this period (Gaffney *et al*., 2007). The landscape of the Offshore ZDE at this time also comprised low-lying plains, bisected in places by deep glacial tunnel valleys.

During the Late Upper Palaeolithic and Early Mesolithic the landscape within the Offshore ZDE would have been relatively dry, with deciduous woodland expanding with the climatic amelioration of the Holocene. However, the accelerating rate of sea level rise would have seen the gradual inundation of the southern and western portions of the Dogger Bank Zone and much of the centre of the Offshore Cable Area through the Mesolithic. By the start of the Neolithic (*c*. 5,500 years BP) the entire Offshore ZDE would probably have been inundated.

Archaeological evidence from the Dogger Bank and southern North Sea is limited and much of the existing body of archaeological material has been recovered as a result of trawler fishing. Although the archaeological context of much of the material is thus not clear, the finds themselves point to an irrefutable prehistoric human presence on and around the Dogger Bank, and in the southern North Sea in general during the Late-glacial period and Holocene. Worked bone and antler has been recovered south of the Dogger Bank, in the Brown Bank region, and a barbed antler point found in peat deposits trawled up by fishermen on the Leman and Ower Banks in the 1930s has been dated to *c*.11,000 years BP (Fischer, 1995). This point is thought to relate to the Maglemosan culture, which is thought to post-date the Mesolithic culture identified at Star Carr on the Yorkshire coast (Coles, 1998). Coles (1999, quoting pers. comm. with Andersen) reports the recovery of a bone artefact from Dogger Bank with a calibrated (i.e. adjusted to calendar years) radiocarbon data of *c*. 6,050 years BC (*c*.8,050 years BP).

Analysis of borehole deposits recovered from palaeochannel features to the south of the Dogger Bank Zone, within the Offshore Cable Area, has recently been undertaken as part of the Humber REC Project. This work has demonstrated that *in situ* organic deposits dating to the early Holocene survive in the Offshore Cable Area (Ben Gearey, pers. comm.). Such deposits are highly significant as they preserve valuable palaeoenvironmental information relating to the processes of environmental change during this period. In addition, the possibility exists that archaeological material might be preserved within these sediments.

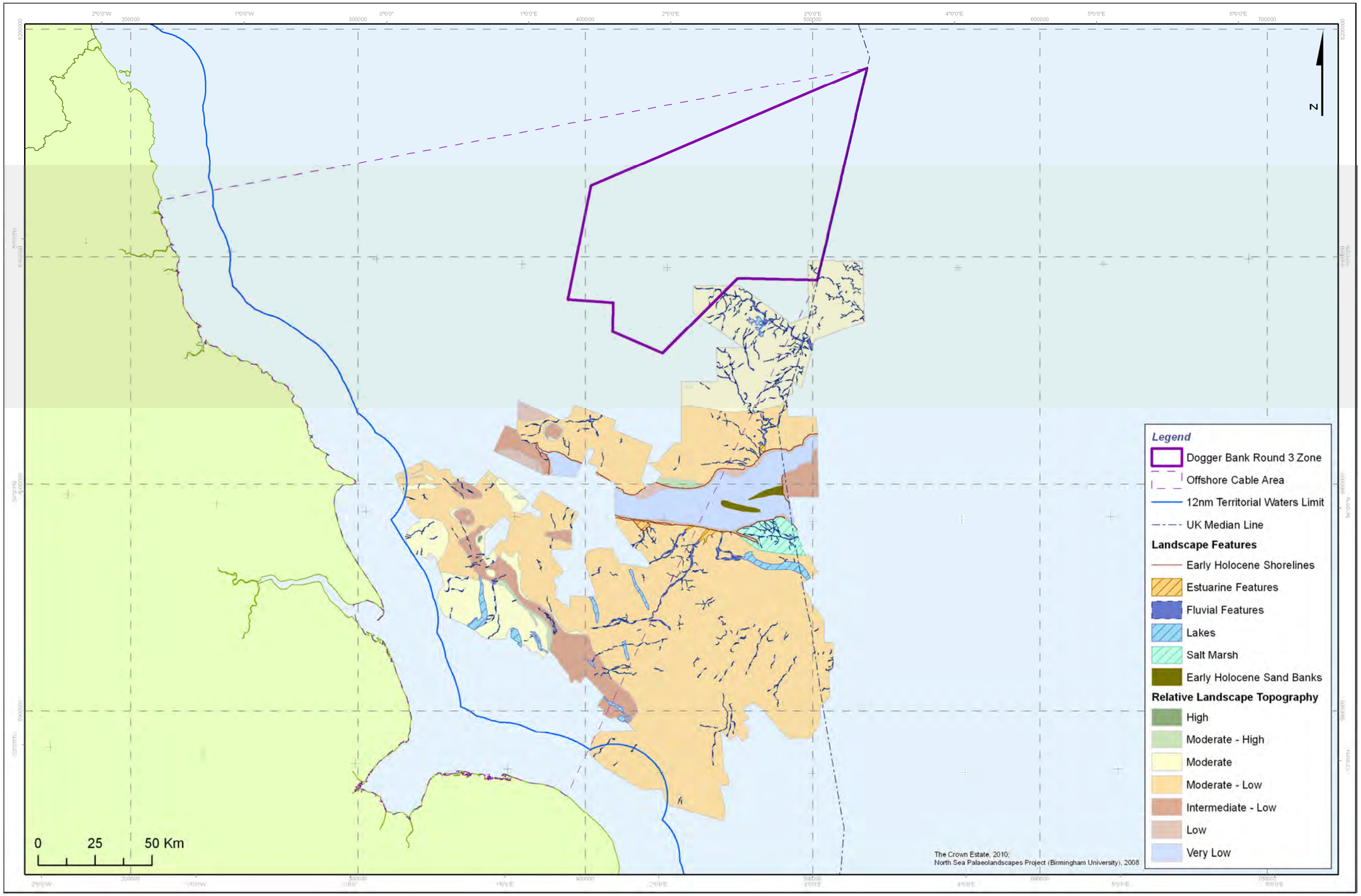


Figure 8.1: North Sea Palaeolandscape Project overlap with the Offshore ZDE.

Mesolithic finds from present day coastal sites within the Onshore Zone Development Envelope, such as Titchwell in Norfolk and Star Carr in East Yorkshire, support the theory that Mesolithic populations exploited and occupied the Dogger Bank – i.e. that hunter-gatherer populations settled and adapted to its shifting coastline and changing environment prior to its final marine inundation.

There is a high potential for Mesolithic sites and a wide range of associated archaeological material to survive within the Holocene sediments of the Offshore ZDE. The likelihood of finding such material during offshore renewable energy development activities depends on a variety of factors, including sediment thickness, exposure and wave action (especially in shallow hollows) and the interaction of development activities with these sites or material. Submerged prehistoric sites found within the Offshore ZDE are likely to be of international importance.

The palaeochannels referred to above drain into the Outer Silver Pit, the major part of which is to the south of the Dogger Bank Zone. NSPP mapping and BGS data for this area suggest that scouring within this feature occurred during the transgression and thus deposits from this period may not survive *in situ*. However Flemming (2002) observes that the flanks of the Silver Pit may contain valley structures where archaeological material may be preserved.

8.4.5 Palaeontology and Palaeo-Botany

Although not strictly speaking archaeological, there have been numerous recoveries from the North Sea, particularly in the nets of fishing trawlers, of palaeontological and palaeo-botanical materials (Stringer, 2006; Peeters *et al*., 2009).

The palaeontological material comprises both Late Pleistocene cold 'mammoth-steppe' species assemblages and warm climate Pleistocene and Holocene species. Although these remains lack a stratigraphic context because of their manner of recovery, this material is nevertheless important to archaeology for the information it does provide regarding landscape, climate and environment, and what that suggests with regard to possible hominin and human activities within the North Sea, including the Offshore ZDE, at different times in the past.

Palaeo-botanical information – which comes from both the analysis of seabed sediment for pollens, and from plant macrofossils like tree stumps recovered by fishermen can also make an important contribution to the understanding of former landscapes in the North Sea and the Offshore ZDE, and their potential occupation and use by hominins and humans in the past (Peeters *et al*., 2009).

Evidence from inter-tidal areas around the UK such as Ynyslas in Wales, the Solent, Hartlepool and Cheshire (Gaffney *et al*. 2009) and from offshore contexts such as Bouldnor Cliff off the Isle of Wight (Momber, 2000) suggests the large-scale and widespread occurrence of submerged forest beds should be expected offshore. For the North Sea this is borne out by the recoveries of tree stumps referred to already, and in the Offshore ZDE by seismic data cited by Peeters *et al*. (2009) which describes the inferred presence of a drowned forest in an infilled river valley on the eastern end of the Dogger Bank.

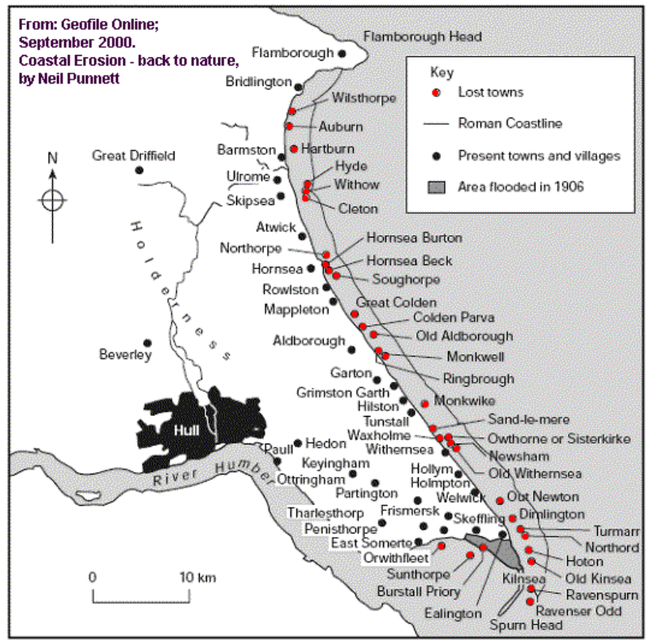


Figure 8.2: The Holderness coast, showing its retreat since Roman times (Source Punnett, N, 2000, Coastal Erosion: Back to Nature, Geofile Online September 2000).

8.4.6 Marine Transgression and Coastal Erosion

In addition to the potential for paleaolithic and mesolithic material, a more recently submerged terrestrial archaeological resource (less than 4,500 years BP) may exist near to the coast in the Offshore Cable Area, in the form of Bronze Age, Iron Age, Roman, Medieval or modern material. The remains of coastal villages recorded as being lost to the sea since the Roman period as a result of the retreat of the Holderness coast are likely to lie within four miles of the present coast, and if they exist may be a consideration when planning cable routes and landfalls (Figure 8.2).

8.4.7 Summary of Submerged Prehistory and Palaeolandscapes

To summarise, there is thus a variable potential for the preservation of submerged prehistoric archaeological sites and materials within the Offshore ZDE, which can be summarised as follows:

- A low probability of archaeological material dating to the Lower-Middle-Upper Palaeolithic surviving in situ. Where any such material does survive, however, it will be of high importance;
- The potential for the survival of a long sediment sequence within the Zone, which can provide deep time palaeoenvironmental and climatic information;
- The potential for the survival in the Offshore ZDE of palaeontological and palaeo-botanical fossils which can inform archaeological interpretations of prehistoric landscape use and early human activities; and
- Evidence that in situ deposits dating to the Late Upper Palaeolithic and Mesolithic do survive in the Offshore ZDE. Relatively detailed information regarding the location and character of landscape forms in the pre-inundation landscape is available for some areas and this may assist in identifying locations of higher and lower potential within the Offshore ZDE.

There is also the potential within the Offshore Cable Area for the submerged remains of coastal villages lost to the sea since the Roman period. The significance of such sites will depend on the nature of their loss and the extent of their preservation.

8.5 Maritime Archaeology

The Dogger Bank Zone lies approximately 125 km off the east coast of England and there are few navigational hazards in the area to act as a focus for vessel loss and shipwreck. However, the Bank itself represents a hazard to shipping because of its shallowness (only 10 -15 m in places) compared with other parts of the North Sea. The shoaling effect of a seabed bank such as Dogger Bank can affect local wave height and currents, causing dangerous sea conditions and thus increase the potential for vessel loss in the area (Merritt *et al*., 2007). Shipping losses in the Offshore ZDE can also be attributed to weather conditions, accident and collision and wartime activity.

Estimates of the number of maritime casualties around the UK coast vary substantially, but 'best guesses' put the number between 100,000 and 500,000, suggesting the potential for an average of between 8 and 40 wrecks for every mile of coastline. Based on these figures it is possible that between 2,000 and 10,000 wrecks may lie off the roughly 250-mile stretch of coast that falls within the boundaries of the Offshore Cable Area.

Based on the evidence of known shipping activities, the majority of these wrecks are likely to be located close to the coast with fewer, in relative terms within the Dogger Bank Zone itself. Nevertheless, numerous wrecks and boat and ship remains can be expected in and on the seabed of the Dogger Bank.

Boat remains and shipwrecks within the Offshore ZDE have the potential to represent sites from the late Mesolithic (*c*. 8,000 years BP), when the area was undergoing marine transgression, right up to the present. These wrecks will reflect the commercial use (trade and fisheries) and naval importance of the North Sea within the context of northwestern Europe, particularly since the early medieval period.

Since the mid-Holocene marine transgression human activity in the Offshore ZDE has been maritime in nature. Mesolithic watercraft – dugouts or logboats, log rafts and possibly hide-covered boats – which represent possibly the earliest maritime craft used in the UK, can be expected to have been in use in and around the Offshore ZDE. There is evidence that these craft were used on inland waters (Ellmers, 1996; McGrail, 1987, 2004) but they were probably also capable of coastal journeys, fishing expeditions and possibly longer journeys in favourable weather. It is possible that such craft were in use by the Mesolithic populations occupying the Dogger Bank and its surrounds, prior to its final inundation at the end of the Mesolithic.

Evidence from the NSPP suggests that during the Holocene the Offshore ZDE contained a network of fluvial systems, and a number of major lakes, such as the Outer Silver Pit Lake (Gaffney *et al*., 2007, 2009). It is likely that these water bodies represented an important resource to Mesolithic human populations and that the type of watercraft referred to above were in use in and on them. As sea level rose during the late Mesolithic and the north and south marine incursions turned Britain into an island, the North Sea basin became a fragmentary terrestrial environment containing a series of small and large islands. These included the so-called Dogger Island within the area of the Offshore ZDE, and it is conceivable that watercraft became increasingly important, not only to exploit resources but also as a means of maintaining contact between human groups occupying these islands, separated by growing bodies of water (Van de Noort, 2011).

Although hide-covered boats may not survive in the archaeological record, there is documented evidence for the more robust logboats to survive in sealed archaeological contexts (McGrail, 1987, 2004). Such remains, if found in the Offshore ZDE, would be of international importance.

By the start of the Bronze Age (*c*.4,400 BP) sea level had reached roughly its current stand and the watercraft described above are unlikely to have ventured as far as the Dogger Bank, although they may have been active within the Offshore Cable Area, close to the coast.

Archaeological evidence from around the UK suggests that sea-going craft were being built during the Bronze Age and that there was trade between the UK and continental Europe, across the North Sea, in cargoes of prestige goods like Scandinavian amber. The remains of a sewn-plank vessel from this period have been found at North Ferriby on the Humber, within the Offshore Cable Area (McGrail, 1996; Cunliffe, 2001; Van de Noort, 2003), and what appear to be the remains of Bronze Age cargos have been found at Dover, and at Salcombe in Devon (Wright and Wright 1947; Clarke, 2004). These finds suggest increasing sea-borne trade across the North Sea and the transport of larger cargoes from the Bronze Age onwards. From this time on, it is likely that the North Sea was more of a thoroughfare than an obstacle, and should be viewed as a 'maritime space' akin to an area of land, with a range of resources, hazards, currents, tides and winds which would have influenced its use (Carver, 1990).

Extensive maritime activities in the North Sea during the Iron Age (2,700 years BP - AD 43) and during the Roman occupation of Britain (AD 43 - 410) are well documented, with evidence of regular trade in goods from Europe (see Du Plat Taylor and Cleere, 1978), and the development of ports and trading centres, such as that at Hengistbury Head in Dorset (Cunliffe, 1990). In the UK this period saw the development of the so-called 'Romano-Celtic' boat type, and the evidence suggests that these were substantial, sea-going vessels used to transport a range of cargoes across a wide area (Marsden, 1994). Direct evidence within the Dogger Bank Zone for seafaring during this period is available in the form of a Spanish 'Dressel 20' amphora dredged up by a fisherman on the Dogger Bank and dated to the 1st to 2nd century AD, which is likely to have been part of the cargo carried by such an Iron Age vessel (Wessex Archaeology, 2004).

During the Saxon (AD 410 - 1066) and early medieval (11 - 12th centuries) periods maritime activity within the Offshore ZDE increased. This was due in part to Saxon and Viking raiding, but was also the result of the intensification of trade and migration networks between northwestern Europe and the UK and the growth of a number of major ports on the east coast of Britain (Hutchinson, 1997; Friel, 2003).

Although trade was relatively low volume the networks in which these ports participated were extensive. Wool was exported to Antwerp, cloth from Boston to Scandinavia, and Newcastle coal was widely traded. Imports included wine from France, with Hull, on the edge of the Offshore Cable Area becoming a major player in this trade, and a strong trade with the Baltic in naval stores such as timber and tar. Hull also dominated the trade routes heading north to Iceland (Hutchinson, 1997).

Maritime activity expanded dramatically in the UK and Continental Europe during the post-medieval period (1500-1800) with the opening up of trade with the East and the New World. Vessel movements between the UK and Europe, across the North Sea, increased substantially and consequently the potential for shipping

losses in the Offshore ZDE also increased through this period (see Young, 2003, 2004).

20th Century wrecks in the North Sea will include iron and steel hulled naval vessels from World War I and World War II. Vessels are known to have been lost in the Offshore ZDE during these wars, notably during the Battle of Dogger Bank in 1915 and the second Battle of Dogger Bank in 1916 (Bennett, 1968; Halpern, 1995).

Historically the Dogger Bank has also been an important fishing ground and has been intensively exploited since at least the early medieval period (Friel, 2003). Fishing related remains on the seabed, including discarded fishing gear, need to be considered as a part of the maritime archaeological record of the Dogger Bank Zone. Such material, which might be viewed as unimportant elsewhere, may have an increased archaeological value due to its association with the Dogger Bank and North Sea fisheries.

8.5.1 Dogger Bank Zone

There are 32 known wrecks listed in the UKHO Wreck Index for the Dogger Bank Zone (see Figure 8.3) and distributed more or less evenly across the Zone. Thirteen are named and, with one exception, all date to the 20th century. The exception is the wreck of the *William and John*, recorded as lost in 1648. For a variety of reasons wreck sites which pre-date 1850 are generally considered to be of historical and archaeological importance, although there is no specific guidance available as to which vessel types, classes or periods are particularly rare or of particular importance. Furthermore, a post-1850 date for a wreck does not preclude it being considered archaeologically important. Broadly, current practice is to investigate the significance of sites on an individual basis.

U66, a German U-boat, was sunk in the Dogger Bank Zone by gunfire from a British destroyer on 2nd October 1917. This wreck is eligible for protection under the terms of the Protection of Military Remains Act (1986). A further wreck of interest in the Dogger Bank Zone is the British steamship *Membland* which was mined and sunk in the southeast corner of the Zone in 1915. The majority (nine) of the other named wrecks in the Dogger Bank Zone are fishing vessels of a variety of types and are evidence of the historical importance of the Dogger Bank as a fishing ground, as discussed above. Nineteen wrecks, for which there is currently no positive identification, have been recorded in the Dogger Bank Zone by the UKHO.

The over-representation in the UKHO records of more modern wrecks is a factor of their iron and steel construction which lends itself to greater visibility in geophysical and other surveys. The preponderance of these sites in the record of known wrecks in the Dogger Bank Zone probably masks the presence of earlier, wooden shipwrecks, such as the *William and John*, which are of potentially great archaeological interest but lower physical profile.

In addition to the UKHO wreck data, Gardline Geosurvey has identified six possible shipwrecks in sidescan sonar data they have collected within the boundary of the Dogger Bank Zone (Gardline Geosurvey, 2010). Two of these wrecks are associated with charted, UKHO wrecks. The first, named W40003 by Gardline, may represent the remains of a small, unnamed steam trawler (UKHO 65545), whilst the other (W40006) may be associated with either the *Wouter* (UKHO 31221) a motor fishing vessel lost in 1971, or an unnamed wreck (UKHO 59595), although it lies roughly 1 km southeast of these two charted wrecks.

The remaining four wrecks located by Gardline are not charted by the UKHO but from the available data appear to be large iron or steel wrecks.

In addition to the known wrecks, the UKHO Wreck Index also lists 100 obstructions, most of which are fisherman's fasteners (see Figure 8.4). These are locations where the fishing community has reported their nets or gear being snagged by unidentified objects on the seabed. These fasteners may be geological (for example, rock outcrops or reefs); palaeobotanical (i.e. ancient tree stumps or forest beds) or they may be anthropogenic and indicate the presence on the seabed of a wreck or other debris derived from human activities. There is a clear spatial element to the distribution of the obstructions, with a cluster in the far northeastern corner and a second, larger cluster in the northwestern corner of the Dogger Bank Zone. These obstructions suggest either that these areas are those generally fished within the Dogger Bank Zone, or that there is a greater prevalence of seabed material in these areas.

8.5.2 Offshore Cable Area

There are more than 2,100 known wrecks listed in the UKHO Wreck Index for the Offshore Cable Area (see Figure 8.3). The majority of these are located within 25 miles of the coast with distinct clusters in the vicinity of ports such as Newcastle-upon-Tyne, Bridlington, Middlesborough and Hull. The concentration of UKHO records in near shore, coastal waters may be a reflection of a) the fact that historically, the bulk of maritime activity has been concentrated close inshore and there was thus a higher incidence of wrecks in this area; b) that this is where most navigational hazards to shipping are to be found; and/or c) the more intensive UKHO surveys of near shore waters for dangerous wrecks. There is also a distinct cluster of wrecks just to the south-west of the Dogger Bank Zone (Figure 8.3), and although most of these sites are unidentified, this clustering may reflect losses in an area of intensive fishing activity in the past.

Once a cable route corridor from the Dogger Bank Zone has been proposed the known wrecks within it will be assessed in more depth for their archaeological importance. In the interim, however, it is worth highlighting that within the Offshore Cable Area there are UKHO records for more than 60 Royal Naval losses, the majority of which date to World War I. Although the second Battle of Dogger Bank on 10th February 1916, between the British 15th Mine-Sweeping Flotilla and the three German torpedo boat flotillas (Halpern, 1995), probably took place within the Offshore Cable Area , the single casualty of that engagement (HMS Arabis) is not among the UKHO wreck records. The bulk of the naval vessels listed by the UKHO – more than 40 – are, interestingly, converted trawlers and fishing vessels used in coastal patrolling activities. In addition, there are records of three British submarines and 12 German u-boats in the Offshore Cable Area, most of which were lost during World War I. Any of these sites are eligible for protection under the terms of the Protection of Wreck Act (1986).

It must be noted that there are also two sites within the Offshore Cable Area protected in terms of the Protection of Wrecks Act (1973). These are, the *Bonhomme Richard* (1779) in Filey Bay, North Yorkshire, and an 18th or 19th century collier brig at Seaton Carew, north of Hartlepool on Teesside.

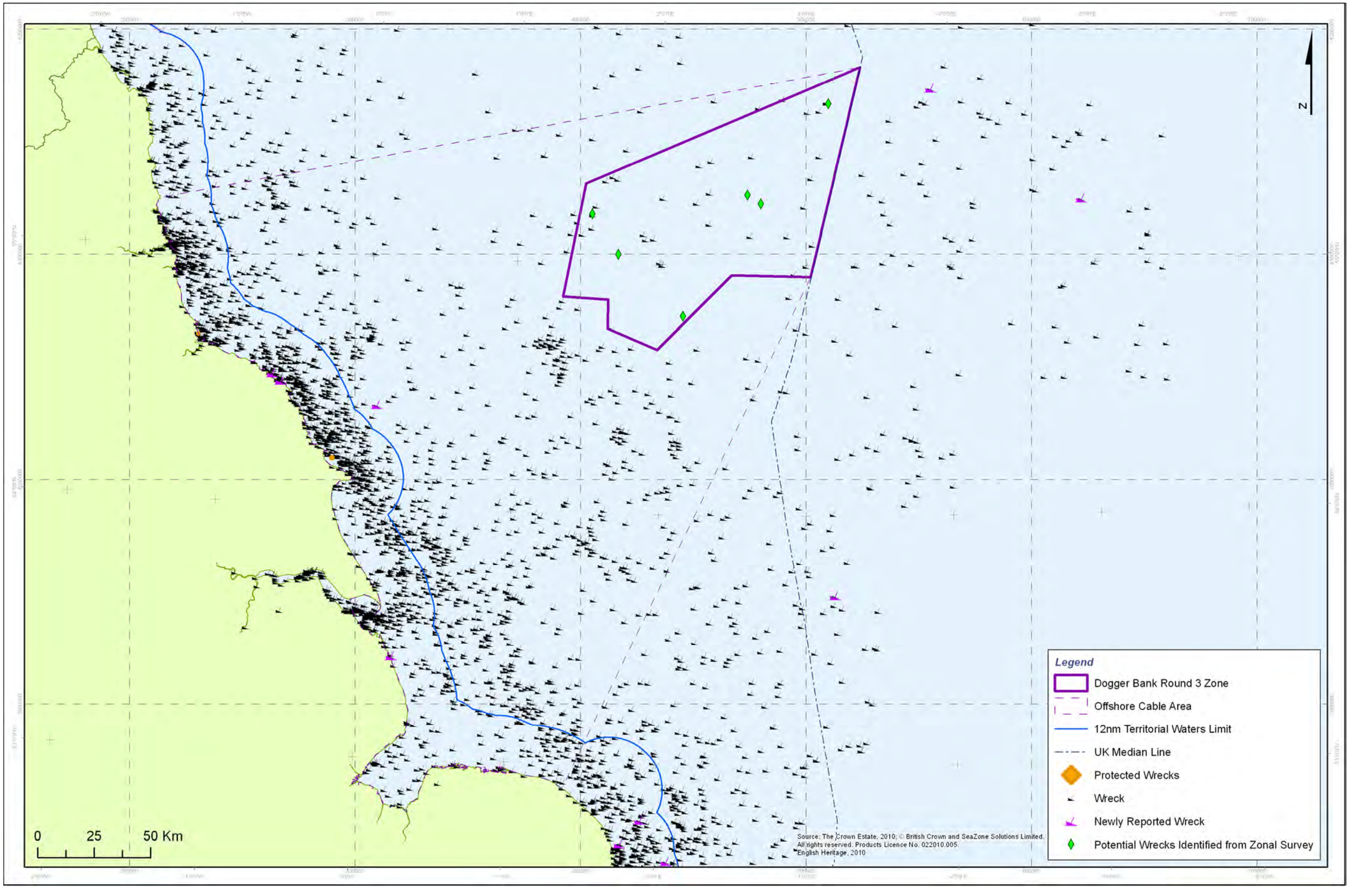


Figure 8.3: UKHO known wrecks and protected wrecks within the Offshore ZDE.

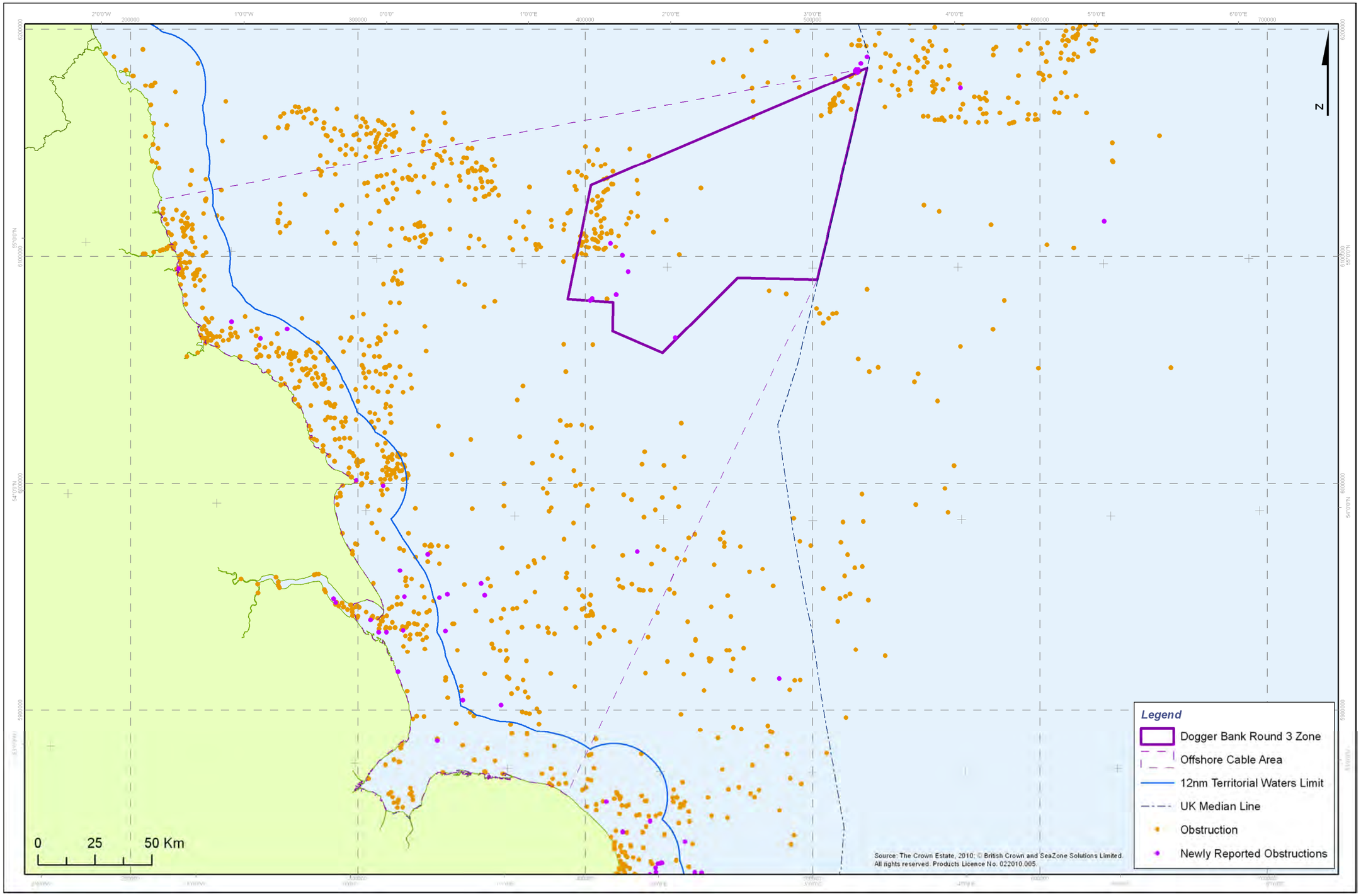


Figure 8.4: UKHO seabed obstructions within the Offshore ZDE.

There are more than 800 seabed obstructions listed in the UKHO data within the Offshore Cable Area (see Figure 8.4). Most are fisherman's fasteners and their exact nature is unknown. However, the records indicate that some are thought to be wrecks whilst others are, for example, piles, navigational light supports or oil and gas wellheads.

8.5.3 Summary of Maritime Archaeology

In summary there is the potential for the remains of boats, ships and other maritime archaeological material in the Offshore ZDE for all periods since *c*. 8,000 BP, although this is not reflected in the known shipwreck record of the Zone which is heavily biased towards wrecks from the last 150 years.

The importance of maritime archaeological sites, examples of which have the potential to be found in the Offshore ZDE, can be broadly summarised as follows:

- Pre-medieval period (*c*.8,000 BP to AD 1508): Very little is known about the watercraft and ships of this long time span and any remains from this period are likely to be of special archaeological interest if discovered within the Offshore ZDE;
- Post-medieval period (1509 to1815): Wrecks dating to this period which encompasses the Tudor and Stuart periods, the English Civil War, the Anglo-Dutch Wars during which the Battle of Dogger Bank took place in August 1781, and the American War of Independence and the French Revolutionary Wars would be of particular interest if found; and
- Modern (mid-19th and 20th centuries): Wrecks of this period are more common in the archaeological record, but continue to contribute to our understanding of the major changes in maritime technology precipitated by the Industrial Revolution. Discrimination may be required in determining the historical and archaeological importance of each vessel, if discovered.

Special social and historical significance is likely to be attached to the wrecks of the naval vessels highlighted above, and care will be needed when dealing with them.

8.6 Aviation Archaeology

Thousands of military and civilian aircraft have been lost in UK waters since the advent of powered human flight in the early 20th century. The bulk of these losses occurred during World War II, but aircraft losses at sea span the entire period of aviation history.

Although records of aircraft losses at sea are extensive, they are seldom tied to accurate positions. Aircraft remains on the seabed are also often ephemeral and not easily discernable in geophysical surveys.

Recently, an increasing number of aircraft wrecks have been discovered during aggregate dredging operations and survey work associated with offshore renewable energy development around the UK (Wessex Archaeology, 2008), and it is now clear that these remains not only survive on the seabed, but are widespread.

National policy guidance, such as English Heritage's *Military Aircraft Crash Sites* (English Heritage, 2002) recognises this 20th century wartime heritage and makes the case for the importance of aircraft crash sites, specifically with regard to existing and planned development proposals which may have an impact on such sites.

Although there was military aviation activity by both Germany and the UK over the North Sea during World War I, there is no evidence that these activities resulted in losses of aircraft within the Offshore ZDE (Layman, 1996).

The likelihood of aircraft losses having occurred in the Zone during World War II, however, is high when its location is considered against known patterns of aircraft activity. The North Sea saw significant levels of aircraft traffic from 1940 onwards, which fall into two broad categories:

- Offensive German operations associated with bombing raids targeting the British Midlands and the north of England, and the associated British fighter response; and
- RAF, and later American, bombing operations against Germany from bases in the east of England which were routed over the North Sea to the Dutch coast where the topography meant that aircraft defences were less dense (Lyall, 1971).

Losses on all sides were the result of bombers crashing into the sea as a result of damage suffered over England or the Continent, aircraft of both sides shot down in aerial combat, and accidents. Many of these losses would have occurred well offshore, and may represent aircraft listed as 'missing' in the records.

A review of distribution maps of World War II Royal Air Force Air/Sea Rescue operations (see Wessex Archaeology, 2008) indicates that a number of recorded operations took place within the vicinity of the Dogger Bank. Whilst the mapped locations of these operations are not wholly reliable, they provide a useful guide to the general frequency of these operations in the Offshore ZDE, and suggest that although well offshore and outside the areas of major concentration of UK wartime aircraft losses, there is a clear potential for the presence of aircraft remains in the Offshore ZDE. Further desk-based work and other investigations, such as geophysical survey, will be required to more accurately determine the potential for aircraft remains in this area.

There are 16 known aircraft wrecks in the Offshore ZDE listed in the UKHO records (see Figure 8.5). One is a modern (i.e. post-1945) helicopter, six are modern military aircraft, and three date to World War II. The age and identity of six are unknown. All military aircraft crash sites are automatically protected under the Protection of Military Remains Act 1986, and may not be disturbed without a licence.

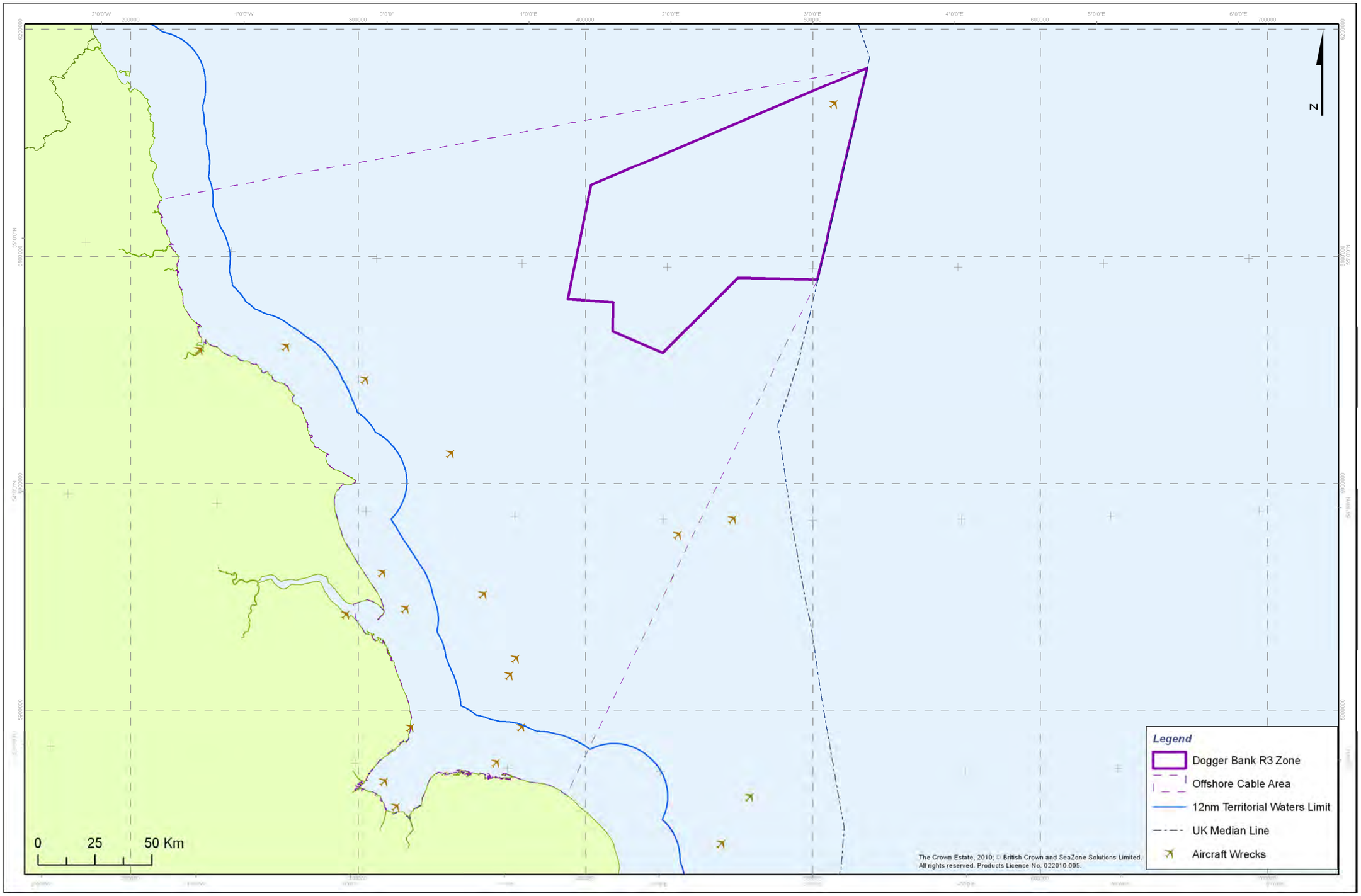


Figure 8.5: UKHO known aircraft wrecks within the Offshore ZDE.

8.7 Unexploded Ordnance

Wartime activities have resulted in the potential presence of a variety of unexploded ordnance (UXO) and may be considered part of the archaeological record of the Offshore ZDE.

Many vessels (both military and merchant navy) were sunk in British waters during World Wars I and II and some of these carried both live and inert ordnance. Likewise, ordnance can be expected on any World War II aircraft wreck. In addition to UXO associated with maritime and aircraft wrecks, individual UXO articles may occur on the seabed where they were fired without detonating, jettisoned or dumped during times of conflict. Potential UXO is discussed below.

8.7.1 Sea mines

Extensive minefields are understood to have been laid around the coast of the UK in the early period of World War II as a precaution against possible invasion. There is evidence, that the Offshore Cable Area was bisected by an extensive minefield which ran roughly parallel to the coast (UKHO, 1945). In addition to British activities, there may also have been unrecorded German mine-laying, by air, submarines or E-Boats. There is no accurate record of the number and type of mines laid within and in the vicinity of the Offshore ZDE.

Mine-laying locations during World War I have not been established. However, the historical presence of mines within the Offshore ZDE can be inferred from a number of examples in the UKHO shipwreck data for the Offshore ZDE of vessels lost as a result of hitting mines.

Although attempts were made to clear sea mines after World War II, it is likely that a high proportion of sea mines were not recovered from the sea floor. Consequently, the possibility of encountering British or German mines in the Offshore ZDE cannot be discounted, and because of the mobile nature of the marine environment, there is potential for munitions to have moved from where they were originally deployed.

8.7.2 Naval projectiles

Historic armament firing ranges were located along the northeast coast of England, some of which may have been in operation prior to World War II. Munitions fired from these sites are unlikely to be found within the Dogger Bank Zone, due to the distance between the Zone and the batteries, but may be encountered within the Offshore Cable Area.

Similar (and generally larger) munitions will have been used offshore by naval vessels during World Wars I and II. Of note is the Battle of Dogger Bank which took place within or in close proximity to the Dogger Bank Zone on 24 January 1915. The battle involved significant shell fire between the British and German fleets and resulted in the sinking of the German battle cruiser, *SMS Blücher* (Bennett, 1968; Halpern, 1995). The precise location of the battle or the wreck of the *SMS Bülcher* is not known.

8.7.3 Torpedoes and depth charges

Torpedoes and depth charges were deployed in UK waters during both World Wars, from both ships and aircraft. Failed torpedoes sink to the seabed with their warheads intact when they run out of fuel and several have been recovered from the waters around the UK in recent years. Depth charges were also used off the coast of the UK during World War II.

The likelihood of encountering unexploded torpedo warheads or depth charges is low as they were commonly deployed in relatively small numbers.

8.7.4 Aerial ordnance

Aerial attacks on both naval and merchant shipping, particularly during World War II, were carried out in the North Sea, with high concentrations of attacks in the Humber estuary and coastal areas beyond by the Lufwaffe (Bates, 1994; Whiting, 1999).

In the latter part of World War II the Offshore ZDE would have been over flown by large numbers of Allied and German bombers. During these raids bombers often jettisoned their payloads due to fighter interception and the need to reduce weight and increase manoeuvrability when mechanical problems threatened the aircraft or when they had failed to reach the intended target and were returning to base (Bates, 1994; Whiting, 1999; Fleischer, 2004). Such munitions may be present within the Offshore ZDE.

8.7.5 Munitions dumping

After the end of World War II, the UK was faced with the need to dispose of an enormous quantity of surplus munitions, for which dumping at sea was the only practical method of disposing of the bulk of this ordnance (Jappy, 2001). The occurrence of official munitions dumping grounds within the Offshore ZDE are not known, but historic admiralty charts should be reviewed for official confirmation.

8.8 Summary

With the exception of the positions of known wrecks listed in the UKHO Wreck Index, this chapter does not indicate any other areas within the Offshore ZDE that are restricted due to maritime or aviation archaeology.

In terms of the prehistoric archaeology and palaeolandscapes of the Offshore ZDE, there is a demonstrable, general potential for sites and material on or below the seabed, particularly, but not exclusively from the last c. 10,000 years. In general, it is important to stress the limitations of baseline archaeological data for all three archaeological themes. There is a very real potential, during the individual wind farm site EIAs for identifying or locating previously unknown archaeological sites.

This chapter indicates that there is varying potential for the preservation of submerged prehistoric archaeological sites and materials within the Offshore ZDE. The survival, *in situ*, of Lower, Middle and Upper Palaeolithic material is unlikely, but current evidence indicates that *in situ* deposits dating to the Late Upper Palaeolithic and Mesolithic do survive in the Dogger Bank Zone. There is also the potential for the survival of a long sediment sequence which can provide palaeoenvironmental and climatic information.

There is also the potential for the remains of maritime losses in the Offshore ZDE for all periods since *c*. 6,500 years BP, whilst UKHO records and World War II Air/Sea Rescue operations suggest the presence of a substantial number of aircraft wrecks in the Offshore ZDE.

Lastly, this chapter indicates that there is potential for unexploded ordnance to be encountered within the Offshore ZDE.

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9. Navigation and Shipping

9.1 Introduction

The Dogger Bank Zone and the Offshore Cable Area are navigated by a wide range of vessels including merchant, fishing, military, marine aggregate dredgers and recreational craft.

This ZoC chapter has been compiled by Anatec Ltd and discusses:

- Shipping density;
- Fishing vessel activity;
- Recreational craft routes; and
- Key navigational features.

Navigation and shipping within the Dogger Bank Zone and Offshore Cable Area has been the subject of studies by Anatec Ltd (2010a – c, 2011a – c, which assess pre-existing data and an on-going Automatic Identification System (AIS) surveys.

The current AIS surveys were commissioned by Forewind in order to develop a comprehensive data set over time, to characterise vessel movements within the Dogger Bank Zone, including any seasonal and tidal variations. The 272 days of survey coverage between April 2010 and August 2011 are captured in this report, and will be continually added to as more data become available throughout the duration of ZAP.

In addition to the AIS data surveys stakeholders consultation is on-going and a radar survey of the Zone has been carried out to collect data on smaller craft movements that are not captured by AIS. Where collected this data has been included in the overall data analysis.

9.2 Data and Literature

Guidance documents used to inform the Dogger Bank Zone navigation and shipping study were:

- Marine Guidance Note (MGN 371) Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Reponses;
- MGN 372 - Guidance to Mariners Operating in the Vicinity of OREIs; and
- DECC Methodology for Assessing Marine Navigational Safety Risks of Offshore Wind farms.

The data sources used to inform the Dogger Bank Zone navigation and shipping study (Anatec Ltd, 2010a) were:

- Admiralty Chart 2182b;
- AIS Survey data (272 days duration);
- Fishing vessel surveillance data (aerial sightings and satellite);
- Recreational vessel data (Royal Yachting Association (RYA) and Cruising Association (CA));
- Military Practice and Exercise Area charts;
- TCE licensed and application aggregate dredging areas; and
- Maritime incident data (MAIB).

To demonstrate the navigational issues occurring within the Dogger Bank Zone, a 10 nm buffer was applied to the Zone to provide context during analysis. However it should be noted that fishing vessel satellite data, due to data availability, was only plotted within the Dogger Bank Zone boundary.

Since the Offshore Cable Area is spatially extensive, there are currently no comprehensive AIS shipping data coverage available for the entire area for a uniform period. Therefore, in order to characterise the Offshore Cable Area, Anatec Ltd (2010b) used the following data sources:

- Fishing vessel satellite data;
- International Maritime Organisation (IMO) ship routeing measures; and
- Anatec Ltd Ship Routes database, which combines the following data:
  - Movement analysis – the number of movements per year on routes passing through UK waters is estimated by analysing a number of data sources including port callings data and voyage information obtained directly from ship operators; and
  - Routeing analysis – routes taken between ports are obtained from a number of sources, including offshore installations, standby vessels and shore-based survey data; passage plans, port and pilot consultation, and Admiralty charts and publications.

This navigation and shipping characterisation has assessed traffic densities within the Dogger Bank Zone and Offshore Cable Area, in order to better understand the issues and to guide development.

9.3 Overview

The Dogger Bank Zone is located approximately 68 nm from the nearest land at Flamborough Head. The Offshore Zone Development Envelope (ZDE) includes the Dogger Bank Zone and the Offshore Cable Envelope which extends to the coastline between East Anglia and Northumberland and encompasses a number of major port areas including the Tees, Humber and the Wash (Figure 9.1; Anatec Ltd, 2010b).

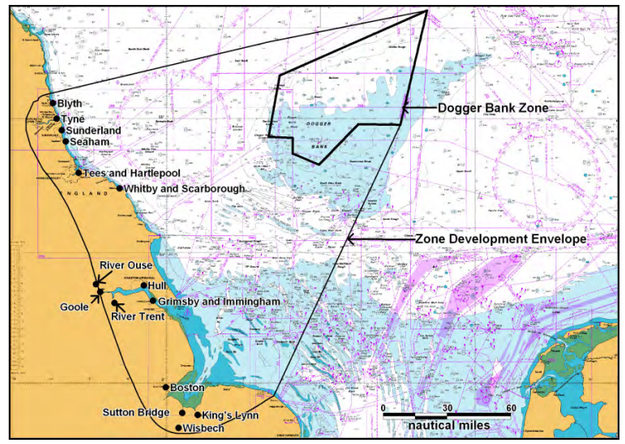


Figure 9.1: Chart overview of the Offshore ZDE in relation to major port areas and IMO routing measures (Anatec Ltd, 2010b) (Admiralty chart data source ARCS. Copyright Licence 15670).

Within the Dogger Bank Zone, the water depth (at Lowest Astronomical Tide (LAT)) ranges between 18 m and 62 m. Deeper draught vessels tend to avoid the shallower areas to the south of the bank (South West Patch) where there are overfalls and breaking swells which can be hazardous to navigation (Anatec Ltd, 2010a). There are no IMO routeing measures or offshore

installations within 10 nm of the Zone. Anatec Ltd (2010a) also indicates that local ports do not influence traffic movements within the Zone since the nearest coastline is more than 60 nm away.

9.4 Shipping Density

9.4.1 Dogger Bank Zone

Shipping density information in the Dogger Bank Zone is based on analyses of vessel tracks recorded by AIS over a 128 day period in April and May, 2010 (Anatec Ltd, 2010a) combined with a further 30 days in January and February 2011 (Anatec Ltd, 2011a) and 114 days between March and August 2011. AIS is carried by merchant shipping using the area (all ships above 300 tonnes) and also by fishing vessels of at least 45 m overall length. A proportion of smaller fishing vessels and recreational craft also carry it, although voluntarily. The AIS survey was carried out by the MV Sea Profiler, Kommandor Jack, Fugro Commander, Vigilant, Tridens 1, and L'Espoir. It was also supplemented by additional AIS data available from coastal and offshore stations.

An analysis of the vessel types recorded as passing within the Dogger Bank Zone during the survey periods (excluding <1% of shipping which was unspecified) shows that the majority of vessel tracks within the Dogger Bank Zone were made by fishing vessels (44%), cargo ships (32%), tankers (14%), tugs (2%) and passenger vessels (1%) (Anatec Ltd, 2010a – c, 2011a – c). Figure 9.2 shows AIS tracks of commercial vessels within the Zone. Fishing vessel activity is described separately in Section 9.5 of this chapter.

The AIS survey also measured the number of vessels per day recorded within the Dogger Bank Zone, and these data show that there were, on average, 11 vessels per day passing within the Zone boundary during the 272 days of the survey. The busiest days recorded were the 11th May, 12thMay and the 6th June 2010 on which 34 vessels were recorded. The quietest day was the 24th August 2010 when only 1 vessel was recorded (Anatec Ltd, 2010a; 2010b; 2011a).

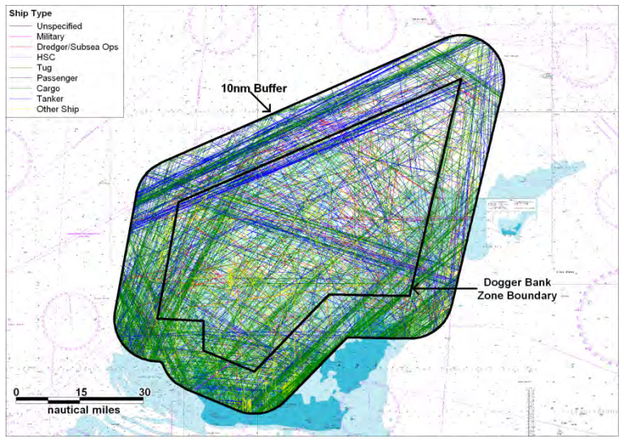


Figure 9.2: Vessel tracks within the Dogger Bank Zone showing 272 Days of AIS survey data (Anatec Ltd, 2010 a-c and 2011 a-c) (Admiralty chart data source ARCS. Copyright Licence 15670).

The AIS track data collected during the surveys were converted to vessel density grids(1 km x 1 km) to assist in identifying hot-spots of vessel activity (Anatec Ltd, 2010c). The shipping density excludes fishing vessels and temporary traffic such as vessels serving drilling rigs. The grid is shown in Figure 9.3 overleaf and was ranked based upon indicative density ranges for shipping traffic around the UK. The density ranges are equivalent to the following:

- Very Low: 0 to 9 ships per year per nm^2;
- Low: 10 to 49 ships per year per nm^2;
- Moderate: 50 to 199 ships per year per nm^2;
- High: 200 to 600 ships per year per nm^2; and
- Very High: 600+ ships per year per nm^2.

Based on these ranges, the AIS survey data collected to date indicate that shipping densities within the Dogger Bank Zone are predominantly very low to low. It is noted however, that the data also shows some moderate shipping density in the Zone.

9.4.2 Offshore Cable Area

For the Offshore Cable Area, the variation in shipping density within the entire Offshore ZDE was assessed using the Ship Routes database, as described in Section 9.2 above. The Offshore ZDE was divided into a grid containing 4,216 cells with an average cell size of 2 nm x 2 nm (Anatec Ltd, 2010b). Cells were ranked as per the UK density ranges from very low to very high defined in Section 9.4.1.

Figure 9.4 shows the results of this analysis and indicates that the highest density areas are off the east coast where the shipping traffic transits between ports within the Offshore ZDE (e.g. The Wash, Humber, Tees); as well as beyond the Offshore ZDE (e.g. northwards to the Forth and southwards to the Thames).

The Ship Routes data is indicative and therefore, the apparent NW to SE route through the Dogger Bank Zone, identified using the Ship Routes Database (Figure 9.4) is less evident when viewed using actual AIS data as shown in Figure 9.3.

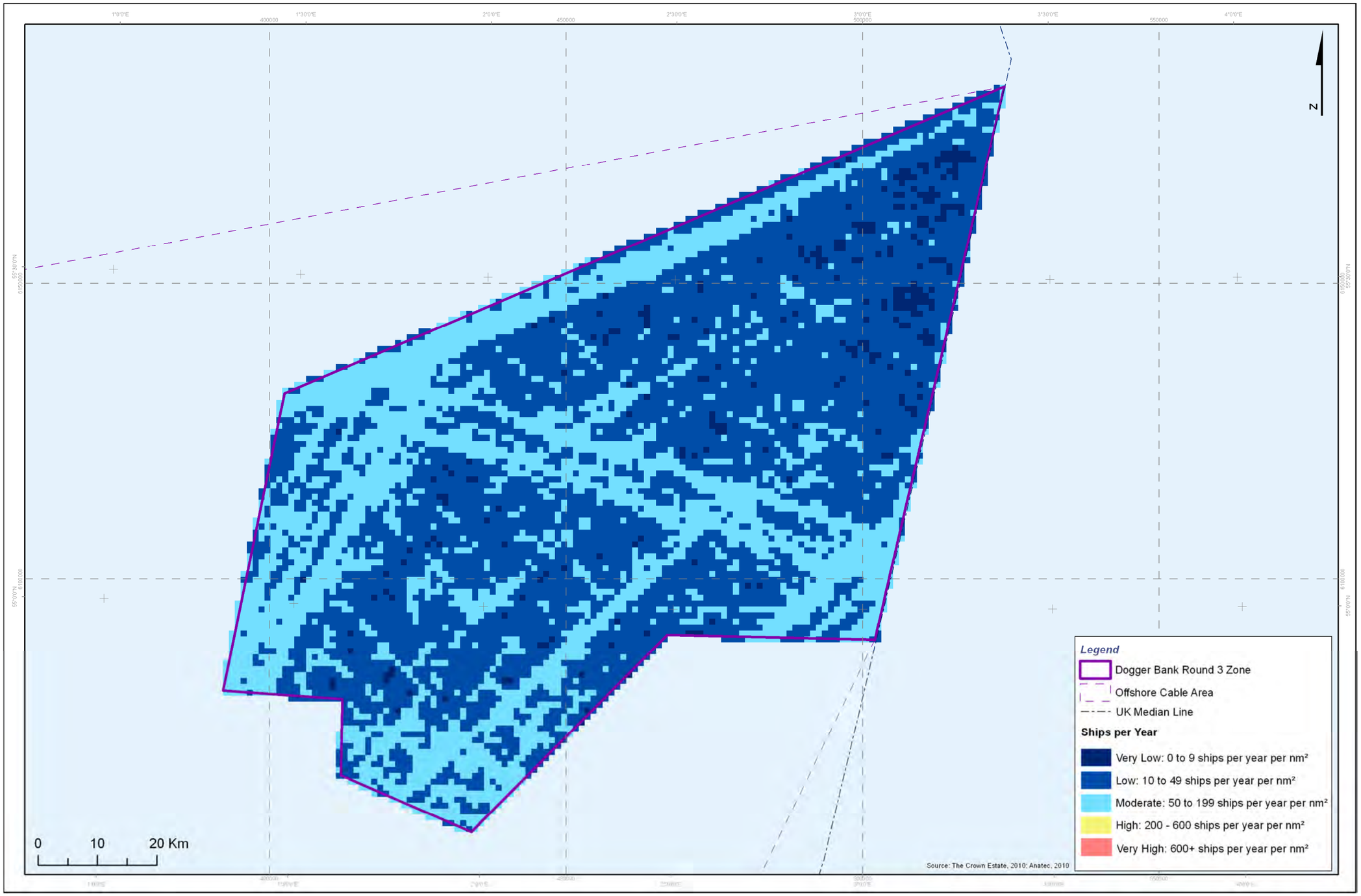


Figure 9.3: Shipping densities within the Dogger Bank Zone (excluding fishing vessels), derived from 272 days of AIS survey data (Anatec Ltd, 2010c).

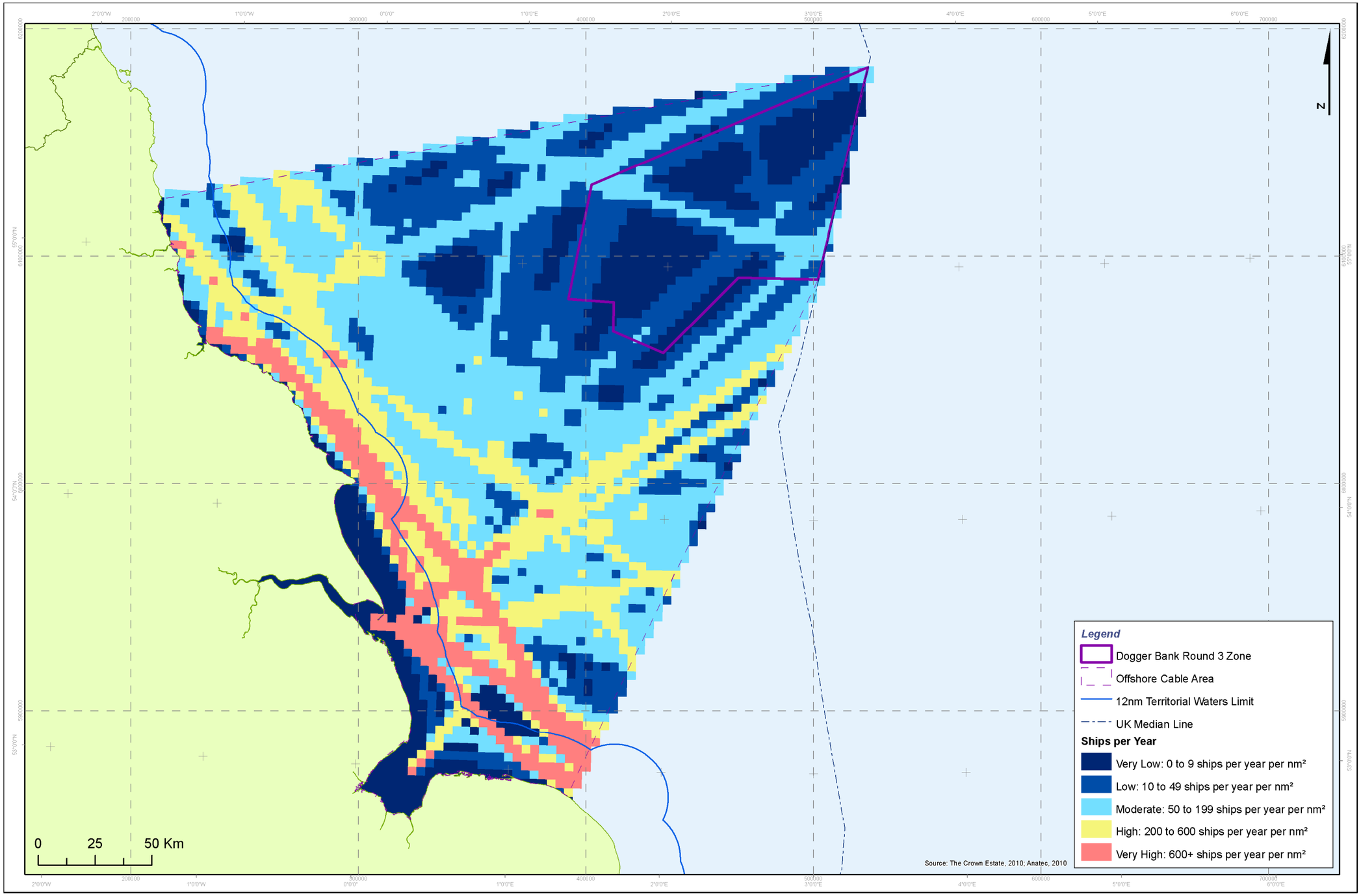


Figure 9.4: Shipping densities within the Offshore ZDE, derived from Ship Routes data (Anatec Ltd, 2010b).

9.4.3 Identification of main routes in relation to the Dogger Bank Zone

Main Routes have been identified by principles set out in MGN 371. The AIS survey data was assessed and vessels transiting on similar headings and locations have been identified as a route. Ten commercial vessel routes transit through or in close proximity to the zone (Figure 9.5).

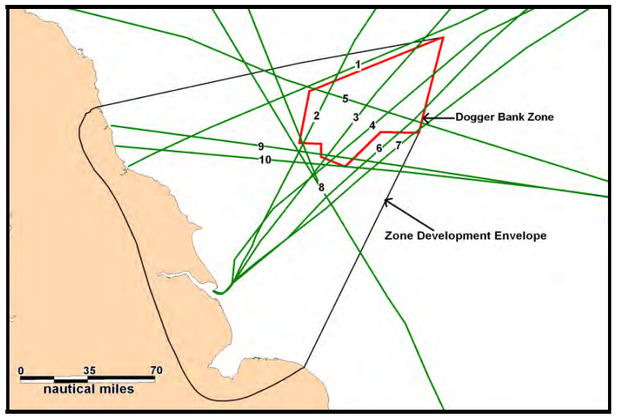


Figure 9.5: Main commercial vessel routes (Anatec 2011c).

9.5 Fishing Vessel Activity

9.5.1 Dogger Bank Zone

Analysis of the AIS data also allowed the density of fishing vessel activity for the Dogger Bank Zone to be identified and this is presented in Figure 9.6. In this instance, the grid was ranked specifically for the levels of fishing vessel traffic occurring in the Dogger Bank Zone and so shows 1km x 1km cells with densities equivalent to:

- Very Low: < 20 ships per year per nm^2;
- Low: 20 to 50 ships per year per nm^2;
- Moderate: 50 to 100 ships per year per nm^2;
- High: 100 to 250 ships per year per nm^2; and
- Very High: ≥ 250 ships per year per nm^2.

AIS is not mandatory for fishing vessels less than 45 m in length and therefore Anatec also analysed longer-term fishing vessel surveillance data (based on the latest available satellite data and aerial sightings) for the area. Satellite data record the positions of fishing vessels of 15 m length and over every two hours. 365 days of satellite data from 2009 for all vessel nationalities was analysed, which at the time of writing was the latest available.

The density grid for satellite fishing vessel position is presented in Figure 9.7shows some discrete differences from the density plot obtained from AIS data (Figure 9.6) and follows the same density rankings as mentioned above. This may be owed to the differences in vessels tracked by each method or to the satellite data recording vessel positions every two hours and therefore potentially double counting vessels. However, there are consistencies with regards to high densities recorded in the western and southern parts of the Dogger Bank Zone. The majority of fishing vessels tracked by satellite were from Denmark (68%) followed by the UK (14%).

Aerial sightings data are collected through the deployment of surveillance aircraft and the sea fisheries inspectorate. Fisheries statistics in the UK are reported by ICES statistical Rectangle and Subsquare. The Dogger Bank Zone is encompassed by 21 ICES Subsquares. The fishing vessel sightings within each ICES Subsquare encompassing the Zone during a five-year period (2005- 2009 is presented in Figure 9.8). Subsquare 39F1/3 on the Dogger Bank Zone's western margin had the highest average sightings per patrol at just over three vessels.

When discussing sightings data it should be noted that because the number of patrols varies significantly per Subsquare, this may introduce a bias into the data. The majority of fishing vessels identified within the Dogger Bank Zone were registered in the UK (44%) and Denmark (37%) (Figure 9.8). Approximately 50% were trawlers (unidentified type) and a further 42% were identified as beam trawlers. 86% of vessels sighted were engaged in fishing i.e. gear deployed, 13% were steaming (transiting to/from fishing grounds) and 1% were laid stationary (vessels at anchor or pair vessels whose partner vessel is taking the catch whilst the other stands by).

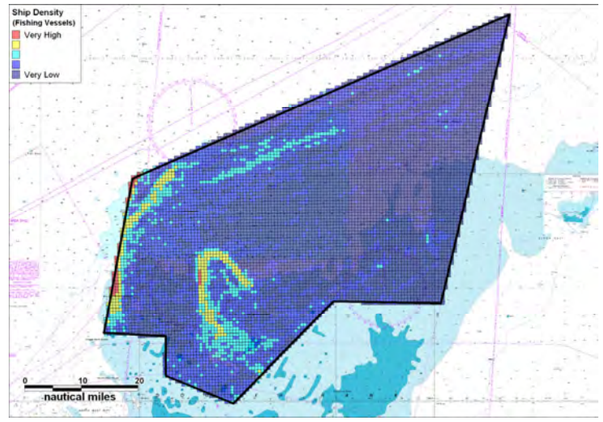


Figure 9.6: Fishing vessel density grid based on 272 Days of AIS survey data (April 2010 – August 2011) (Anatec Ltd, 2010 a-c and 2011a-c) (Admiralty chart data source ARCS. Copyright Licence 15670).

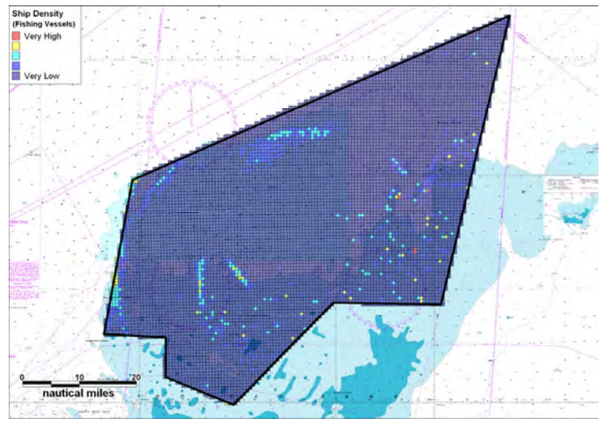


Figure 9.7: Annual fishing vessel density plot from 2009 satellite data (Anatec Ltd, 2010a) (Admiralty chart data source ARCS. Copyright Licence 15670).

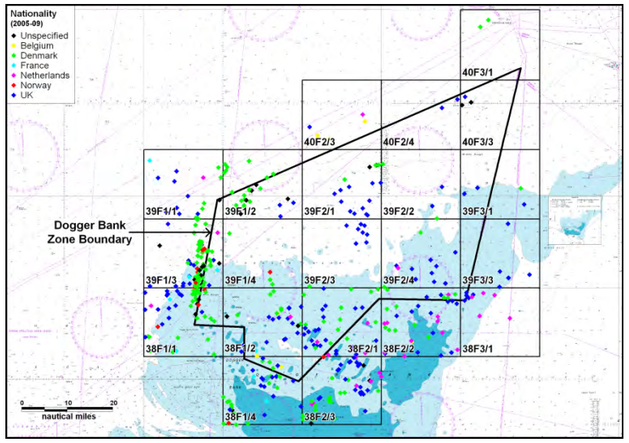


Figure 9.8: Annual fishing vessel aerial sightings by nationality (2005 – 09) in ICES sub squares encompassing the Dogger Bank Zone (Anatec Ltd, 2010a) (Admiralty chart data source ARCS. Copyright Licence 15670).

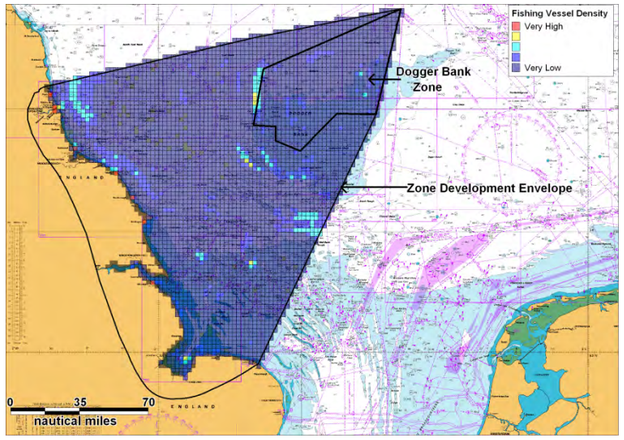


Figure 9.9:Annual fishing vessel density in the Offshore ZDE plotted from 2009 satellite data (Anatec Ltd, 2010b) (Admiralty chart data source ARCS. Copyright Licence 15670).

9.5.2 Offshore Cable Area

The fishing vessel density within the Offshore Cable Area has been estimated, based on satellite tracking data from 2009, which is the latest data to include both UK and non-UK vessels. Positions were obtained every two hours. The fishing vessel density plot is presented in Figure 9.9. Due to differences in the commercial vessel densities occurring between the Dogger Bank Zone and the Offshore Cable Area, the rankings associated with the standard classification of densities have been amended to show improved context for both areas. The densities ranking for this report are as follows;

- Very Low 0 to 20 ships per year per nm^2;
- Low 20 to 50 ships per year per nm^2;
- Moderate 50 to 100 ships per year per nm^2;
- High 100 to 250 ships per year per nm^2; and
- Very High ≥250 ships per year per nm^2.

It is evident that there is considerable variation in fishing vessel levels within the entire Offshore ZDE. It should be noted that these data only cover vessels 15 m length and over. Smaller vessels, which are likely to be particularly active near shore, are not represented. Commercial fishing activity within the Offshore ZDE is discussed in more detail in Chapter 10 – *Commercial Fisheries.*

9.6 Recreational Vessels

There is limited recreational vessel activity in the Dogger Bank Zone. Recreational vessels are not captured by the AIS data but are instead based on information published by the RYA and the CA.

The data on recreational use of the UK's marine environment were based on consultation and qualitative data collection from RYA and CA members, through the organisations' specialist and regional committees and through the RYA affiliated clubs. RYA (2005) notes that recreational boating around the UK, both under sail and power is highly seasonal and highly diurnal. Recreational craft routes are divided into Heavy, Medium and Light Use based on the following RYA classification:

- Heavy Recreational Routes: Very popular routes on which a minimum of six or more recreational vessels will probably be seen at all times during summer daylight hours. These also include the entrances to harbours, anchorages and places of refuge;
- Medium Recreational Routes: Popular routes on which some recreational craft will be seen at most times during summer daylight hours; and
- Light Recreational Routes: Routes known to be in common use but which do not qualify for medium or heavy classification.

Figure 9.10 and Figure 9.11shows that there are two medium-use routes between Newcastle-Esbjerg and Newcastle and Germany passing through the Dogger Bank Zone, based on RYA data. There are also four light-use routes between Forth-Elbe, Lowestoft-Bergen, Whitby-Skagerrak and Humber-Skagerrak. There are no heavy use cruising routes crossing the Dogger Bank Zone.

In addition to yacht cruising, there is also an annual North Sea Triangle race which crosses from Mainland Europe to the UK and back. As part of this yachts will, in certain conditions, route through the Dogger Bank Zone.

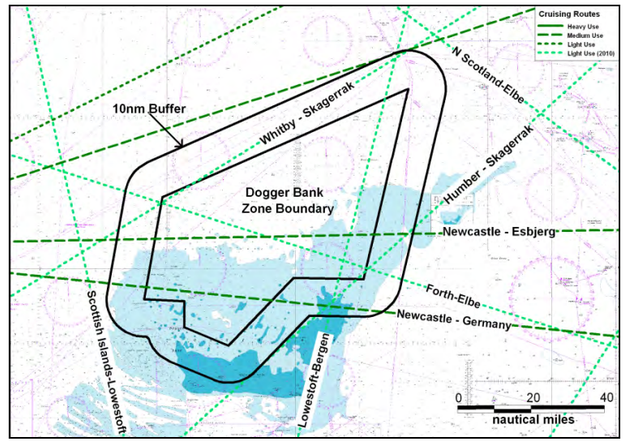


Figure 9.10: RYA cruising routes in the Dogger Bank Zone (Anatec Ltd, 2010a) (Admiralty chart data source ARCS. Copyright Licence 15670).

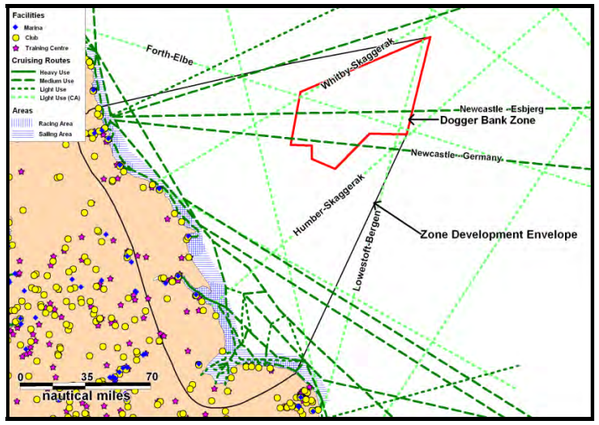


Figure 9.11: RYA cruising routes in the Offshore ZDE (Anatec Ltd, 2010a).

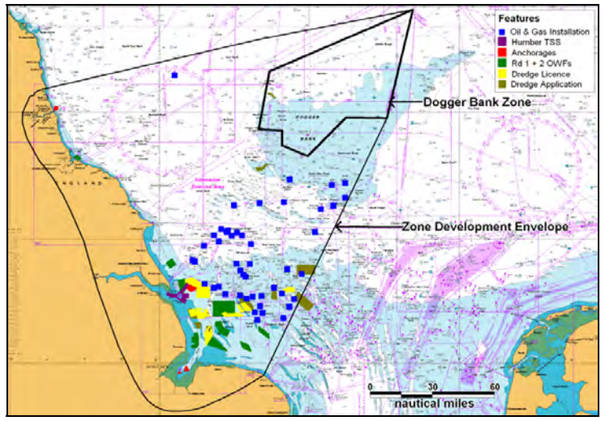


Figure 9.12: Navigational features within the Offshore ZDE (Anatec Ltd, 2010b) (Admiralty chart data source ARCS. Copyright Licence 15670).

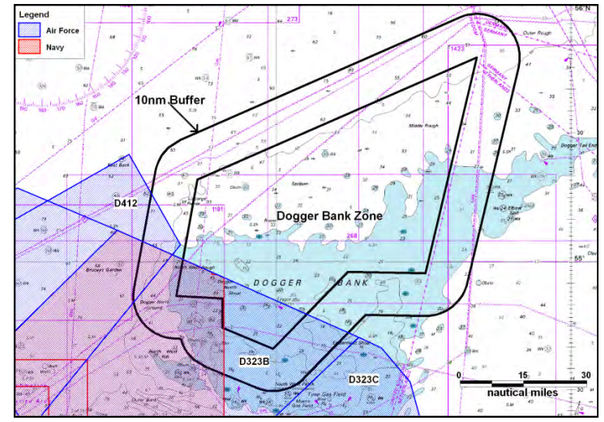


Figure 9.14: Military Practice Areas (shown in purple) within 10nm of the Dogger Bank Zone (Anatec Ltd, 2010a) (Admiralty chart data source ARCS. Copyright Licence 15670).

9.7 Navigational Features

Within the Offshore ZDE there are a number of significant navigational features (Figure 9.12) including oil and gas surface installations, the Humber Traffic Separation Scheme (adopted by the IMO), charted anchorages, Round 1 and 2 offshore wind farms, and marine aggregate licence and application areas. Figure 9.12 shows the application area located within the zone.

The charted anchorages within the Offshore ZDE are near the entrances to the ports of Wisbech and Sutton Bridge; King's Lynn, Humber, and Tyne. In addition to these charted anchorages, larger vessels waiting to enter the Humber are known to anchor a few miles north of the designated anchorage (Anatec Ltd, 2010b).

There are currently no licensed dredging areas within 10 nm of the Dogger Bank Zone, although there is an application by CEMEX UK Marine Limited for Area 466/1 within the western boundary of the Zone, shown in Figure 9.13. The presence of marine aggregate areas represents a potential future increase in shipping traffic to and from the area. Marine aggregate areas are discussed in more detail in Chapter 13 – *Marine Aggregates and Disposal.*

The presence of military surface and submarine vessels represents shipping traffic that may occur in the vicinity of the Dogger Bank Zone for national defence purposes. Further information regarding military practice areas is provided in Chapter 12 – *Military, Aviation and Radar*.



Figure 9.13: Dredging Application Area 466/1 within the Dogger Bank Zone (Anatec Ltd, 2010a) (Admiralty chart data source ARCS. Copyright Licence 15670).

There are two military practice areas overlapping the Dogger Bank Zone and another within 10 nm, as shown in Figure 9.14. D412 Staxton which is located outside the Zone, and D323B, which overlaps the southwest part of the Zone, are RAF Danger Areas. A Submarine Exercise Area also intersects the southwest corner of the Zone.

9.8 Summary

The Dogger Bank Zone and the Offshore Cable Area are navigated by a wide range of vessels including merchant ships, fishing vessels, recreational vessels, military vessels and marine aggregates dredgers. Deeper draught ships avoid the shallow areas of the Dogger Bank, particularly in the shallow southern part known as South West Patch.

There are no IMO routeing measures or offshore installations within 10 nm of the Dogger Bank Zone. Anatec Ltd (2010b) also indicates that since the nearest coastline is more than 60 nm from the Dogger Bank Zone, there are no local ports which influence traffic movements. The main shipping activity within the Dogger Bank Zone recorded during the 272 day AIS survey, between April 2010 and June 2011, consists of fishing vessels (44%), cargo ships (32%), tankers (14%), tugs (2%) and passenger vessels(1%). On average, 11 ships per day passed within the Dogger Bank Zone boundary.

Shipping density recorded in the Dogger Bank Zone during the AIS survey is relatively low by comparison with densities experienced elsewhere in the Offshore ZDE and around the UK, though there is an indication of moderate to high densities of traffic transecting the western and south-eastern boundaries of the Zone. Within the wider Offshore ZDE, including the Offshore Cable Area, the variation in shipping density presented by Ship Routes (see

Section 9.2) data indicates that the busiest areas are just off the east coast where shipping traffic transits between ports. Ten main commercial vessel routes that transit through or within close proximity to the zone have been identified. These routes also indicate low traffic levels in comparison to elsewhere in the Offshore ZDE and the UK.

Fishing vessel densities and distributions in the Dogger Bank Zone recorded during the AIS survey and by 2009 satellite data demonstrate some general similarities, with the greatest concentrations of activity occurring along the western margin of the Zone and southwest of its centre. Aerial surveillance data also reflects this with the greatest concentrations occurring within ICES Subsquare 39F1/3 on the western margin. The majority of fishing vessels tracked by satellite within the Zone were trawlers, predominantly from Denmark (68%) and the UK (14%).

Satellite data indicates that there is considerable variation in fishing vessel levels within the Offshore Cable Area. Vessels less than 15m in length, which are likely to be particularly active near shore, are not represented by the satellite data. Commercial fishing activity within the Offshore ZDE is discussed in more detail in Chapter 10 – *Commercial Fisheries.*

Recreational vessel activity in the Dogger Bank Zone, based upon data provided by the RYA, includes two medium-use routes between Newcastle-Esbjerg and Newcastle and Germany. There are also four light-use routes between Forth-Elbe, Lowestoft-Bergen, Whitby-Skagerrak and Humber-Skagerrak. In addition to yacht cruising in the area, an annual North Sea Triangle race crossing the North Sea is noteworthy. Recreational boating, both under sail and power is likely to be highly seasonal and diurnal.

There are a number of navigational features in the Offshore ZDE, mostly confined to the southern part of the Offshore Cable Area. These include oil and gas surface installations, the Humber Traffic Separation Scheme, charted anchorages, Round 1 and 2 licensed wind farm areas, and marine aggregate licence and application areas. One marine aggregate application area (Area 466/1) is located just inside the western boundary of the Dogger Bank Zone, which represents a potential future increase in vessel traffic to and from the area. There are two military practice areas which overlap the southwest part of the Dogger Bank Zone: a RAF Danger Area and a Submarine Exercise Area.

The AIS survey, commissioned by Forewind, is on-going and additional data will be analysed along with data from radar surveys (under taken where possible) to collect data on smaller vessels not captured by AIS (Radar Data has been analysed separately in Anatec Ltd, 2011a and 2011 c). It is anticipated that a comprehensive data set will develop over time, to characterise vessel movements within the Dogger Bank Zone, including any seasonal and tidal variations.

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Royal Yachting Association, 2005.*UK Coastal Atlas of Recreational Boating; Recreational Cruising Routes, Sailing and Racing Areas around the UK Coast*; 2nd edn by RYA; Supported by Trinity House.

10. Commercial Fisheries

10.1 Introduction

The following chapter provides a characterisation of the types, relative levels and distributions of commercial fishing activities taking place in the Offshore Zone Development Envelope (ZDE).

For the purposes of this assessment commercial fishing is defined as any fishing activity carried out for declared, taxable profit.

10.2 Data and Literature

The principal data and Information sources used are given below:

- Marine Management Organisation (MMO);
    - o Landings values and effort (2001-2010);
    - o Surveillance sightings (2001-2010); and
    - o Satellite tracking (Vessel Monitoring System (VMS)) (2005-2009);
- Dutch and Belgian landings and effort statistics;
- EU, Collaborative and National Fisheries Research institutes publications;
- International Council for the Exploration of the Sea (ICES) publications;
- Information gathered through preliminary consultation with stakeholders; and
- Brown & May Marine databases.

10.2.1 Data Limitations, Gaps and Sensitivities

Fisheries Statistics by ICES Rectangle

ICES statistical rectangles are the smallest spatial units used by the EC and member States for the collation of fisheries statistics. The boundaries of the rectangles align to 1° of longitude and 30' of latitude and their areas approximate to 3,500 km^2 in the sea area relevant to the Dogger Bank Zone. The limitations of data collated by ICES rectangles should be recognised in respect of the size of the rectangles in comparison to wind farm development areas.

The Offshore ZDE and the ICES rectangles considered in this characterisation are shown in Figure 10.1.

It should also be noted that fishing activity is generally not evenly distributed over the entire area of an ICES rectangle. In addition, with towed gears, where individual trawl tows can be up to 12 to 14 nm in length and may cross rectangle boundaries, catches are often recorded in only one rectangle.

The fisheries data collected by ICES rectangle and collated by the MMO and other national data centres are principally derived from vessels daily EC log sheets which vessels over 10 m in length are obliged to complete and submit. The collation of fisheries data and the extent to which they are released varies between EU national fisheries institutes. The statistics available from the MMO include data for all UK vessels irrespective of landing port and foreign vessels landing into UK ports.

Effort and landings from the UK, Belgium and the Netherlands have been used for the production of this chapter. Data have been requested from other countries but has not yet been received at the time of writing.

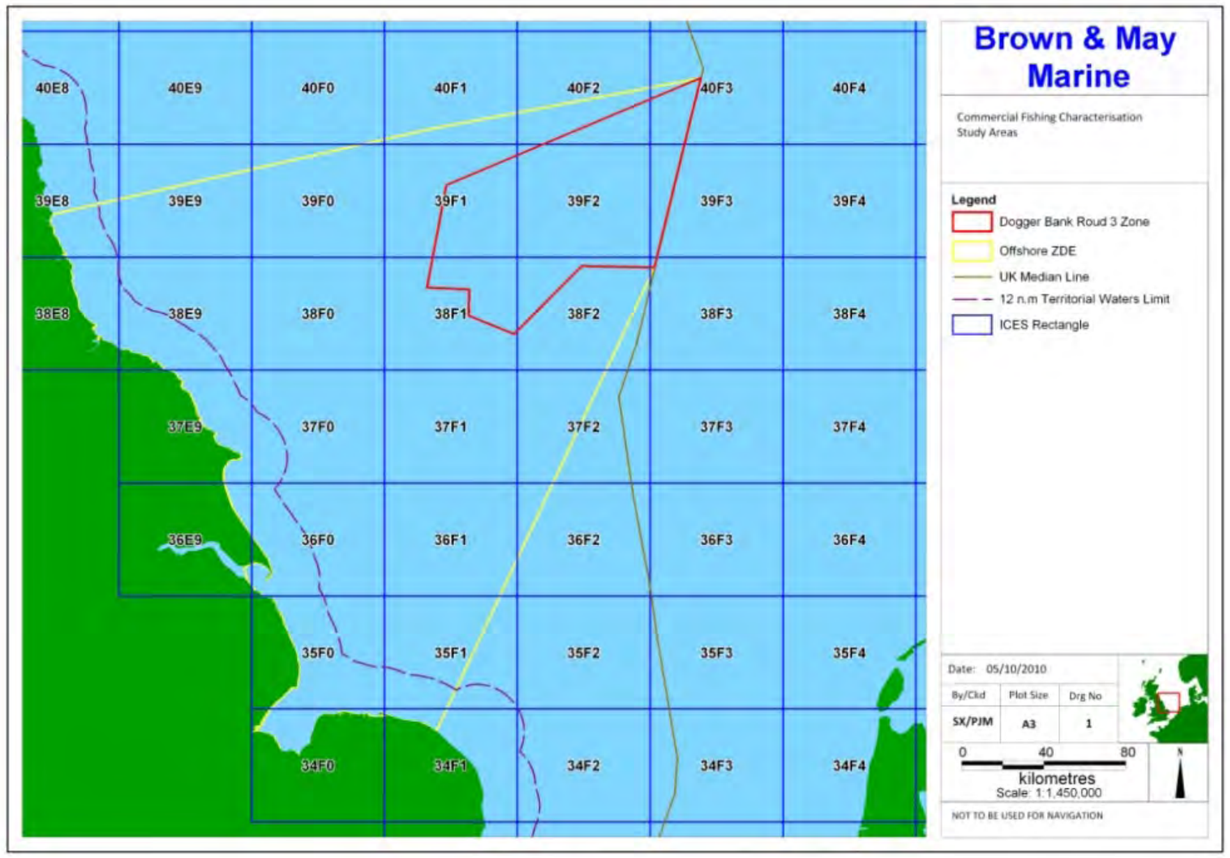


Figure 10.1: ICES rectangles in relation to the Offshore ZDE.

Satellite Tracking Data

Satellite tracking of EU registered fishing vessels of more than 15 m in overall length was introduced in 2005. The positions of the vessels are transmitted approximately every two hours via satellite link into the MMO and other national EU control centres.

Following an EU Court ruling brought by French fishing interests, since 2006, the MMO has not been permitted to release VMS data on non-UK vessels. Objections lodged by the UK National Federation of Fishermen's Organisations (NFFO) have also restricted the level of detailed VMS data that the MMO can release. Other national data centres, have to date, also been reluctant to release detailed VMS data.

It should be noted that there has been a recent change in UK and EU policy with regards to the release of satellite tracking data. The coordinates of the vessels can no longer be released; instead the number of plots by vessel type in a grid of rectangles of approximately 70 nm^2 is given with a breakdown of density by gear type. The 2009 data have therefore been analysed independently from the 2005-2008 data sets given the differences in format.

MMO Surveillance Sightings

Surveillance sightings in UK waters are recorded by fishery protection aircraft and surface craft as a means of policing fisheries legislation. These data provide a good indication of the relative distribution of fishing activity by method and nationality. Given the frequency of surveillance flights which, over a given area are generally once a week and only during daylight hours, surveillance data are, however, not appropriate for a quantitative assessment of fishing activity within discrete areas.

Stakeholder Consultation

Introductory consultation has been undertaken with the principal UK and European national fisheries stakeholders as well as some preliminary consultation with relevant UK fishermen. As full consultation will be an on-going process over the longer term, the primary purpose of the initial consultation was to introduce the project to stakeholders, to obtain information at the zonal level and to ascertain their concerns.

10.3 Overview

The spatial distribution of fishing within the Dogger Bank Zone is shown in Figure 10.2. This illustrates fishing density based on VMS data recorded for all nationalities in 2006, the only year for which comprehensive VMS data are currently available. The density of sightings over the majority of the Zone was relatively low, with the highest concentration occurring along and just outside the western boundary of the Zone.

The numbers and percentages of VMS sightings in the Dogger Bank Zone by nationality are given in Table 10.1. The majority of sightings were of Danish vessels (66.1%), followed by UK (20.7%) and to a lesser extent Swedish (6.0%) and Dutch (4.8%) registered vessels. The remaining countries accounted for only a small percentage of the total number of sightings (2.4%).

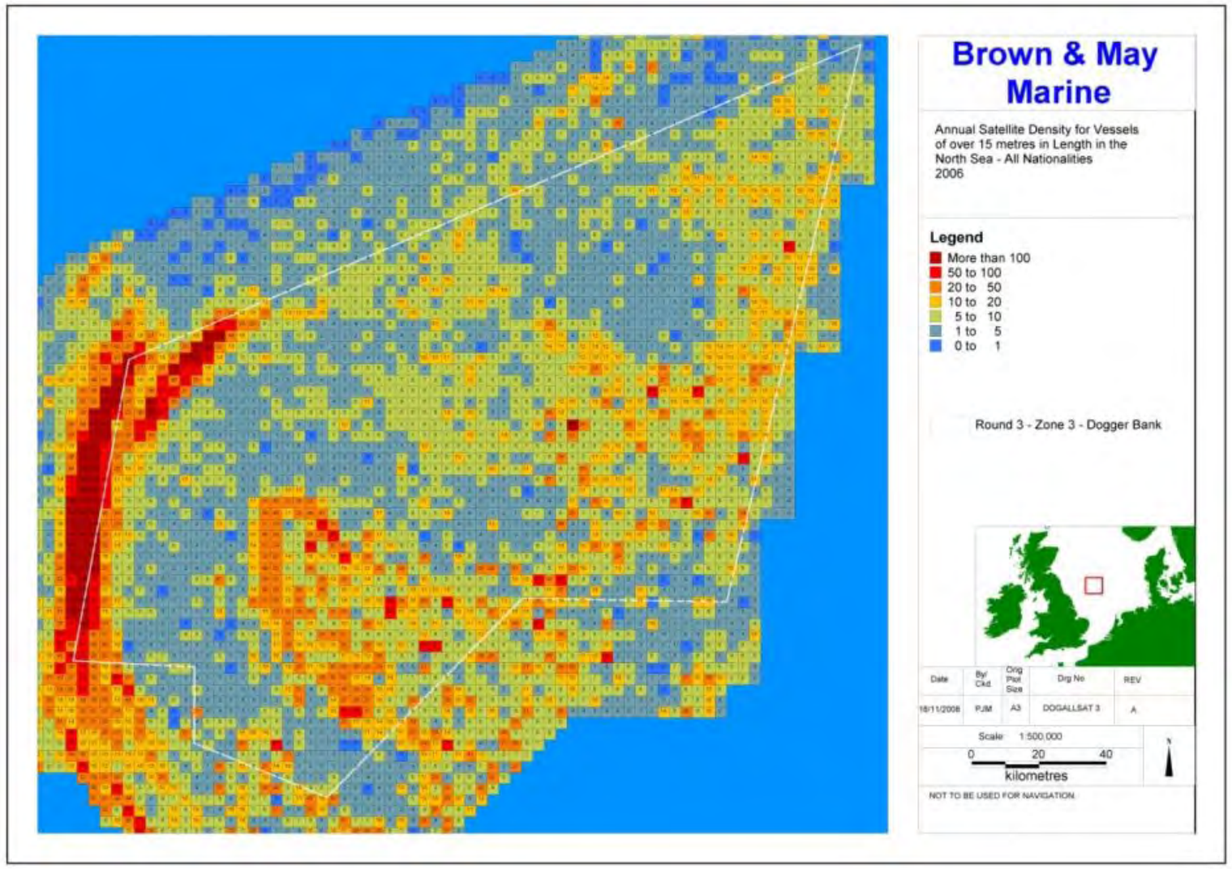


Figure 10.2: 2006 Average annual density of satellite tracked (VMS) positions of vessels of over 15 m in length - all nationalities (MMO, 2006).

Table 10.1: Numbers and percentages of satellite sightings recorded in 2006 within the Dogger Bank Zone by vessel nationality (MMO, 2006).

Country	No. of Position Plots	Percentage
Denmark	15,735	66.1 %
UK	4,920	20.7 %
Sweden	1,427	6.0 %
Netherlands	1,154	4.8 %
Other	570	2.4 %

The prevalence of Danish vessels' VMS sightings in the Dogger Bank Zone is corroborated by the findings of the April – May 2010 navigational survey (Figure 10.3) which also observed the highest proportion of vessels within the Zone to be Danish.

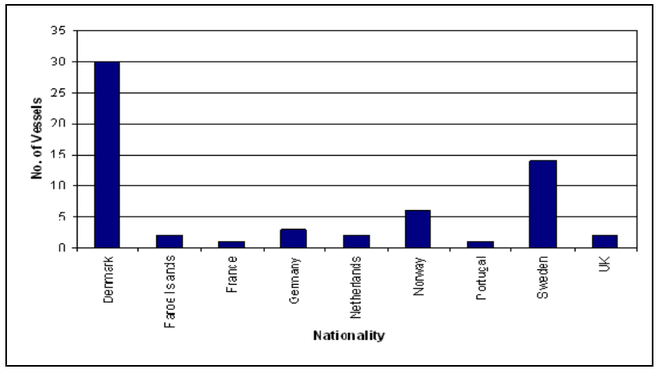


Figure 10.3: Number of fishing vessels within the Dogger Bank Zone by nationality observed during April to May 2010 radar surveys (Anatec, 2010).

The distribution of fishing within the wider Offshore ZDE by nationality is illustrated in Figure 10.4 based on MMO surveillance sightings (2001-2010). The Dogger Bank Zone records relatively low levels of activity in comparison to areas to the west and south of the Zone.

The numbers of surveillance sightings by nationality and fishing method recorded from 2001 to 2010 within the Dogger Bank Zone are given in Table 10.2. A noticeable feature is the progressive decline in the number of annual sightings, particularly UK sightings. Whilst this may in part be a result of the frequency of surveillance flights, it may also be a reflection of the decline of the UK east coast fishing fleet since 2000 as a consequence of decommissioning schemes, the sale of licenses and quotas and progressively restrictive conservation measures.

Figure 10.5 shows the relative annual average effort for the UK, Dutch and Belgian fleets in the North Sea, 2005 - 2009. This does not include effort from other nationalities; however, their effort is likely to be significantly less than that of the Dutch, Belgian and UK fleets. Effort within the Dogger Bank Zone records significantly less effort than other rectangles in the North Sea.

Table 10.2: Surveillance sightings recorded within the boundary of the Dogger Bank Zone from 2001-2010 (MMO, 2011).

Nationality	Method	Year									
		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
United Kingdom	Beam trawler	41	41	67	56	24	9	22	3	13	0
	Trawler (all)	8	13	6	1	1	0	0	0	3	1
	Bottom seiner	4	0	4	2	1	1	1	4	3	1
	Gill netter	6	7	1	1	0	0	0	1	1	0
	Purse seiner	2	5	2	2	0	0	2	0	0	0
	Other	2	0	3	1	2	3	0	1	0	4
	Total	**63**	**66**	**83**	**63**	**28**	**13**	**25**	**9**	**20**	**6**
Denmark	Trawler (all)	36	52	22	25	12	1	0	3	15	12
	Industrial trawler (sandeeler)	2	5	12	17	5	0	0	2	1	11
	Bottom seiner	2	2	1	5	1	5	1	6	2	0
	Gill netter	5	5	2	2	1	0	0	0	2	0
	Other	4	0	4	1	6	1	2	0	2	8
	Total	**49**	**64**	**41**	**50**	**25**	**7**	**3**	**11**	**22**	**31**
Netherlands	Beam trawler	4	8	30	21	1	0	1	0	0	0
	Trawler (all)	2	5	0	0	0	1	0	0	1	0
	Other	0	1	1	0	0	0	0	0	2	0
	Total	**6**	**14**	**31**	**21**	**1**	**1**	**1**	**0**	**3**	**0**
Belgium	Beam trawler	17	12	3	2	2	0	0	0	1	0
	Stern trawler (pelagic/demersal)	0	0	0	0	0	2	0	0	0	0
	Total	**17**	**12**	**3**	**2**	**2**	**2**	**0**	**0**	**1**	**0**
Sweden	Trawler (all)	0	3	9	1	0	0	0	1	3	1
	Industrial trawler (sandeeler)	0	0	6	0	0	0	0	0	0	4
	Other	0	2	1	0	0	0	0	0	0	0
	Total	**0**	**5**	**16**	**1**	**0**	**0**	**0**	**1**	**3**	**5**
Norway	Trawler (all)	0	5	0	0	0	0	0	0	3	0
	Industrial trawler (sandeeler)	0	0	2	1	0	0	0	0	0	4
	Other	1	0	1	0	0	0	0	0	0	0
	Total	**1**	**5**	**3**	**1**	**0**	**0**	**0**	**0**	**3**	**4**
Germany	Various	0	1	0	0	0	1	0	2	5	2
Faroes	Various	1	4	1	0	1	0	0	0	1	0
France	Various	1	1	0	0	1	0	1	0	0	0
TOTAL (All Nationalities & Methods)		**138**	**172**	**178**	**138**	**58**	**24**	**30**	**23**	**58**	**48**

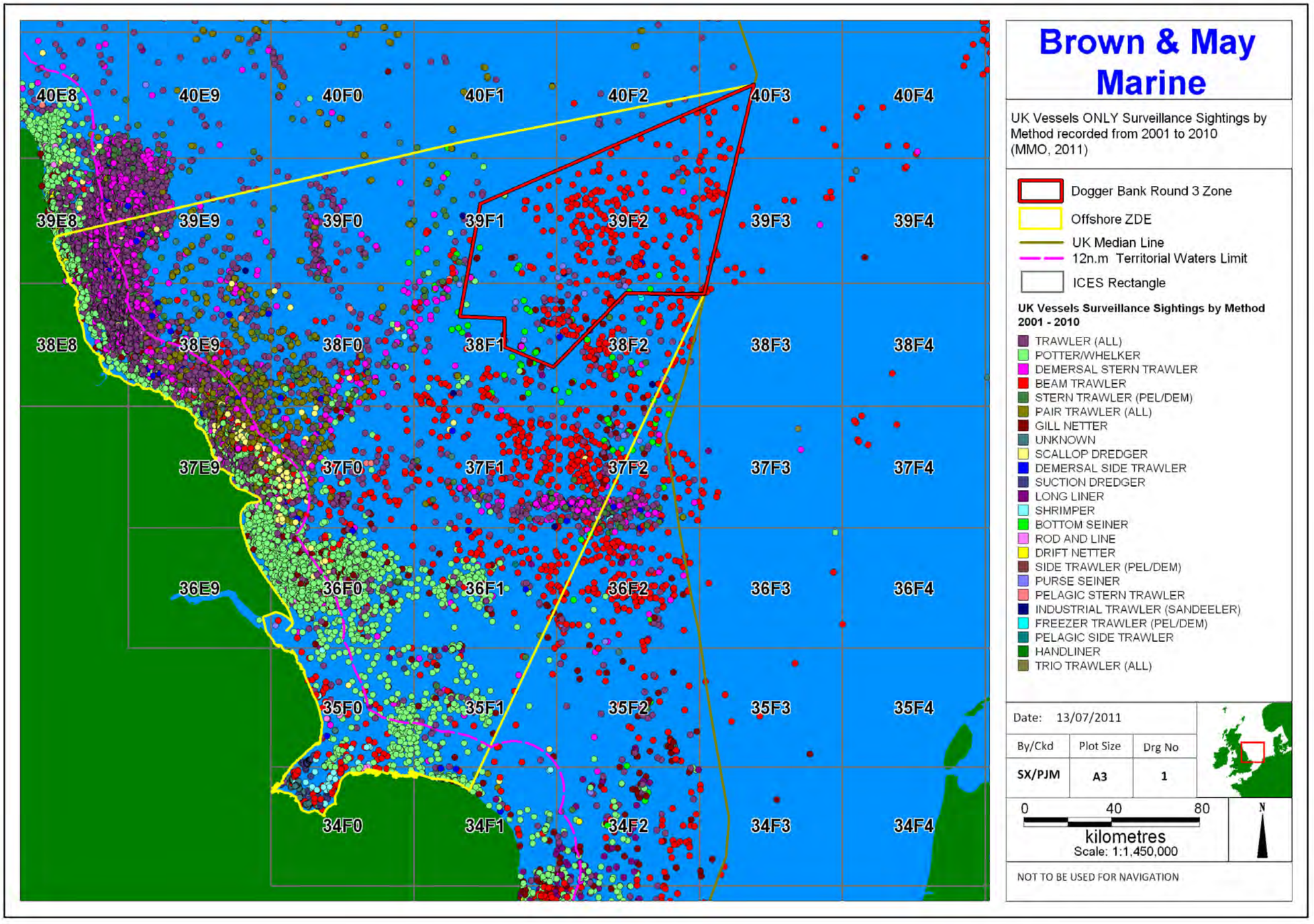


Figure 10.4: Surveillance sightings by nationality (2000-2010) (MMO, 2011).

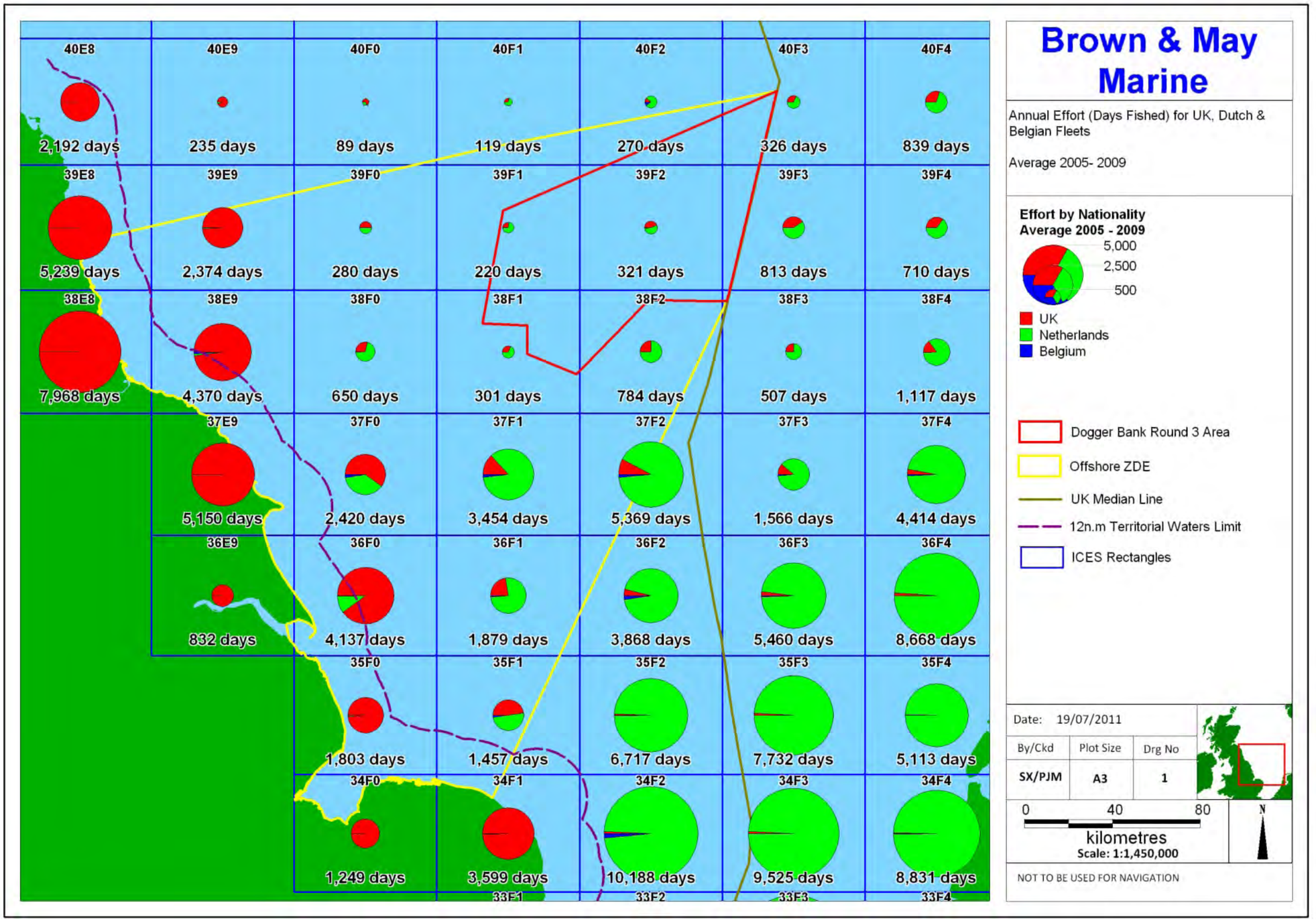


Figure 10.5: Average annual effort (days fished) by ICES rectangle for UK, Dutch and Belgian fleets, 2005 -2009.

10.4 UK Activity

An overview of the principal species targeted by the UK fleet within the Offshore ZDE is given in Figure 10.6 expressed as annual landings values by species (average 2001-2010). As is apparent, a large proportion of the landings in ICES rectangles relevant to the Dogger Bank Zone are for plaice, a species specifically targeted by beam trawlers. It is also of note that the values of landings from rectangles within which the Dogger Bank Zone falls are significantly lower than in those closer to the UK coast where a wider diversity of species are targeted.

The annual effort (days fished) by method in the Offshore ZDE (average 2001-2010) is illustrated in Figure 10.7. Beam trawling accounts for the majority of UK effort in rectangles relevant to the Dogger Bank Zone. It should be noted, however, that as a consequence of a significant proportion of UK registered beam trawlers being under Dutch ownership, exploiting UK quotas, particularly plaice quotas, the majority of the beam trawler sightings identified as UK are effectively Dutch (pers com. VisNed, 2010).

Of the catches taken by beam trawlers from the ICES rectangles within which the Dogger Bank Zone falls, 97.9% of the landings by value are into Dutch ports, principally Harlingen (Table 10.2), again reflecting that the majority of UK activity in the Zone is by UK registered but Dutch owned and operated vessels.

Table 10.2: Percentage of total landings values of beam trawlers by port of landing from 2000 to 2010 (MMO, 2011).

Port	Country	Percentage beam trawlers
Harlingen	Netherlands	76.9%
Urk	Netherlands	10.3%
Unspecified Dutch Port	Netherlands	5.1%
Den Helder	Netherlands	3.0%
Lowestoft	UK	1.8%
Ijmuiden	Netherlands	1.7%
Scheveningen	Netherlands	0.6%
Grimsby	UK	0.1%
Delfzil	Netherlands	0.1%
Hartlepool	UK	0.1%
Stellendam	Netherlands	0.1%
Eemshaven	Netherlands	0.1%
Peterhead	UK	0.1%
Cove (Leith)	Uk	0.0%

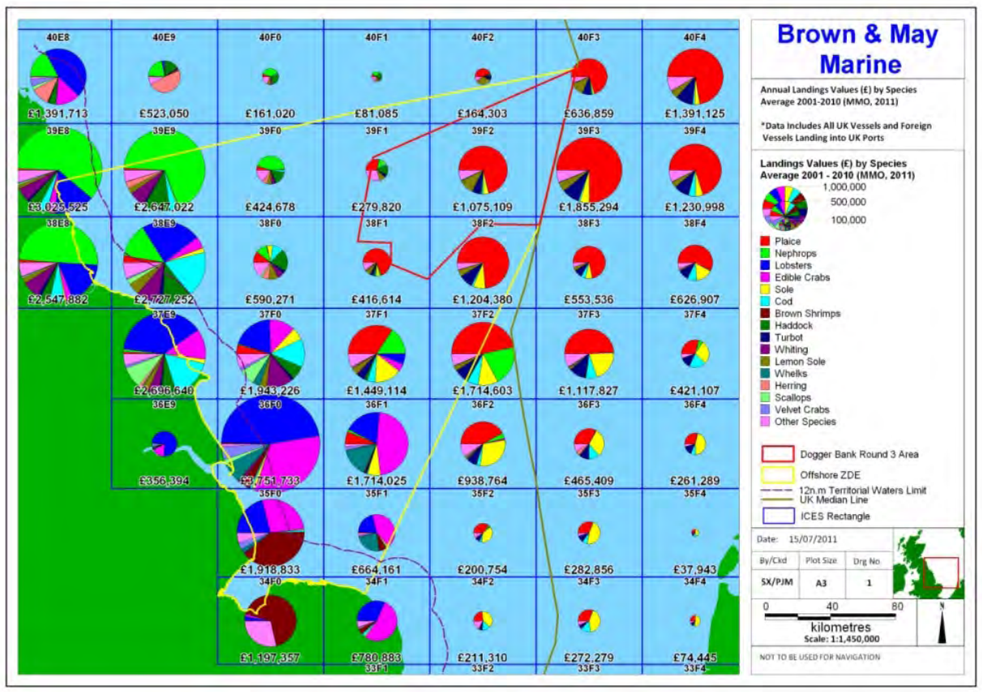


Figure 10.6: Annual landings values by species (average 2001-10) for UK vessels and foreign vessels landing into UK ports (MMO, 2011).

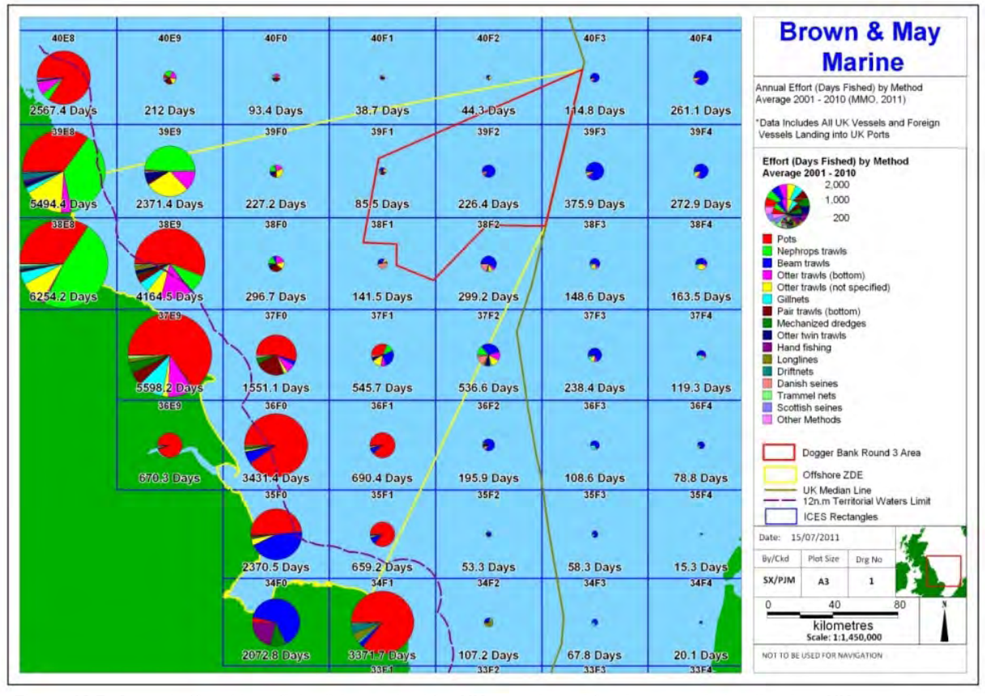


Figure 10.7: Annual effort (days fished) by method for UK vessels and foreign vessels landing into UK ports (average 2001-2010) (MMO, 2011).

An overview of the distribution of UK vessels over 15 m in length within the Offshore ZDE is given in Figure 10.8 based on annual VMS data (average 2005-2008). The numbers and percentages of position plots recorded within the Dogger Bank Zone by fishing method are detailed in Table 10.3. As suggested by landings values and effort data, the majority of UK activity within the boundaries of the Dogger Bank Zone is by beam trawlers which account for 75.8% of the position plots within the Dogger Bank Zone for the period 2005-2008 (Table 10.3). This pattern is also reflected in the surveillance sightings data (Figure 10.9) which show that the majority of UK vessels within the Zone are beam trawlers.

Table 10.3: Number of UK Vessels VMS Position Plots recorded from 2005 to 2008 within the Dogger Bank Zone (MMO, 2009).

Vessel Type	No. of position plots	Percentage
Beam trawler	15,749	75.8%
Bottom seiner	2,333	11.2%
Null	1,241	6.0%
Demersal side trawler	727	3.5%
Demersal stern trawler	264	1.3%
Stern trawler (pel/dem)	166	0.8%
Purse seiner	107	0.5%
Long liner	74	0.4%
Pair trawler (all)	66	0.3%
Freezer trawler (pel/dem)	23	0.1%
Gill netter	13	0.1%
Trawler (all)	5	0.0%
Potter/whelker	5	0.0%

Other fishing methods of relative importance are demersal seine netting, and demersal trawling, accounting for 11.2% and 4.8% of the total VMS position plots within the Dogger Bank Zone respectively.

Figure 10.10 shows the satellite density of all UK vessels over 15 m in 2009, with patterns that are broadly similar to those shown in the 2005-2008 data sets. Figure 10.11 and Figure 10.12 provide a breakdown of density by gear type showing small mesh beam trawl gear and whitefish gear respectively.

In the case of beam trawl vessels, it can be seen that the northern and western portions of the Dogger Bank Zone record low activity and the southern and eastern portions moderate levels (Figure 10.11). Density levels for whitefish gear are low in the northern and middle portions of the Dogger Bank Zone, again with moderate levels in the southern and eastern portions (Figure 10.12).

Both the VMS tracking and surveillance sightings show lower levels of UK beam trawling activity in the western portion of the Dogger Bank Zone.

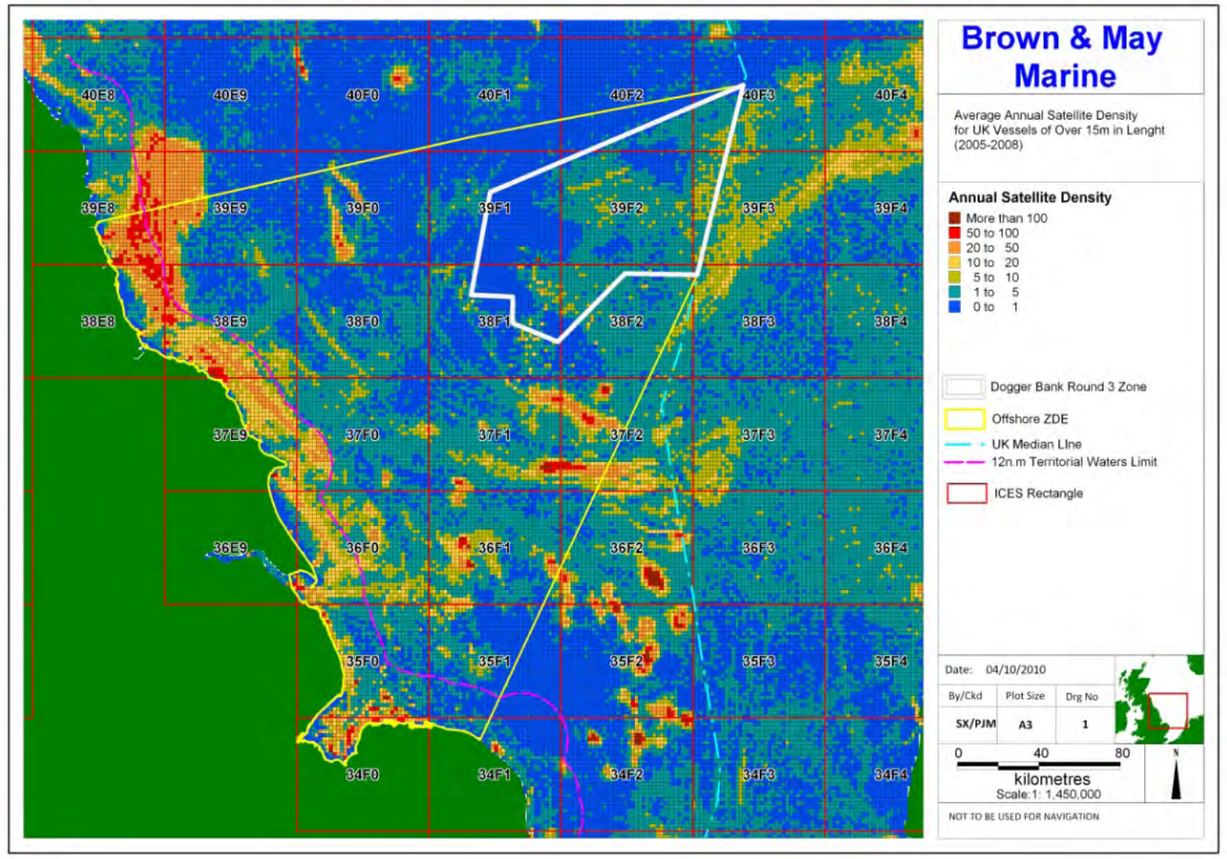


Figure 10.8: Average annual satellite (VMS) density for UK Vessels of over 15m in length (2005-2008) (MMO, 2009).

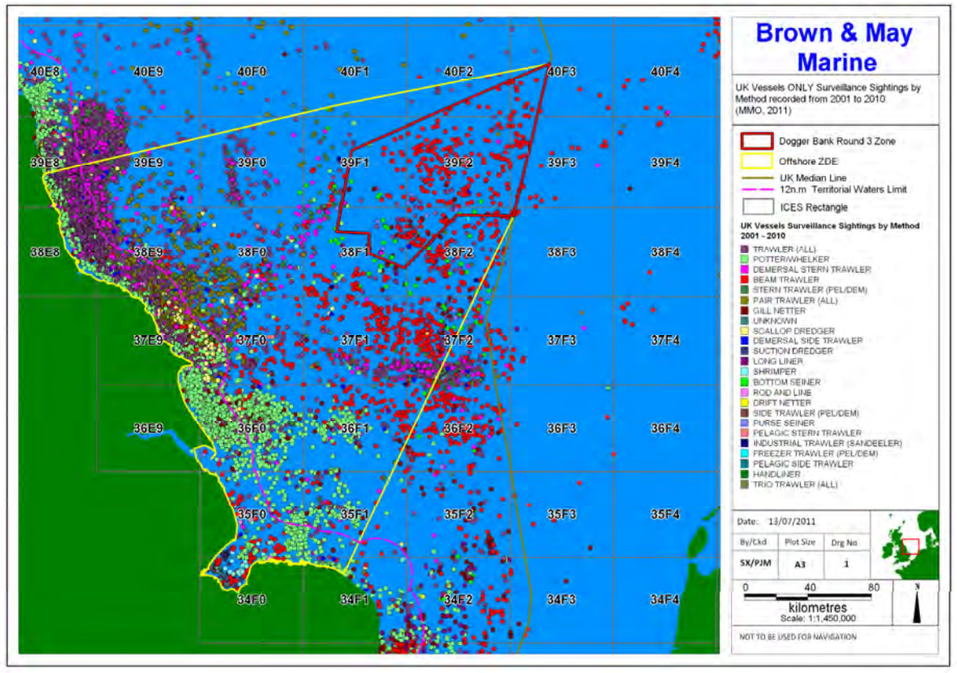


Figure 10.9: UK vessels surveillance sightings by fishing method (2001-2010) (MMO, 2011).

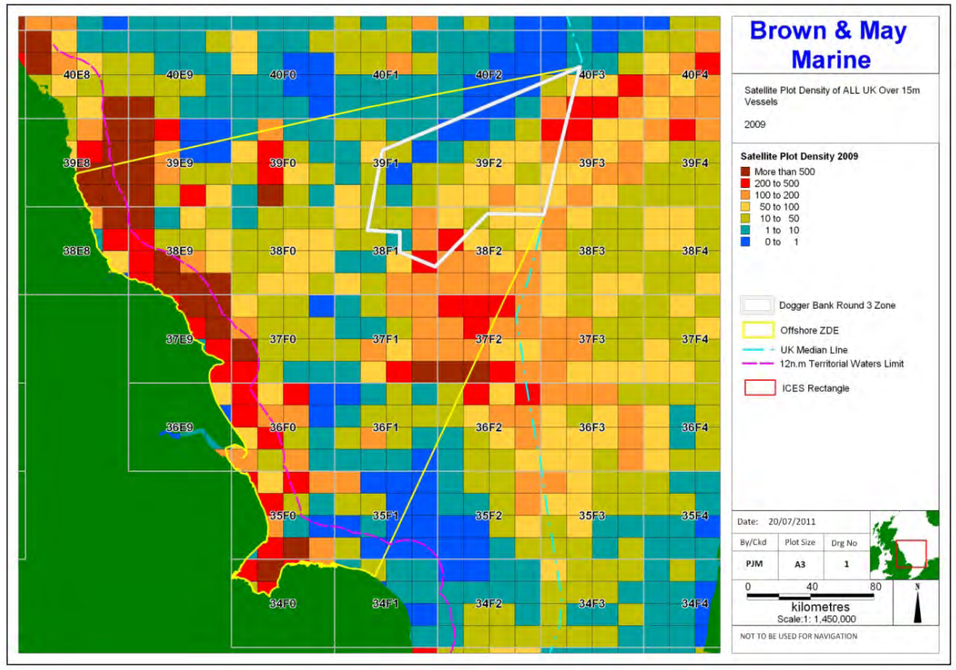


Figure 10.10: Satellite (VMS) density plot of all UK vessels over 15 m in length (2009) (MMO, 2009).

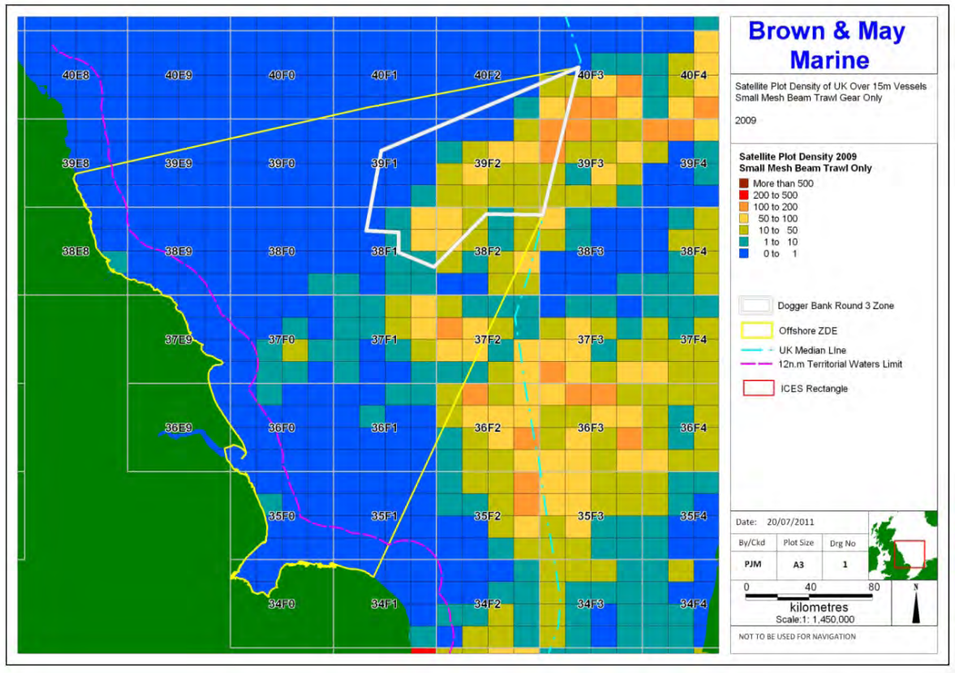


Figure 10.11: Satellite (VMS) density plot of UK small mesh beam gear vessels over 15 m (2009) (MMO, 2009).

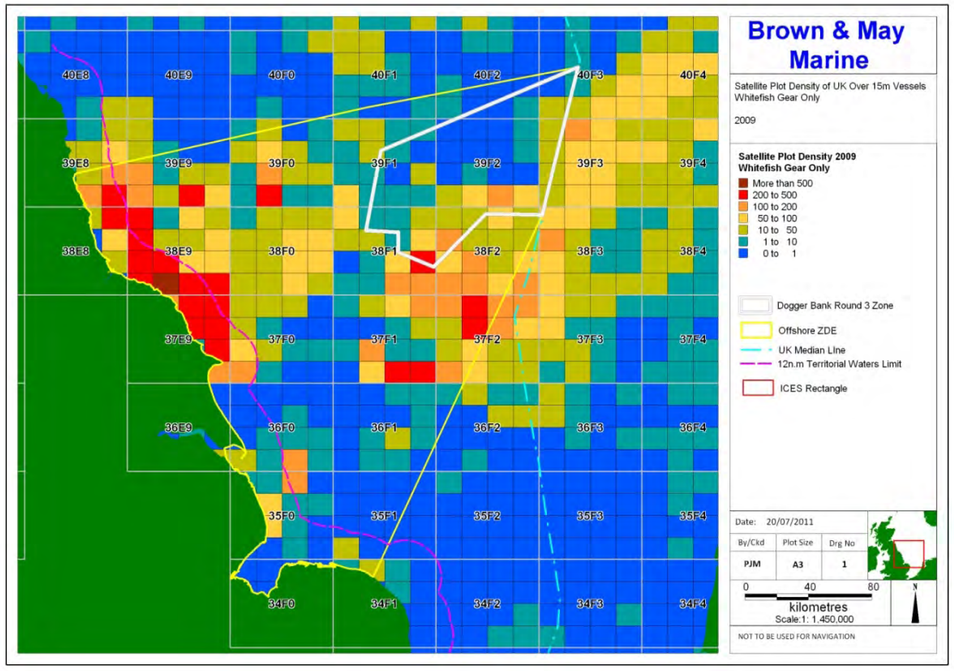


Figure 10.12: Satellite (VMS) density plot of UK whitefish gear vessels over 15 m (2009) (MMO, 2009).

10.5 Danish Activity

An indication of the levels of Danish fishing activity is given in Figure 10.13 and Figure 10.14. These illustrate 2006 VMS data within the Dogger Bank Zone and MMO surveillance sightings (2000 to 2009) in the Offshore ZDE for Danish vessels only.

Within the Dogger Bank Zone, fishing activity by Danish vessels appears to be concentrated along the western boundary of the zone. Activity, albeit at lower densities was also recorded in areas in the south of the Zone.

The majority of surveillance sightings within the Dogger Bank Zone correspond to trawlers and industrial trawlers, most likely targeting sandeels. It is of note that the distribution of Danish VMS and surveillance sightings approximates to the distribution of the sandeel fishing grounds (ICES, 2007) (Figure 10.15).

Other methods of relative importance within the Round 3 Zone are bottom seiners and gill netters. Fishing activity by these methods appears to concentrate close to the southern and eastern boundaries of the Dogger Bank Zone.

10.6 Swedish Activity

Fishing activity by Swedish registered vessels appears to be low within the boundaries of the Round 3 Zone (Figure 10.16 and Figure 10.17). The distribution of Swedish vessels mirrors that of Danish vessels being almost entirely concentrated along the western boundary of the zone mainly targeting industrial species such as sandeels. As for Denmark the majority of surveillance sightings within the Zone are of trawlers and industrial trawlers.

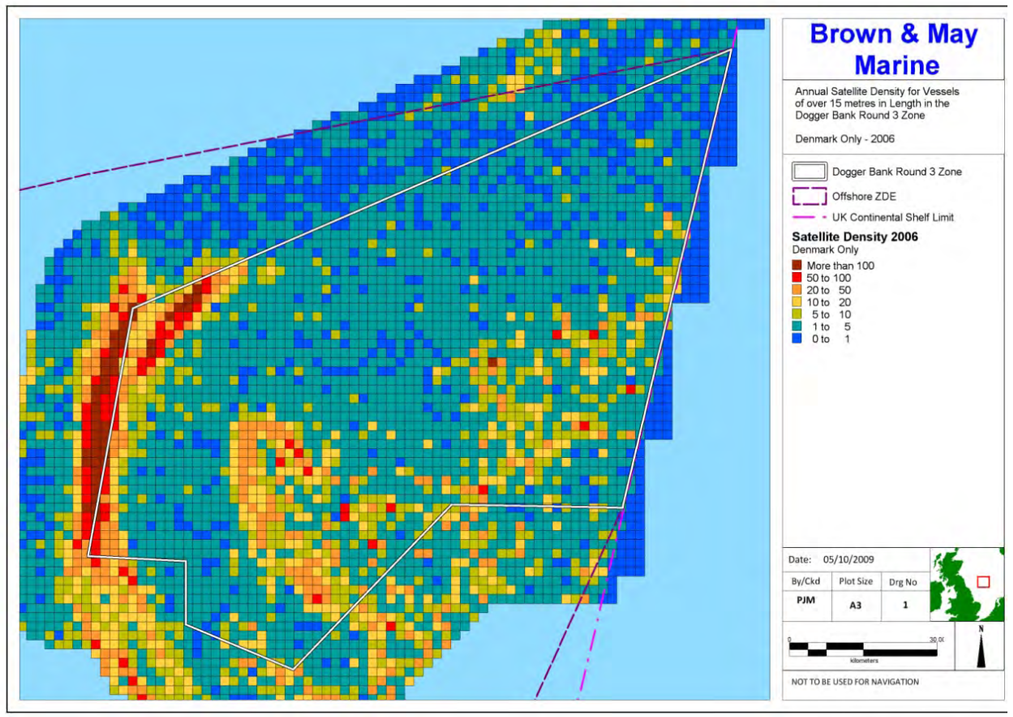


Figure 10.13: 2006 annual satellite (VMS) density for Danish vessels of over 15 m in length (MMO, 2006).

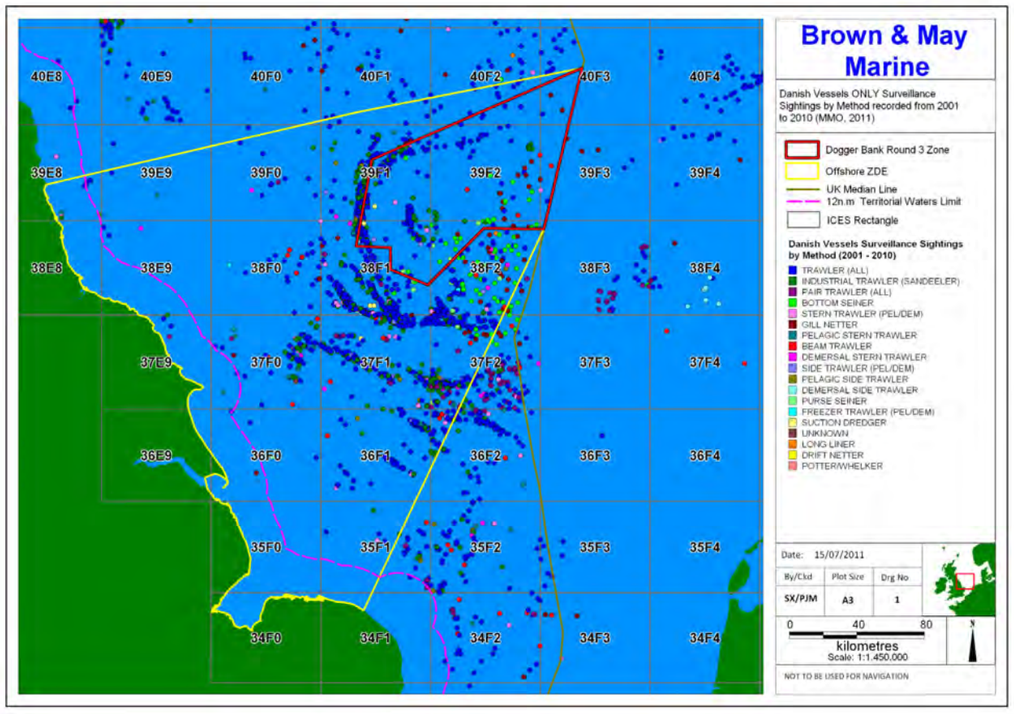


Figure 10.14: Surveillance sightings of Danish vessels by fishing method (2001-2010) (MMO, 2011).

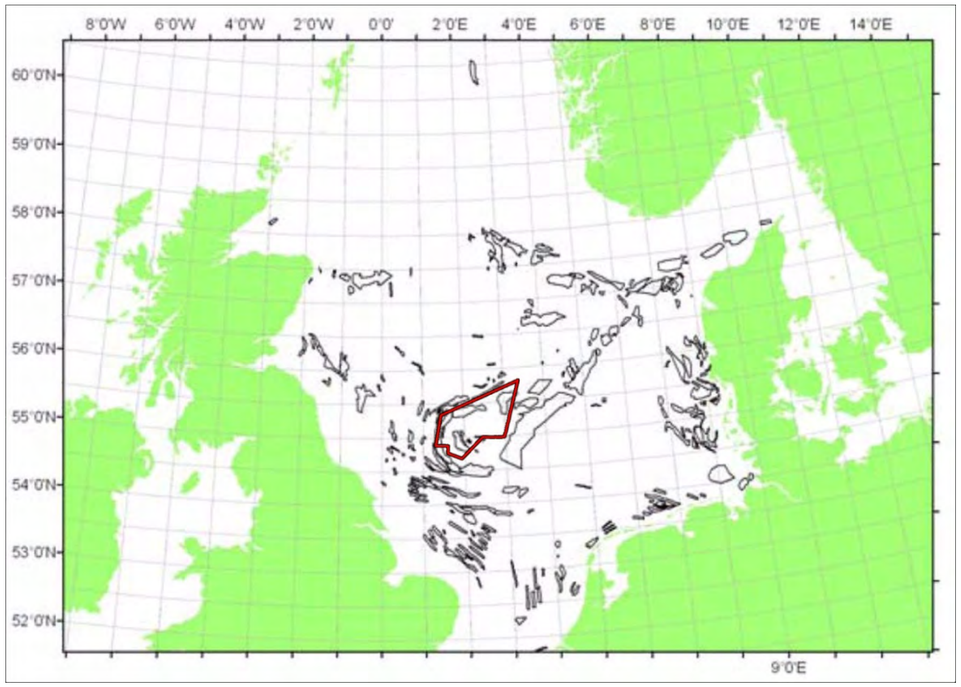


Figure 10.15: Sandeel fishing grounds in the North Sea (ICES, 2007).

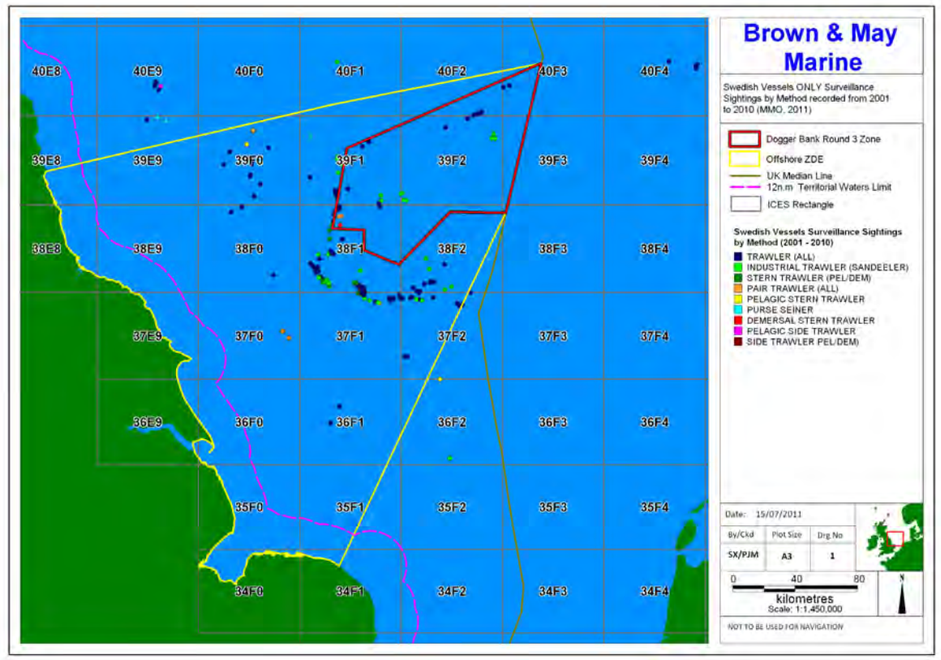


Figure 10.17: Swedish Vessels Surveillance Sightings by Method (2001-2010) (MMO, 2011).

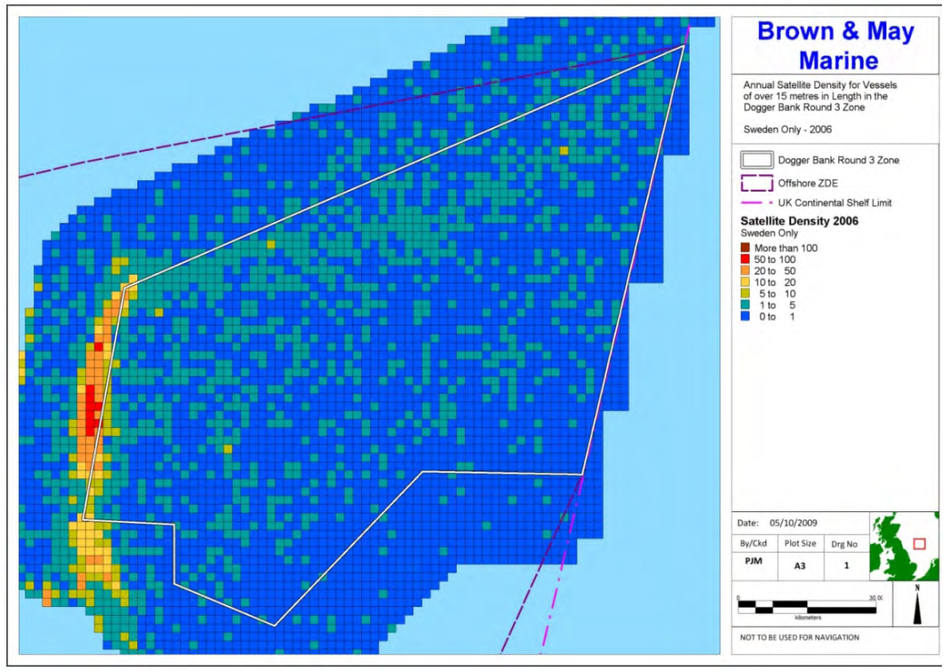


Figure 10.16: Annual Satellite Density for Swedish Vessels of over 15m in Length (MMO, 2006).

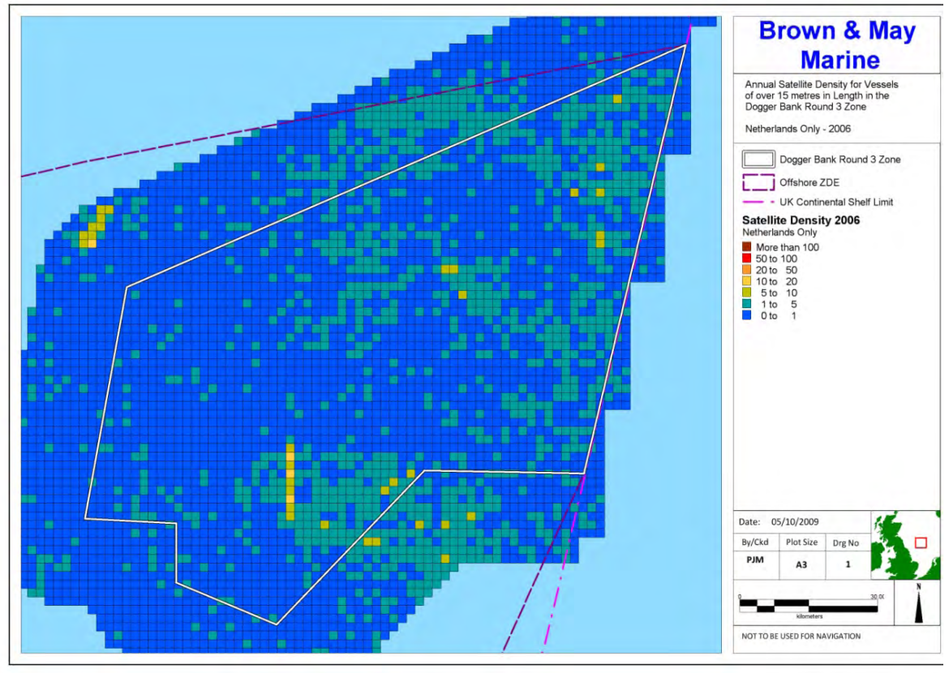


Figure 10.18: Annual Satellite Density for Dutch Vessels of over 15m in Length (MMO, 2006).

10.7 Dutch Activity

The available MMO VMS data (Figure 10.18) indicate minimal levels of activity by Dutch registered fishing vessels within the Dogger Bank Zone. Whilst the MMO has been unable to release VMS data of non-UK vessels since 2006, charts provided by the Netherland's Fishermen Organisation (VisNed) showing VMS position plots of Dutch fishing vessels for the years 2006-2008 (Figure 10.19) show that the limited activity which does occur is mainly concentrated along the southern and eastern boarders of the Zone. The MMO surveillance sightings (Figure 10.20) identify Dutch activity within the Zone to be almost entirely by beam trawlers.

Figure 10.19 indicates that the proportion of activity by Dutch registered vessels within the Zone is minimal in comparison to the southern and central North Sea. The average annual effort and landings values, shown in Figure 10.21 and Figure 10.22 respectively also show significantly lower effort and value within the Zone compared to other rectangles in the southern and central North Sea.

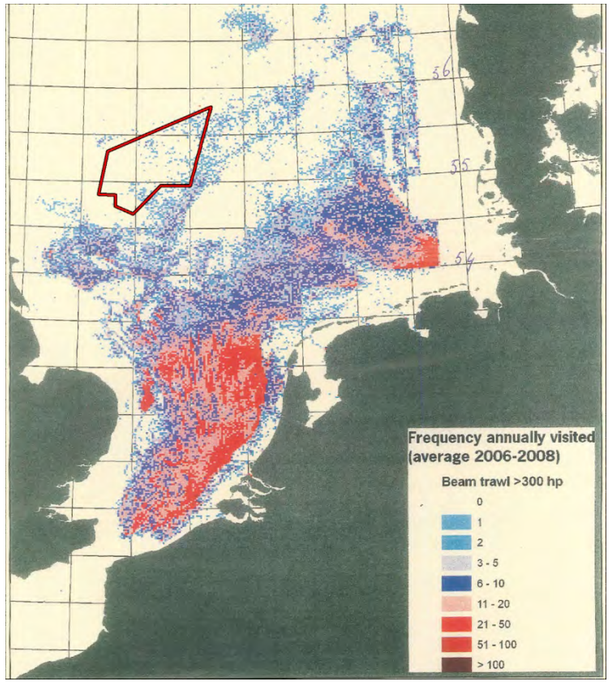


Figure 10.19: Dutch beam trawler effort based on VMS data (2006-2008) (VisNed, 2010).

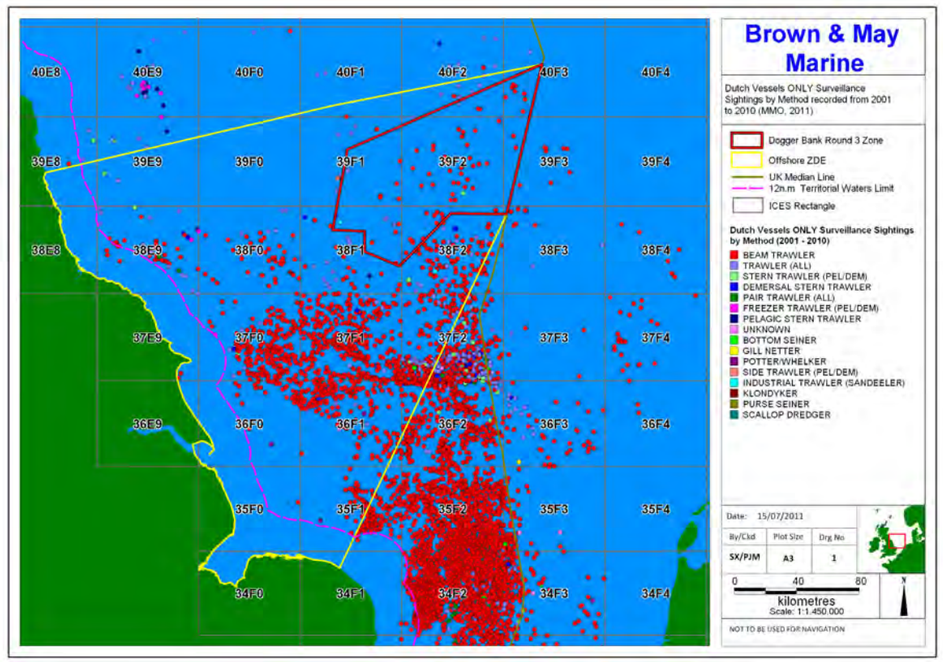


Figure 10.20: Dutch Vessels Surveillance Sightings by Method (2001-2010) (MMO, 2011).

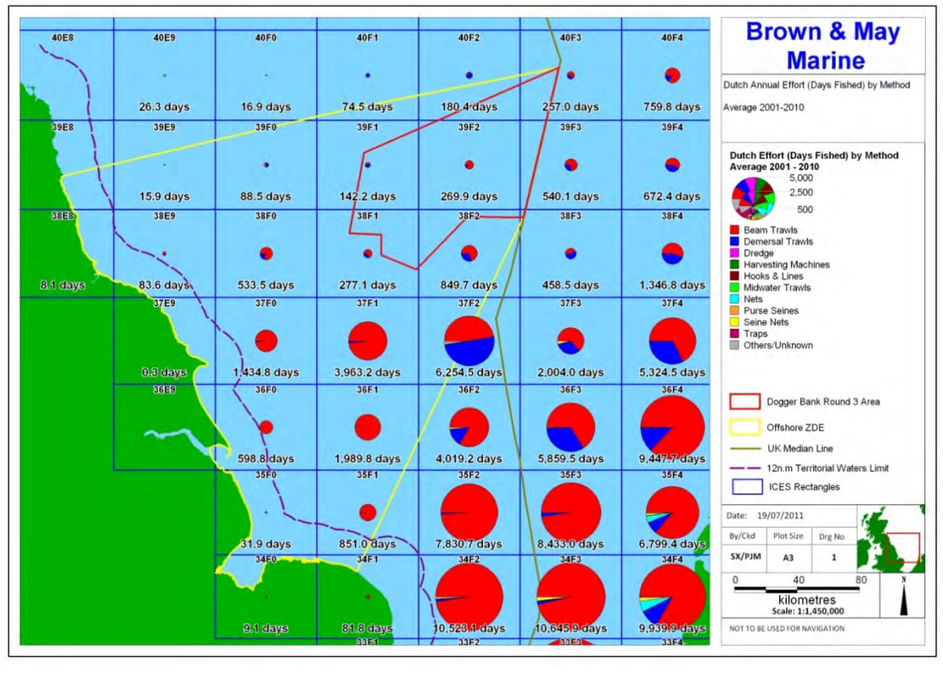


Figure 10.21: Dutch Average Annual Effort (days fished) by Method by ICES Rectangle, 2001 - 2010.

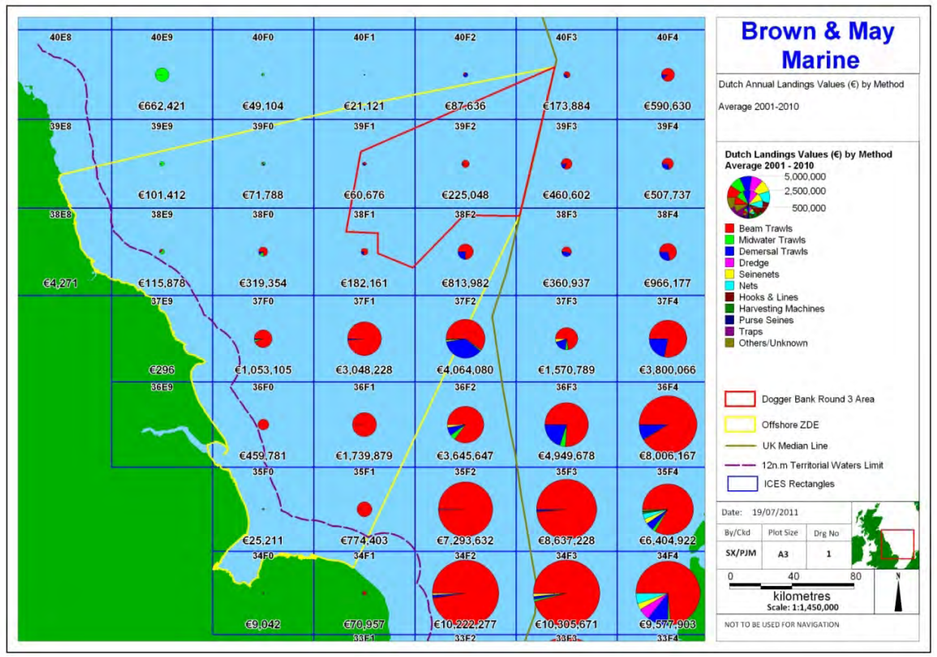


Figure 10.22: Dutch average annual value (€) by fishing method by ICES rectangle, 2001 – 2010.

10.8 Other Nationalities

As suggested by Figure 10.23, Figure 10.24 and Table 10.1, activity by fishing vessels from other nationalities not discussed above has been negligible within the Dogger Bank Zone. There is however a small amount of Norwegian activity taking place. This is focussed in the same area along the western boundary of the site where Danish and Swedish activity is concentrated, indicating that industrial species such as sandeels are the main target species.

In addition, as illustrated by the MMO surveillance sightings (Figure 10.24) activity by Belgian beam trawlers has also been recorded within the Zone. It is however understood that, as for UK beam trawlers, a proportion of the Belgian registered beam trawlers are, in fact, Dutch owned and operated.

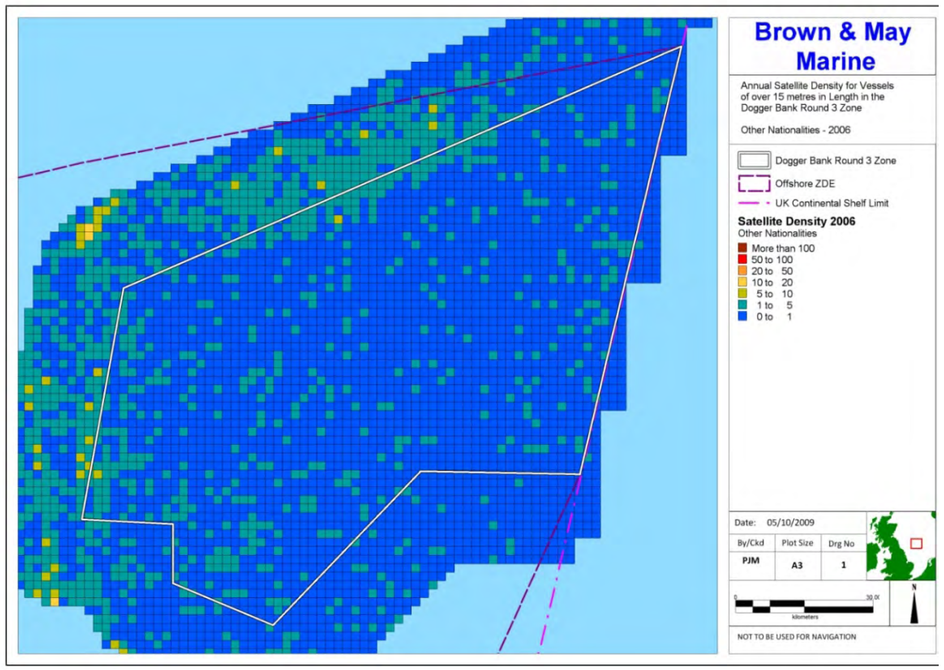


Figure 10.23: Annual satellite (VMS) density for vessels of over 15m in length of other nationalities (MMO, 2006).

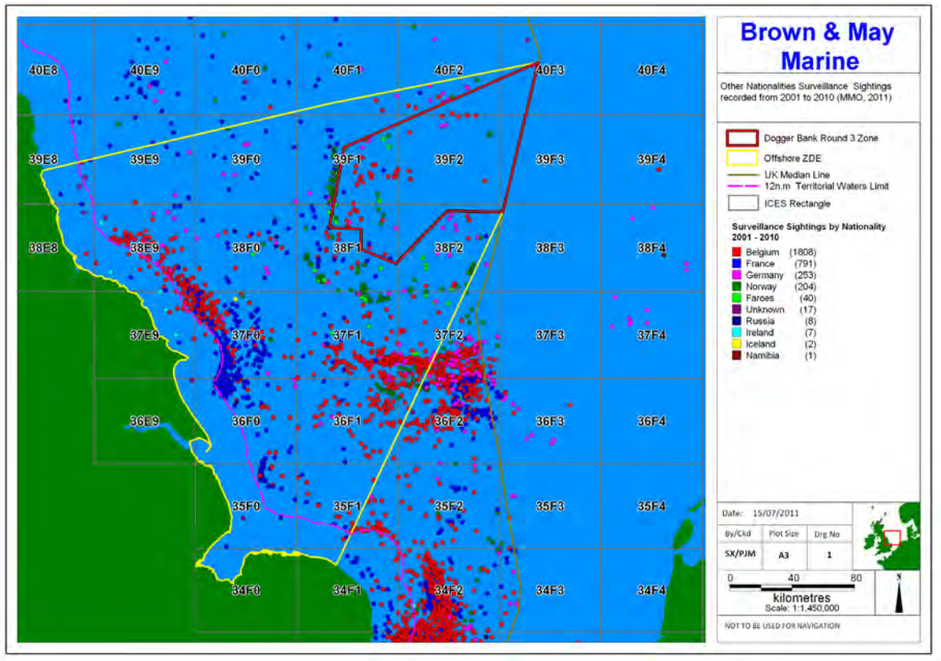


Figure 10.24: Other nationalities surveillance sightings by nationality (2001-2010) (MMO, 2011).

10.9 Summary

From the data and information given above, the Dogger Bank Zone can be characterised as an area sustaining comparatively low levels of fishing activity, mainly from Danish, Dutch and UK vessels targeting a limited number of species.

The highest numbers of vessels observed within the Zone by VMS and fisheries surveillance have been Danish demersal trawlers and UK beam trawlers. Whilst the majority of beam trawlers observed operating in the zone are categorised as UK registered vessels, they are effectively Dutch vessels, being Dutch owned and crewed.

Lower levels of seine netting and gill netting have also been recorded in the Zone, as well as occasional activity by long liners, pelagic vessels and potters.

An indication of the relative importance of the Dogger Bank Zone to UK and Dutch fishing can be gauged from a recent joint Cefas-IMARES study (Lee *et al*., 2009) of fishing activity within and adjacent to the original Dogger Bank dSAC boundary which partly covers the Dogger Bank Zone (the dSAC boundary has since been modified to produce the smaller, present day cSAC boundary) (see Figure 10.25 and Chapter 7 – *Nature Conservation*).

The Cefas-IMARES study concluded that between 2006 and 2007 for UK otter and beam trawlers, the revenue derived from fishing the core rectangles covering the dSAC area accounted for between less than 3% to 7% of their total fishing revenues from ICES sub areas IVb and IVc (i.e. the central and southern North Sea).

In the case of Dutch fishing vessels, the total values from the proposed SAC compared to those from ICES areas IVb and IVc were low at 0.8% for 2006 and 1.9% for 2007. Taking that the area of the Dogger Bank Zone is smaller than the area of the original dSAC, it is reasonable to assume that the relative value to UK and Dutch fishing of the Dogger Bank Zone will be lower than that calculated for the dSAC.

It should also be noted, however, that for certain other smaller vessel categories, the dSAC was found to be of greater relative importance. The main example cited were UK anchor seiners which derived between 76% and 90% of their annual revenues between 2006 and 2007 from within the proposed SAC area. Analysis of individual vessel VMS position plots and consultation with principal vessel owners and agents (pers com. Jubilee Fishing Company, 2010), identifies these as five Grimsby based vessels. Unfortunately insufficient data were available to make a similar assessment for Danish fishing vessels.

The VMS and surveillance data indicates that fishing activity is not uniformly distributed across the Dogger Bank Zone. The most noticeable concentration of activity is along the western boundary of the Zone. This activity is predominantly by Danish vessels, mainly targeting industrial species such as sandeels. For 2011, the Danish allocation of the EU sandeel quota for ICES areas IIa, IIIa and IV of was 228,514 tonnes out of a total 242,250 tonnes, i.e. 94% (Europa, 2011). As shown by Figure 3.9, there are extensive sandeel fishing grounds within the North Sea and those adjacent to the western boundary of the Dogger Bank Zone represent only a small proportion of the total North Sea sandeel fishing areas.

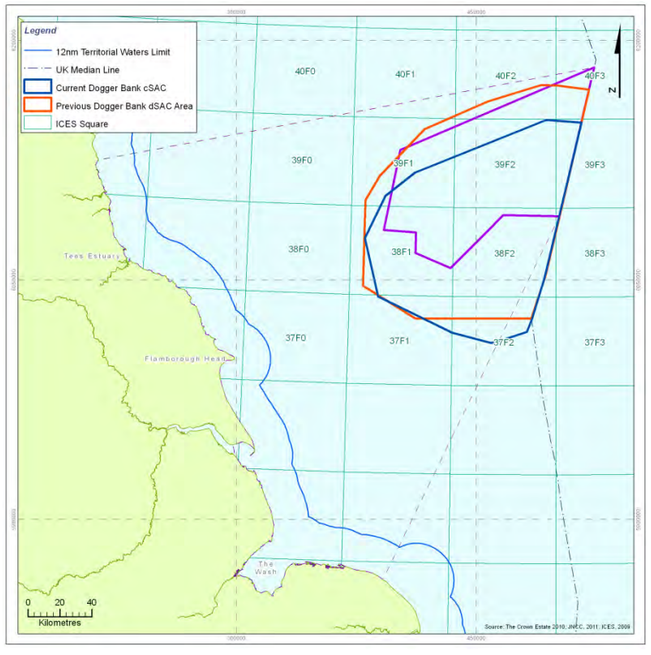


Figure 10.25: ICES rectangles present in relation to the Dogger Bank Zone, former Dogger Bank dSAC boundary and current cSAC boundary.

Lower incidences of Danish anchor seine netting and gill netting have also been observed within the southern sector of the Zone, with the seine netters generally operating in similar areas to the UK seine netters.

The majority of beam trawling within the Zone has tended to occur east of 2°E, with moderately higher densities of activity appearing to occur closer to the eastern and southern boundaries of the Zone.

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Lee J., South A., Darby C., Robinson P & Hintzen N, 2009. *Spatial and temporal analysis of VMS data to provide standardised estimates of fishing effort in consultation with the fishing industry*. Case Study: Fishing activity within proposed UK Natura 2000 area on Dogger Bank.

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11. Oil and Gas

11.1 Introduction

The oil and gas industry is well established within the North Sea and this chapter presents an overview of its activities within the Offshore Zone Development Envelope (ZDE).

Current leasing and licensing regimes mean it is possible for the same area to be licensed to an oil/gas company and an offshore wind development company at the same time. This has consequences for both industries in terms of siting infrastructure, as well as survey operations, since each developer's seismic survey programmes may impact the others.

Where oil and gas surface or subsea infrastructure exists, safety zones of 500 m radius may apply, as determined by the United Nations Convention on the Law of the Sea (UNCLOS) and the Geneva Convention on the Continental Shelf 1958 (Health and Safety Executive, 2008).

Typically, extended safety zones, up to 9 nm in radius, may surround some oil and gas surface installations to allow safe helicopter access (see Chapter 12 – *Military, Aviation and Radar*).

11.2 Data and Literature

This chapter provides a high level, desk-based appraisal of oil and gas activity existing within the Offshore ZDE. The key data and literature that have been interrogated include:

- UK DEAL (July, 2011), Department of Energy and Climate Change (DECC) (July, 2011), SeaZone (January, 2011), TNO Geological Survey of the Netherlands (TNO) (July, 2011), Norwegian Petroleum Directorate (NPD) (June, 2011), Denmark Energy Agency (DEA) (July, 2011), and the German Landesamt für Bergbau, Energie und Geologie (LBEG) (July, 2011) GIS data, detailing licence information, fields and infrastructure;
- Web-based databases provided by UK DEAL and DECC;
- DECC Oil and Gas website - provides information on oil and gas licensing, infrastructure and life cycles of oil and gas fields;
- Oil & Gas UK website; and
- Offshore Energy Strategic Environmental Assessment (OESEA): Appendix 3h – Other users and material assets (DECC, 2009), as amended by the OESEA2 (DECC, 2011a).

The GIS datasets are considered to be spatially accurate and figures based on these data are understood to be correct at the time the UK DEAL, DECC, SeaZone, TNO, NPD, DEA and LBEG datasets were published. However, given the continual development in hydrocarbon exploration and production, changes may have occurred since the data were released. UK DEAL (2011) and DECC (2011) data include details of infrastructure and activities occurring on the UK Continental Shelf (UKCS), while the SeaZone (2011), TNO (2011), NPD (2011) DEA (2011) and LBEG (2011) data have been included within the figures in this chapter to provide contextual information on activity immediately adjacent to the Offshore ZDE, beyond the UK Median.

11.3 Overview

North Sea oil and gas reserves represent an internationally significant hydrocarbon resource, the basis for a prolific industry that has developed extensively since petroleum licensing powers were extended over the UKCS under the UK Continental Shelf Act of 1964.

The Offshore ZDE is located in the Southern North Sea (Permian) Basin and the Mid-North Sea High Area of the UKCS (Oil & Gas UK, 2010a) – an area which corresponds with North Sea oil and gas fields. Within these fields there are extensive networks of surface and subsea infrastructure. At present, activity within the Offshore ZDE is mostly concentrated to the south of the Dogger Bank Zone, in the southern gas fields. The current status of licence blocks, and oil and gas infrastructure within the Offshore ZDE is summarised in the following sections.

11.4 Oil and Gas Licences

DECC's licensing system covers oil and gas within Great Britain, its territorial sea and the UKCS, and licences are issued by DECC through competitive annual Seaward Licensing Rounds under the Petroleum Act 1998 (as amended). The licence process is continuous, therefore requiring changes to be monitored and incorporated throughout the Zonal Characterisation and ZAP process. Background information on licence types and procedures can be found in Appendix F.

In addition to extant licences, further licences were applied for during the 26th Round in 2010. Screening under the Habitat Regulations 2010 identified 56 licence applications in the southern North Sea as having the potential to impact relevant European sites of nature conservation importance, and these were taken forward to Appropriate Assessment (DECC, 2011b). The 56 licence applications considered in the Appropriate Assessment are detailed in Table 11.1 below; 33 of these are within the Offshore ZDE. In total, 31 licences were awarded in the Offshore ZDE during the 26th Round without requiring Appropriate Assessment.

Table 11.1: 26th Round licence applications selected for Appropriate Assessment (DECC, 2011b).

26th Round licence blocks included in Appropriate Assessment							
41/18	41/19	41/20	41/24	41/25	42/27	43/15a	43/20a
43/20c	44/01	44/02	44/03	44/04	44/05	44/14	44/15
44/16a	44/17d	44/17e	44/17f	44/18c	44/23c	44/23d	44/24c
44/30	45/01	47/02b	47/03g	47/06	47/07	47/13b	47/18
47/19b	48/08d	48/09b	48/14c	48/18e	48/19d	48/20b	48/25a
48/30c	49/14a	49/17d	49/18b	49/19b	49/21c	49/22b	49/23b
49/23c	49/24d	49/26b	49/27c	49/28c	52/05c	53/01b	53/02c

The Appropriate Assessment (DECC, 2011b) was made available for public consultation in May 2011. The conclusions of the Appropriate Assessment are that exploration and production in these licence blocks will not affect the integrity of relevant European sites, though a formal decision on licences will not be made until after the consultation period, which closes on the 19th August 2011.

The licence status of all blocks within the Offshore ZDE at the time of writing are presented in Figure 11.1 and listed in Appendix G.

Pending the outcome of the consultation on the OESEA2 (DECC, 2011a), DECC is minded to publish a notice in the Official Journal of the European Union inviting applications under the 27th Seaward Licensing Round. The exact areas available in the Round will be subject to the conclusions of the OESEA2 and Ministerial decisions.

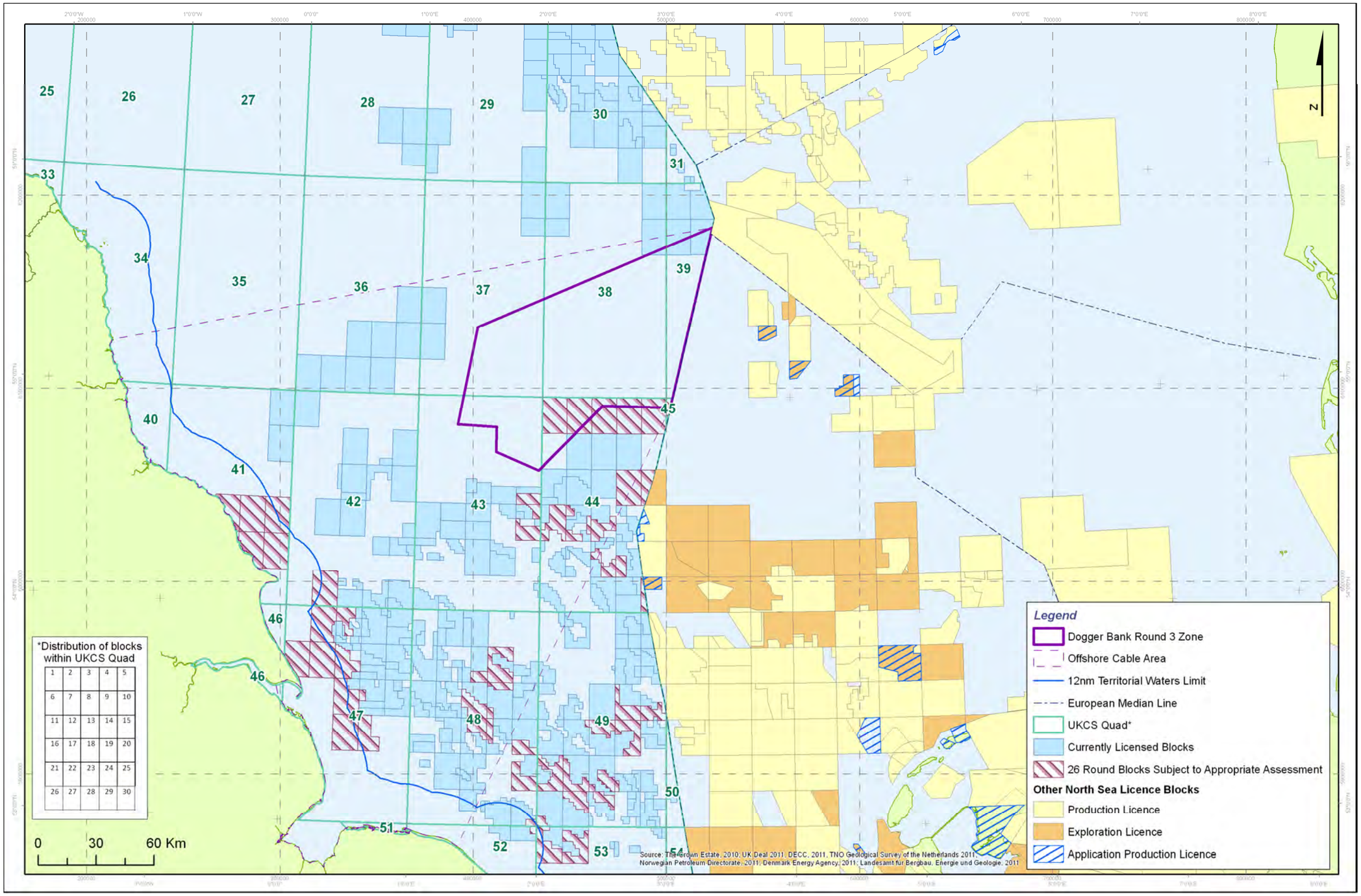


Figure 11.1: Status of licence blocks within and around the Offshore ZDE.

11.4.1 Dogger Bank Zone

UK DEAL data (2011) indicates that four blocks, located partially within the Dogger Bank Zone, are currently licensed (Figure 11.1 and Table 11.2). 26th Round applications for 'Promote' type licences for blocks 44/01 to 44/05 and for 45/01, with proposals to conduct seismic surveys and "drill-or-drop", may be successful pending the formal outcome of the recent Appropriate Assessment (DECC, 2011b). DECC's "drill-or-drop" condition means a licence will expire if, during the licence's initial term, the licensee cannot make a commitment to drill (see Appendix F for summary of licence types).

A licence, held until recently by PA Resources UK Limited, for blocks 43/09, 43/10 and 44/06 in the south of the Dogger Bank Zone was relinquished in early 2011 following the 26th Round.

Table 11.2:Current licences within the Dogger Bank Zone (UK DEAL, 2011; DECC, 2011c).

Licence Block	Licence Number	Licence Type	Licensee	Effective	Expiry
44/07	P1730	Promote	Volantis	01/05/2010	01/05/2036
38/10	P1829	Traditional	Nexen	10/01/2011	10/01/2037
39/06	P1829	Traditional	Nexen	10/01/2011	10/01/2037
39/07	P1829	Traditional	Nexen	10/01/2011	10/01/2037

Block 44/07 is a Promote type licence held by Volantis Exploration Limited. In 2008, Volantis entered into a strategic alliance with Venture North Sea Gas to bid for Licences and has submitted applications both in its own right and in partnership with Venture North Sea Gas (Volantis, 2010).

Blocks 38/10, 39/06 and 39/07 in the northeast corner of the Dogger Bank Zone form part of a 26th Round award to Nexen Petroleum U.K. Limited in partnership with Apache North Sea Limited and Bayerngas Europe Limited for a Traditional licence (DECC, 2011c) (see Appendix F for summary of licence types). The licence includes a firm commitment to drill one well and undertake seismic surveys (DECC, 2010a).

11.4.2 Offshore Cable Area

There are a total of 180 licences (whole or partial blocks) within the Offshore Cable Area, including the same four blocks which were noted as occurring partially within the Dogger Bank Zone (see Figure 11.1) (UK DEAL, 2011). 31 of these blocks were awarded licences in the recent 26th Licensing Round, with a further 32 blocks awaiting the outcome of the recent Appropriate Assessment and a formal licence agreement.

There are no Fallow blocks listed in DECC's latest (January 2011) annual Fallow block release list (DECC, 2011d) as occurring within the Offshore ZDE (see Appendix F for summary of licence types). Previously released Fallow blocks have since been relinquished.

11.5 Seismic Survey Activity Relating to Oil and Gas

Seismic exploration is undertaken by oil and gas operators for licensing purposes. The Offshore Petroleum Activities (Conservation of Habitats) 2001 Regulations require holders of a Production or Exploration Licence to obtain written consent before carrying out geological surveys (including seismic) or shallow water drilling wholly or partly on the UKCS. A company must apply to DECC for consent using the Petroleum Operations Notices 14 (PON 14) process. The PON 14 requirement also applies to companies undertaking speculative surveys, not directly related to a particular licence exploration programme. DECC register details of PON 14 applications and consents on their website (DECC, 2011e).

There are two potential conflicts posed by simultaneous seismic surveys:

- Potential health and safety concerns associated with the limited manoeuvrability of vessels due to the amount and length of equipment being towed; and
- Potential impacts to data integrity due to the seismic survey sources utilised by the oil and gas industry being considerably more powerful than those required for offshore wind survey investigations.

These factors could lead to significant programme delays as the seismic data required by Forewind underpins the geological understanding of the Dogger Bank Zone.

Table 11.3 and Figure 11.2 present UKCS quads and blocks in proximity to the Offshore ZDE (Quads 25 to 54) which have PON 14 applications for seismic surveys (as of 20th July 2011) and which, therefore, have the potential to impact on Forewind's own surveying operations.

Table 11.3: PON 14 applications for UKCS seismic surveys in proximity to the Offshore ZDE (Quads 25 to 54 as of 20th July 2011) (DECC, 2011e).

DECC Ref.	Quad / Block	Operator	Proposed Start	Proposed End	Consented
2270	38/30, 39/26, 44/04-05, 44/09-10, 44/13-15, 44/18-19, 44/24, 45/01	Fugro	01/09/2010	31/12/2011	23/08/2010
2355	Quads 29 and 30 (various blocks)	Conoco Phillips UK Ltd	15/03/2011	10/08/2011	17/11/2010
2382	29/04d, 29/05b, 29/05c	Total	01/05/2011	15/09/2011	19/11/2010
2400 / 2401	Quads 43 and 44 (various blocks)	CGG Veritas	01/03/2011	31/12/2011	11/03/2011
2404	Quads 28 and 29 (various blocks)	CGG Veritas	01/03/2011	31/12/2011	25/02/2011
2412	38/05, 38/10, 39/01, 39/06a	Nexen	21/01/2011	21/06/2011	17/01/2010
2438	Quads 28 and 29 (various blocks)	Ikon Science	01/04/2011	01/09/2011	
2444	Quad 29 (various blocks)	BP	15/04/2011	05/09/2011	20/04/2011
2466	44/19b	Tullow Oil SK Ltd	01/04/2011		27/04/2011
2469	28/03-05, 28/08-10, 28/13-15, 29/01- 02, 29/06-07, 29/11	Polarcus UK Ltd	01/05/2011	31/08/2011	10/05/2011
2472	29/01c	Summit Petroleum	01/04/2011	31/10/2011	24/03/2011
2481	29/10	Ithaca	01/04/2011	14/07/2011	01/04/2011
2482	28/3-5, 28/8-10, 28/13-15, 29/1, 29/6, 29/11	Dolphin Geophysical Limited	01/04/2011	01/10/2011	10/06/2011
2486	30/06	Ithaca	01/04/2011	14/07/2011	01/04/2011
2487	30/13	GDF Suez E&P UK Ltd	30/03/2011	15/05/2011	06/04/2011
2488	30/01d	Maersk	06/04/2011	31/05/2011	04/04/2011
2493	28/04	Western Geco Ltd	11/04/2011	31/07/2011	12/04/2011
2497	30/02a	Maersk	27/04/2011	31/05/2011	03/05/2011
2510	30/16	Talisman	25/04/2011	10/06/2011	04/05/2011
2517	42/28d to 42/28l	E.On Ruhrgas UK	01/09/2011	tbc	23/06/2011
2518	29/05	Total	29/04/2011	21/06/2011	28/03/2011
2522	48/16b, 48/17b, 48/17d	Hansa Hydro-carbons Limited	28/04/2011	31/07/2011	28/04/2011
2525	49/30b-FT	Tullow	15/06/2011	tbc	11/07/2011
2536	30/24, 30/29	Enquest Britain Ltd	20/05/2011	20/07/2011	20/05/2011
2539	28/1-11, 29/1-3	PGS Exploration (UK) Ltd	28/05/2011	31/11/2011	31/05/2011
2560	28/1-11, 29/1-3	PGS Exploration (UK) Ltd	11/07/2011	31/09/2011	
2563	48/1a	Dana	30/07/2011	31/08/2011	
2565	29/15, 29/20, 30/8, 30/13, 30/16, 30/18, 30/21	CGG Veritas	14/07/2011	31/08/2011	08/07/2011
2570	44/28b	Tullow Oil SK Ltd	08/07/2011	20/08/2011	01/07/2011

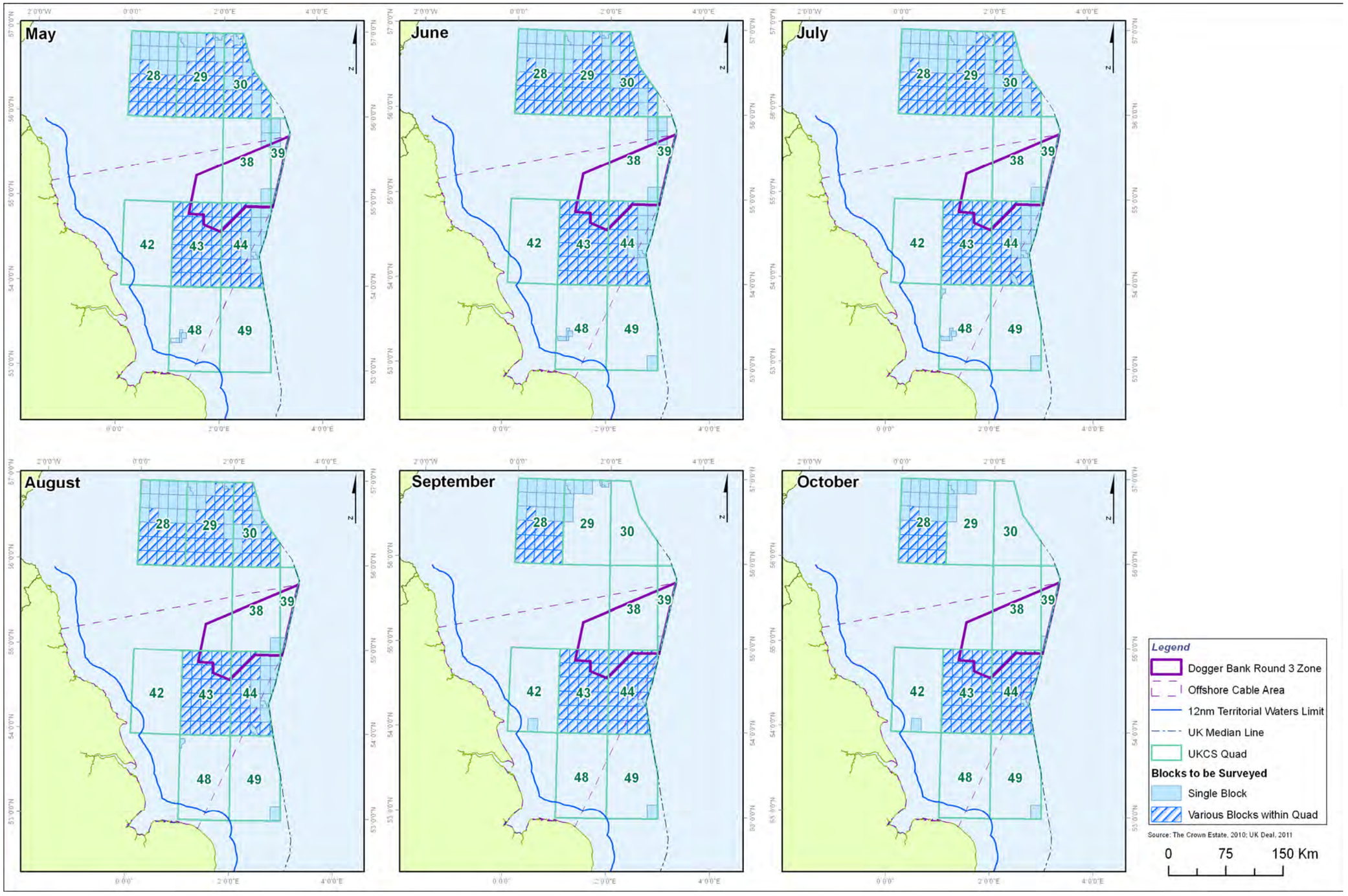


Figure 11.2: Known UKCS blocks subject to oil and gas seismic surveys in proximity to the Offshore ZDE (Quads 25 to 54 as of 20th July 2011) (DECC, 2011e).

11.6 Fields

A field is a geographical area under which an oil or gas reservoir lies and where the reservoir is the underground formation where oil and gas has accumulated. The Dogger Bank Zone and the Offshore Cable Area lie in the southern North Sea and almost all the hydrocarbon fields in this area are gas fields. The locations of fields in the Offshore ZDE are shown in Figure 11.3. Fields are defined by UK DEAL (2011) as Producing, Not Producing, Under Development and Discovery.

The Cygnus field, situated in UKCS blocks 44 /11 and 44/12 to the south of the Dogger Bank Zone (see Figure 11.3), was first discovered in 1988 while drilling in block 44/12. However, the reservoir quality and fluid content of this field was not fully understood until appraisal wells were drilled in 2009 and 2010. Preliminary estimates indicate that the field may have reserves of two trillion cubic feet of gas (Offshore Technology, 2010). Field is operator, GDF Suez, owns a 38.75% stake, Centrica has a 48.75% stake and Endeavour holds the remaining 12.5%.

The Breagh gas field is a recent discovery located in block 42/13 (see Figure 11.3). Field developments have been proposed by RWE Dea UK SNS Ltd which owns a 70% interest, with the remaining 30% share belonging to Sterling Resources Ltd.

As fields become depleted, and the UK's need for gas imports and storage increases, some fields in the Offshore ZDE are being converted into natural gas storage sites. One such site currently exists at the Rough offshore gas field and in October 2010 ENI were awarded a gas storage licence for the Deborah field near the Bacton gas terminal in Norfolk, just beyond the Offshore ZDE boundary (DECC, 2010b). There are also proposed sites within the Offshore ZDE at the Forbes, Esmond and Gordon gas fields (Figure 11.3). Depleted fields also have the potential to be used for Carbon Capture and Storage and this is discussed further in Chapter 15 – *Other Marine Users*.

11.7 Surface Infrastructure

The main types of surface infrastructure include:

- Platforms;
- Floating Production, Storage and Offloading vessels (FPSO's); and
- Drilling rigs (jack-up and semi-submersible).

These are described more thoroughly in Appendix F. Surface structures are automatically protected by a 500 m safety zone measured from the perimeter of each structure (Health and Safety Executive, 2008) and a further 6 nm safety zone surrounds surface installations to allow for helicopter access (Civil Aviation Authority, 2010).

There is currently no surface infrastructure in the Dogger Bank Zone; however there are 69 surface structures present in the Offshore Cable Area (UK DEAL, 2011) and these are shown in Figure 11.4 and described in Appendix G. The majority of these are found to the south and southwest of the Offshore ZDE.

Between mid-2011 and mid-2012, RWE dea UK will be developing the recently discovered Breagh gas field in UKCS block 42/13. Proposals include a platform, Breagh Alpha (see Figure 11.4), seven wells and a pipeline connecting the field to the Teesside gas terminal (RWE dea UK SNS Ltd, 2010).

Booster Platform 37/4A, situated to the north of the Offshore ZDE, and Booster Platform 36/22A, to the west of the Dogger Bank Zone are both located on the Ekofisk 2/4J to Teesside pipeline (the 'Norpipe'), which is discussed in Chapter 14 – *Cables and Pipelines*. UK DEAL (2011) indicates that both booster platforms are active, though it should be noted that ConocoPhillips, the principle owners and operators of infrastructure linked to the Ekofisk field, are taking steps towards decommissioning and removing such infrastructure between 2009 and 2013 (ConocoPhillips, 2009; Petroleum Safety Authority Norway, 2009).

Wells shown in Figure 11.4 with the status 'drilling' are likely to have drilling rigs present as at the time of the UK DEAL 2011 data release.

The SeaZone (2011), TNO (2011), NPD (2011) DEA (2011) and LBEG (2011) datasets indicate that surface infrastructure is also present to the east of the Offshore ZDE, on the Dutch, German, Danish and Norwegian continental shelves (see Figure 11.4).

11.8 Subsea Infrastructure

The main types of subsea infrastructure include:

- Wells ('production'; 'completed'; 'suspended' or 'plugged and abandoned');
- Subsea trees;
- Subsea templates; and
- Subsea manifolds.

The structures are defined in Appendix F. Manifolds and production wells associated with surface infrastructure may have a 500 m safety zone surrounding them. However, most subsea structures, including all wellheads in the Dogger Bank Zone, do not have safety zones making it imperative that their positions are well defined. Appendix G lists all wellheads and other subsea infrastructure occurring within the Offshore ZDE.

11.8.1 Dogger Bank Zone

There are 16 exploration wells evenly distributed across the Dogger Bank Zone (Figure 11.4, Table 11.4). These are all plugged and abandoned with the possible exception of well 43/10-1 which is reported by UK DEAL(2011) to be complete but released as a 'dry hole'. DECC (2011f), however, class the well as abandoned. Nine of the plugged and abandoned wells were released in the 1970s with the most recent being released on 25th January, 2010 by ExxonMobil (UK DEAL, 2011). Former Licence P1259, which included parts of Quads 37 and 38 within the Dogger Bank Zone, was relinquished following its Exploration Term, having identified no viable hydrocarbons (Esso Exploration and Production UK, 2009). UK DEAL (2011) lists all of the wells in the Dogger Bank Zone as dry holes (except well 39/16-1 which is unknown), indicating that there have been no significant hydrocarbons found in the Dogger Bank Zone to date.

Table 11.4: Wellheads in the Dogger Bank Zone (UK DEAL, 2011).

Well	Status	Completion Date	Operator	Release Date	Water Depth
37/23- 1	Abandoned	29/07/1970	Chevron	08/08/1977	38.1 m
37/25- 1	Abandoned	13/03/2009	ExxonMobil	25/01/2010	40.0 m
38/16- 1	Abandoned	21/10/1967	BP	09/01/1976	40.5 m
38/18- 1	Abandoned	29/07/1967	BP	09/06/1976	39.9 m
38/22- 1	Abandoned	07/11/1967	Chevron	09/06/1976	35.4 m
38/24- 1	Abandoned	04/10/1983	BP	03/07/1989	32.0 m
38/25- 1	Abandoned	21/06/1969	BP	08/08/1977	30.5 m
38/29- 1	Abandoned	31/03/1965	Chevron	09/06/1976	26.8 m
43/03- 1	Abandoned	25/07/1966	BHP	09/06/1976	26.8 m
39/7- 1	Abandoned	31/07/1971	ENI	22/01/1979	51.2 m
39/11- 1	Abandoned	13/06/1971	ENI	22/01/1979	44.2 m
39/16- 1	Abandoned	17/07/1997	HESS	22/04/2003	33.8 m
43/02- 1	Abandoned	17/02/1989	BP	05/12/1994	28.0 m
43/03- 1	Abandoned	26/07/1966	Whitehall	09/06/1976	26.8 m
43/05- 1	Abandoned	09/06/1994	BHP	30/05/2000	24.2 m
43/10- 1	Completed	24/03/1997	BP	21/10/2002	28.7 m
44/06- 1	Abandoned	22/11/1992	BP	06/08/1998	22.6 m

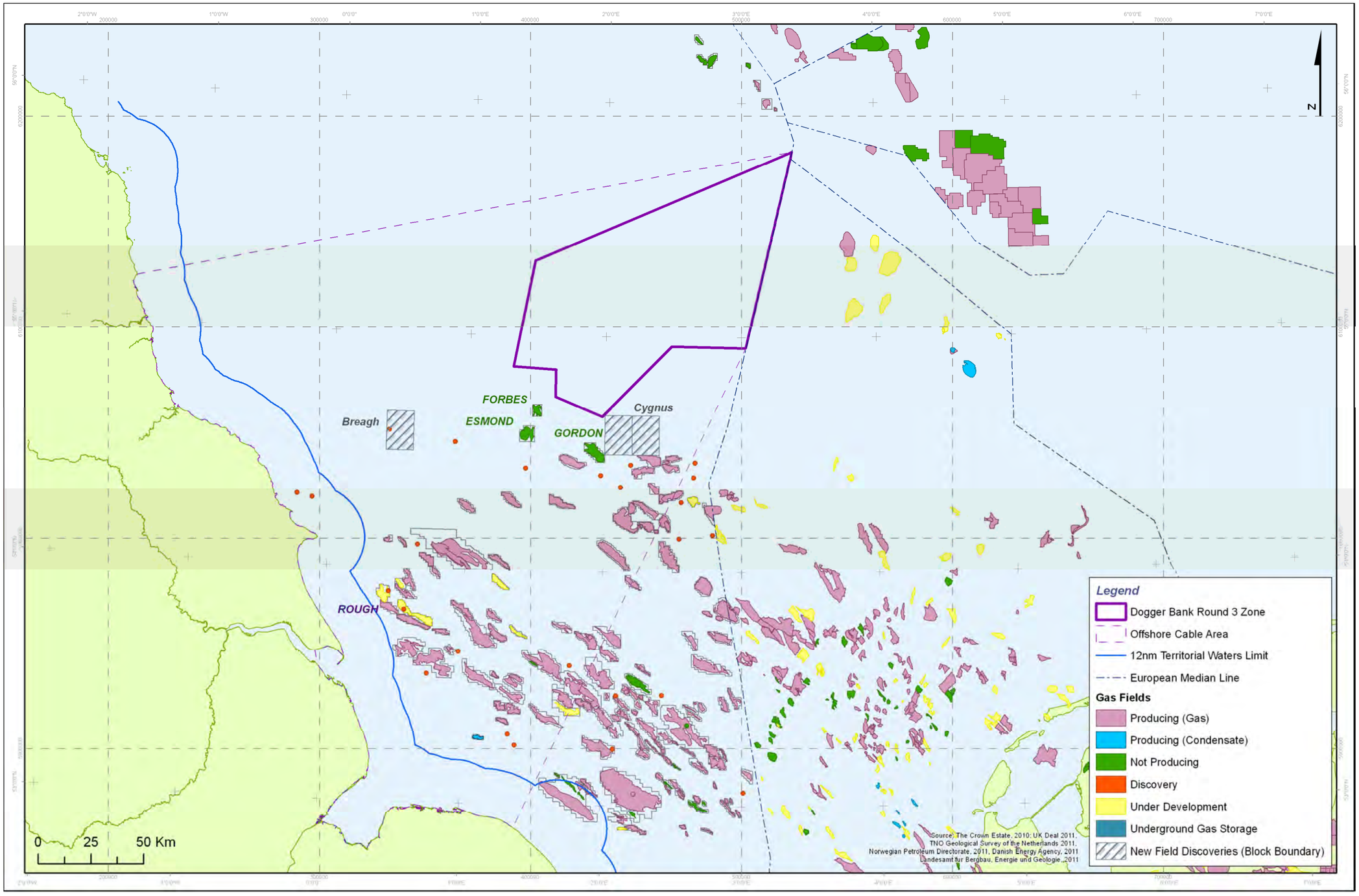


Figure 11.3: Location of oil and gas fields within the Offshore ZDE. The Field Determination Boundary is the boundary for legal and tax purposes and is determined by DECC based on the consented Field Development Plan.

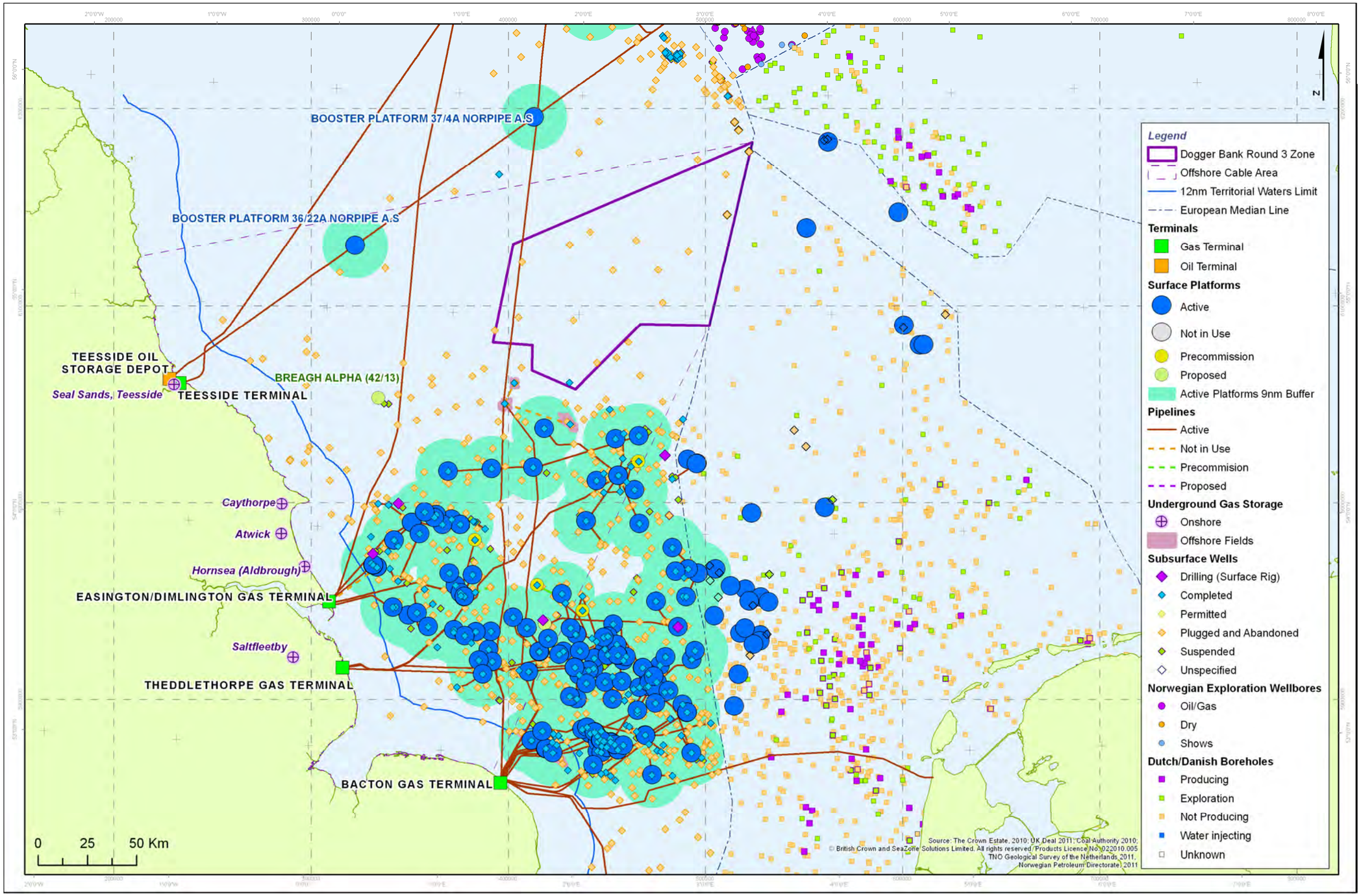


Figure 11.4: Oil and gas surface and subsea infrastructure within the Offshore ZDE and surrounding waters.

11.8.2 Offshore Cable Area

Subsea infrastructure within the Offshore Cable Area is extensive and, like the surface infrastructure, is more concentrated in the gas fields in the south of the Offshore ZDE. The subsea infrastructure is shown in Figure 11.4 and the different types summarised in Appendix F. There are in excess of 900 wells in the Offshore Cable Area and details of these can also be found in Appendix G.

The SeaZone (2011), TNO (2011), NPD (2011) DEA (2011) and LBEG (2011) datasets indicate that subsea infrastructure is also present to the east of the Offshore ZDE, on the Dutch, German, Danish and Norwegian continental shelves (see Figure 11.4).

11.9 Pipelines

Pipelines transport oil, gas or gas condensate between wellheads, platforms and land based terminals. Depending on the size and use of a pipeline some are laid directly on the seabed and some are trenched and back-filled. Further details of pipelines are given in Chapter 14 – *Cables and Pipelines*.

11.10 Decommissioning of Installations and Licence Relinquishments

When offshore facilities become redundant, the owners of the offshore infrastructure are responsible for preparing and carrying out a decommissioning programme (DECC, 2011g). DECC's decommissioning unit works with operators to develop a programme that meets all domestic and international obligations and which addresses the reasonable concerns of stakeholders.

Under DECC's licensing process, operators are required to relinquish parts of their licensed areas at timescales stipulated within the licensing agreement. Table 11.5 summarises the relinquishment obligations of oil and gas operators required by DECC (DECC, 2011g).

Table 11.5: Relinquishment requirements for Seaward Production Licences (DECC, 2011g).

Seaward Production Licence Type	Relinquishment Requirements
Traditional	50% of area after the initial term (4 years)
Promote	50% of area after the initial term (4 years)
6 yr Frontier	75% of area after 3 years, with 50% of the remainder after a further 3 years
9 yr Frontier	75% of the area after 3 years, with 50% of the remainder after a further 6 years

11.10.1 Dogger Bank Zone

Information available from DECC (2011h) indicates that there are currently no decommissioned installations within the Dogger Bank Zone.

Licence relinquishments in the Dogger Bank Zone during the period 2002-2011 have been concentrated in the northeast and southeast parts of the Zone (DECC, 2011c) and include the relinquishment of blocks 43/09, 43/10 and 44/06 in the south of the Dogger Bank Zone following the 26th Round (see Figure 11.1 and Figure 11.5). Further details are provided in Appendix G.

Table 11.6: Decommissioned installations within the Offshore ZDE (DECC, 2011h).

Field	Operator	Main Installation	Approved Decommission Option	Year Approved
Forbes and Gordon	BHP Billiton	Infield Pipelines	Decommission in situ – retrench any area of pipeline with less than 0.4m depth of cover	2003
Esmond	BHP	2 x fixed steel platforms	Removal to shore	1995
Gordon	BHP	Fixed steel platform	Removal to shore	1995
Forbes	BHP	Fixed steel platform	Removal to shore	1993

11.10.2 Offshore Cable Area

DECC's list of decommissioned installations (2011h) indicates that four decommissioned installations exist within the Offshore Cable Area. Table 11.6 summarises these installations and the respective fields.

The locations of these fields are indicated in Figure 11.3 and are to the south west of the main Dogger Bank Zone. The fields are no longer producing hydrocarbons. It is not known whether any structures remain on the seabed following the removal of the platforms.

In addition to the decommissioned installations, the majority of licence blocks in Quads 44, 47 and 48, where exploration has been most concentrated in the Offshore Cable Area, have undergone some type of licence relinquishment in the period 2002-2011 (DECC, 2011c). A total of 61 licence blocks or partial blocks have been relinquished by licence holders since the 26th Round of licensing (see Figure 11.5), and further details are provided in Appendix G.

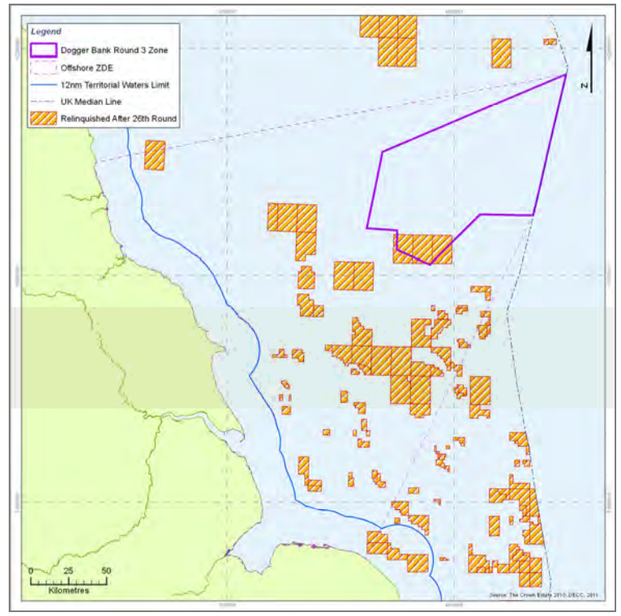


Figure 11.5: Licences relinquished following the 26th Round.

11.11 Terrestrial Facilities

Major land-based gas terminals within the Onshore ZDE are located at the coast at Teesside, Easington and Theddlethorpe where a number of pipelines make landfall (Figure 11.4). There is also a major gas terminal just outside the ZDE, at Bacton; these are all discussed further in Chapter 14 - *Cables and Pipelines*.

Shore based Underground Gas Storage facilities also exist at the coast at Hornsea (Aldbrough), Atwick, Seal Sands (Teeside), Caythorpe and Saltfleetby (Figure 11.4). These facilities utilise underground salt caverns (aquifers) which have been desalinised and dewatered prior to the pumping and extraction of gas through a single borehole.

11.12 Future Projections and Exploration

The Oil & Gas UK annual activity survey reports on the industry's activity on the UKCS from the previous year and provides projections for the next four to five years. The survey is based on

the latest data supplied by all the leading exploration and production companies operating in the UK. Overall, the 2010 survey suggested that UKCS production had been in decline during recent years, owing mostly to a lack of investment since 2006 (Oil & Gas UK, 2010b). However, at the beginning of 2011, the survey detected an increase in proven reserves and a lower rate of decline in production than had been observed over the previous ten years, indicating a greater amount of investment and development than had been suggested by earlier predictions. The trend is expected to increase over 2011 and 2012 (Oil & Gas UK, 2011a). However, despite the increase in investment, the long term trend for UKCS oil and gas is still one of decline. Operating costs have increased and the UK Government's Budget, released in March 2011, increased taxes on North Sea oil and gas production. Oil & Gas UK (2011b) anticipate that the rate of decline is expected to increase as a result of the new Budget.

Certainly, with the number of existing fields in the UKCS ceasing to produce hydrocarbons, Oil & Gas UK (2011b) predict that the rate of decline will increase from approximately 4% per annum to 5.5% per annum over the next decade. This declining trend is also projected by DECC (2011i) up until 2016 (see Figure 11.6).

A general decline in production does not, however, mean an immediate decrease in interest in exploration and potential production in the southern North Sea. A decline in the number of production wells drilled over the past 12 years has been countered somewhat by a slow increase in exploration and appraisal well drilling (Oil & Gas UK, 2011a) and a focus on previously less occupied areas.

Further, the recent increase in proven reserves includes the realisation of one of the largest gas fields in the southern North Sea, the Cygnus field to the south of the Dogger Bank Zone (see Section 11.6).

Historically, the Dogger Bank Zone has not been a significant production area as can be inferred from the absence of fields and hydrocarbon yielding wells. However, the recent focus on the Cygnus field and 26th Round licence applications indicate renewed potential for exploration and development interest within the boundary of the Dogger Bank Zone. The acreage and blocks available for 27th Licensing Round is expected to be announced in early 2012.

Future exploration and production in the Offshore ZDE will therefore need to be followed closely and Forewind are engaged in discussions with key operators in order to better understand their interests and opportunities for co-existence.

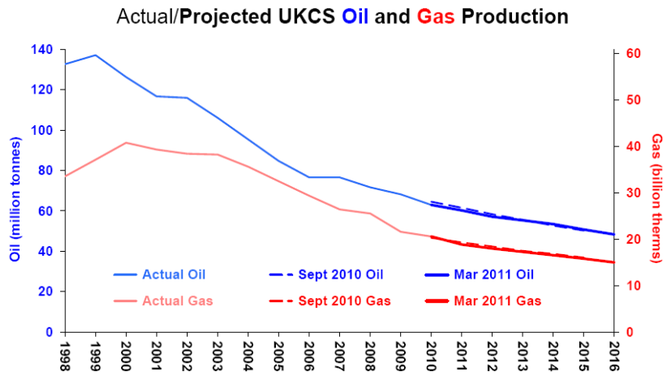


Figure 11.6: Actual and Projected UK oil and gas production and demand (DECC, 2011i).

11.13 Summary

Currently, oil and gas activity in the Dogger Bank Zone is mainly restricted to a low density of plugged and abandoned exploration wells spread evenly across the Zone without any associated surface infrastructure. There is one completed well in the south but this is a reported dry hole and has been released.

Currently only blocks in the south or northeast of the Dogger Bank Zone are licensed for oil and gas operations, with additional blocks pending the formal outcome of the Appropriate Assessment. Any licensing, exploration and development activity and infrastructure will need to be considered and on-going communication with all licence holders will be important.

In the Offshore Cable Area, many oil and gas structures exist and should be an on-going focus in further Zonal Characterisation work. An area with a particularly high oil and gas activity level exists to the south west of the Dogger Bank Zone in the south of the Offshore Cable Area.

As a result of the changing conditions in the oil and gas sector and the commercial sensitivity of future plans it is particularly difficult to project future oil and gas interest in the large Offshore ZDE. This highlights the need for thorough communication with oil and gas operators in order to ensure oil and gas and wind energy interests do not conflict.

Awards of licences in future Rounds will change the baseline description for oil and gas with potential new infrastructure and installations being constructed. It is therefore important that the Zonal Characterisation captures these changes. To achieve this, the most up to date data sets will be sourced at each stage of the planning process.

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12. Military, Aviation and Radar

12.1 Introduction

The Ministry of Defence (MoD) and Civil Aviation Authority (CAA) have a shared interest in UK waters and overlying airspace. The MoD has rights to practice aerial, surface and submarine operations, which occur within defined Practice and Exercise Areas (PEXA), while the CAA requires the safe passage of aircraft to and from airports and aerodromes. Both operate Communications, Navigation and Surveillance (CNS) infrastructure (e.g. radar and technical sites) to monitor airspace.

Wind turbine arrays are considered to affect military, aviation and radar activities by:

- Creating a physical obstruction which excludes activities or compromises safety; and
- Effecting CNS infrastructure and other equipment through electromagnetic interference (WEDCA, 2002).

The CAA and National Air Traffic Services (NATS) may object to developments which threaten air safety, and similarly, the MoD may object where there is potential for its activities and national security to be compromised.

This chapter considers the occurrence and extent of the following activities within the Offshore ZDE:

- MoD exercises;
- Civil aviation activities;
- Offshore Helicopter Main Routes, Search and Rescue;
- The extent of civil and military CNS; and
- Met Office Radar.

12.2 Data and Literature

The information provided in this chapter has been based upon a review of the following:

- SeaZone data (January 2011) detailing military PEXA areas and aeronautical sites (aerodromes);
- UK Hydrographic Office (UKHO) PEXA charts Q6401 and Q6405, as amended by Notice to Mariners 0455/2010, 4915/2006 and 5194/2005;
- NATS En-Route Ltd (NERL) 'Self Assessment' Primary Surveillance Radar interference zones, and consultation zones for Secondary Surveillance Radar sites, navigation aids and Air-Ground-Air (AGA) communication stations (July 2010);
- CAA Helicopter Main Routes (HMRs);
- The CAA and NATS UK Integrated Aeronautical Information Publication (IAIP) (CAA and NATS, 2011) and relevant CAA Civil Aviation Publications (CAPs);
- Interim Guidelines for Wind Energy and Aviation Interests, as detailed in the Wind Energy, Defence & Civil Aviation Interests Working Group report (WEDCA, 2002);
- Offshore Energy Strategic Environmental Assessment (SEA), Appendix 3h – Other users and material assets, s amended by the Offshore Energy SEA 2 (Department of Energy and Climate Change (DECC), 2009; 2011); and
- Technical reports produced by XY Associates (2009a, 2009b).

In addition, general enquiries were made to the safeguarding departments of NATS and the MoD. The NERL Radar interference zones and consultation zones were accurate as of June 2010. Beyond that date they are considered indicative and subject to change.

The aforementioned data and literature provide an overview of military activity, civil aviation and radar extents within the Offshore ZDE. It should be noted however that the precise offshore extents of some military activities such as low flying and military CNS have not been formally defined.

12.3 Overview

The Offshore ZDE includes areas used for military, aviation and radar purposes. Two MoD PEXAs are known to intersect the southwest of the Dogger Bank Zone, specifically an air force danger area and a submarine exercise area. Other PEXAs occur across the Offshore Cable Area and include army and air force danger areas at the coast used for live firing and demolition of unexploded ordnance.

Civil aviation infrastructure and activities are less likely to be directly affected by the physical presence of wind turbines in the Dogger Bank Zone, though consideration is given to Helicopter Main Routes (HMR) and Search and Rescue (SAR) operations.

CNS infrastructure and the potential for interference from wind turbines are more complex issues. NERL self assessment data and Forewind correspondence with the MoD, NATS and the CAA suggests that civil airspace and air traffic management systems, and meteorological radar are unlikely to be affected by development in the Dogger Bank Zone, owing to the distance from shore. The offshore extents of military long range CNS systems and are currently less well understood.

12.4 Ministry of Defence Exercises

The MoD has access to UK airspace and waters for air force, navy and army operations training. During peacetime, these occur within defined training areas, including PEXA. The presence of a PEXA does not preclude other activities except for some firing and danger areas where airspace restrictions can apply. A number of PEXA are present within the Offshore ZDE. Each PEXA is presented in Figure 12.1, with the details of each summarised in Table 12.1.

Military aerodromes onshore are subject to individual safeguarding criteria.

12.4.1 Dogger Bank Zone

The PEXA within the Offshore ZDE include part of the Southern Managed Danger Area (MDA), designated as D323B, an air force PEXA which overlaps the southwestern part of the Dogger Bank Zone. D323B, is designated for Air Combat Training and High Energy Manoeuvres between altitudes of 5,000 and 66,000 feet. The area incorporated within the Dogger Bank Zone is approximately 6% of the D323B PEXA and 2% of the entire Southern MDA. The large Flamborough Head submarine exercise area also overlaps the southwest of the Zone. Wind turbines have the potential to cause acoustic disturbance to submarine SONAR as well as causing a physical obstruction.

The easterly limit of the Staxton danger area (D412), used for Air to Air Firing, lies two kilometres to the west of the Dogger Bank Zone.

Low flying can take place in airspace below 2,000 feet over all UK offshore waters, though there are no formal designated areas for this activity and no Tactical Training Areas over the sea beyond the Low Flying System (LFS) limit of 3 nautical miles offshore (WEDCA, 2002; DECC, 2009; 2011). Consequently, the Dogger Bank Zone does not incorporate any such formal low flying designations.

Offshore aerospace may be within the aircraft approach and exit path for RAF Spadeadam, located 242 km west of the Dogger Bank Zone in Cumbria. RAF Spadeadam is home to the Electronic Warfare Tactics Range (EWTR), Europe's only facility for electronic warfare training, where British and NATO forces practice high energy and high speed tactical radar and missile avoidance manoeuvres at altitudes as low as 100 feet (XY Associates, 2009a; WEDCA, 2002).

12.4.2 Offshore Cable Area

Further to the Southern MDA and submarine exercise area occurring within the Dogger Bank Zone, other air force PEXA extend over the Offshore Cable Area. Sections of the Southern MDA extend to the south and west of the Zone and represent wider coverage of the Offshore Cable Area than any other PEXA. The Staxton danger area (D412) and Druridge Bay danger areas (D513, D513A and D513B) lie to the west of the Zone and are used for Air to Air Firing at various altitudes from surface level up to 23,000 feet. D513A is also used for ship manoeuvres though these are non firing exercises. The Flamborough Head and Outer Silver Pit areas are used for submarine exercises (see Figure 12.1).

At the coastline, air force danger areas at Holbeach (D207), Cowden (D306), Donna Nook (D307) and Wainfleet (D308) are outlined for a range of air to surface firing and bombing activities, as well as for the demolition of unexploded ordnance. An army PEXA at Rowlston (X5309) is used for surface firing exercises. The army firing facility, X5405, at Whitburn near Newcastle has been relinquished, as detailed in Notice to Mariners 0455/2010.

Table 12.1: MoD Practice and Exercise Areas occurring in the Dogger Bank Zone and Offshore Cable Area (Source: UKHO, 2004a; UKHO, 2004b; Notice to Mariners 5194/2005; Notice to Mariners 4915/2006).

Location	Serial No.	Name	Type	Practice	Altitude Range
Dogger Bank Zone	D323B	Southern MDA	RAF Danger Area	Air Combat Training, High Energy Manoeuvres	5 – 66. (5,000 to 66,000 feet)
	-	Flamborough Head Submarine Exercise Area (large)	Navy	Submarine	Surface and sub-surface
Offshore Cable Area	D207	Holbeach	RAF Danger Area	Air to Surface Firing, Bombing	SFC – 23. (0 to 23,000 feet)
				Demolition of Unexploded Ordnance	SFC – 5. (0 to 5,000 feet)
	D306	Cowden	RAF Danger Area	Demolition of Unexploded Ordnance	SFC – 5. (0 to 5,000 feet)
	D307	Donna Nook	RAF Danger Area	Air to Surface Firing, Bombing, Firing	SFC – 20 & 23. (0 to 20,000 feet & 23,000 feet)
				Demolition of Unexploded Ordnance	SFC – 5. (0 to 5,000 feet)
	D308	Wainfleet	RAF Danger Area	Air to Surface Firing, Bombing, Firing	SFC – 23. (0 to 23,000 feet)
				Demolition of Unexploded Ordnance	SFC – 5. (0 to 5,000 feet)
	D323A	Southern MDA	RAF Danger Area	Air Combat Training, High Energy Manoeuvres	5 – 66. (5,000 to 66,000 feet)
	D323B	Southern MDA	RAF Danger Area	Air Combat Training, High Energy Manoeuvres	5 – 66. (5,000 to 66,000 feet)
	D323C	Southern MDA	RAF Danger Area	Air Combat Training, High Energy Manoeuvres	5 – 66. (5,000 to 66,000 feet)
	D323D	Southern MDA	RAF Danger Area	Air Combat Training, High Energy Manoeuvres	25 – 66. (5,000 to 66,000 feet)
	D323E	Southern MDA	RAF Danger Area	Air Combat Training, High Energy Manoeuvres	25 – 66. (5,000 to 66,000 feet)
	D323F	Southern MDA	RAF Danger Area	Air Combat Training, High Energy Manoeuvres	25 – 66. (5,000 to 66,000 feet)
	D412	Staxton	RAF Danger Area	Air to Air Firing	SFC – 10. (0 to 10,000 feet)
	D513	Druridge Bay	RAF Danger Area	Air to Air Firing	SFC – 10. (0 to 10,000 feet)
	D513A	Druridge Bay	RAF Danger Area	Air to Air Firing, HM Ships (non firing exercises, practices and trials)	SFC – 23. (0 to 23,000 feet)
	D513B	Druridge Bay	RAF Danger Area	Air to Air Firing	SFC – 23. (0 to 23,000 feet)
	-	Flamborough Head Submarine Exercise Area (large)	Navy	Submarine	Surface and sub-surface
	-	Flamborough Head Submarine Exercise Area (small)	Navy	Submarine	Surface and sub-surface
	-	Outer Silver Pit Submarine Exercise Area	Navy	Submarine	Surface and sub-surface
	X5309	Rowlston	Army surface	Firing	SFC – 0.5. (0 – 500 feet)

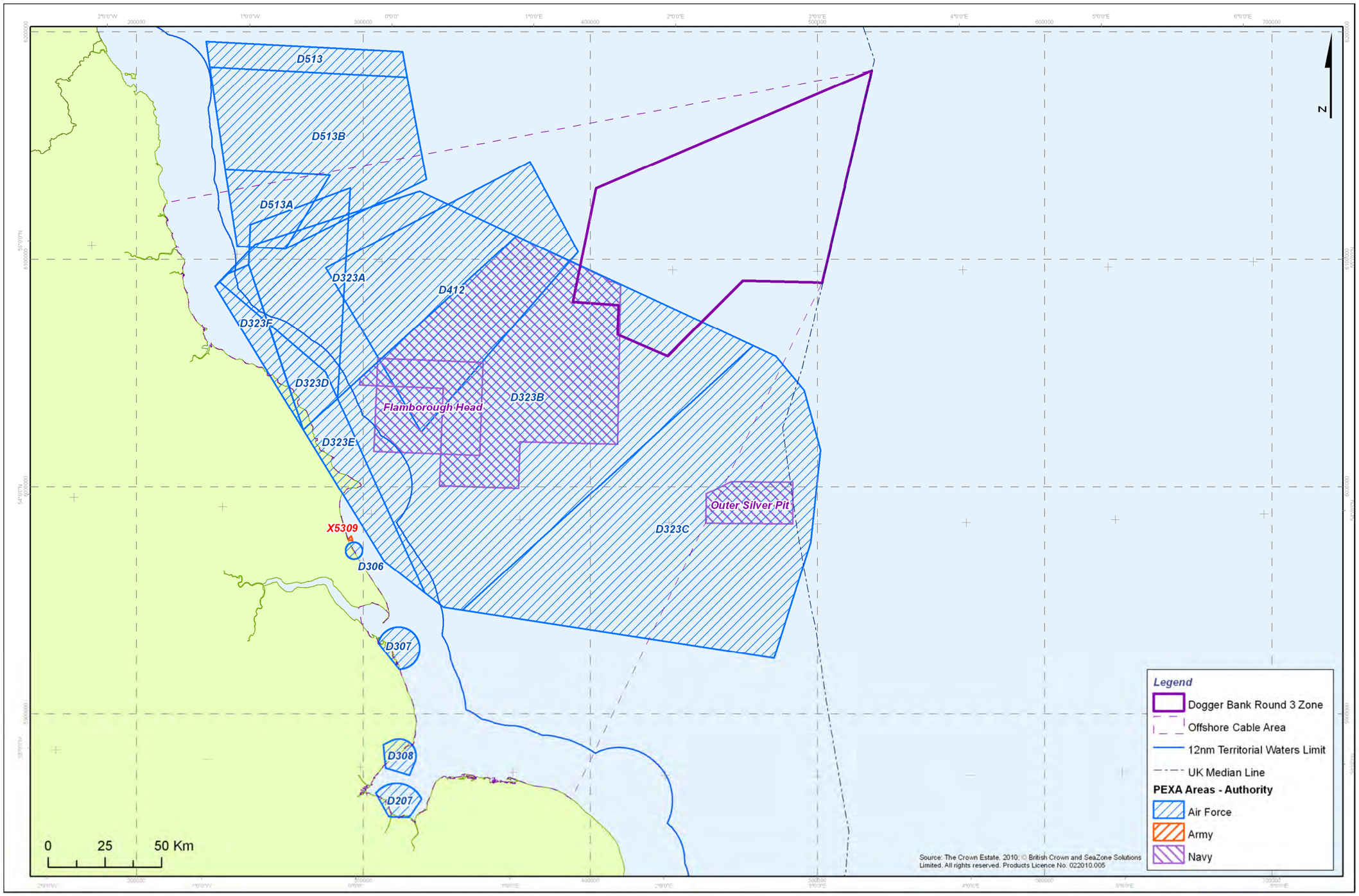


Figure 12.1: Military Practice and Exercise Areas in the Offshore ZDE.

12.5 Civil Aviation

The aerodromes and air traffic control zones occurring within the ZDE are presented in Figure 12.2. Aerodromes are safeguarded against inappropriate developments in their vicinity, as outlined in CAP 738 (Safeguarding of Aerodromes, 2006), where proposed wind turbine sites should be notified to the CAA's Directorate of Airspace Policy (DAP) prior to application for planning permission. Wind farms that may fall within the line of site of an aerodrome may raise objections based on the potential for physical obstruction and interference with CNS infrastructure (see Section 12.7). This may vary on a case-by-case basis but WEDCA (2002), CAP 738 (2006), CAP 670 (Air Traffic Services Safety Requirements, 2011) and CAP 764 (CAA Policy and Guidelines on Wind Turbines, 2011) provide generic criteria: Aerodrome safeguarding is limited to the vicinity of the aerodrome, which can be a 5, 17 or up to 30 km radius depending upon the associated type and intensity of air traffic. CAP 168 (Licensing of Aerodromes, 2011) lays down specific safeguarding criteria for individual licensed aerodromes. These involve identifying where obstructions, such as wind turbine developments, should not penetrate. Owing to the distance of the Dogger Bank Zone offshore, aerodromes are unlikely to be directly affected.

Control zones are present around major or multiple aerodromes and incorporate the approach corridors. Within the ZDE, control zones are associated with Newcastle and Durham Tees airports (CAA & NATS, 2011), which are 184 km and 166 km from the Dogger Bank Zone respectively.

12.6 Helicopter Routing and Search and Rescue

Helicopters serve oil and gas surface infrastructure such as platforms and Floating Production, Storage and Offloading vessels (FPSOs). The CAA Helicopter Main Routes (HMR), defined by the UK Aeronautical Information Publication (AIP), are indicative of the routes utilised. A large number of turbines beneath an HMR could force aircraft to fly higher in order to maintain a safe vertical separation from wind turbines. This may not be possible when flying through low cloud on days when the zero degree isotherm (icing level) is below 2,000 ft (CAP 764, 2011).

Based on operational experience, an area 2 nm either side of a HMR should ideally be obstacle free, though providing a 2 nm obstacle free area on one side of the route is maintained, the CAA may consider a wind farm development to be acceptable (CAP 764, 2011). The 2 nm distance is based upon operational experience, the accuracy of navigation systems and the distance that would provide time and space for helicopter pilots to descend safely to an operating height below the icing level (CAP 764, 2011). Currently, all HMRs in the Offshore ZDE are located at least 35 km south of the Dogger Bank Zone.

The CAA also indicate the need to maintain a 9 nm obstacle-free radius around offshore surface infrastructure, such as oil and gas platforms, to allow for controlled and missed approaches from all directions (CAP 764, 2011; DECC, 2009; 2011). Wind turbines within this 9 nm area would potentially impair the ability to conduct safe operations. The HMRs, corresponding 2 nm safety margins, and 9 nm approach radii are presented in Figure 12.2. Currently, no platforms and 9 nm radii occur within the Dogger Bank Zone.

Helicopter based Search and Rescue (SAR) are operated by HM Coastguard and the MoD. Within the ZDE, RAF Sea King helicopters operate from RAF Boulmer and RAF Leconfield, with an operating range of approximately 250 nm (Figure 12.2). SAR operations are unplanned events and thus can occur anywhere over land or sea. Wind turbines can cause obstruction to nearby SAR and may increase the risk of offshore collisions.

12.7 Communications, Navigation and Surveillance

Both military and civil aviation rely on CNS infrastructure to support airspace and air traffic management. Military CNS also has a crucial role in providing air defence surveillance for the UK and NATO.

12.7.1 Civil Airspace and Air Traffic Management

Civil airspace and air traffic surveillance and management infrastructure is comprised of the following systems which can be affected by wind farms:

- Primary Surveillance Radar (PSR);
- Secondary Surveillance Radar (SSR); and
- Aeronautical Navigation Aids (Navaids) (WEDCA, 2002).

Self-assessment data provided by NERL for these facilities show that the range of interference for sites relevant to the ZDE do not extend as far as the Dogger Bank Zone. While the data are only indicative, they suggest that interference with civil CNS systems is unlikely to be significant. The NERL Radar interference zones and consultation zones were accurate as of June 2010. Beyond that date they are considered indicative and subject to change. Each of the key CNS systems is briefly discussed here with reference to Figure 12.3.

Primary Surveillance Radar

Primary Surveillance Radar (PSR) operates by radiating electromagnetic energy and detecting the presence and character of the echo returned from reflecting objects. Comparison of the returned signal with that transmitted yields information about the target, such as location, size and whether it is in motion relative to the radar but does not differentiate between types of object or their heights (WEDCA, 2002; CAP 764, 2011).

A radar system's field of view is influenced by the curvature of the earth, variation in topography, and diffraction of the radar signal. Wind turbines, when situated within the field of vision of PSR, have the potential to produce false radar returns (clutter) or mask genuine radar returns from aircraft. The taller a turbine is the greater the distance from the radar that it will remain within the field of view.

Civil PSR in the UK are operated by NERL. Figure 12.3 presents the NERL PSR interference zones relevant to the ZDE for turbines with a blade tip as high as 200 m. The Dogger Bank Zone is sufficiently far offshore for turbine development to avoid interfering with PSR.

Secondary Surveillance Radar

Secondary Surveillance Radar (SSR) does not rely on reflections from objects for detection. Instead, aircraft to be detected are required to carry a transponder, which replies to radar interrogations (WEDCA, 2002; CAP 764, 2011). Although false returns will not be generated by wind turbines, the propagation of the signal can still be reflected or obstructed. In line with CAP 670 (2010) and CAP 764 (2011), the CAA advises a 24 km consultation zone around civil SSR sites. The SSR sites relevant to the ZDE and the corresponding consultation zones are shown in Figure 12.3. The Dogger Bank Zone is sufficiently far offshore that development will not impinge upon SSR coverage.

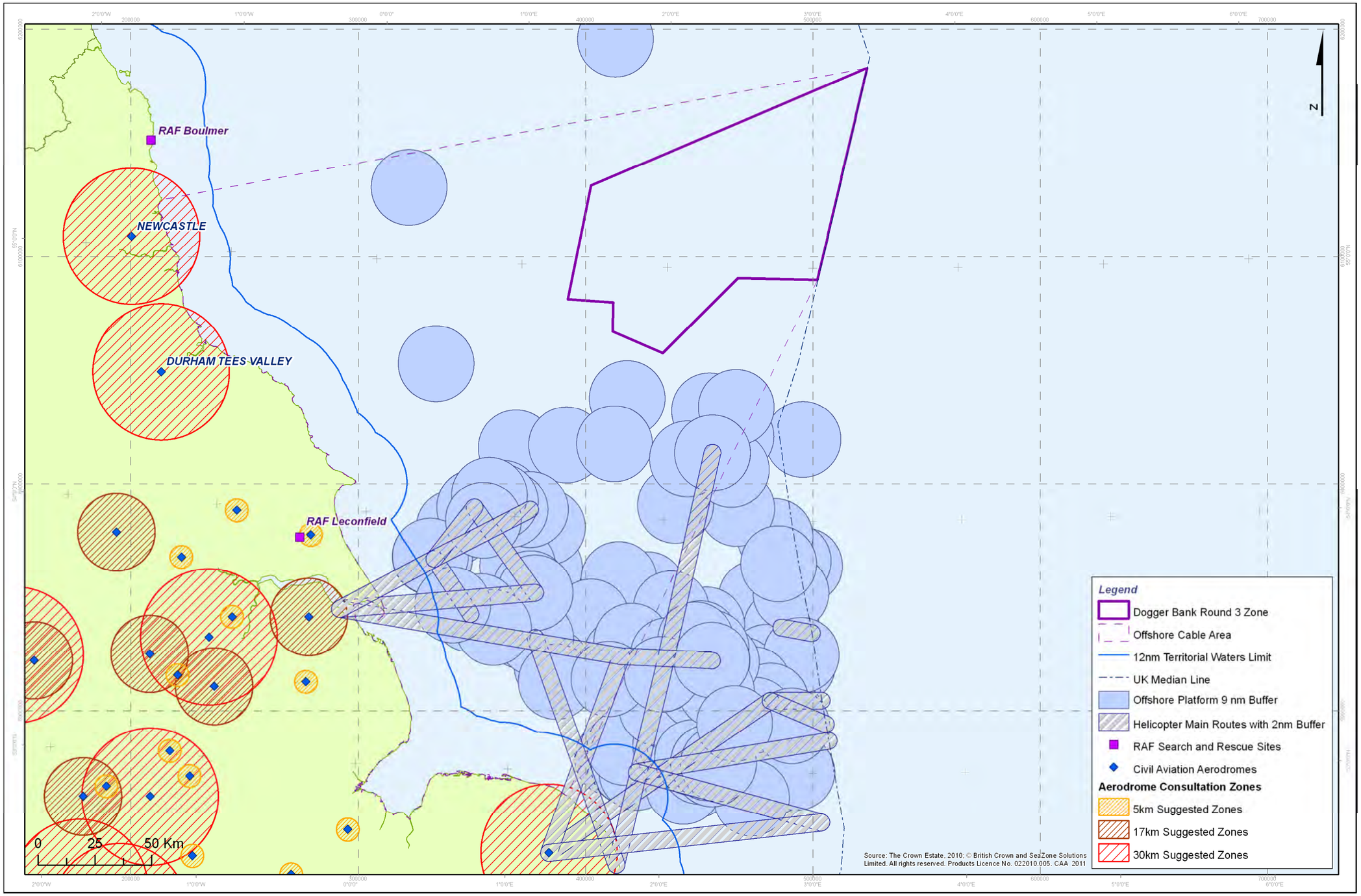


Figure 12.2: Civil aviation aerodromes, air traffic control zones, Helicopter Main Routes and offshore helicopter safety zones around offshore oil and gas installations.

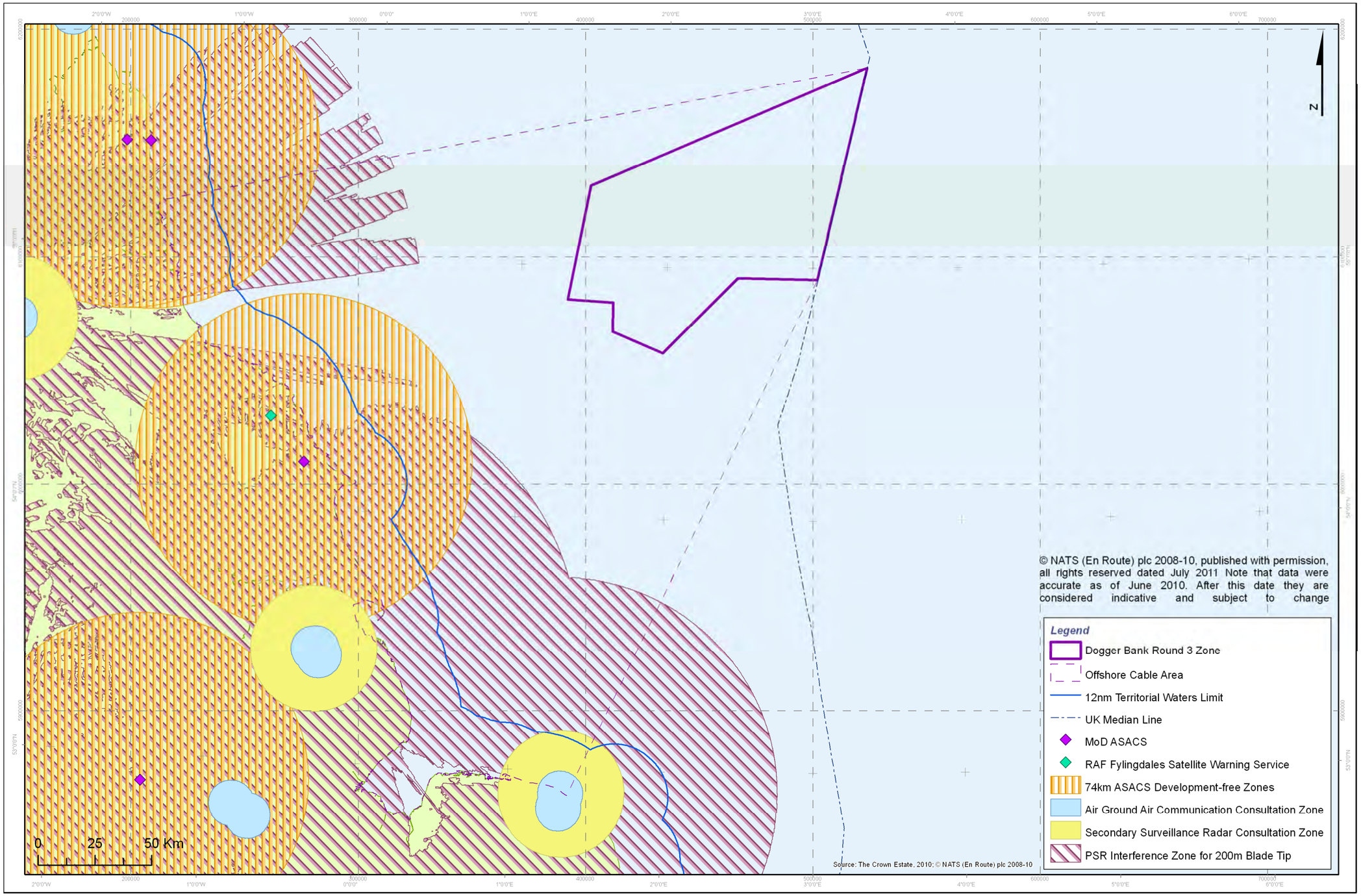


Figure 12.3: Indicative extents of known military and civil Communications, Navigation and Surveillance (CNS) systems across the ZDE.

Aeronautical Navigation Aids

Navaids, including Global Positioning Systems (GPS), Instrument Landing Systems (ILS), Non-Directional Beacons (NDB), Distance Measuring Equipment (DME), Microwave Landing System (MLS), VHF Omni-directional Radio Range (VOR), and Tactical Air Navigation (TACAN) systems (Knill, 2002), together with Air-Ground-Air (AGA) communication facilities can be affected by wind turbine developments. Wind turbines can affect the propagation of the radiated signal from these systems (CAP 764, 2011) and so NERL has applied a 10 km consultation zone around such sites, as detailed in CAP 670 (2011). Those occurring within the ZDE are shown in Figure 12.3, though turbine development offshore in the Dogger Bank Zone will not cause interference.

12.7.2 Air Defence Radar and Surveillance

Military CNS systems are typically more complex than civil aviation systems. They have a similar role as civil systems, serving air traffic management, with PSR and SSR systems as well as Precision Approach Radar (PAR). The MoD also has a role to provide unimpeded airspace surveillance and early warning of air attack against the UK via their Air Surveillance and Control System (ASACS) and RAF Fylingdales' Satellite Warning Service. UK airspace, and thus the ZDE, fall within NATO Air Policing Area 9. It should be noted that information regarding MoD systems is not readily available. The MoD assesses the impacts of wind farms on their CNS on a case-by-case basis.

The North Sea Air Combat Manoeuvring Instrumentation (ACMI) Range once provided a tracking system for UK and NATO aircraft training offshore to the south of the ZDE in the former danger areas, D316 and D317. The range consisted of six BAE Systems oil rig-like tower structures known as Tracking Instrumentation Sub-system Towers (TIS), arranged in a circle of 30 nm diameter, with five TIS towers around the circumference and a single TIS master tower in the centre (Parsons, 2001). However, the danger areas that utilised the ACMI have since become obsolete and it is not expected that a replacement system is operational anywhere else in the North Sea.

Air Surveillance And Control System (ASACS)

The UK ASACS forms a Recognised Air Picture (RAP) of UK and NATO airspace and is comprised of ground-based long range surveillance radar, airborne radar systems, and command and control systems. The following ground-based radar sites (Figure 12.3) operate to form the RAP of the airspace over the Offshore ZDE:

- RAF Boulmer, Northumberland (196 km west of the Dogger Bank Zone);
- RAF Brizlee Wood, Northumberland (194 km west of the Dogger Bank Zone);
- RAF Staxton Wold, North Yorkshire (128 km west of the Dogger Bank Zone);
- RAF Trimingham, Norfolk (221 km south west of the Dogger Bank Zone); and
- RAF Buchan, Aberdeenshire (312 km north west of the Dogger Bank Zone) (XY Associates, 2009a).

The ASACS Force Command Headquarters and NATO Control and Reporting Centre is based at RAF Boulmer (RAF, 2010a) with the adjacent Brizlee Wood facility and other (remote) radar sites informing the RAP.

MoD policy considers wind farms within 74 km of ASACS sites to have a potential impact on their field of view. The Dogger Bank Zone, which is approx 125 km offshore, is therefore beyond the potential field of interference (WEDCA, 2002; DECC, 2009; 2011). Further consultation with the MoD or MoD guidance will ascertain whether consideration should be given to other military CNS systems and their operating characteristics.

RAF Fylingdales

RAF Fylingdales, 130 km to the west of the Dogger Bank Zone (Figure 12.3), provides an uninterrupted Ballistic Missile Early Warning System (BMEWS) for the UK Government, United States' authorities and other allies. Secondly, the facility's Satellite Warning Service contributes to air surveillance (XY Associates, 2009b; RAF, 2010b).

12.8 Meteorological Radar

The Met Office radar network currently consists of 16 sites. The sites relevant to the ZDE are shown in Figure 12.4. They include operational sites at Ingham in Lincolnshire and High Moorsley in Tyne and Wear, and a proposed site at Old Buckenham in Norfolk (Met Office, 2009). Meteorological (weather) radar assesses a thin layer of the atmosphere, typically between 0.5 and 4˚ elevation. The radar returns quantitative data (1 and 2 km resolutions) out to a range of about 75 km and useful qualitative data (5 km resolution) to 255 km (Met Office, 2009). Hutchinson and Miles (2008), identify a 20 km consultation zone around weather radar sites, with developments within 10 km more likely to raise objections. Therefore, interference from the Dogger Bank Zone offshore is extremely unlikely.

It should be noted that the Met Office submitted an invitation to tender for a Weather Radar Network Renewal process in June 2010 in order to increase data resolution (Met Office, 2010). Any technical improvements resulting from this will be considered as ZAP progresses.

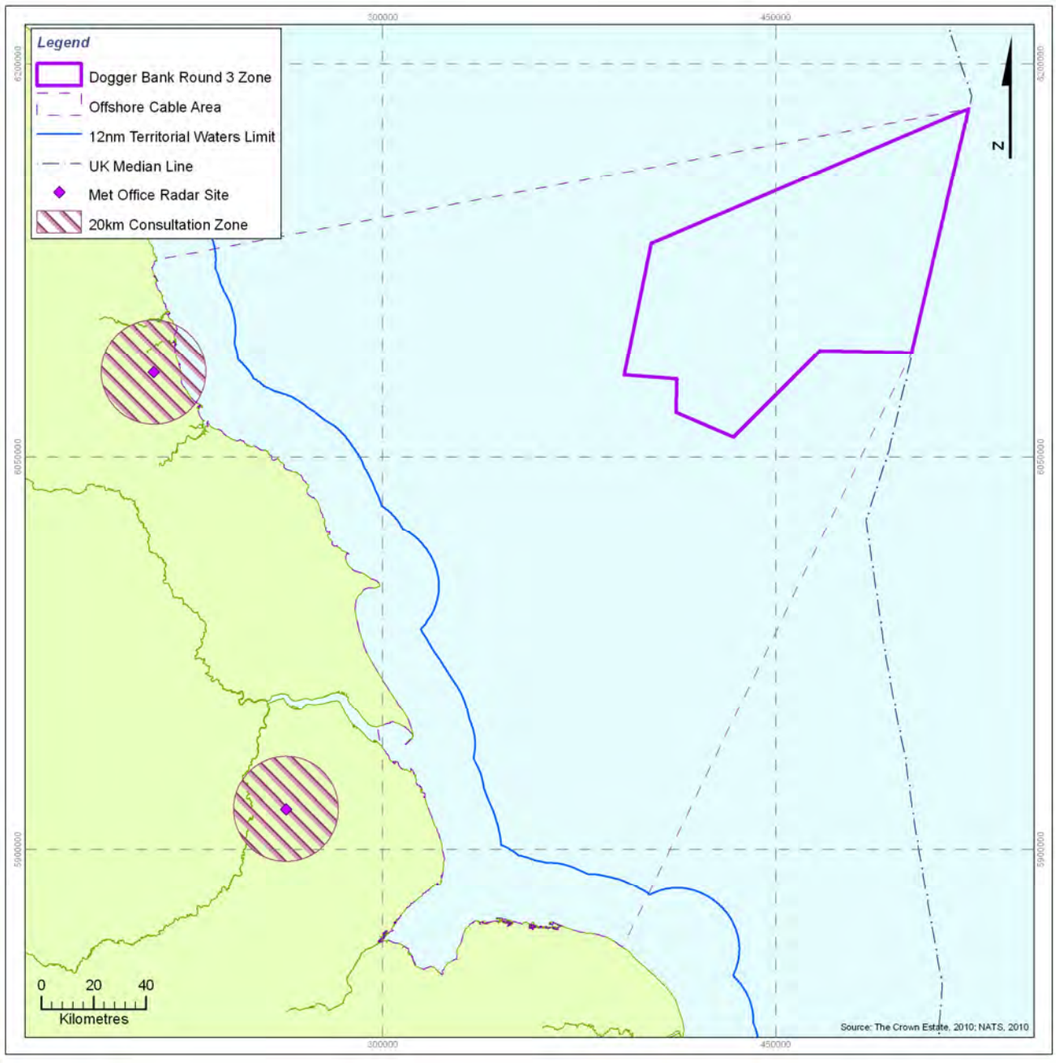


Figure 12.4: Met Office weather radar sites and associated consultation zones at Ingham in Lincolnshire and High Moorsley in Tyne and Wear.

12.9 Summary

The Offshore ZDE includes areas used for military, aviation and radar purposes. A RAF Danger Area and a Submarine Exercise Area both overlap the south west part of the Dogger Bank Zone. Other PEXAs occur across the Offshore Cable Area and include army and air force danger areas at the coast used for live firing and demolition of unexploded ordnance.

There is no notable interaction between civil aviation activities and the Dogger Bank Zone. Helicopter Main Routes serving oil and gas installations are currently confined to the southern part of the Offshore ZDE and do not occur inside the Zone. The Dogger Bank Zone is sufficiently far off shore that there is no apparent likelihood of interference with civil CNS systems such as radar or other technical sites.

Similarly, potential for interference with military CNS systems is shown to be limited, though the issue is complex and not all military systems are known or fully understood. Meteorological radar also demonstrate limited interaction with the Dogger Bank Zone, owing to the distance of the Zone from shore.

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13. Marine Aggregates and Disposal

13.1 Introduction

Marine aggregate extraction and disposal sites occur within the Offshore ZDE. Both represent a defined area where vessels may be present on a regular basis, utilizing an area of the seabed. A proposal for a wind farm in relation to an aggregate extraction area or disposal site may have a bearing on whether these activities are able to continue unhindered, and if vessels can navigate safely to and from these sites.

This chapter provides an overview of the marine aggregate and waste disposal industries and describes the locations and distributions of these activities in relation to the Dogger Bank Zone and the Offshore Cable Area.

13.2 Data and literature

This chapter has reviewed GIS data released by TCE and the Centre for Environment, Fisheries and Aquaculture Science (Cefas) relating to aggregate extraction areas and disposal sites respectively.

In addition to these data, background information pertaining to marine aggregate licensing and activity has been obtained from key literature sources, including:

- The most recent TCE charts detailing licensed dredging areas, application, option and prospecting areas for the Humber Region (TCE, 2011a, 2011b);
- Marine aggregate dredging 1998-2007: A ten-year review (TCE and BMAPA, 2008);
- The Area Involved: Twelfth Annual Report (TCE and BMAPA, 2010);
- Review of UK Marine Aggregate Extraction Activities: Historic patterns of marine aggregate extraction (tonnes) 2000-2005 (TCE, 2010a); and
- MMO guidance on the licensing procedure for marine mineral extraction permissions (MMO, 2010a).

Annual waste disposal figures, acquired from Cefas in March 2011, provide an indication of the relative usage of disposal sites within the Offshore ZDE. The Offshore Energy Strategic Environmental Assessment (SEA) (Department of Energy and Climate Change (DECC), 2009) has provided further background information on both marine aggregate extraction and disposal activity.

The data and literature outlined above provide an overview of marine aggregate extraction and disposal activities in the Offshore ZDE.

13.3 Overview

The aggregate areas that occur within the Offshore ZDE are included within the region defined by TCE as the Humber Region. The Humber Region is a well established area for marine aggregate extraction, with a number of existing marine aggregate extraction areas as well as a number of new areas planned for the future. The majority of licensed aggregate areas are located close to the Humber Estuary and The Wash, though application areas now exist seaward of these and include an area within the Dogger Bank Zone itself.

The majority of the waste disposal sites in the Offshore ZDE are located within 12 nm of the coast where material from capital and maintenance dredging operations near coastal and urban locations can be easily deposited. As such, disposal sites do not occur within the Dogger Bank Zone or in close proximity to it.

13.4 Marine Aggregates

Aggregates comprise sand, gravel and crushed rock, which are used as raw materials by the construction industry. The majority of aggregate comes from land-based sources, but since the 1960s the construction industry has been increasingly reliant on marine sources of aggregate to supplement demand and meet the UK's construction needs.

Approximately 21% of the sand and gravel used in England and Wales is supplied by the offshore marine aggregate industry (TCE, 2010b). One of the main benefits of using marine sources is that ships can deliver aggregates directly to wharves located in urban areas, which reduces transport by road, further reducing congestion and pollution. A summary of the licensing process is given in Appendix H.

Marine sourced aggregates are also used in contract fill projects and in beach replenishment schemes, where large volumes of aggregates are pumped directly from dredgers onto beaches, providing coastal protection as well as enhancing the amenity value and therefore the economy of an area (see Figure 13.1).



Figure 13.1: An aggregate dredger pumping sand to shore to supply a beach replenishment scheme (photo courtesy British Marine Aggregate Producers Association).

13.4.1 Methods of Marine Aggregate Extraction

There are two key methods of marine aggregate extraction:

- Static (anchor) dredging, where a vessel anchors over a thick, localised deposit; and
- Trailer suction hopper dredging, where the aggregate is extracted as the vessel is underway. This method is suitable for more evenly distributed deposits.

Trailer suction hopper dredging (Figure 13.2) is the most commonly used method of extraction throughout UK waters, whereby the material is extracted as the dredging vessel is in motion and the draghead moves slowly over the seabed. A single pass of the 2-3 m wide draghead will extract aggregate to a depth of approximately 30 cm below the level of the existing seabed.

Marine aggregate extraction within licensed areas is undertaken to a high degree of accuracy, with reference to high resolution seismic data and seabed core samples. The dredger's position and tracks are displayed in real time together with licence

boundaries on the ship's navigation computer to ensure that resources are dredged precisely.



Figure 13.2: Screening of marine aggregates on board a trailer suction hopper dredger (photo courtesy British Marine Aggregate Producers Association).

13.4.2 Marine Aggregate Extraction Areas in the Offshore ZDE

The largest areas licensed for marine aggregate dredging in the Humber aggregate region are beyond 12 nm from the coast, though most of the dredging activity occurs in licensed areas between 6 nm and 12 nm from the coast (TCE and BMAPA, 2008). Prospecting licences and application areas are present further offshore including an application area within the Dogger Bank Zone. Figure 13.3 presents all aggregate areas as detailed by TCE (2011a, 2011b). Characteristics of all licence areas and all option, prospecting and application areas are presented in Table 13.1 and Table 13.2 respectively.

Dogger Bank Zone

The sand and gravel resource on the north and west margins of the Dogger Bank elevation is typically between 1 m and 5 m thick compared to sediments on the Dogger Bank itself which are typically less then 1 m thick (see Chapter 2 – *Geology*).

Application Area 466/1 is the only aggregate area within the Dogger Bank Zone (Figure 13.3), situated near the western margin in the area known as North West Rough (Area 466/1). CEMEX UK Marine Ltd is pursuing a production licence for the 11.13 km^2 area. If licensed, the area is likely to provide aggregates to wharves in the Tyne, the Tees, the Humber and mainland Europe. Aggregates from Area 466/1 may also be used for beach replenishment and contract fill projects on occasion. There are currently no production licence areas within the Dogger Bank Zone.

Offshore Cable Area

Prospecting Area 485, located approximately 20 km south west of the Dogger Bank Zone at the Southernmost Rough, encompasses Application Areas 485/1 and 485/2 (Figure 13.3). Both applications belong to CEMEX UK Marine Ltd.

Further to the south of the Dogger Bank Zone, off the Humber estuary, aggregate extraction areas are relatively more concentrated. Production licences, prospecting licences and application areas are situated close to the Offshore ZDE boundary with the majority situated close to the mouth of the Humber estuary (see Figure 13.3, Table 13.1 and Table 13.2).

Table 13.1: Details of marine aggregate production licences occurring within the Offshore ZDE.

Marine Aggregate Licence Areas				
Occurrence	**Licence Area No.**	**Area (km^2)**	**Active Dredge Zone (km^2)**	**Company**
Offshore Cable Area	102	36.34	14.52	British Dredging Ltd *
	105	165.94	48.23	British Dredging Ltd *
	106/1	3.94	0.00	Hanson Aggregates Marine Ltd
	106/2	3.20	0.00	Hanson Aggregates Marine Ltd
	106/3	35.36	26.33	Hanson Aggregates Marine Ltd
	107	48.95	11.31	British Dredging Ltd *
	197	26.18	8.45	Tarmac Marine Dredging Ltd
	408	31.47	3.45	Hanson Aggregates Marine Ltd
	440	52.81	12.00	Westminster Gravels Ltd
	441/1	13.25	0.00	Westminster Gravels Ltd
	441/2	34.42	12.23	Westminster Gravels Ltd
	480	9.84	2.44	Hanson Aggregates Marine Ltd
	481/1	6.07	6.07	Tarmac Marine Dredging Ltd and Van Oord Ltd
	481/2	1.93	1.93	Tarmac Marine Dredging Ltd and Van Oord Ltd

* Licences formerly belonging to British Dredging Ltd are now held by CEMEX UK Marine Ltd

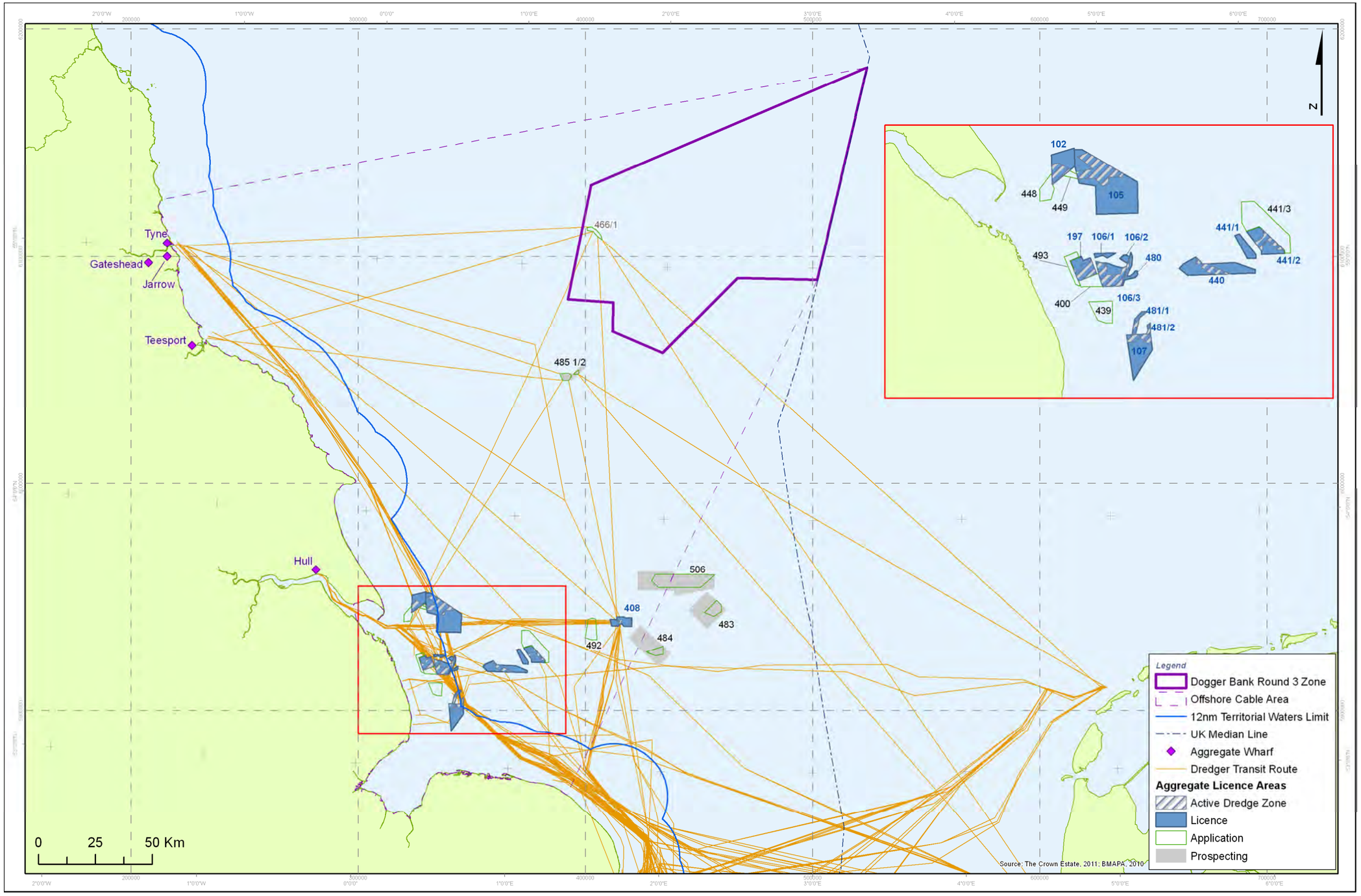


Figure 13.3: Aggregate areas and transit routes.

Table 13.2: Details of marine aggregate option, prospecting and application areas occurring within the Offshore ZDE.

Marine Aggregate Option/Prospecting and Application Areas				
Occurrence	**Aggregate Area**	**km²**	**Status**	**Company**
Dogger Bank Zone	466/1	11.13	Application	CEMEX UK Marine Ltd
Offshore Cable Area	400	14.26	Application	Hanson Aggregates Marine Ltd
	439	26.28	Application	Hanson Aggregates Marine Ltd
	441/3	73.11	Application	Westminster Dredging Ltd
	448	16.72	Application	CEMEX UK Marine Ltd
	449	4.18	Application	CEMEX UK Marine Ltd
	484	142.38	Prospecting	DEME Building Materials UK Ltd
	485	28.50	Prospecting	CEMEX UK Marine Ltd
	485/1	12.05	Application	CEMEX UK Marine Ltd
	485/2	2.48	Application	CEMEX UK Marine Ltd
	490	135.43	Prospecting	DEME Building Materials UK Ltd
	492	38.41	Application	Hanson Aggregates Marine Ltd
	493	12.21	Application	Tarmac Marine Dredging Ltd
	506	138.71	Application	DEME Building Materials UK Ltd
Other Humber Region Aggregate Areas adjacent to the Offshore ZDE	483		Prospecting	DEME Building Materials UK Ltd
	483		Application	DEME Building Materials UK Ltd
	484		Application	DEME Building Materials UK Ltd
	491		Prospecting	DEME Building Materials UK Ltd

13.4.3 Extraction History

A total of 37.33 million tonnes of marine sand and gravel was dredged from The Crown Estate licensed areas in the Humber Region between 1998 and 2007. Averaged across the cumulative footprint of dredging, this represents 21.7 cm of sediment removed from the areas dredged (TCE and BMAPA, 2008).

During 2009, 2.5 million tonnes of aggregate were dredged from a permitted licensed tonnage of 5.05 million tonnes. In addition 0.55 million tonnes were specifically dredged for a beach replenishment scheme (TCE and BMAPA, 2010).

Figure 13.4 a) and b) show a breakdown of the area of seabed licensed and the area of seabed dredged in the Humber Region between 1998 and 2007 respectively. The area of seabed licensed decreased by a net 19.14 km^2 during this period, and Figure 13.4 a) shows a significant decrease in 2002, with the greatest changes occurring beyond 12 nm of the coast (TCE and BMAPA, 2008).

In 2009, the total area licensed for dredging in the Humber Region was 469.89 km^2. Not all of the total licensed area is available to be dredged at any one time. Licences are zoned to minimise the environmental footprint of the dredging, either as part of the licence conditions or on a voluntary basis. As a result of this zonation the total active dredge area available to be dredged within the Humber Region during 2009 was 146.99 km^2 (less than 30%) (TCE and BMAPA, 2010). Further, only a small proportion of the active dredge areas is actually dredged in any one year. Figure 13.4 b) shows that approximately 10% of the licensed area in the Humber Region was dredged in 2007 (TCE and BMAPA, 2008).

13.4.4 Dredger Transit Routes and Landing Wharves

BMAPA has published the transit routes typically used by marine aggregate dredgers from wharves to licensed aggregate extraction areas around the UK coast. Routes to application areas have been designed by marine aggregate companies and are indicative of the routes likely to be used. A review of the transit routes shows that vessels would pass through part of the Dogger Bank Zone to Area 466/1, if it becomes licensed (see Figure 13.3).

The routes represent the movements of the vessels between the wharves surrounding the North Sea. It is evident that aggregates from the Humber Region are landed at a number of wharves around the North Sea, both in the UK and mainland Europe.

Of the 2.5 million tonnes of aggregate dredged from the Humber Region in 2009, 0.6 million tonnes (24%) were landed at wharves in the Northeast of England, located on the Tyne, Tees and Humber rivers. Some 0.09 million tonnes (4%) were landed elsewhere in England, and 1.84 million tonnes (74%) were landed at wharves in mainland Europe (TCE and BMAPA, 2010).

The BMAPA transit routes show that the key UK wharves serving the Humber Region are located on the Tyne (Tyne, Jarrow and Gateshead), the Tees (Tees and Tees Port) and Humber rivers (Hull).

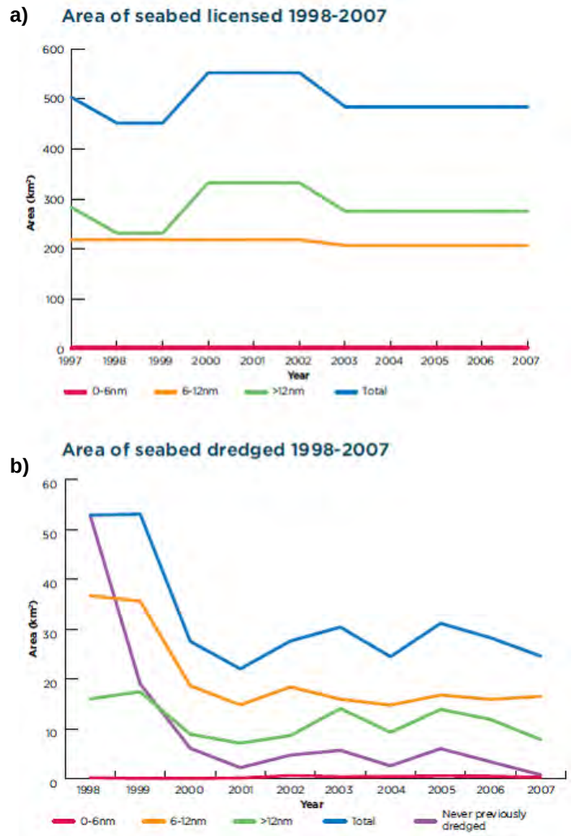


Figure 13.4: a) Area of seabed licensed and (b) area of seabed dredged in the Humber region (1998 – 2007) (TCE and BMAPA, 2008).

13.5 Disposal Activity

Marine disposal sites in English waters below Mean High Water Springs (MHWS) are designated by Cefas, with the disposal of dredged material controlled under the Food and Environmental Protection Act (FEPA) 1985. All disposal sites are assessed during the FEPA assessment processes for disposal applications and, if an application is approved by the Secretary of State, a FEPA licence is granted by the MMO.

The disposal of liquid industrial waste and colliery minestone ended in 1992 and 1995 respectively. Similarly the dumping of sewage sludge was brought to an end in 1998 in compliance with the requirements of the Urban Waste Water Treatment Directive (MMO, 2010b; DECC 2009). Licences are however, available for the disposal of capital and maintenance dredge material (which may potentially contain contaminants), aggregate dredging spoil, seabed injection of drill cuttings and produced waters arising during the exploration for, or production of, offshore hydrocarbons (MMO, 2010b).

Beneficial use schemes, such as beach replenishment and habitat creation projects, are also included under FEPA, but under a different licence type from the activities listed above (Pers. Comm., S. Paccito, Cefas, 25th May 2010).

Some construction activities may also require a FEPA licence if depositing material on the seabed. Unless specifically consented under the Petroleum Act 1998, this includes activities such as pipeline protection using rock dumping or the deposit of concrete mattresses. For instance, open disposal site HU202 (see Figure 13.5), is a temporary disposal site that was opened for the purpose of receiving temporary deposits from a pre-sweep activity during the construction of a pipeline, due to the nature of the pre-sweep survey that had to be undertaken. The material was temporarily deposited to HU202, then after the pipeline was laid, the material was re-deposited to its original location on the seabed (Pers. Comm., M. Robson, MMO, 6th August 2010).

Disposal sites are classified as 'Open', 'Disused' (no licensed activity for five years or more), or 'Closed' (not used within the last ten years).

13.5.1 Disposal Sites within the Offshore ZDE

No disposal sites exist within the Dogger Bank Zone. Within the Offshore ZDE, there are over 30 disposal sites which are classified as 'Open', having been used within the last five years (see Figure 13.5). Details of open sites licensed under FEPA are included in Table 13.3, which specifies the annual tonnages between 1998 and 2008. A null means there was a licence but nothing was deposited. On some occasions, while some sites were classed as open, they were not licensed for use during particular years. Sites in the Humber Region are identifiable by the 'HU' prefix and sites in the Tyne Region are identifiable by the 'TY' prefix.

Sites TY160, HU020, HU030, HU060 and HU080 are evidently the most heavily used – each consistently receiving over one million tonnes of material per annum (Table 13.3). Figure 13.5 also shows the locations of 'Disused' and 'Closed' sites, classified as such if unused for five and ten years respectively.

As of April 2011, there were no known future disposal sites (in the application process) in the North Sea, though new sites may arise from future applications.

The majority of the waste disposal sites in the Offshore ZDE are located within 12 nm of the coast where material from capital and maintenance dredging operations near coastal and urban locations can be easily deposited. No disposal sites occur within the Zone or in close proximity to it, but should be considered when designing the export cable routes.

13.6 Summary

Marine aggregate extraction and disposal sites occur within the Offshore ZDE. The majority of licensed aggregate areas are located close to the Humber estuary and The Wash, though application areas now exist seaward of these, including Application Area 466/1 within the Dogger Bank Zone itself, for which a production licence is being sought by CEMEX UK Marine Ltd.

Licensed marine aggregate extraction areas, Option and Prospecting Areas represent rights to an area of the seabed, granted by TCE. Marine aggregate application areas have been identified specifically for a viable aggregate resource. They are areas for which an exclusive Option Agreement with TCE has been secured and for which TCE have confirmed that they are minded to issue a Production Licence, pending the award of a Dredging Permission by the MMO.

Application Area 466/1 occupies a relatively small area on the western margin of the Dogger Bank Zone and could potentially be awarded a Production Licence (typically 15 years in duration) with scope for renewal in the future. Aggregate dredgers will need to access aggregate extraction areas safely.

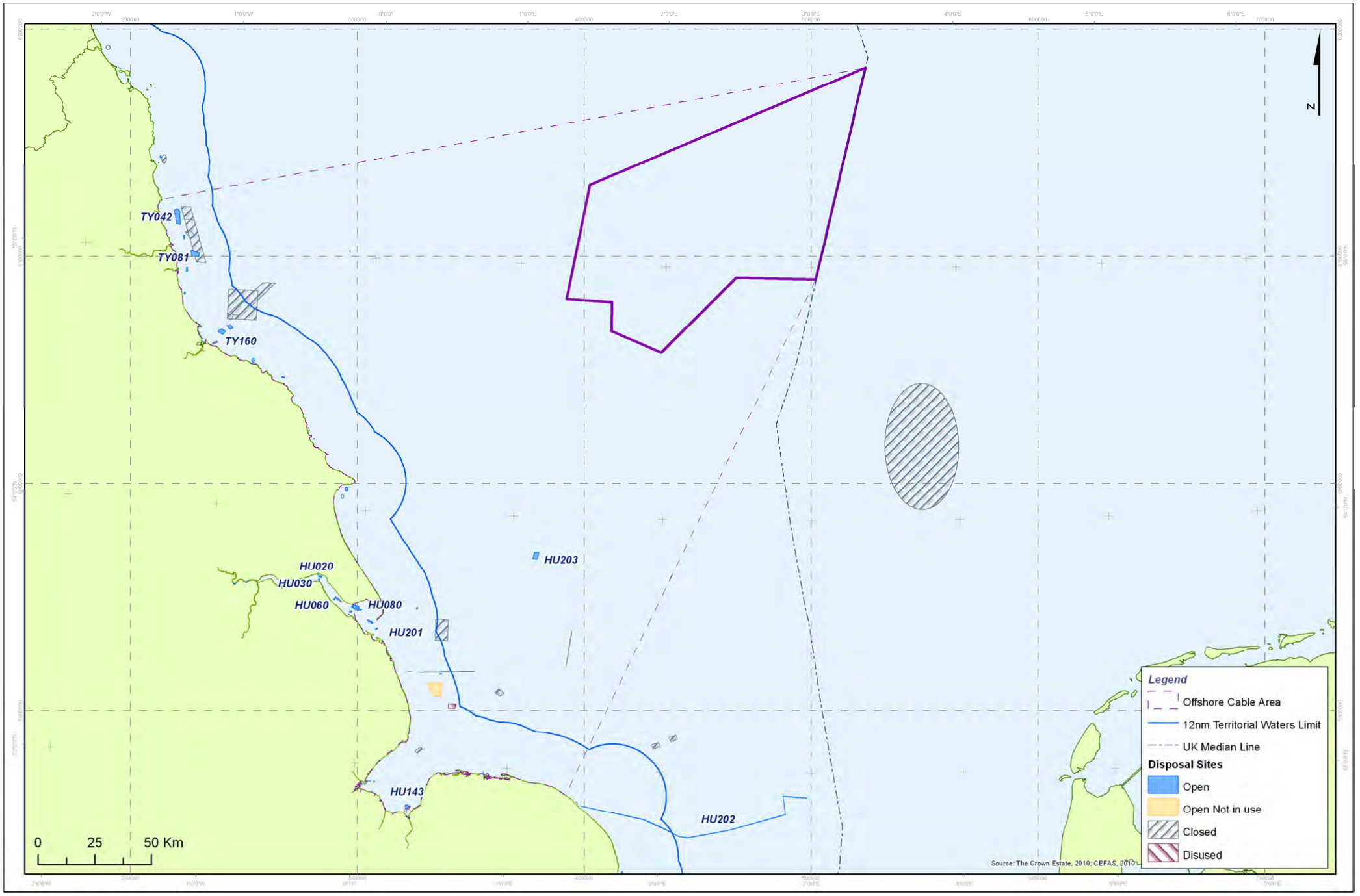


Figure 13.5: Disposal sites within and adjacent to the Offshore ZDE.

Table 13.3: Details of open waste disposal sites in the Offshore ZDE (Source: Cefas, 2010).

Disposal Site	Site Name	Annual tonnage (dry weight)										
		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
TY022		2,720	1,600	67,600	0	0	0	0	33,800	2,720	1,600	67,600
TY025		No Licence	48,600	13,770	0	0	650	30,663	0	17,620	0	0
TY042	Blyth A + B	242,688	161,204	0	263,315	264,432	237,273	133,883	199,911	133,960	187,650	195,970
TY070	North Tynne	209,870	337,470	54,220	242,775	67,723	125,832	89,119	867,492	160,752	206,586	194,730
TY081	Souter Point (Outer)	247,676	327,110	37,142	167,882	170,615	35,877	321,649	345,919	89,189	141,190	137,348
TY085	Tyne Tunnel	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	0
TY090	Sunderland	197,328	184,690	0	193,758	0	236,368	0	201,574	No Licence	0	286,730
TY130	Noses Point	19,142	28,401	17,177	19,238	17,670	9,156	35,858	27,946	19,273	28,910	29,392
TY150	Tees Bay C	1,942,110	0	0	0	0	0	21,384	472	0	0	7,950
TY160	Tees Bay A	310,866	1,226,699	1,508,831	2,003,029	1,548,345	2,020,061	1,454,292	2,401,341	1,921,664	2,265,081	1,992,884
TY180	Whitby	31,520	41,720	106,270	79,420	54,447	86,089	42,302	31,847	72,151	36,657	45,674
TY181	Cleveland Potash Outfall	No Licence	No Licence	300	0	0	0	56,432	0	44,558	58,070	40,010
TY190	Scarborough Rock	4,050	15,690	2,380	5,260	4,070	8,409	1,331	47,102	2,922	1,985	6,108
TY193	Tyne Burial Site	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence
HU015	Bridlington A	6,720	11,040	21,380	13,860	17,120	11,360	2,550	8,000	6,880	4,960	3,360
HU020	Humber 4b/Hook	235,314	331,415	252,833	166,580	141,965	264,945	197,235	216,905	156,460	114,390	127,685
HU030	Humber 4	2,009,174	1,828,187	1,289,602	1,343,826	1,543,189	1,472,404	1,635,917	1,594,512	1,620,639	1,624,536	679,197
HU040	Whitgift Bight (River Ouse)	38,180	6,575	5,575	0	1,115	3,345	15,565	10,035	10,105	3,380	5,765
HU041	Goole Reach	42,040	6,690	9,720	10,220	33,451	18,500	21,855	14,565	28,125	8,305	17,010
HU046	Hull Marina	No Licence	No Licence	No Licence	No Licence	44,400	29,600	No Licence	No Licence	No Licence	No Licence	No Licence
HU060	Humber 3a	3,789,405	2,547,476	2,531,003	3,600,106	3,137,399	4,098,315	3,935,056	4,483,622	7,346,646	8,606,826	4,851,564
HU080	Humber 1a	3,506,220	4,719,030	4,190,217	4,241,355	7,307,587	4,366,425	2,801,211	448,446	0	0	0
HU090	Humber 2	809,118	639,142	713,975	708,221	423,099	681,309	610,857	626,677	928,871	641,382	363,051
HU112	Pyewipe Channel	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	26,800	0	No Licence	No Licence
HU114	Wash Bank	No Licence	No Licence	No Licence	No Licence	0	0	764	1,066	88	88	0
HU139	Boston 6	61,179	0	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence
HU141		32,843	0	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence
HU143	West Stones	26,760	56,650	96,065	41,122	69,478	91,210	84,873	67,540	83,480	70,115	77,500
HU150		46,288	31,069	34,091	14,869	33,863	22,920	28,289	14,610	30,018	3,855	4,590
HU151	Wells Beneficial Use 1	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence
HU152	Wells Beneficial Use 2	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence
HU153	Wells Beneficial Use 3	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence
HU160		99,341	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence
HU162	North Killinghome Cargo Haven	24,830	0	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence
HU170	Boston 7	No Licence	59,978	54,443	46,403	59,742	52,039	39,506	48,662	14,544	27,517	18,831
HU199		No Licence	No Licence	No Licence	No Licence	No Licence	62,693	0	160,864	75,902	0	0
HU200	West Of Inner Drowsing Bank	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence
HU201	Humber 4b/Hook Extension	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence
HU202	Conoco Pipeline Trench	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	25,838	0	No Licence	No Licence	No Licence
HU203	Babbage	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	No Licence	130,859

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14. Cables and Pipelines

14.1 Introduction

Subsea cables and pipelines serving the oil and gas industries transect the Dogger Bank Zone and Offshore Cable Area. This chapter discusses the locations and key characteristics of:

- Subsea telecommunications cables;
- Subsea power cables;
- Subsea oil and gas pipelines; and
- Coastal pipeline infrastructure.

14.2 Data and Literature

Subsea cables have been identified using SeaZone and Kingfisher Information Service-Cable Awareness (KIS-CA) GIS datasets checked against International Cable Protection Committee (ICPC) records and UKHO Admiralty charts for the North Sea.

Operational export cables for existing Round 1 and Blyth offshore wind farms were available in the SeaZone dataset, while proposed cable routes for Round 1 and 2 wind farms and Hornsea Project One, currently proposed or under construction, were digitised from relevant Environmental Statements and datasheets (Centrica Energy, 2007; 2009a; 2009b; E.ON, 2008; Scira Offshore Energy Ltd, 2006; Narec, 2010) or provided by the developers (RWE nPower Renewables, Warwick Energy, Dong Energy, SMartWind).

Cables may exist in addition to those identified by the KIS-CA data. KIS-CA specifically advises that the locations of pre-1987 out-of-service cables, including historical telegraph cables, may not be given.

Subsea pipeline, coastal sewer and outfall data were acquired from UK DEAL (July, 2011) and SeaZone (January, 2011). Where pipelines occur within or in close proximity to the Offshore Zone Development Envelope (ZDE) have been discussed, following a review of information from the Department of Energy and Climate Change (DECC), including the Offshore Energy Strategic Environmental Assessment (SEA) and Offshore Energy SEA2 (DECC, 2009; 2011a), and the most recent offshore oil and gas infrastructure maps (DECC, 2011b).

14.3 Overview

The Dogger Bank Zone is intersected by two active telecommunications cables and one out-of-service telecommunications cable. Cables also occur in the Offshore Cable Area, including operational and proposed export cables serving wind farms closer to shore. One active gas pipeline passes through the Dogger Bank Zone while an extensive network of pipelines is notable in the Offshore Cable Area, particularly towards the southern gas fields. Outfall and sewer pipelines associated with the water companies occur along the coastline. All are discussed separately below.

14.4 Subsea Telecommunication Cables

Offshore subsea cables used for telecommunications cross the Dogger Bank Zone and Offshore Cable Area, as detailed in Figure 14.1 and Table 14.1. There are currently no known additional telecommunications cables planned within the Offshore ZDE (ICPC, 2010).

14.4.1 Dogger Bank Zone

The ‘VSNL North Europe’ and ‘UK-Germany 6’ cables pass from west to east in the southern-most part of the Dogger Bank Zone. Both cables are active and make landfall at Filey on the Yorkshire coast. The out-of-service ‘UK-Denmark 4’ cable runs from southwest to northeast, from Scarborough (Table 14.1 and Figure 14.1).

14.4.2 Offshore Cable Area

North of the Zone, the active ‘Pangea North’ cable makes landfall at Redcar, while the ‘CANTAT 3 F4’ cable has recently been taken out-of-service. ‘Norsea Coms 1’ connects Stavanger in Norway with five offshore oil and gas platforms (Draupner, Ula, Ekofisk, Valhall and Murdoch) (North Sea Communications AS, 2010). The cable only passes into the Offshore Cable Area at Murdoch before running south to make landfall at Lowestoft on the Suffolk coast. The ‘Stratos 1’ cable in the south of the Offshore Cable Area extends from Sherringham on the Norfolk coast and splits into multiple branches to the east of the Offshore Cable Area.

Table 14.1: Details of telecommunications cables occurring in the Dogger Bank Zone and Offshore Cable Area (Source: KIS-CA, 2010; ICPC, 2010).

Occurrence	Cable	Status	Route From	Route To	Operator / Maintenance Authority
Dogger Bank Zone and Offshore Cable Area	UK-Denmark 4	Out-of-service	Scarborough, North Yorkshire	Blaabjerg, Denmark	BT, TDC Denmark
	VSNL North Europe	Active	Hunmamby (Filey), North Yorkshire	Eemshaven, Netherlands	TATA Communications
	UK-Germany 6	Active	Filey, North Yorkshire	Norden, Germany	BT, Deutsche Telekom AG
Offshore Cable Area alone	CANTAT 3 F4	Out-of-service	Redcar, North Yorkshire	CANTAT 3 F3C/F5 splice (Danish Continental Shelf)	BT, TDC Denmark, Deutsche Telekom AG
	Pangea North UK/DMK	Active	Redcar, North Yorkshire	Fanø, Denmark	Alcatel-Lucent (ASN)
	Norsea Coms 1	Active	Lowestoft, Suffolk	Stavanger, Norway	North Sea Communications
	Stratos	Out-of-service	Sheringham, Norfolk	(multiple terminals, southern North Sea)	BT, BAE

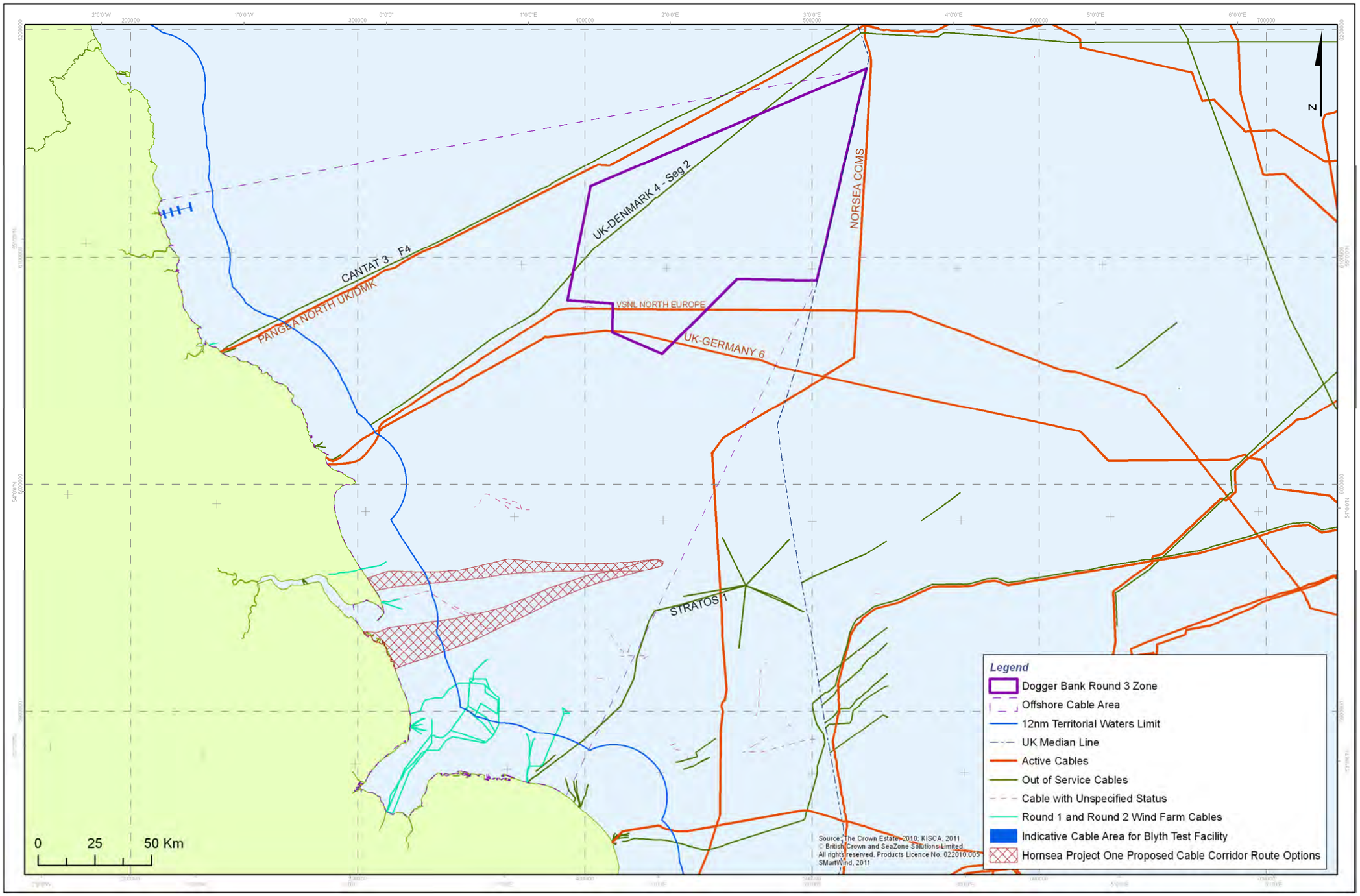


Figure 14.1: Cable routes across the Dogger Bank Zone and Offshore Cable Area.

14.5 Subsea Power Cables

There are currently no active subsea power cable interconnectors within the Dogger Bank Zone or Offshore Cable Area. There are however, power cables close to the coastline, which include connections from Skegness in Lincolnshire to the operational Round 1 wind farms Inner Dowsing and Lynn; and turbine connections at Blyth in Northumberland. Several cable routes have also been proposed for other Round 1 and Round 2 wind farms, including connections from Westermost Rough to Tunstall and Humber Gateway to Easington in Yorkshire; Triton Knoll to Mablethorpe and Lincs, Race Bank and Docking Shoal to Sutton Bridge in Lincolnshore; Dudgeon and Sherringham Shoal to Sherringham in Norfolk; and the proposed demonstration site at Blyth (see Figure 14.1). Two options for cable routes are being considered by SMartWind to provide a connection between Hornsea Project One and Killingholme, to the south of the Humber Estuary (see Figure 14.1). Array cables will also be present at each wind farm. Further information on these wind farms and the Blyth demonstration site is provided in Chapter 15 – *Other Marine Users*. It is recognised that as Round 3 wind energy projects in the North Sea develop towards 2020, the export and array cables associated with the Dogger Bank Zone and other Round 3 Zones to the south may also need to be taken into consideration, as subsequent cables may need to cross them.

Various proposals for a European offshore "Supergrid" have been considered. The most recent proposals include:

- An agreement in February 2011 between Scottish and Southern Energy, Vattenfall and Norwegian utilities Adger Energi, E-Co Energi and Lyse to build the 1.2 – 2 GW "NorthConnect" between Scotland and Norway, planned to be operational by 2020 (NorthConnect, 2011);
- A "SuperNode" configuration for trading power between offshore wind farms, the UK and other North Sea nations, with phase 1 expected to be operational between 2015 and 2020 (Friends of the Supergrid, 2010) (Figure 14.2 and Table 14.2);
- Proposals for an East Coast High Voltage Direct Current (HVDC) link between north-east Scotland and north-east England (The Crown Estate, 2008);
- The European Wind Energy Association's (EWEA) 20 Year Offshore Network Development Masterplan, proposing an offshore grid of cables linking European nations and offshore wind farm projects (EWEA, 2009); and
- Other interconnectors between various European countries, for example, cable connections between Norway and continental Europe, with a total capacity of up to 4,200 MW, including a UK-Norway connection (National Grid, 2009; Statnett, 2010).

Consequently, EU member states are moving toward a supergrid concept with the intention of upgrading existing transmission assets in Europe by 2030. Progress on interconnector and supergrid proposals should be followed closely as it could result in both development implications and connection opportunities.

Table 14.2: Interconnection and "SuperNode" capacities for the Supergrid phase 1 proposal (Friends of the Supergrid, 2010).

Supergrid Connection	Capacity (GW)
Dogger – Germany Offshore	10
Dogger – Norfolk Bank	5
Dogger – Firth of Forth	5
Dogger – Norway	5
Germany Offshore – Munich	10
London – Norfolk Bank	5
Norfolk Bank - Belgium Offshore	2
"SuperNode"	**Capacity (GW)**
Belgium Offshore	2
Dogger – Hornsea	10
Germany Offshore	10
Norfolk Bank	5
Munich	10
Firth of Forth	5

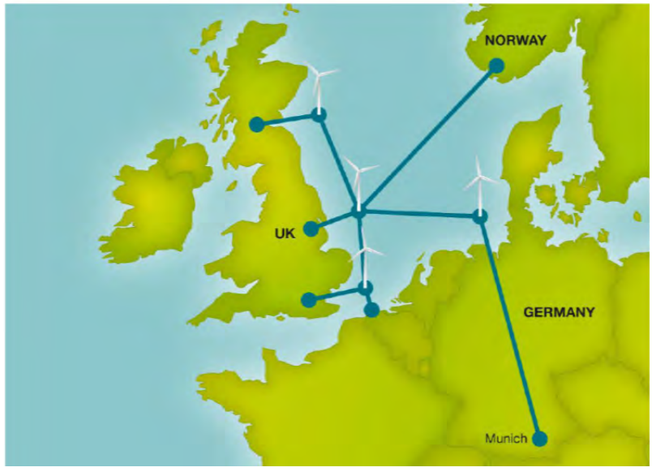


Figure 14.2: The Supergrid Phase 1 proposal (Friends of the Supergrid, 2010).

14.6 Subsea Pipelines

A network of oil and gas pipelines, including hydraulic and chemical 'umbilicals', serve oil and gas facilities in the North Sea, connecting offshore platforms, terminals and refineries at the coast. There are over 150 licensed sections of pipeline and umbilical within the Offshore ZDE, most of which are located to the south of the Dogger Bank Zone where the southern North Sea gas platforms are most concentrated (see Chapter 11 – *Oil and Gas*). Details of all pipelines and umbilicals are given in Appendix I.

14.6.1 Dogger Bank Zone

Shell UK's 'Shearwater Elgin Area Line' (SEAL) runs from north to south down the western side of the Dogger Bank Zone (see Figure 14.3). The SEAL transports gas from the Shearwater and Elgin Franklin platforms to the Bacton Gas Terminal on the Norfolk coast and subsequently on to adjacent transmission facilities. The 34 inch diameter line was commissioned in 2000 and has a total length of 474 km (UK DEAL, 2010; Shell UK, 2010).

The Franpipe and Zeepipe pass to the east of the Dogger Bank Zone and UK Median, through Dutch, German, Danish and Norwegian waters (Figure 14.3). The 42 inch diameter Franpipe gas line, operated by Gassco, runs 840 km from the Draupner East riser platform in Norwegian Waters to the Port Ouest terminal at Dunkerque on the French coast (Gassco, 2008a).

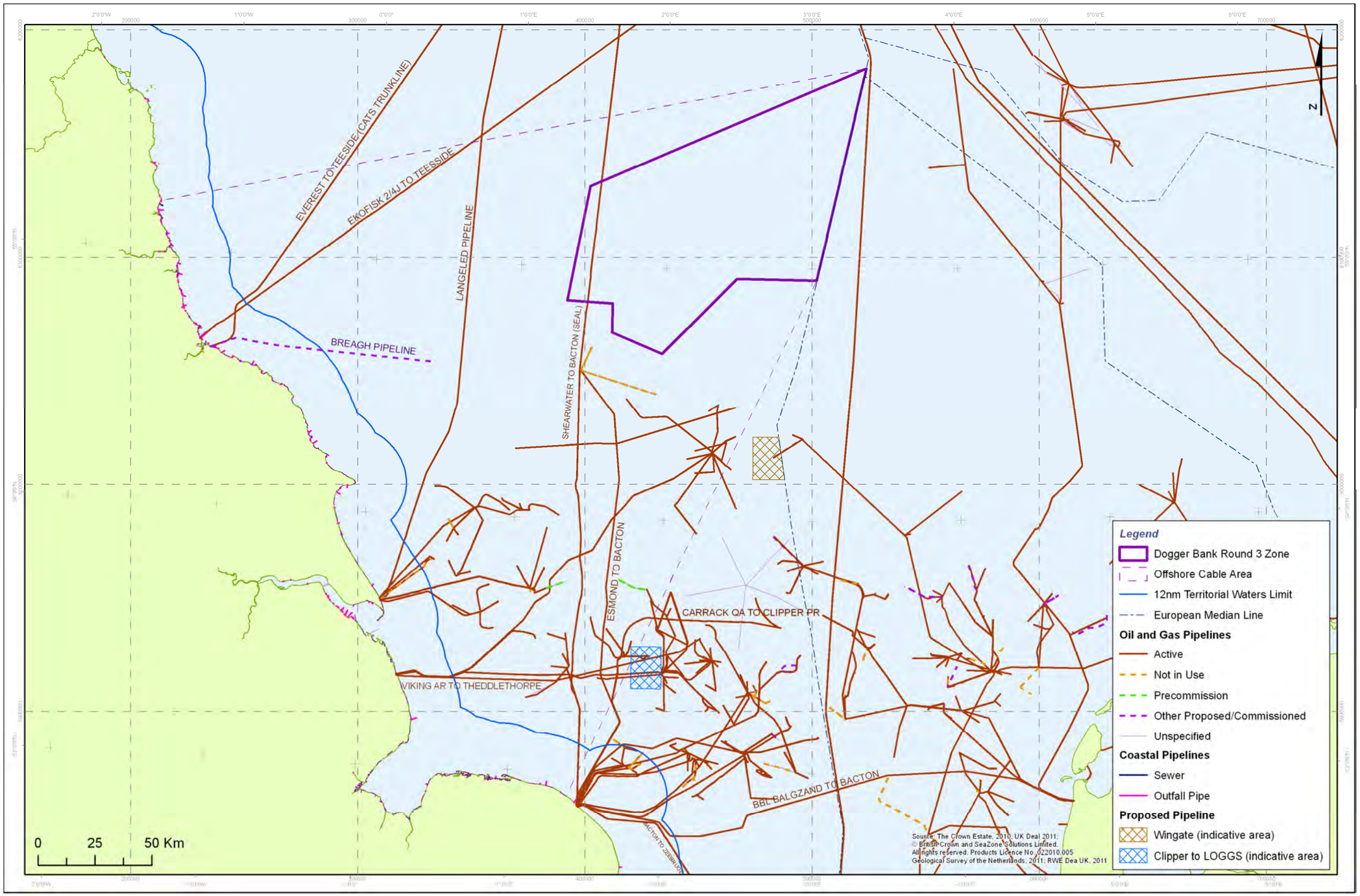


Figure 14.3: Oil and gas pipelines and coastal pipelines across the Dogger Bank Zone and Offshore Cable Area.

Gassco also operates the 40 inch Zeepipe gas line running for 814 km from the Norwegian Sleipner gas field to a receiving terminal at Zeebrugge in Belgium (Gassco, 2008b). Both the Franpipe and Zeepipe lines are closest at the north-east tip of the Dogger Bank Zone, where both lie in German waters, parallel with a section of the Norsea Coms 1 cable (see Section 14.4.2). Here, the Franpipe and Zeepipe are less than two kilometres from the Dogger Bank Zone (see Figure 14.3).

14.6.2 Offshore Cable Area

To the north and west of the Dogger Bank Zone lie the Everest to Teesside 'Central Area Transmission Service' (CATS) pipeline, the Ekofisk 2/4J to Teesside pipeline and the Langeled pipeline (Figure 14.3). Bacton, to the south of the ZDE, is also the terminus for a number of pipelines which pass through the Offshore ZDE.

The Everest to Teesside CATS pipeline, operated by BP Exploration, originates at the BP operated Everest gas field in the central North Sea and transports gas 404 km through the 36 inch diameter pipe to the processing terminal in Teesside (UK DEAL, 2010; CATS, 2010). ConocoPhillips' 34 inch diameter Ekofisk 2/4J to Teesside pipeline (the 'Norpipe') also terminates at Teesside, transporting oil from the Ekofisk field (2/4J platform) on the Norwegian Continental Shelf (UK DEAL, 2010). The 44 inch diameter Langeled gas pipeline, operated by Gassco, exports natural gas from Nyhamna in Norway to the Easington terminal in Yorkshire (Metoc plc, 2004).

In the south of the Offshore ZDE, the network of pipelines is extensive and complex (Figure 14.3). Each pipeline is detailed in Appendix I. The most extensive pipelines in this area include:

- Murdoch-Caister, Valiant, and Viking gas pipelines, connecting fields with the Theddlethorpe terminal;
- Cleeton and West Sole gas pipelines, connecting fields with the Easington terminal; and
- Guinevere / Lancelot and Esmond to Bacton gas pipelines connecting fields with the Bacton terminal.

Sections of the BHP operated Esmond to Forbes and Esmond to Gordon gas pipelines, less than 30 km south of the Dogger Bank Zone, are not in use (Figure 14.3).

A review of information provided by DECC (2011c) on oil and gas pipelines consented under the Petroleum Act 1998 (as amended) indicates that there are proposed and commissioned pipelines that were being approved in 2011 but are not yet included in the UK DEAL and SeaZone datasets. These include:

- RWE dea UK SNS Ltd's gas pipeline from the Breagh platform to Teesside Terminal (Coatham Sands), for which construction commenced in June 2011;
- RWE dea UK SNS Ltd's LOGGS gas export pipeline, connecting the Clipper South platform to the ConocoPhillips PR platform facility at the LOGGS complex (Valiant North), where gas will then be exported to Theddlethorpe in Lincolnshire along an existing pipeline; and
- Wintershall's gas pipeline between the Wingate platform and the UK Median.

Although these, pipelines are not included in the GIS dataset, the UK Continental Shelf (UKCS) licensing blocks in which they will be located are shown in Figure 14.3.

14.7 Coastal Pipeline Infrastructure

Numerous pipelines occur at the coastline (Figure 14.3). Most are wastewater outfalls and sewers associated with the water companies, Northumberland Water, Yorkshire Water and Anglian Water. Some outfalls may be associated with underground gas storage facilites, through which underground salt caverns may be flooded and dewatered (see Chapter 11 – *Oil and Gas*).

14.8 Summary

This chapter has identified cables and pipelines which may influence development in the Dogger Bank Zone and Offshore Cable Area.

The Dogger Bank Zone is intersected by two active telecommunications cables, 'VSNL North Europe' and 'UK-Germany 6', and one out-of-service telecommunications cable, 'UK-Denmark 4'. The SEAL gas pipeline also passes within the boundary of the Dogger Bank Zone.

Other cables and pipelines occur in the Offshore Cable Area, including operational and proposed export cables serving wind farms closer to shore and a network of pipelines serving gas platforms and terminals in the southern part of the Offshore ZDE. Outfall and sewer pipelines associated with the water companies occur along the coastline. Active cables and pipelines within the Dogger Bank Zone should be avoided when siting turbines while export cables should acknowledge cable crossing protocols with agreements from operators.

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15. Other Marine Users

15.1 Introduction

Elements of the human environment within the Offshore ZDE have been discussed in the previous chapters on Navigation and Shipping; Oil and Gas; Military, Aviation and Radar; Marine Aggregates and Disposal; and Cables and Pipelines. Other notable activities, known to occur within the Offshore ZDE or which have been identified as emerging industries, are addressed in this chapter, specifically:

- Other renewable energy;
- Underground Coal Gasification (UCG);
- Carbon Capture and Storage (CCS); and
- Recreation and tourism.

15.2 Data and Literature

Data delineating offshore wind farm boundaries were provided by TCE, while information regarding these sites and other offshore renewable energy projects was acquired from a review of records held by Renewable UK and relevant literature, as cited in the reference list at the end of this chapter. Underground Coal Gasification licence areas were obtained through The Coal Authority. Carbon Capture and Storage was also investigated by reviewing available literature from the Department of Energy and Climate Change (DECC) and TCE.

Information regarding recreation and tourism was based upon designated bathing waters and recreational boating. Designated bathing waters and recreational boating areas provide an indication of areas of the coast which are likely to be popular for a variety of leisure pursuits. The Environment Agency holds records of bathing waters designated under the EC Bathing Water Directive, together with information about their water quality status. The 2009 and 2010 data were downloaded, together with a review of which beaches were awarded the European Blue Flag status in 2010 and 2011, in order to provide an indication of areas that are popular with beach goers. Royal Yachting Association (RYA) cruising routes, sailing and racing areas, marinas, clubs and training centres were obtained from the RYA's second edition of the UK Coastal Atlas of Recreational Boating (RYA, 2009).

The focus of this chapter and preceding chapters has addressed the key activities occurring in the Offshore ZDE. The underlying datasets are considered to be accurate in demonstrating their locations and spatial extents. Gaps may exist in the account for recreation and tourism, owing to the variety of other activities that can take place at the coast (e.g. angling, scuba diving, surfing, windsurfing, etc). The presence of national trails and caravan parks has also been considered as part of the Onshore Zonal Characterisation (see Chapters 16 and 17).

15.3 Overview

With the exception of RYA cruising routes, none of the activities discussed in this chapter occur within the boundary of the Dogger Bank Zone, tending to be concentrated nearer the coast at present. In the Offshore ZDE, offshore renewable energy projects are predominantly wind energy projects, many of which are yet to be consented and constructed. These include small scale sites at the coast and Round 1, 2 and 3 sites located to the south and south-west of the Dogger Bank Zone.

UCG is currently limited to five conditional licence areas in coastal waters. There is also great potential for CCS in depleted North Sea oil and gas fields and saline aquifers, and a number of demonstration projects are likely to take place over the coming decade. Both UCG and CCS are likely to utilise boreholes or wells similar to those associated with the oil and gas industry.

Recreational sailing and designated bathing waters occur frequently in the coastal region of the ZDE with a sparse distribution of moderate-use RYA cruising routes in the Dogger Bank Zone itself.

15.4 Renewable Energy

The southern North Sea has previously been a focus for offshore wind farm development for independent projects, such as the existing Blyth site, and during TCE leasing Rounds 1 and 2 (TCE, 2010a). Development has mostly been focused around the Humber estuary and The Wash in this region owing to suitable water depths and the availability of grid connections.

With the announcement of the Round 3 awards in 2009 wind energy development in the North Sea has accelerated, with the Dogger Bank, Hornsea and Norfolk Zones becoming the largest areas outlined for development to date. To support the growth in wind energy a proposal exists for a demonstration site in Blyth, at which new turbine technologies may be tested. Wave and tidal energy in the North Sea is still in its infancy relative to wind energy (TCE, 2010b). However, a test facility is operational in the Humber estuary. Table 15.1 and Figure 15.1 provide an overview of the wind farms that occur within the Offshore ZDE. Each wind farm will have a network of inter-array cables and will be connected to the UK mainland via subsea export cables.

15.4.1 Blyth Offshore Wind Turbines and Breakwater

Two turbines, each of 2 MW capacity, are located approximately 1.5 km offshore from Blyth with nine 300 kW turbines fronting the port's breakwater. The breakwater turbines were developed by AMEC Wind on behalf of Hainsford Energy (Blyth Harbour) Limited and became operational in 1993. The two offshore turbines, which were developed by a consortium comprising E.ON UK Renewables, Shell Renewables, Nuon UK and AMEC Wind on behalf of Blyth Offshore Windfarm Ltd (now solely owned by E.ON UK), came online in 2000 (New and Renewable Energy Centre (Narec), 2010; Renewable UK, 2011). Both projects are now operated by Sinclair Knight Merz (SKM).

15.4.2 Rounds 1 and 2

TCE's first round of offshore wind farm development began in 2000 with the aim of providing developers with an opportunity to build demonstration scale projects of 30 turbines or less (TCE, 2010a). In the Offshore Cable Area, this includes Centrica Energy's sites at Inner Dowsing and Lynn, 5 km east of Skegness became operational in 2009 with a combined capacity of 194 MW produced by 54 turbines (Centrica Energy, 2009; Renewables UK, 2011). EDF Energy's 62 MW site at Teesside, 1.5 km east of Teesmouth, has been consented for 27 turbines (Table 15.1 and Figure 15.1).

The Round 2 tender process in 2003 enabled larger scale commercial projects to be identified, some beyond the 12 nm territorial waters limit. The resultant projects include eight Round 2 sites located in the Humber and The Wash region of the Offshore Cable Area (Table 15.1 and Figure 15.1). The Lincs and Sheringham Shoal sites are currently under construction while the Humber Gateway site received consent on 9th February 2011 (E.ON UK, 2011). All other Round 2 sites within the Offshore Cable Area are currently seeking consent. Triton Knoll, if

completed, will be the largest of the Round 2 sites in the ZDE with a target capacity of up to 1,200 MW.

Table 15.1: Operational and planned offshore wind projects in the Offshore ZDE (Renewable UK, 2011; New and Renewable Energy Centre (Narec), 2010; The Crown Estate, 2010c).

Name	Current Developer	Capacity	Round	Status
Blyth	E.ON UK Renewables	4 MW	Other	Operational
Inner Dowsing	Centrica Energy	97 MW	1	Operational
Lynn	Centrica Energy	97 MW	1	Operational
Teesside	EDF Energy	62 MW	1	Consented
Lincs	Centrica Energy	270 MW	2	Under construction
Sheringham Shoal	Scira Offshore Energy	317 MW	2	Under construction
Humber Gateway	E.ON UK	300 MW	2	Consented
Docking Shoal	Centrica Energy	540 MW	2	Application submitted
Dudgeon East	Warwick Energy Ltd	560 MW	2	Application submitted
Race Bank	Centrica Energy	620 MW	2	Application submitted
Westermost Rough	DONG Energy UK	240 MW	2	Application submitted
Triton Knoll	RWE npower renewables	1,200 MW	2	Planned
Hornsea Zone	SMartWind Limited	4 GW	3	Zone Appraisal and Planning (Project One planned)
Blyth Demonstration Site	Narec	100 MW (variable)	Other	Planned
Dogger Bank	Forewind	<13 GW	3	Zone Appraisal and Planning (Project One planned)

15.4.3 Round 3

The Round 3 sites, awarded in 2009, were identified by TCE as suitable areas on the UK Continental Shelf for developers to plan and design offshore wind farms of a scale required in order to meet the UK's 2020 offshore wind objectives.

The Dogger Bank Zone is the largest of the Zones identified. Also within the Offshore Cable Area is the Hornsea Zone, being developed by SMartWind, a consortium of Mainstream Renewables and Siemens. The Hornsea Zone is located approximately 60 km to the south of the Dogger Bank Zone and lies 34 km to the west of the Yorkshire coast. With an area of 4,735 km^2 the Hornsea Zone has a target capacity of 4 GW (Renewable UK, 2011). SMartWind, like Forewind, is presently engaged in the Zone Appraisal and Planning (ZAP) phase of planning and development.

In November 2010, SMartWind submitted plans and their scoping report to the Infrastructure Planning Commission (IPC), outlining the chosen location for their first "Subzone" (a study area determined during the Zone Appraisal and Planning (ZAP) process which is broadly similar to a "Tranche" in the Dogger Bank Zone). The Subzone will accommodate SMartWind's 'Project One', which will have an installed capacity of up to 1.2 GW (SMartWind, 2010). The Project One Subzone occupies the narrow central section of the Hornsea Zone (see Figure 15.1) with the Project One grid connection expected at Killingholme on the south bank of the Humber estuary.

15.4.4 Blyth Demonstration Site

Narec has applied to TCE for a lease to develop an offshore wind demonstration site, comprising 20 pre-consented 'pods', at which tenants may deploy prototype or demonstration turbines and foundations. These pods will be in four parallel rows, increasing in distance offshore and with water depths of 15, 35, 45 and 55 m to allow testing of alternative installation and foundation types in conditions that are representative of many of the Round 3 Zones (Narec, 2010).

The site has been designed to meet the requirements of TCE, Government, Energy Technologies Institute, and the Carbon Trust's Offshore Wind Accelerator programme (Narec, 2010). Surveys, EIA and planning are currently underway for the demonstration site proposal.

15.4.5 Pulse Tidal Energy

The Pulse tidal energy project is the only other known renewable energy installation in the ZDE. The 100 kW 'Pulse-Stream 100' test site, located approximately 1 km off the south bank of the Humber near Immingham, began generating electricity in May 2009. The power is exported to Millennium Chemicals, a large plant on the south bank of the estuary. Ultimately, the facility's capacity is intended to be increased to 1 MW (Pulse Tidal, 2009).

15.5 Underground Coal Gasification

Underground Coal Gasification (UCG) is the conversion of coal in-situ, into a synthetic gas that can be processed to provide a variety of fuels. The process requires wells to be drilled into coal seams, with an intake well for oxidants (water and/or oxygen) and an outtake well for extracting the gas (UCG Association, 2011).

Following an EU trial in the 1990's, supported by the Department of Trade and Industry (DTI), it was proven that Underground Coal Gasification (UCG) is feasible in European coal seams. It was concluded that there was potential for coal reserves in the UK to be utilized this way, especially considering the large quantities of offshore coal potentially available (DECC, 2011a).

From oil and gas drilling, offshore coal is known to exist over vast areas of the North Sea. Prime areas of coal, accessible from the shoreline lie along the Northumberland, Lincolnshire and Norfolk coasts. Consequently, the UK coal resource close to shore and offshore could provide a long term gas supply (DTI, 2004).

Licensing of offshore UCG areas and infrastructure in relation to coal access falls to The Coal Authority, a non-departmental public body sponsored by DECC. A licence from DECC is also required under the Petroleum Act 1998 for the extraction of the gas produced. Onshore developments are also subject to planning permission from the local planning authority or from the Infrastructure Planning Commission (IPC) if the maximum gas flow rate is to exceed 4.5 million m^3/day. Figure 15.1 shows that there are eight conditional licence areas along the coast of the Offshore ZDE and a further two areas to the north of the ZDE boundary. The licensees of these areas are detailed in Table 15.2.

The Coal Authority's conditional licences enable prospective operators to secure the rights to access coal but do not permit UCG operations to commence until all other rights and planning permissions are in place (DECC, 2011a).

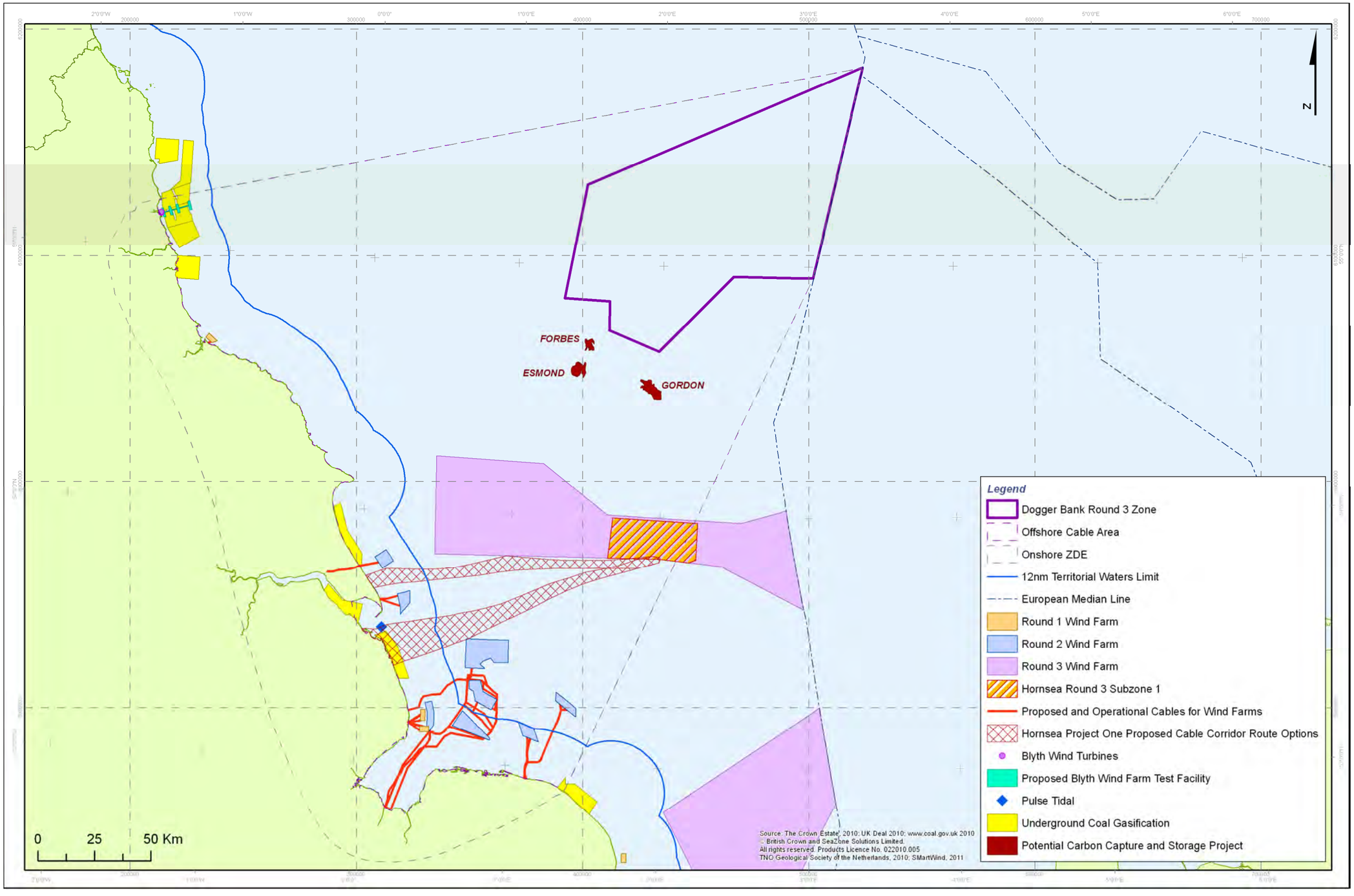


Figure 15.1: Renewable energy and Underground Coal Gasification licences in the Offshore ZDE.

Table 15.2: Conditional Underground Coal Gasification licences within and adjacent to the Offshore ZDE (The Coal Authority, 2011).

Location	Conditional Licence	Licensee
Offshore Cable Area	East Anglia Offshore	East Coast Energy Ltd
	South Humber Offshore	Europa Oil & Gas Resources Ltd / Oxford Energy Consulting Ltd
	Humberside Coastal	East Coast Energy Ltd
	Holderness Offshore	Europa Oil & Gas Resources Ltd / Oxford Energy Consulting Ltd
	Sunderland Offshore	East Coast Energy Ltd
	Tynemouth Offshore	Five Quarter Energy Ltd
	Blyth Offshore	Five Quarter Energy Ltd
	Lynemouth Offshore	Five Quarter Energy Ltd
North of the ZDE	Longhoughton Offshore	Five Quarter Energy Ltd
	Amble Offshore	Riverside Energy (Amble) Ltd

15.6 Carbon Capture and Storage

Carbon Capture and Storage (CCS) combines three distinct processes: capturing CO_2 at a power station or other major industrial plant; transporting it by pipeline or by tanker; and then storing it in geological formations such as saline aquifer formations or depleted oil and gas fields. There are therefore synergies for CCS and underground gas storage (UGS) (see Chapter 11 – *Oil and Gas*).

CCS in depleted gas fields is generally agreed to be the lowest cost and lowest risk option for early CCS deployment, although storage in oil reservoirs and saline aquifers is expected to be needed as CCS capacity expands (HM Government, 2010). As a result the southern and central North Sea is likely to be an ideal candidate for CCS.

At present, the only two active CCS projects in the North Sea are at Sleipner in Norwegian waters (British Geological Survey, 2011; Carbon Capture and Storage Association (CCSA), 2011a) and a small scale operation at the Dutch K12-B gas field (GDF Suez and TNO, 2010). There are currently no active CCS projects within the Offshore ZDE.

The UK Government's target to reduce carbon emissions by 80% by 2050 has led the Department of Energy and Climate Change to progress with a programme of four commercial-scale CCS demonstration projects, to be implemented by 2020 with more substantial developments taking place at a point when the industry is more technologically and economically advanced (DECC, 2011b). CCS demonstrator projects are likely to be associated with areas of high CO_2 emissions, such as Humberside, Teesside and Tyneside within the ZDE, and the UK Government plans to promote their co-location (DECC, 2011b).

Competition for the first demonstration project began in November 2007, with ScottishPower and its consortium with National Grid and Shell confirmed as the sole remaining bidder. Their proposals will link the coal-fired Longannet power station in the Firth of Forth in Scotland with Shell's Goldeneye gas field in the central North Sea, over 300 km north of the Offshore ZDE. Confirmation of Government funding is expected later in 2011 (DECC, 2011d). DECC is currently developing the selection process for the next three demonstration projects.

In addition to ScottishPower's Longannet to Goldeneye proposal, there are number of CCS proposals currently being considered in the UK which are likely to contend for funding through the DECC demonstration programme. The onshore carbon capture elements of these proposals are outlined by the CCSA (2011b) and these may result in the development of offshore infrastructure at storage sites located within the Offshore ZDE. Therefore, the proposals that may be relevant to the Offshore ZDE include the following:

- National Grid's plans to capture CO_2 from the proposed 900 MW Don Valley power station at Stainforth, adjacent to the Hatfield colliery near Doncaster in South Yorkshire. CO_2 would be transported via a buried pipeline to a pumping station to be located between Hornsea and Bridlington, before being taken offshore to a suitable storage site. The onshore pipeline route is being designed so that further projects in the region could potentially connect in the future (National Grid, 2011);
- Calix's proposal for a 450 MW plant, again located adjacent to the Hatfield colliery near Doncaster in South Yorkshire (CCSA, 2011b);
- Alstom UK Ltd, Drax Power Limited and National Grid's proposal for a new 436 MW CCS demonstration project at a power station based in Selby, North Yorkshire (CCSA, 2011b);
- C.GEN's proposals for a 520 MW gasification power station integrated with CCS at Killingholme on the south bank of the Humber Estuary (C.GEN, 2011); and
- Proposals made by a consortium led by Progressive Energy Ltd to build an 850 MW plant called Eston Grange on Teesside (CCSA, 2011b).

There is evidently potential for future development of CCS demonstration projects in the Offshore ZDE and developments should be followed closely. Notably, the Forbes, Esmond and Gordon gas fields to the southwest of the Dogger Bank Zone (Figure 15.1) are depleted fields which have been identified for potential underground storage of natural gas (see Chapter 11 – *Oil and Gas*), and may therefore offer CCS opportunities as well.

15.7 Potash

Potash is a generic term for a variety of potassium bearing minerals, although it is Sylvinite that is primarily mined around the UK. Around 90% of UK potash is used in the production of fertilizer with the remainder being used in the chemical and pharmaceutical industries. However, around 60% of all UK production is exported to Europe each year. The Crown Estate are responsible for the deposits of potash occurring beneath the UK seabed and issue a lease for its extraction.

The Boulby potash mine, situated on the North Yorkshire coast, is the UK's only commercial potash mine and has been operating since 1973. It is currently managed by Cleveland Potash Ltd. Mining operations cover some 13.5 km, reaching approximately 5 km offshore. During 2011, York Potash – part of Sirius Minerals – signed an agreement to explore for potash under the seabed off the coast of Hunsdale, situated to the south of Boulby. The drilling of test boreholes marks the first phase in the possible development of a potash mine between Scarborough and Whitby (The Crown Estate, 2011).

15.8 Recreation and Tourism

15.8.1 Bathing Waters and Blue Flag Beaches

Coastal bathing waters are designated under the Bathing Water Directive (76/160/EEC, as revised by 2006/7/EC, which will be implemented in stages between now and 2015 when the original Directive will be repealed) and assessed on a monthly basis against mandatory and guideline standards for water quality during the May to September bathing season.

Table 15.3: Designated Bathing Waters and Blue Flag beaches in the ZDE (Defra, 2010; Blue Flag, 2011b).

	Designated Bathing Water	Bathing Water Status 2010 / Blue Flag 2011	Bathing Water Status 2009 / Blue Flag 2010
Norfolk	Cromer	Excellent	Excellent
	East Runton	Excellent	
	Sheringham	Excellent	Excellent
	Wells	Excellent	Excellent
	Old Hunstanton	Excellent	Good
	Hunstanton Main Beach	Excellent	Excellent
	Heacham	Good	Excellent
Lincolnshire	Skegness	Excellent	Excellent
	Ingoldmells South	Excellent	Excellent
	Chapel St Leonard	Excellent	Excellent
	Anderby	Excellent	Excellent
	Moggs Eye	Excellent	Excellent
	Sutton-on-Sea	Excellent	Excellent
	Mablethorpe Town	Excellent	Excellent
	Cleethorpes	Excellent	Excellent
East Yorkshire	Withernsea	Excellent	Good
	Tunstall	Excellent	Good
	Hornsea	Excellent	Good
	Skipsea	Excellent	Good
	Fraisthorpe	Good	Excellent
	Wilsthorpe	Good	Good
	Bridlington South Beach	Good	Good
	Bridlington North Beach	Good	Excellent
	Danes Dyke, Flamborough	Excellent	Excellent
	Flamborough South Landing	Excellent	Good
N. Yorkshire	Reighton	Excellent	Excellent
	Filey	Excellent	Excellent
	Cayton Bay	Excellent	Excellent
	Scarborough South Bay	Good	Excellent
	Scarborough North Bay	Excellent	Excellent
North Yorkshire	Robin Hoods Bay	Good	Good
	Whitby	Excellent	Excellent
	Sandsend	Excellent	Excellent
	Runswick Bay	Good	Good
	Staithes	Fail	Good
	Saltburn	Fail	Good
	Sea at Marske Sands	Excellent	Excellent
	Redcar Stray	Excellent	Excellent
	Redcar Granville	Excellent	Excellent
	Redcar Lifeboat Station	Excellent	Excellent
	Redcar Coatham	Excellent	Excellent
Durham	Seaton Carew North Gare	Excellent	Excellent
	Seaton Carew Centre	Good	Excellent
	Seaton Carew North	Good	Good
	Crimdon	Good	Excellent
	Seaham Hall Beach	Excellent	Excellent
	Seaham Beach	Excellent	Excellent
Tyne & Wear	Roker - Sunderland	Excellent	Excellent
	Seaburn - Sunderland	Excellent	Excellent
	Marsden	Excellent	Excellent
	South Shields	Excellent	Excellent
	Tynemouth King Edwards Bay	Excellent	Excellent
	Tynemouth Long Sands South	Excellent	Excellent
	Tynemouth Long Sands North	Excellent	Excellent
	Tynemouth Cullercoats	Good	Excellent
	Whitley Bay	Excellent	Excellent
North-umberland	Seaton Sluice	Excellent	Excellent
	Blyth South Beach	Good	Excellent
	Newbiggin South	Excellent	Excellent
	Newbiggin North	Excellent	Good

The mandatory water quality standards set by Directive 76/160/EEC are not to exceed 10,000 total coliforms per 100 ml and 2,000 faecal coliforms per 100 ml in 95% of samples. Beaches that comply with this standard are awarded 'Good' status. Compliance with the more stringent guideline standards set by the Directive (not exceeding values of 500 total coliforms per 100 ml and 100 faecal coliforms per 100 ml in 80% of water quality samples, and 100 faecal streptococci per 100 ml in 90% of samples taken) is required to achieve 'Excellent' water quality status, one of the criterion required by the international Blue Flag beach award scheme (Blue Flag, 2011a).

Sixty designated Bathing Waters occur along the coast within the ZDE, indicating the locations of some of the most popular beaches. These are depicted in Figure 15.2 and Table 15.3, including information on water quality status provided by the Department for Environment, Food and Rural Affairs (Defra, 2010).

Blue Flag status in Europe is reviewed and announced annually on the 5th June, and therefore considers national bathing water quality compliance from the previous season (i.e. 2010 Blue Flag awards consider 2009 bathing water results). Blue Flag beaches listed by Blue Flag (2011b) are also depicted in Figure 15.2 and Table 15.3.

15.8.2 Recreational Boating

Figure 15.2 presents the RYA cruising routes, sailing and racing areas, marinas, clubs and training centres (RYA, 2009). Further to the areas defined in this figure, recreational boating is likely to take place ubiquitously throughout the waters of the Dogger Bank ZDE, but will demonstrate seasonal and diurnal variations. Cruising routes are classified by the RYA (2009) as Heavy, Medium and Light Use, defined as:

- Heavy Recreational Routes: - Very popular routes on which a minimum of six or more recreational vessels will probably be seen at all times during summer daylight hours. These also include the entrances to harbours, anchorages and places of refuge;
- Medium Recreational Routes: - Popular routes on which some recreational craft will be seen at most times during summer daylight hours; and
- Light Recreational Routes: - Routes known to be in common use but which do not qualify for medium or heavy classification.

Dogger Bank Zone

There are two medium-use routes which pass through the Dogger Bank Zone (Figure 15.2). The most northerly of these two routes is between Newcastle-Esbjerg in Denmark while the more southerly of the two routes is between Newcastle and Germany. Recent information from the Cruising Association in 2010 suggests that there may also be four light-use routes between Forth-Elbe, Lowestoft-Bergen, Whitby-Skagerrak and Humber-Skagerrak. In addition to yacht cruising, there is an annual North Sea Triangle race crossing the North Sea which may pass through the area. This has been discussed further in Chapter 9 – *Navigation and Shipping*.

Further to recreational boating, it is worth noting that the Dogger Bank is a destination for wildlife boat tours, with a key operator being Wildlife Tours and Education (2009), based in Sheringham in Norfolk.

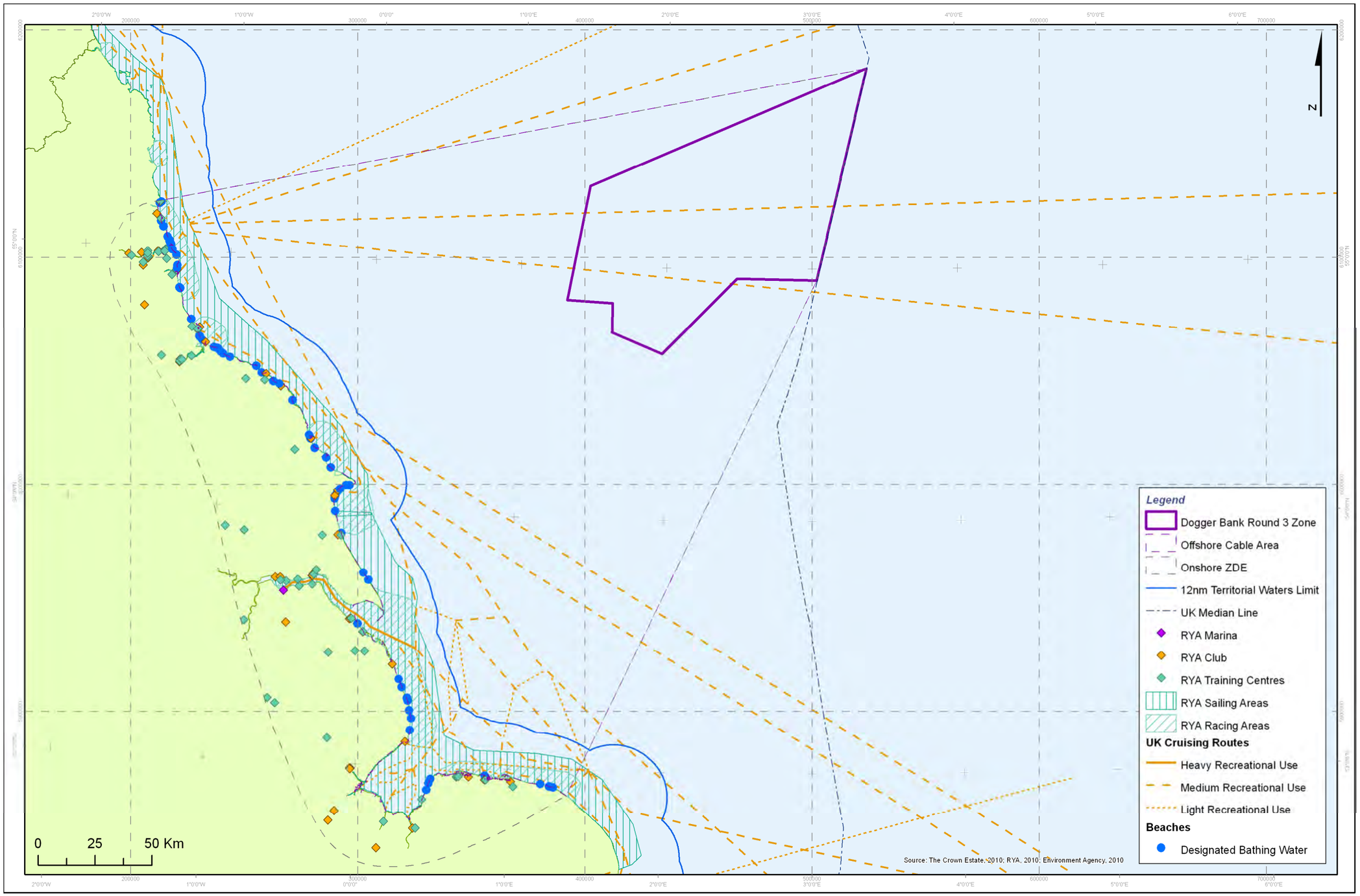


Figure 15.2: Recreation and tourism users across the Dogger Bank Zone and Offshore Cable Area.

Offshore Cable Area

Boating activity increases towards the coast. Sailing areas front the entire coastline while racing areas are defined around the major estuaries in the ZDE, around Flamborough Head and off the coast of Norfolk. Cruising routes also increase in number closer to the coast, but the only heavy-use route is located within the Humber estuary where there is also a relatively high concentration of marinas, clubs and training centres (Figure 15.2).

15.9 Summary

Offshore wind energy projects are in a phase of extensive development particularly to the south of the Dogger Bank Zone where Round 1, 2 and 3 sites are either operational or have been identified for potential development.

Underground Coal Gasification (UCG), Carbon Capture and Storage (CCS) and potash mining are in the initial development stages and yet to yield any significant development or infrastructure. There are eight conditional licences for UCG within the coastal waters of the Offshore ZDE, which are subject to planning permission and therefore no infrastructure is currently in place. UCG is likely to use similar offshore infrastructure as current oil and gas extraction. While there is potential for CCS in depleted North Sea gas fields and saline aquifers, no formal proposals currently exist within the Offshore ZDE. However, a number of onshore carbon capture projects have been proposed which may require offshore storage within the Offshore ZDE, and which may be awarded funding during DECC's demonstration programme or thereafter.

Designated bathing waters occur frequently in the coastal region of the ZDE and many of the beaches are popular recreational facilities. Recreational sailing also occurs frequently within coastal waters, however there is only a sparse distribution of moderate-use RYA cruising routes in the Dogger Bank Zone itself.

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Part III – Onshore Zonal Characterisation

16. Onshore Zone Development Envelope

16.1 Introduction

This chapter characterises the environmental, planning and land use constraints within the Onshore ZDE based on the data which has been collected to date. The geographical extent of the onshore part of this zone, referred to as the Onshore Zone Development Envelope (ZDE), is defined by the need for multiple cable connections along the east coast of England. The Onshore ZDE includes all National Grid infrastructure as defined within the ODIS report (National Grid, 2009). However, the Onshore ZDE has been extended northwards to investigate cable connection options that minimise offshore cable route distances and to ensure that coverage is provided should there be any future changes to the infrastructure identified in the ODIS report. The Onshore ZDE area, as illustrated in Figure 16.1, covers an area of the east coast of England of approximately 15,646km^2, stretching from Norfolk up to the southern part of Northumberland and extending approximately 50 km inland from the coastline. The purpose of this report is to characterise the environmental, planning and land use constraints of the Onshore ZDE.

Chapter 17 – *Creyke Beck Substation Study Area* describes the site-specific Creyke Beck Substation Study Area in more detail. The chapter will be updated and added to as additional grid connections are accepted by Forewind during the course of ZAP and associated Substation Study Areas become defined.

16.2 Data Sources

The data used to characterise the Onshore ZDE have been divided into four main themes. The four main themes are:

- Environmental data;
- Cultural heritage data;
- Land use and infrastructure data; and
- Planning policy data.

Table 16.1 identifies the data sets that have been collected in this assessment for each of the four themes. Data sources used fall into three main categories:

- Ordnance Survey OpenData – Freely available mapping data covering small and mid-scale mapping;
- Publicly available information from government agencies – official designated sites from Natural England and English Heritage; and
- Providing the backdrop to the thematic datasets are a number of relevant Ordnance Survey background mapping datasets. For the Onshore ZDE, OS Mini-scale and OS 1:250,000 have been used for mapping.

Table 16.1: Potential Planning, Environmental and Engineering Constraints.

Theme	Potential Constraint	Issues and Data to be Considered
Environmental Constraints	Ecological Designations	Special Areas of Conservation (SAC), Special Protection Areas (SPA), Sites of Special Scientific Interest (SSSI), Ramsar sites, National Nature Reserves (NNR), Local Nature Reserves (LNR), RSPB nature reserves, Important Bird Areas (IBA) and Ancient Woodland. Such sites may have seasonal constraints (e.g. summer breeding birds, wintering birds) which could influence the timing of construction activities.
	Water	The location of water features, including main rivers and water bodies such as lakes and reservoirs, and areas of flood risk.
Cultural Heritage Constraints	Cultural Heritage	World Heritage Sites, Scheduled Ancient Monuments, Listed Buildings, Historic Gardens and Heritage Coasts.
Land Use and Infrastructure Constraints	Services	The location and proximity to a number of services including gas pipelines and high voltage lines and towers.
	Topography	Steep slopes, valleys, coastal cliff lines which could have implications on engineering design.
	Geology	Geological SSSI, Regionally Important Geological Sites and large scale geological mapping.
	Land uses	Areas which are considered to be of sensitive land use, such as airports, hospitals, residential areas and schools.
	Landscape and Visual	Areas of Outstanding Natural Beauty (AONB), Local Landscape Designations, National Parks, National Cycleways, Long Distance Routes, public rights of way and bridleways, and Registered Parks and Gardens.
	Transport	Major transport routes such as motorways, A and B class roads, and railways.
Planning Policy Constraints	Planning constraints	Greenbelt, land designations/allocations, shoreline management plans informing likely coastal retreat issues

16.3 Environmental Constraints

There are a number of internationally and nationally important environmental designated areas within the Onshore ZDE. These are illustrated on Figure 16.2. These are as follows:

16.3.1 Nature Conservation

- Special Protection Areas (SPA) (11 in total);
- Special Areas of Conservation (SAC) (20 in total). In some cases, areas are designated as both SPAs and SACs. Important sites within the Onshore ZDE include the Humber Estuary, North York Moors, the Wash and North Norfolk Coast, and the Northumberland Coast;
- Sites of Special Scientific Interest (SSSI) (357 in total). Notable SSSIs include Flamborough Head and Robin's Hood Bay (Maw Wyke to Beast Cliff); and
- National Nature Reserves (NNR) (22 in total). Notable NNR's include the Saltfleetby to Threedlethorpe Sand Dunes, The Wash, Spurn Head and Gibraltar Point (south of Skegness).

16.3.2 Landscape

- Areas of Outstanding Natural Beauty (AONB). There are three in this Onshore ZDE. These are the Lincolnshire Wolds, the Norfolk Coast, and the Northumberland Coast; and
- Five Heritage Coast areas within the Onshore ZDE. These are the Northumberland Coast, Durham Coast, North Yorkshire and Cleveland, Flamborough Head, Spurn Head (also a National Nature Reserve) and the North Norfolk Coast.

Regional and local environmental designations have been mapped where possible for the Onshore ZDE constraints Figure 16.2. These include regional parks, local nature reserves, and local landscape designations.

There are other environmental constraints which are worthy of note at the Onshore ZDE level as they are important in terms of engineering considerations. These are water features, topography and geology. The main constraints found within the Onshore ZDE at this time include:

- The estuaries of the Humber, Tees, Wear and Tyne;
- Watercourses such as the River Nene and the Great River Ouse which flow into The Wash; and
- Cliffs and elevated topography between Scarborough and Middlesbrough.

The estuaries of the Tyne, Tees, and Wear are located in an urban and industrial setting, though the north and south banks of the Tees Estuary mouth is designated as a SPA and SSSI. However, the Humber is designated SPA, SAC and SSSI for its full length.

The Onshore Zonal Characterisation (ZoC) has also considered the geological characteristics of the study area. The broad findings of the geology of the Onshore ZoC are as follows:

- Hard rock Limestone from Northumberland to Middlesbrough;
- Sandstones makes up the North York Moors;
- South of Scarborough to Skegness is Chalk overlain by Glacial Till from Scarborough to the Humber and Alluvium south of the Humber; and
- Clays and mudstone are found south of Skegness and are overlain by Alluvium.

16.4 Cultural Heritage

There are two World Heritage Sites located within the Onshore ZDE. These are:

- Hadrian's Wall, which enters in Newcastle; and
- Durham City Cathedral, in Durham.

There are also numerous Scheduled Monuments (2,304 in total). Together with the World Heritage Sites, these pose a potential constraint to development. Special consent would be required should any proposals be expected to affect these sites. It is likely that any proposals affecting a Scheduled Monument would depend on the type of monument and its condition. However, it would be expected that consultation would be required with English Heritage and County Archaeological teams. Scheduled Monuments have been mapped on the Onshore ZDE (Figure 16.3), though the specific details of monuments are not reported at the Onshore ZoC level. More detailed information is provided for monuments located within the Substation Study Area (Chapter 17 – *Creyke Beck Substation Study Area*).

In addition to World Heritage Sites and Scheduled Monuments, features of more local sensitivity recorded within the Onshore ZDE include the following:

- Battlefields (four in total); and
- Listed buildings (19,867 in total).

The details of these are recorded for the Substation Study Area only (see Chapter 17 – *Creyke Beck Substation Study Area*).

16.5 Land Use and Infrastructure

As described, the Onshore ZDE covers a vast area of approximately 15,464 km^2 encompassing the major urban centres of Hull and Grimsby and the conurbation of Newcastle, Sunderland, Middlesbrough and Hartlepool in the north east. There are also a number of seaside towns spread along the east coast such as Whitby, Scarborough, Bridlington and Skegness. Outside of these urban areas the majority of the Onshore ZDE is sparsely populated with small towns such as Beverley, Hornsea, Louth, and Driffield.

Being such a sparsely populated area there are relatively few major transportation routes within the Onshore ZDE, with the exception of road and rail routes serving the major urban centres. However, there are a number of motorways within the Onshore ZDE and short distances of dual carriageway. There are limited rail routes in the Onshore ZDE, though there are routes south of Middlesbrough to Saltburn, from Scarborough south via Bridlington and Beverley to Hull, and from Cleethorpes along the southern bank of the Humber to Barton upon Humber, next to the Humber Bridge. Skegness and Whitby are also accessed by rail from the west. These infrastructure routes are illustrated on Figure 16.4.

There are also four National Trails located within the Onshore ZDE. These are the Cleveland Way, Hadrian's Wall Path, Yorkshire Wolds Way and the Norfolk Coast Path. Other important long distance trails include the Trans Pennine Trail.

The North York Moors National Park, which stretches from just north of Scarborough to just south of Middlesbrough, is located within the Onshore ZDE. National Parks are protected areas due to a combination of countryside, wildlife and cultural heritage value. People also live and work in the National Parks and the farms, villages and towns are protected along with the landscape and wildlife. The North York Moors National Park landscape comprises moorland, coastline, ancient woodland and a number of historic sites. Development within the Park is administered by the North York Moors National Park Authority.

The study has also mapped a number of other land based designations and descriptions for the Onshore ZoC. This review has shown the following:

- Grade 1 agricultural land, the best and most versatile, is found in the fenlands south of The Wash;
- Swathes of Grade 2 land along the Yorkshire and Lincolnshire Wolds and to the east of Hull. Grade 2 land is also considered to represent best and most versatile agricultural land;
- There are no Greenbelt areas within the Onshore ZDE with the exception of areas immediately around Newcastle upon Tyne and Sunderland; and
- There are a number of military shooting ranges and Danger Areas within the Onshore ZDE. Areas include coastline just to the south of Hornsea, part of The Wash's coastline, and a number of stretches along the Lincolnshire coastline.

Other land uses not mapped at the Onshore ZDE level, but which are considered at the Substation Study Area level include: landfill sites, mineral sites, areas of recreation such as golf courses and caravan/holiday parks, and woodlands. It was not practical to map these features at the Onshore ZDE level.

16.6 Planning

The Onshore ZDE is covered by a range of unitary authorities, borough and district councils and city councils. Each has a local planning framework based on either old local plans or emerging Local Development Framework (LDF) plans. A review of the plans and authorities for the whole Onshore ZDE has not been undertaken at this time. Such a review is undertaken at the Substation Study Area level and reported in Chapter 17 – *Substation Study Area*.

In addition to the local planning authorities, The North York Moors National Park Authority is the relevant planning body for the National Park.

There are a number of planning features that will be collected for the Substation Study Areas including shoreline management policies, mineral consultation zones, flood risk areas, ancient woodlands, local nature reserves, parks and gardens, bridleways and footpaths. Information is generally sourced from web based searches of planning authority websites. Some planning authorities hold this information in searchable web based form. However, these data sets have not been mapped at the Onshore ZDE level due to the complexity of data collection for the size of the Onshore ZDE.

16.7 Summary

This section summarises the characterisation of the Onshore ZDE based on the datasets collected to date. A summary of the key findings is as follows:

- A number of Habitat Directive sites are found within the Onshore ZDE with a high proportion being coastal SPA sites;
- There are three important AONBs – Northumberland Coast, Norfolk Coast and Lincolnshire Wolds;
- The Humber Estuary dominates as a large inland water body;
- There are numerous Scheduled Monuments in the Onshore ZDE but only two World Heritage Sites, Durham Cathedral and Hadrian's Wall;
- There are a number of National Trails which cross the Onshore ZDE;
- The North York Moors National Park is located within the Onshore ZDE; and
- Five Heritage Coast areas existing along key parts of the study coastline.

The Onshore ZDE is also largely rural and undeveloped with relatively few large urban centres, with the exception of Hull, Newcastle, Sunderland and Middlesbrough. Since there are few urban centres there are also relatively few major transport routes in the Onshore ZDE.

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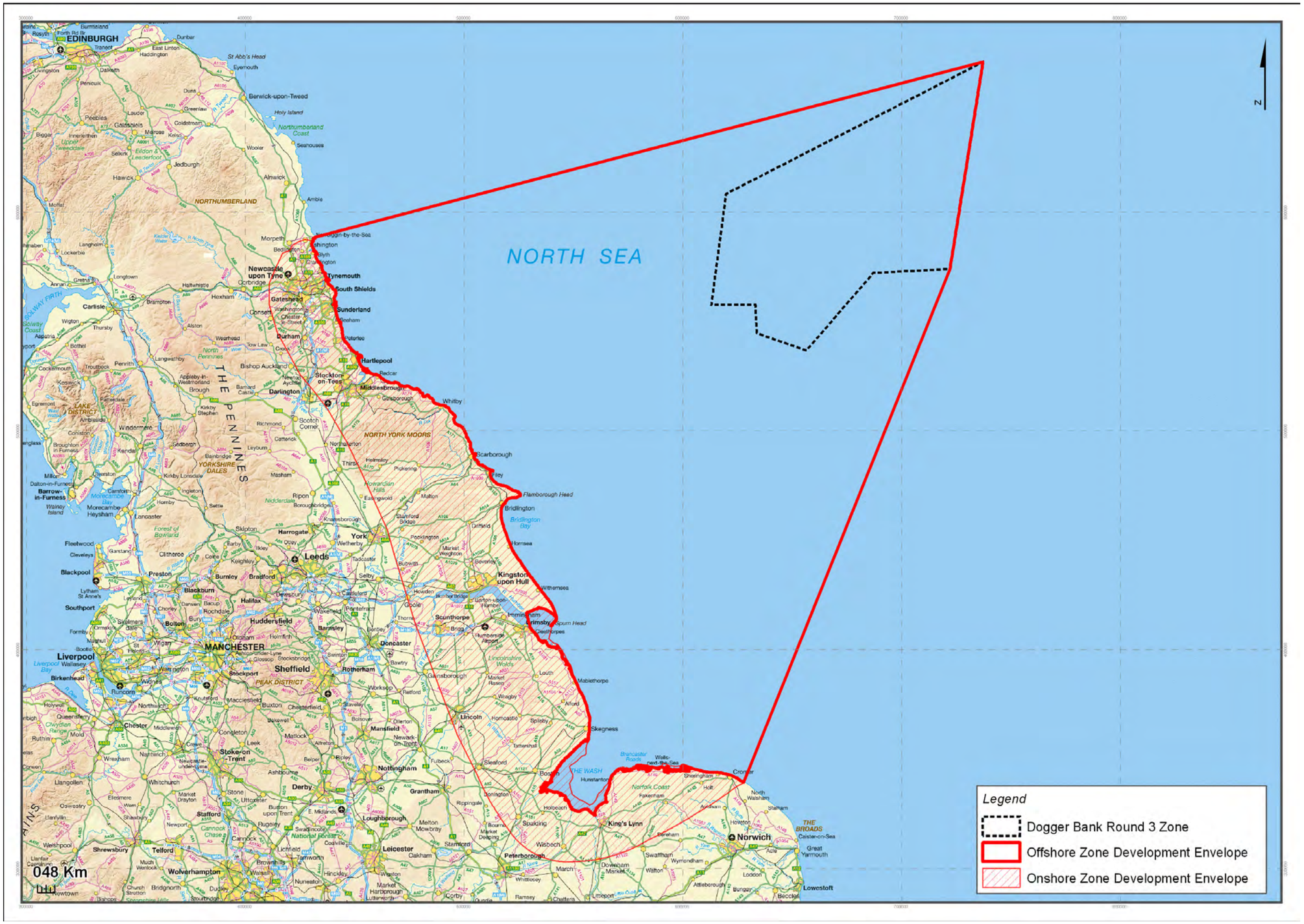
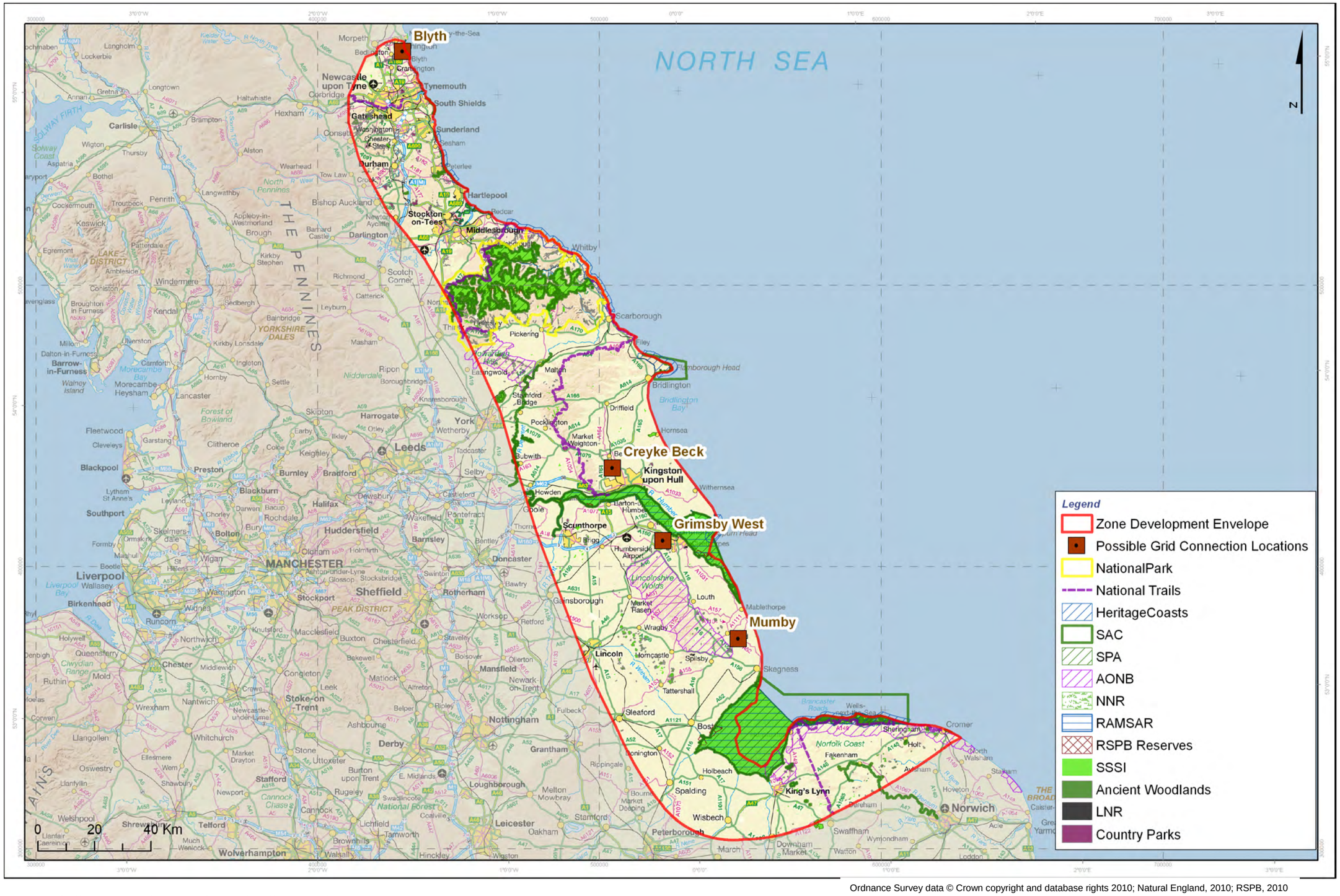


Figure 16.1: Onshore and Offshore ZDE

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Figure 16.2: Environmental designations within Onshore ZDE

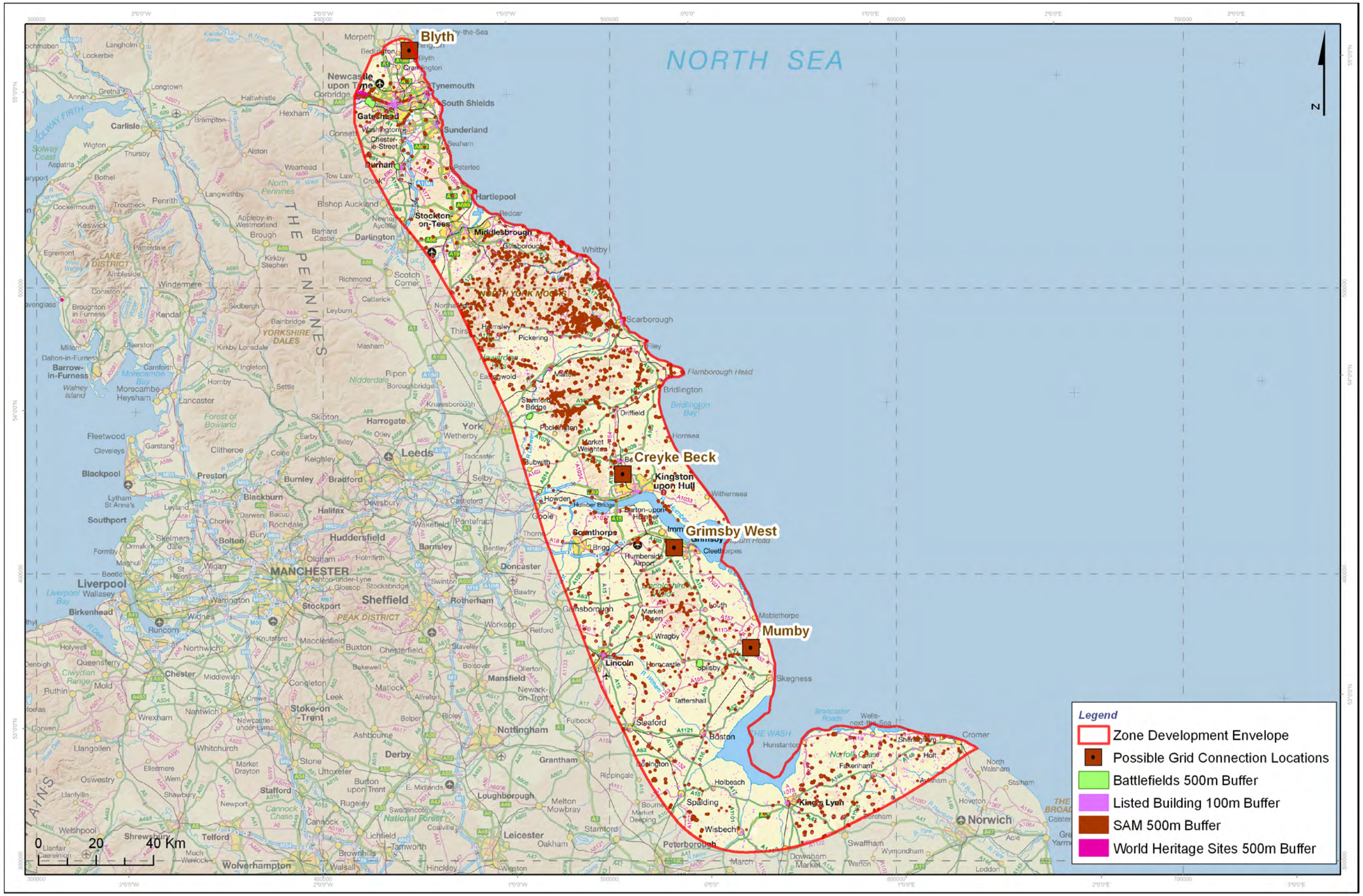
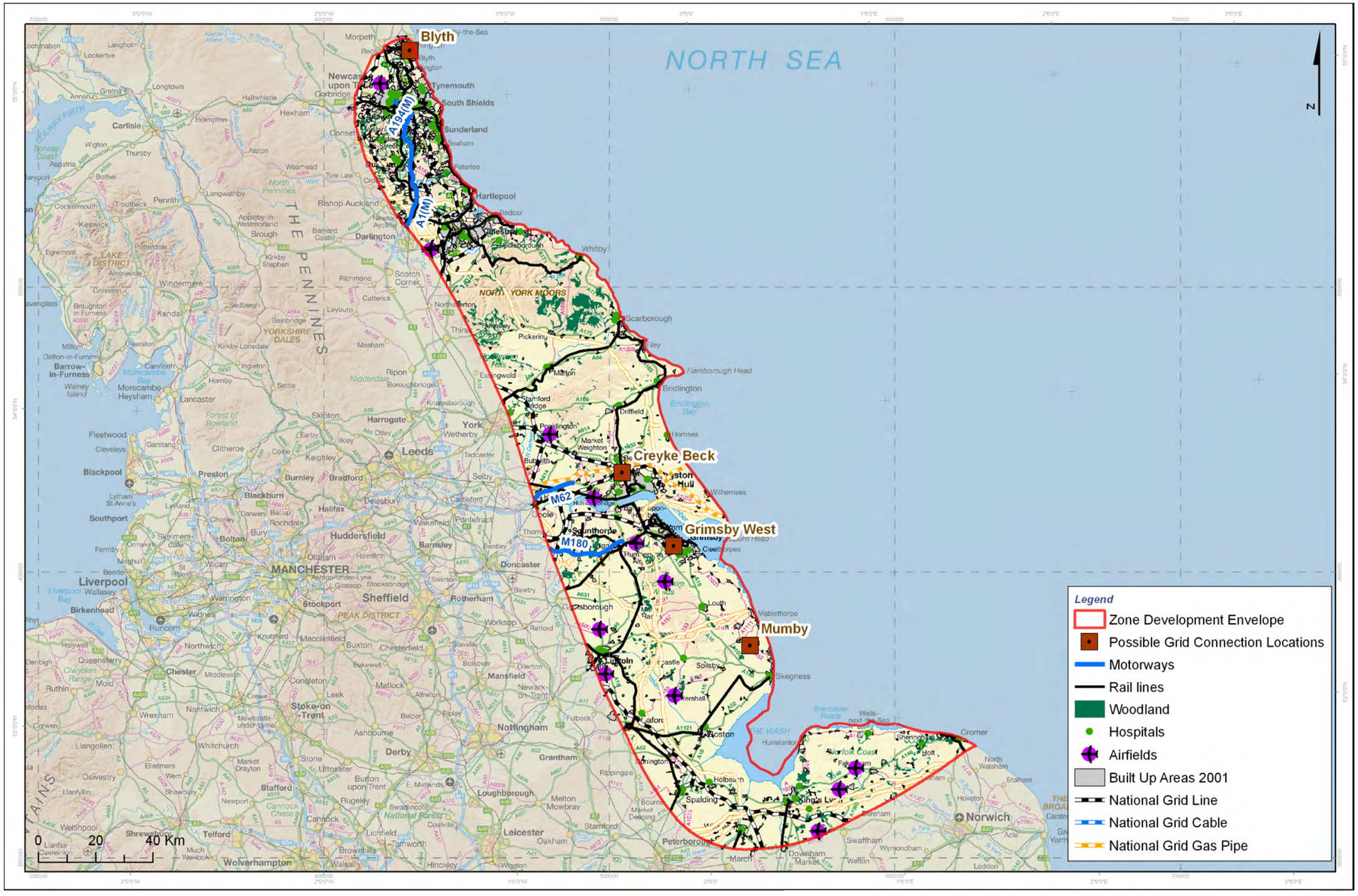


Figure 16.3: Cultural Heritage

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Figure 16.4: Infrastructure within the Onshore ZDE

17. Creyke Beck Substation Study Area

17.1 Introduction

Forewind has accepted a grid connection offer made by National Grid to connect the first 1 GW of the Dogger Bank Offshore Wind Farm into the national electricity grid network at Creyke Beck, in the East Riding of Yorkshire. Creyke Beck is an existing 400 kV substation located to the north of Hull.

Following the accepted National Grid offer for Creyke Beck, it was necessary to establish an area of search for the characterisation study. This area, or Substation Study Area, has been based on the following approach:

- A large enough study area was developed to allow the development of cables routes that considered alternative routes due to possible offshore and onshore constraints;
- An area sufficiently large enough to enable the selection of a site for a new DC converter station;
- The study area considered coastal landing points and for this reason the zone is wider at the coastline extending as far south as Easington and an equal distance north to just south of Bridlington; and
- The Humber Estuary was initially included in the study area to compare constraints here with overland routes. (As the process evolved this was removed from the study area see Section 17.4).

The Creyke Beck Substation Study Area initially defined for characterisation is shown in Figure 17.1.

The study area was later refined following consultation with stakeholders, as described in Section 17.4. The updated study area is shown in Figure 17.2. For the purposes of this report, all the constraints data is shown in relation to the original boundary shown in Figure 17.1.

17.2 Data Sources

The Onshore ZoC data sources were previously outlined within Table 16.1 (see Chapter 16 – *Onshore Zonal Characterisation*). The more detailed review of the Substation Study Area includes additional data sets and is therefore based on the following

- Publicly available information from government agencies – official designated sites from Natural England and English Heritage; and
- Bespoke data purchases – more detailed 1:25,000 mapping purchased for selected areas from emapsite (www.emapsite.com).

Freely available mapping from Ordnance Survey has also been used. The datasets include the following:

- OS Streetview – 1:10,000 scale mapping covering selected areas surrounding grid connection points and grid routes;
- OS Meridan2 mapping – identifying roads, rail rivers and lakes at a nominal scale of 1:50,000;
- OS Boundary line – identifying local government boundaries and Mean High Water Mark;
- OS Landform Panorama DTM – a digital terrain model based on interpolated spot heights at 50 m horizontal interval; and
- 1:25,000 scale OS mapping, used to identify field boundaries, public rights of way and watercourses and drains. This dataset is not freely available and, for the Substation Study Areas, has been purchased on behalf of Forewind from emapsite (emapsite, 2010).

Planning policy information at this stage of the study has been collected by reference to information held on the East Riding Council website (East Riding Council, 2010a), which provides a mapping tool for the local development framework. For this Substation Study Area information from this website has been collected and manually digitised into the GIS database.

17.3 Environmental Constraints

17.3.1 Nature Conservation Designated Sites

There are a significant number of ecological constraints within the initial Creyke Beck Study Area including:

- Humber Estuary SPA, SAC, SSSI, Ramsar, designated principally for breeding (little tern) and wintering birds. There are a number of qualifying wintering birds including bittern *Botaurus stellaris*, golden plover *Pluvialis apricaria* and hen harrier *Circus cyaneus*;
- Hornsea Mere SPA and SSSI, designated for over wintering gadwall *Anas strepera*;
- Skipsea Bail Mere SSSI, which is designated for the lake deposits located beneath the site;
- Dimlington Cliffs SSSI which is designated for its visible sediment sequence at the cliffs;
- A further 9 SSSIs (Lambworth Meadows SSSI, Leven Canal SSSI, Roos Bog SSSI, Kelsy Hill Gravel Pits SSSI, Burton Bushes, Melton Bottom Chalk Pit, Withow Gap, The Lagoons SSSI and Pulfin Bog SSSI); and
- Spurn Head NNR and Heritage Coast.

Figure 17.3 shows the locations of these designations. As statutory sites they are provided with a high level of international and national protection. Hornsea Mere, Spurn Head and the SSSIs are relatively small sites. Consultation with Natural England[1] has also highlighted the importance of the intertidal areas of the Humber Estuary for breeding birds, wintering birds and shellfish (local cockle and mussel beds). It was also highlighted at this meeting that scour of sediments is also prevalent.

17.3.2 Nature Conservation and Ecology

There are a further five local nature reserves (Beverley Parks, Southorpe, Sigglesthorne Station, Hudsons Way, Humber Bridge). These are non-statutory sites, and are recognised at a county level for their biodiversity value.

At this early stage it has not been possible to collect information on the presence or otherwise of protected species. Such investigations are reserved for more specific cable route studies. However, it is likely that most cable routes within the Substation Study Area will encounter habitats suitable for protected species. A review of published information has shown the following:

- Great crested newts are present throughout the study area and are prevalent north and east of Hull (JNCC, 2010a);

[1] Meeting between Forewind and Natural England 20th September 2010.

- Otters are not expected to be located within the study area (JNCC, 2010b);
- Bats are expected to be present, though no Habitat Directive Schedule 2 species are found in the study area (JNCC, 2010c);
- It is not clear whether water vole would be present but it is expected that suitable habitat would be present (JNCC, 2010d);
- Badgers are relatively widespread and it is expected that badgers are present within the study area; and
- Various species of birds, out with the SPA sites already defined, will be found and will either roost in winter or breed in summer.

The Substation Study Area also includes areas of woodland, including ancient woodland. Ancient woodland has been mapped as a discrete data set, whilst other areas of woodland and plantation are visible on 1:25,000 mapping. There are a total of 17 ancient woodlands comprising approximately 100 ha in the Creyke Beck Substation Study Area.

17.3.3 Landscape and Visual Amenity

The existing Creyke Beck substation is located within the 'Wolds Area of Landscape Protection.' This is a local plan designated area in Policy EN3 (East Riding Council, 1997). This policy states:

Within the Wolds area of landscape protection, proposals which are otherwise acceptable in the open countryside and, in particular, small scale tourism and recreation proposals associated with the area's cultural and natural heritage, will only be permitted where:

1. *They will not be prominent in or harm the quality of the landscape; and*
2. *In terms of design, materials, colour and landscape treatment, they are of a high standard in scale and character with their surroundings; and*
3. *Individually and cumulatively with other development, they will not give rise to levels of traffic, noise or visitor pressure likely to harm the quiet character or nature conservation interest of the area.*

Creyke Beck substation is at the eastern extremity of the designated area. Its boundary limit is marked by the A1079 to the north and east, and the north to south running Bridlington to Hull railway line, located approximately 150 m to the east of the substation. There are no other landscape designations within the Substation Study Area. However, the East Riding of Yorkshire Council has identified an area around Brandesburton as an area of Special Landscape Character and has set up a project called the 'Countryside Project.' This project aims to implement landscape improvements and improve the recreational use of the project area. This area is illustrated on Figure 17.3.

Further details on the landscape character of East Riding can be found in the East Riding of Yorkshire Landscape Character Assessment (East Riding Council, 2005).

17.3.4 Flood Risk, Watercourses, Hydrology and Hydrogeology

The Humber Estuary is the dominant water feature near to (10 km) the Substation Study Area. Details on the physical environment of the coast, including the Humber, are outlined further within Chapter 2 – *Geology and Physical Environment.* However, in summary the Humber Estuary is typified by strong local tidal currents with average surface velocities reaching 2 m/s at the mouth. The estuary is also dominated by muddy sediments, which are exposed at low tide along the banks of the estuary.

The Creyke Beck substation is located partly within and adjacent to a floodplain zone, with the chance of flooding each year being 0.5% (1 in 200) or less. This floodplain extends eastwards from the substation and is associated with the River Hull. The floodplain is about 3.5 miles wide. Further east there is a floodplain for the Holderness Drain which is approximately 1.5 miles wide. There is also a significant area of flood risk to the south east of Hull on the southern banks of the Humber Estuary.

The Substation Study Area is a relatively flat area and is extensively farmed and with this comes land drainage. As a result the area has a large number of local field drains. There is an Internal Land Drainage Board that manages land drainage of the drains around the River Hull and the Holderness Drain catchment. This is the Beverley and North Holderness Internal Drainage Board (IDB) (York Consortium of Drainage Boards, 2010). This study does not map which drains are managed by the IDB or which are main rivers as administered by the Environment Agency. However, Byelaws are associated with such drains and rivers. Most IDB Byelaws set certain engineering requirements for watercourse crossings.

A review of groundwater use has also been undertaken with reference to the Environment Agency website (Environment Agency, 2010). The Creyke Beck substation is located within an Inner Zone of a Groundwater Source Protection Zone (SPZ). This is associated with a groundwater abstraction from the underlying Chalk Aquifer. An Inner Zone is defined as an area with a 50 day travel time for groundwater from any point below the water table to the point of abstraction. A further Inner Zone is located to the east at Dunswell. The SPZ (including Outer Zone and Total Catchment) extends north of Beverley and almost as far east as the Holderness Drain.

Development within an SPZ often depends on site specific issues and these have not been reviewed in this instance. For instance, an SPZ which has a significant thickness of slowly permeable drift material will be less sensitive than an SPZ which receives groundwater recharge directly and quickly.

There are no other SPZs within the Substation Study Area. Other water usage in the study area has not been examined. Information on abstractions may be obtained from the Environment Agency and local land owners.

17.3.5 Shoreline Management and Coastal Erosion

The Humber Estuary Coastal Authorities Group (HECAG) Flamborough Head to Gibraltar Point Shoreline Management Plan Consultation Draft 2009 covers the stretch of coastline in this study. The main feature of interest in this plan is the Holderness Cliffs. The Holderness Cliffs extend approximately 60 km from Sewerby to Easington and range in height from less than 3 m to around 40 m. They are formed of glacial tills, with an average height of 15 m, reaching around 40 m at Dimlington. The cliffs are actively eroding through repeated landslide activity. The coastline topography of the substation study area is illustrated in Figure 17.4.

Consequently, the Holderness coast area has been confirmed as an area of managed retreat. The Holderness coast has retreated by around two kilometres over the last 1,000 years causing the loss of 26 villages listed in the Domesday survey of 1,086. Latest

surveys show that overall the average rate of retreat is c. 1.8 m/year.

As a result there are specific policies with respect to development in the local plan. Policy ENV 5 states:

ENV 5 – The Council will only approve development proposals in the Holderness coastal zone which are not likely during the life expectancy of the development to:

1. *lead to a requirement to construct new or to extend or enhance existing coastal protection or flood defences*
2. *interfere significantly with natural coastal or estuarine processes*
3. *increase the risk of flooding and coastal erosion on site or elsewhere*
4. *be affected by the risk of coastal erosion within the developments estimated lifespan*
5. *conflict with nature conservation policies of this plan.*
6. *preclude reasonably practical options to conserve or enhance important coastal habitats by managed retreat or soft engineering techniques.*

Small scale extensions to existing development will be permitted providing the whole development meets the life expectancy criterion.

Further Policy ENV 8 is more specific to development within the Holderness Coast, which states:

ENV 8 – In the undeveloped coastal zone (as defined on the Proposals Map), no development will be allowed to encroach within 30 metres of the cliff edge. Between 30 metres and the coastal zone boundary development of a generally open nature, extensions to or the conversion of existing buildings or structures may be permitted. Development of a temporary nature may also be permitted on the basis of a temporary planning permission and subject to its' removal before it is affected by erosion. Where the developer is able to demonstrate that the development has specific locational requirements that make the location outside the coastal zone inappropriate, new development may be permitted within the coastal zone beyond 200 metres of the eroding cliff. In all the above cases proposals should accord with Policy Env5 of this Plan.

Managed local retreat is also earmarked for New Bank flood defences within the Easington / Kilnsea area, and on the Spurn Head.

These areas of managed retreat and coastal zone management have been provided as a GIS data set.

Coastal flood defences are also a consideration for the selection of coastal landing points of the offshore cable. Coastal flood defences protect the towns of Bridlington, Hornsea and Withernsea, the village of Mappleton and the gas terminals at Easington. Flood defences are also present at Spurn Head but are now largely derelict as they have not been actively managed since the 1960s. There have also been significant failures and breaches of defences since the 1970s. Further breaches of these flood defences are expected in the future with the policy of managed retreat.

17.3.6 Cultural Heritage Issues

The following cultural heritage features have been identified as part of this study:

- There are no World Heritage Sites located within the Creyke Beck study area;
- There are 92 Scheduled Monuments;
- There are also 1,494 listed buildings within the Substation Study Area and these have been captured within the GIS database;
- There are no recorded battlefields within the Substation Study Area; and
- A total of five parks and gardens have been identified. These are Thwaite Hall, Burton Constable, East Park in Hull, Pearson Park, and Risby Hall.

As highlighted in Chapter 16 – *Onshore Zonal Characterisation*, a check of the Historic Environment Register has not been undertaken and therefore other recorded cultural heritage features have not been recorded as part of this study.

17.3.7 Land Use and Infrastructure Issues

Land use and infrastructure constraints found within the Creyke Beck study area are listed in the following sections:

Transport

Immediately to the east of the Creyke Beck substation (approximately 150 m to the east) is the Bridlington to Hull railway line. No other railway lines are located within the study area.

Major trunk roads within the study area include:

- A1079 which is located to the north east of the substation. It is a single carriageway running northwest (from the direction of York) to southeast (towards Hull). A section of carriageway is duelled approximately one mile to the northwest of the substation;
- A1174 single carriageway road running north to south from Beverley to Hull;
- A1035 which runs west to east from Beverley before joining the A165;
- A165 which runs south to north from Hull to Bridlington. This is a single carriageway with the exception of a stretch east of Routh to Brandesburton; and
- A1033 which is a single carriageway which runs from Hull to Withernsea.

Most other roads are minor roads and comprise only a small number of B carriageways. Most notably is the B1242 which runs along the coast from north of Hornsea to Withernsea.

The Humber Estuary is also used as a shipping lane, with the Port of Hull being one of the busiest in the UK with over 100 shipping movements per day. Further details of shipping movements are covered within Chapter 9 – *Navigation and Shipping*.

Electricity Infrastructure

There are three major National Grid overhead lines which all converge on Creyke Beck substation. Two leave the site in a westerly direction, whilst the last travels in a westerly direction around the Hull urban fringe before heading south.

Gas Infrastructure

The Holderness coast is an important area for gas distribution and storage. The main features identified within the study area include the following:

- Gas storage facilities north of Hornsea and at Aldbrough. These are underground gas storage facilities within salt caverns approximately two kilometres beneath ground. Both facilities are fed by gas pipelines;
- Gas terminal at Easington which is one of three major UK gas terminals. There are three operating plants at this site which store and process North Sea gas. A number of major National Grid gas pipelines leave the Easington terminal running northwest along the south bank of the Humber Estuary;
- A major National Grid gas pipeline from Easington runs south to north through the study area, and will be a constraint of any cable corridor;
- A further National Grid gas pipeline, again from Easington, runs approximately one mile to the north of the Creyke Beck substation; and
- Three pipelines currently cross the mouth of the Humber Estuary. Two of the pipes are owned by Tranco / National Grid and used for gas transmission; one is owned by Centrica and was used to transport condensate.

Water

At this stage of the study it has not been possible to obtain details of water supply and sewage networks. Once a cable corridor is selected this information will be obtained from Yorkshire Water.

Other Land Use Constraints

The following observations have been made with regards to land use and quality within the Substation Study Area:

- The Substation Study Area is sparsely populated with the exception of Hull. Important towns also include Beverley to the north of the substation and the coastal towns of Hornsea and Withernsea. Small villages and farmsteads are also located throughout the Substation Study Area;
- There is no Greenbelt within the Substation Study Area;
- Agricultural land within the Substation Study Area is classified as predominantly Grade 2 and 3. This indicates that agricultural land is of a high quality and therefore it is expected that there is high value arable farming within the Substation Study Area;
- There are a small number of active and historic landfill sites located within the Substation Study Area. These are mainly located around Beverely, Brandesburton and to the east of Hedon at Burnstwick. These sites have not been added to the GIS database at this stage due to ease of obtaining a freely available dataset. The Environment Agency are statutory consultees with respect the landfill sites along chosen cable corridors;
- There are a number of caravan parks and campsites located predominantly along the Holderness Coast. These are visible on the 1:25,000 OS mapping and have not been mapped in this study;
- A number of golf courses are also visible from OS mapping. These tend to be located adjacent to the main centres of population, including Beverley, Cottingham, Hornsea and Withernsea;
- There is a military danger area between Great Cowden and Aldbrough on the coast, which stretches inland to the B1242. This also extends out to sea as indicated on Figure 17.3; and
- There are no significant woodland areas within the substation study area with only small areas of woodland plantation found. Areas of woodland have not been mapped but are visible from the 1:25,000 OS mapping.

A review of coastal topography has also been undertaken using OS Landform Panorama DTM. The results of this are shown in Figure 17.4.

Planning Issues

The study area is located within the East Riding of Yorkshire (ERY) Council administrative area. The development plan for the East Riding currently consists of:

- The Regional Spatial Strategy (2008);
- The Joint Structure Plan (2005);
- Four East Riding Local Plans:
  - Beverley Borough (1997 – still current 2006);
  - Boothferry Borough (1999 – still current 2006);
  - East Yorkshire Borough (1997 – still current 2006); and
  - Holderness District (1999 – still current 2006);
- The Minerals Local Plan (2004); and
- The Waste Local Plan (2004).

As part of the new planning system introduced in 2004, ERY Council is developing a Local Development Framework. This is a collection of planning documents which will become the Development Plan for the East Riding, but this is currently not approved.

Due to the large extent of the study area it has not been possible to review all existing relevant policies for the study area. This will be undertaken once pipeline corridors are determined within the study area. However, it has been possible to access the ERY Council Interactive Map (East Riding Council, 2010b) to search for important relevant policies for the study area. Important policies relating to landscape designations and coastal retreat have already been examined in this Chapter (see Section 17.3.5).

In addition to landscape and coastal retreat, the Interactive Map also shows flood risk areas which have also been discussed previously. Other designated areas include mineral consultation zones. Development within a mineral consultation zone will be referred to the Mineral Planning Authority. There are only scattered areas of mineral consultation and it is expected that these can be avoided by a cable route. Mineral consultation zones are illustrated in Figure 17.3.

From a review of the Interactive Map there are no additional sensitive policies identified at this time which could present a major constraint to development.

17.4 Refinement of the Creyke Beck Substation Study Area

From the collection of data during the Onshore ZoC (see Chapter 16 – *Onshore Zonal Characterisation*) and following initial consultation with consultees[2] it has become apparent that there are significant technical, health, safety and environmental concerns associated with the installation of cables up the Humber Estuary. For these reasons Forewind have decided to remove the Humber Estuary from the Creyke Beck Substation Study Area. The revised boundary for the study area is illustrated in Figure 17.2.

17.5 Summary

The review of the Creyke Beck substation study area has shown that there are a range of potential constraints within the study area, of varying sensitivity to development. The nature of the sensitivity of constraints is dependent on the scale of constraint and whether the constraint is protected by a statutory designation. Overall the Creyke Beck Substation Study Area is not a significantly constrained area.

The constraints identified within the revised Creyke Beck Substation Study Area and which are identified as having a statutory designation include the following:

International designations

- The Habitat Directive sites of the Humber Estuary and Hornsea Mere.

National designations

- Spurn Head NNR and Heritage Coast;
- Trans Pennine National Trail;
- Scheduled Monuments; and
- Thirteen SSSIs.

A summary of the additional environmental, cultural heritage, land use and planning constraints which will be listed are as follows:

Environmental constraints

- The flood risk zone associated with the River Hull and Holderness Drain;
- The Holderness coast suffers from significant erosion along much of its length and is protected in the relevant local plan;
- Local nature reserves;
- Internal Drainage Board land drains and other river crossings; and
- Groundwater source protection zones.

Cultural heritage constraints

- Listed buildings.

Land use constraints

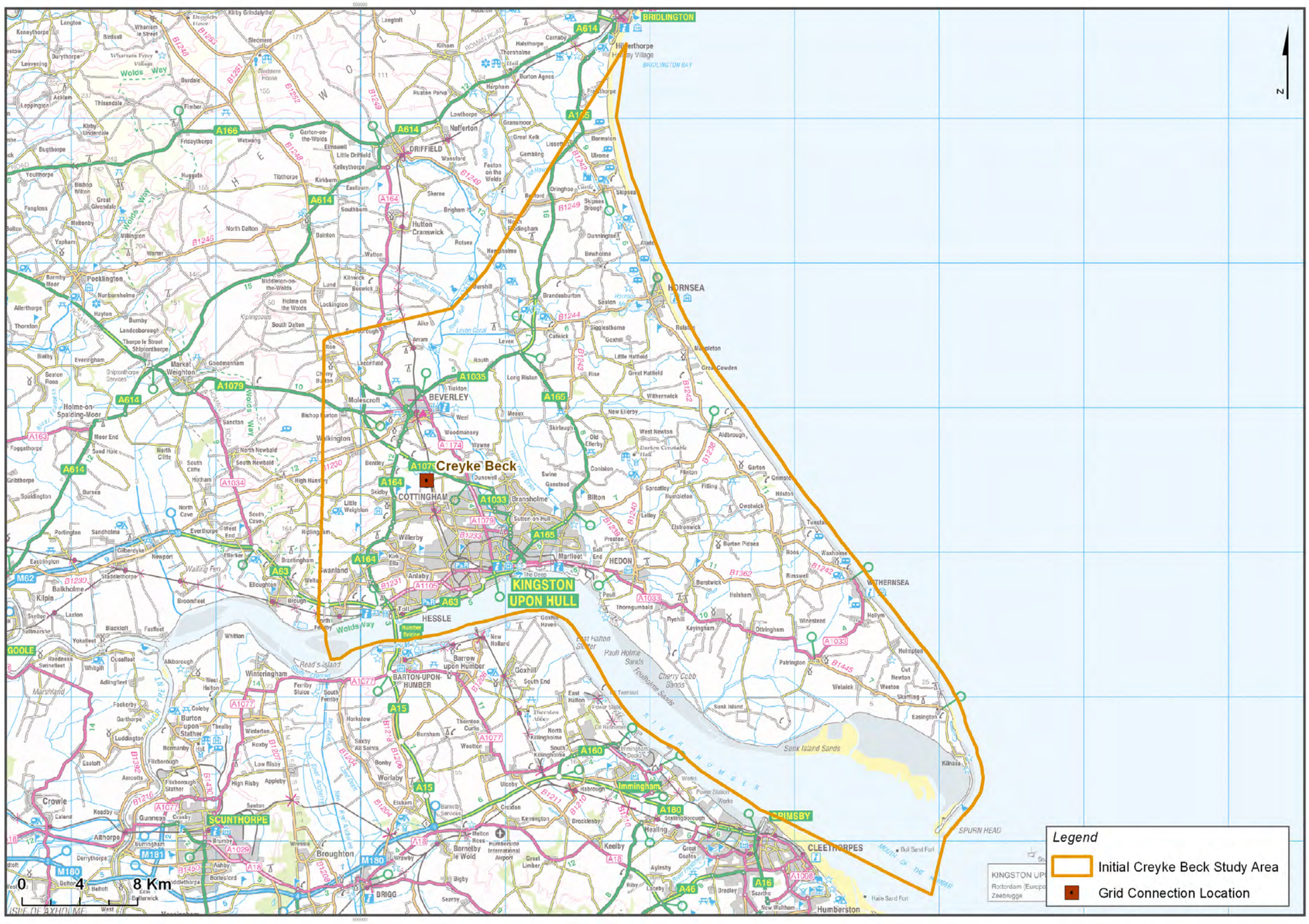
- Major trunk roads and the Bridlington to Hull railway;
- A small number of B Class roads;
- Small number of C Class roads;
- Grade 2 and 3 agricultural land;
- Military firing zone;
- Caravan parks and campsites;
- Landfill sites;
- National Grid electricity and gas infrastructure; and
- Gas storage facilities.

Planning constraints

- Wolds Area of Landscape Protection;
- Areas of managed retreat and coastal protection; and
- Mineral consultation zones.

Identification of a final cable route to this substation location will require detailed consideration of all of these factors. These factors will be considered at the EIA stage in dialogue with consultees and will also be balanced against technical considerations of the grid connection design.

[2] ABP, as the Competent Harbour Authority, has indicated that it would object to a cable route up the Humber Estuary due to the potential for scour and exposure of cables conflicting with port safety and other activities e.g. dredging of channel routes and shipping lanes. Natural England has also indicated that it would object to cable routes crossing mudflats of the Humber Estuary SSSI/SPA. Natural England has also expressed concern relating to cables crossing intertidal mudflat areas of the Humber Estuary.



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Figure 17.1:Initial Creyke Beck Substation Study Area

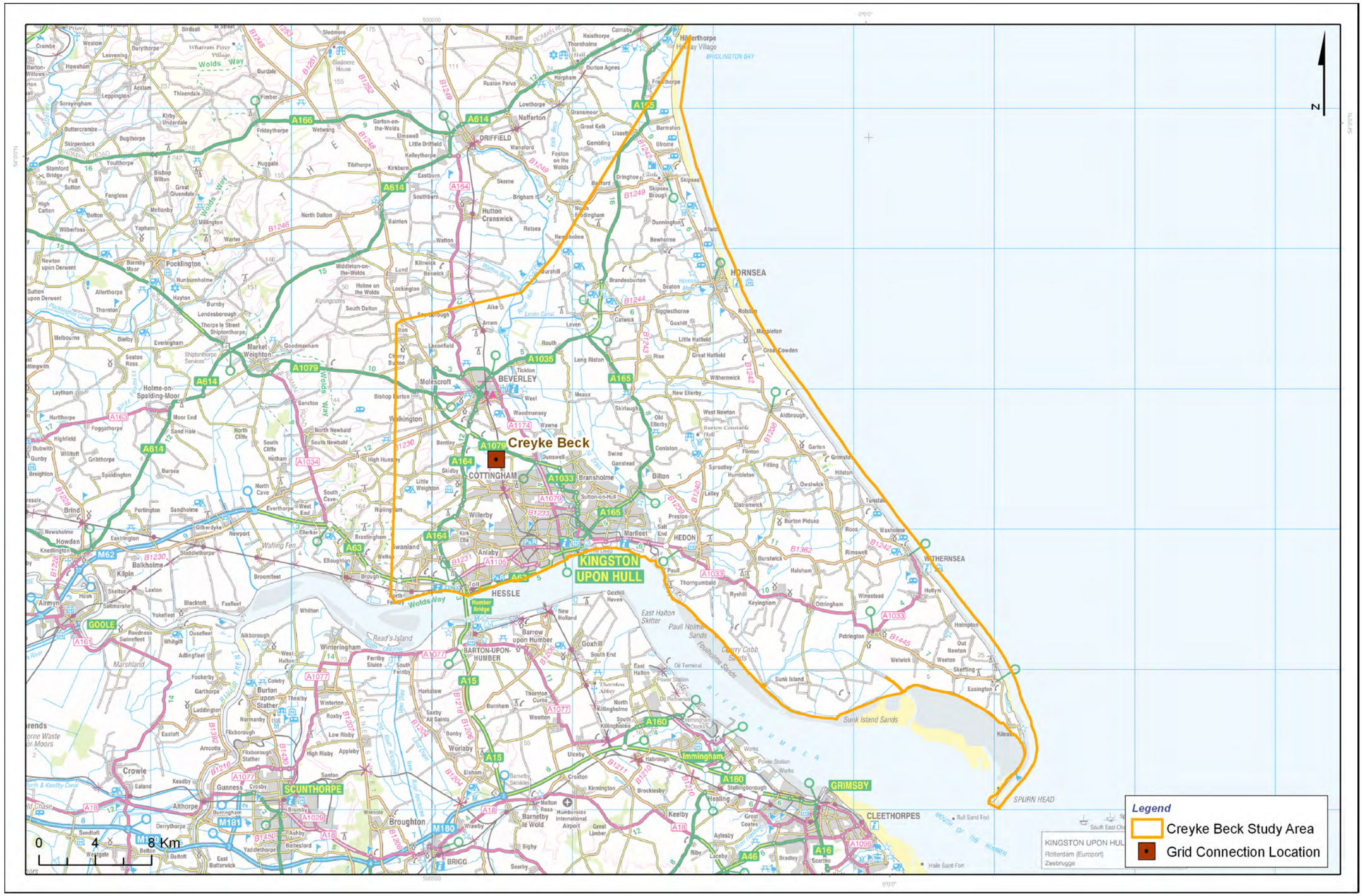


Figure 17.2: Revised Creyke Beck Substation Study Area

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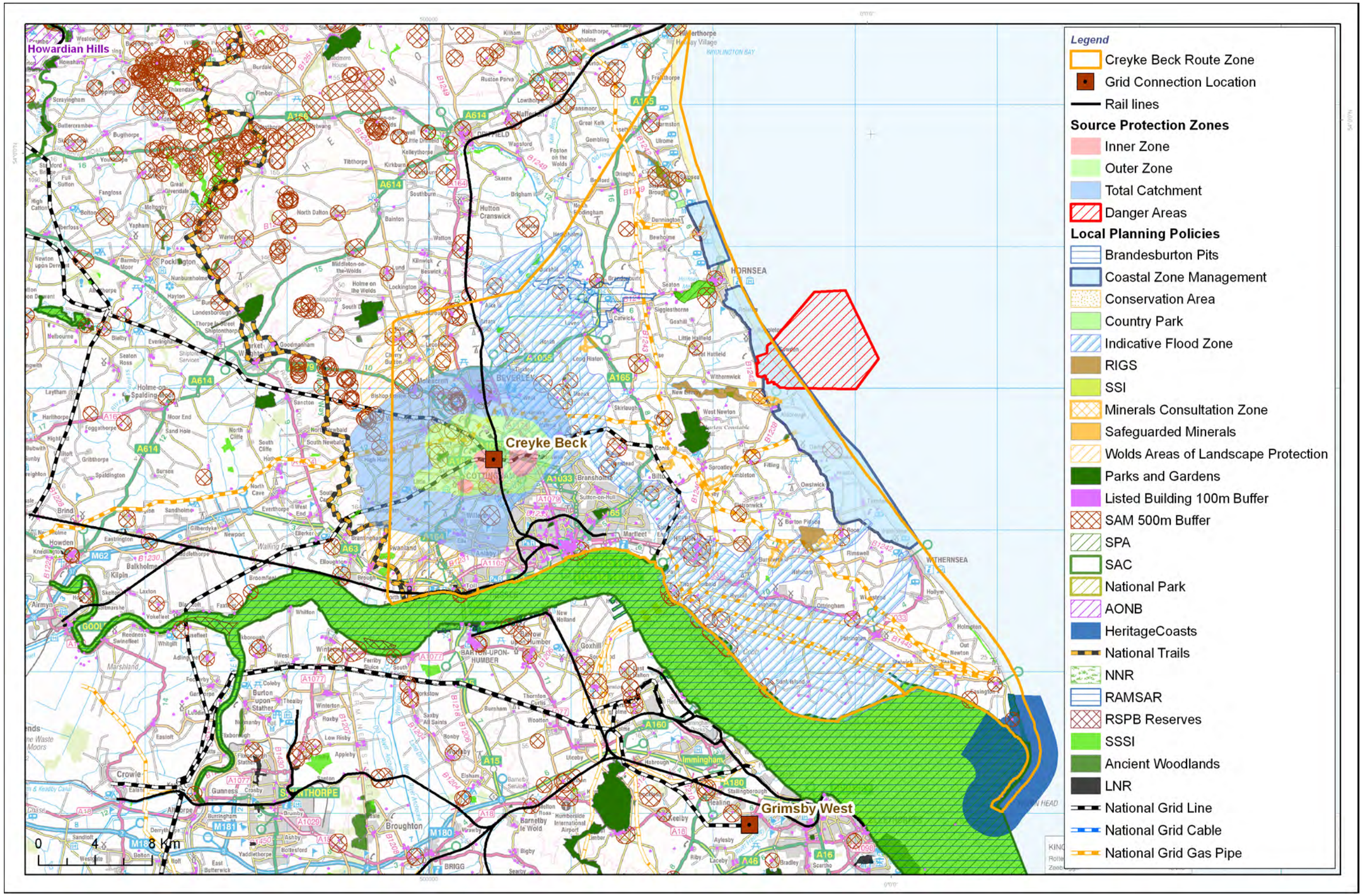
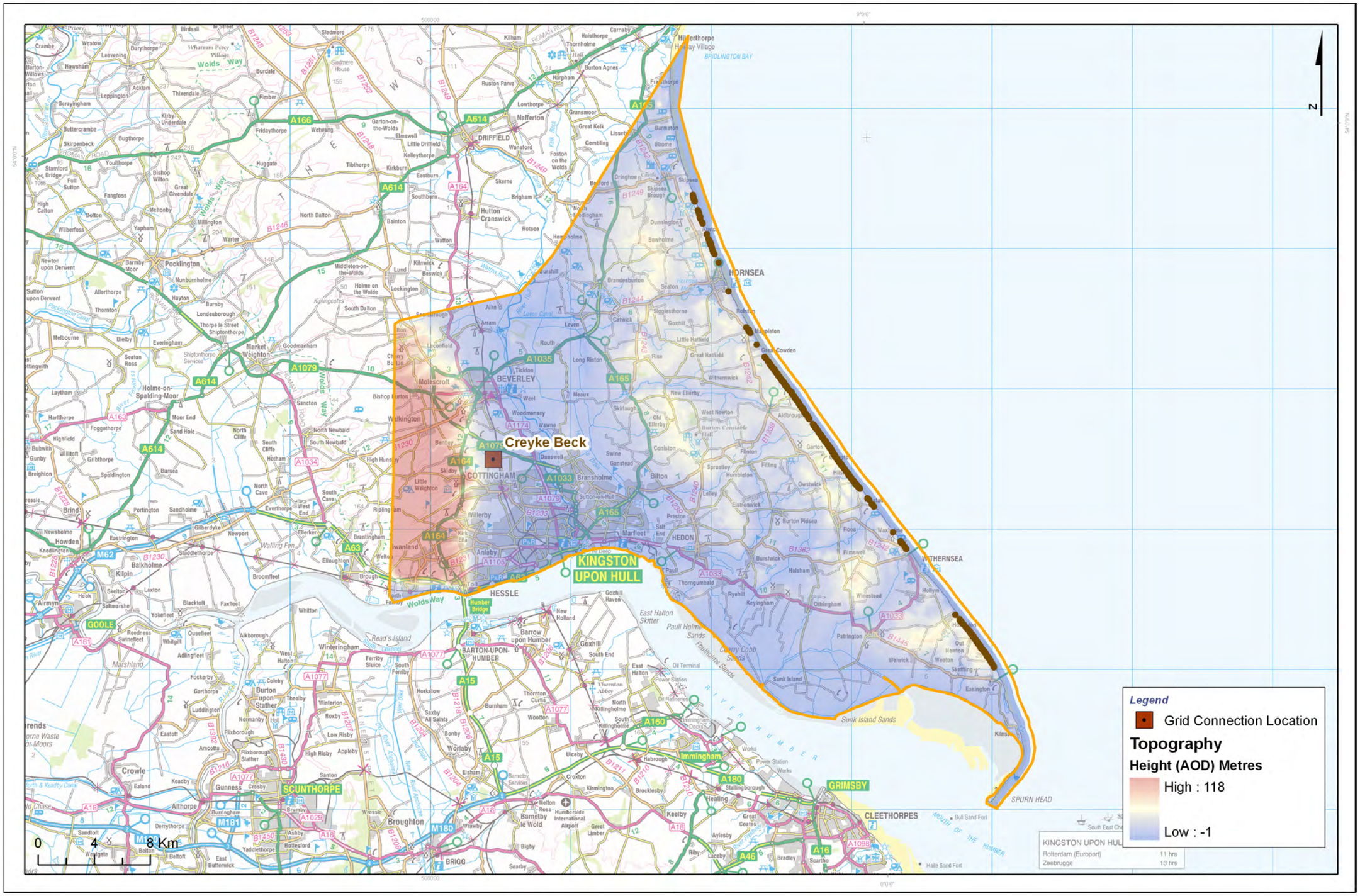


Figure 17.3: Potential Constraints in Creyke Beck Substation Study Area

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abase rights 2010

Figure 17.4: Creyke Beck Substation Study Area Topography

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