Dogger Bank Zonal Characterisation

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Emu Contact: Joe Edgell

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Client Contact:	Gareth Lewis	

QA	Name	Signature	Date
Project Manager	Joe Edgell		07/10/2010
Report written by	Emu Ltd, Anatec Ltd, Brown & May Marine, Cork Ecology, RPS Energy, SKM Enviros		
Report checked by	Joe Edgell		07/10/2010
Report authorised by	Bruce Tomlinson		

This document has been authored and prepared by Emu Ltd (with content provided by SKM Enviros, Cork Ecology, and Anatec Ltd) with the exception of chapters 2 and 10 which have been authored by RPS Energy and Brown & May Marine respectively.

Emu Limited
Head Office
1 Mill Court
Durley
Southampton
SO32 2EJ
www.emulimited.com
T: 01489 860050
F: 01489 860051

Forewind Ltd
Davidson House
Forbury Square
Reading
RG1 3EU

www.forewindenergy.com

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Executive Summary

This document is the Zonal Characterisation Document that presents the interim findings of a characterisation exercise undertaken across the Zone Development Envelope. It has been produced to inform Forewind of environmental factors which may influence:

- Wind farm planning and development in the Dogger Bank Round 3 (R3) Zone; and
- Ancillary cable routes and grid infrastructure across a broader „Zone Development Envelope" (ZDE).

This „interim report" interprets the information compiled by Forewind up until the end of July 2010 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. In addition, this report acknowledges the more recent advancement to the status of sites identified for potential designation under the European Commission"s Birds and Habitats Directives. This includes the progression in status of an area of the Dogger Bank from a draft Special Area of Conservation (dSAC) to a possible SAC (pSAC).

The Zonal Characterisation (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 xvii.

The information provided by this report has been used to support the identification of the first „Tranche" or area for development within the Dogger Bank Zone, a process which is outlined in Forewind"s Tranche A Identification Report[1]. As Forewind move forwards 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, which is due for completion in December 2012.

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.

Both the Offshore and Onshore Zonal Characterisations provide 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.

Offshore Zone Development Envelope

The Offshore ZoC Document is comprised of 14 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, geology of the Dogger Bank Zone to 50 m below the seabed, and the shallow geology of the Offshore Cable Area.

The Dogger Bank Zone covers a relatively shallow elongate north-west oriented area of approximately 8,656 km^2 surrounded by deeper water, which extends north-east into the Danish Sector of the North Sea and south onto the shallowest part of the Dogger Bank. Water depths 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 north-west, 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 north-east 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 south-west.

Benthic ecological communities in the Offshore ZDE are described in *Benthic Ecology*. 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 *Fish Resource and Ecology*. The chapter identifies those species which occur on priority lists such as those produced by OSPAR and the UK BAP. One report indicated the possible importance of the margins and slope areas of the Dogger Bank and outlined a potential cod nursery area. Other work records that important concentrations of cod eggs have been found in the waters to both the south and east of the Dogger Bank; partially within the Offshore Cable Area. The protected habitat „seapen and burrowing megafauna" may be present on the northern edge of the

[1] Forewind Ltd, 2010. *Tranche A Identification Report*. [Online] Available at: http://www.forewind.co.uk

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. At least fifteen species of seabirds are likely to occur regularly in the Offshore ZDE. At least seven 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 seven highlighted species are fulmar, gannet, lesser black-backed gull, herring gull, great black backed gull, kittiwake and guillemot. In addition, razorbill, little auk and puffin may also be important species in the Dogger Bank Zone, depending on the time of year. 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 pSAC 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 establish the likelihood of far field coastal Special Protection Areas (SPAs) being affected.

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 Dogger Bank Zone and the Offshore Cable Corridor are navigated by a wide range of vessels. *Navigation and Shipping* analyses pre-existing data as well as data collected during an ongoing 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 to high densities of traffic transecting the western and south-eastern margins 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 south-west 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 & skates and 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 spread evenly across 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 south-western 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 south-west 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 *Marine Aggregates and Disposal*. 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 north-west part. A further two active 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) and Carbon Capture and Storage (CCS) 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 ZoC 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 Hull 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.

Glossary of Terms

Term	Description
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 that is uniform in environmental conditions and in its distribution of animal and plant life.
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 '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 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.
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 new term used to describe what used to be call 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.
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.
SCI	Sites that have been adopted by the European Commission but not yet formally designated by the government of each country.

SeaZone	Marine geospatial data provider.
Shoreline Management Plans	Coastal defence policies for coastal sediment cells and sub-cells.
Static (anchor) dredging	Where a dredger anchors over a thick, localised deposit and extracts from a localised point.
Substation Study Area	Area around the proposed substation at Creyke Beckbe to be studied regarding the 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	Area for development within the Dogger Bank Zone.
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.
ZDE	The area comprising all development associated with the Zone including: onshore grid connection corridors and infrastructure and offshore cable corridors.
ZoC Document	The Zonal Characterisation 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

List of abbreviations/acronyms for the Dogger Bank	
Acronyms/ abbreviations	**Description**
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
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
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
MarBEF	Marine Biodiversity and Ecosystem Functioning
MarLIN	Marine Life Information Network
MCZ	Marine Conservation Zone
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
SKM	Sinclair Knight Merz
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
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
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 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
- The Crown Estate 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 ongoing development.

The Crown Estate has published a framework document (The Crown Estate, 2010[2]) which sets out the common principles of ZAP across all R3 developments. Forewind have adopted the principles of ZAP, establishing a bespoke ZAP strategy in accordance with the 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.

Stakeholder Workshop reports, this ZoC document, and a Tranche A Identification report have been developed as part of the first phase of the ZAP strategy, 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).

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 The Crown Estate. 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 R3.

Therefore, in R3, The Crown Estate 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 13 GW of offshore wind farm projects at the Dogger Bank Zone by 2023. 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 ongoing 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 – Area to be defined in 2011;
- Tranche C – Area to be defined in 2012; and
- Tranche D – Area also to be defined in 2012.

Within each Tranche, 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 Last accessed: 3rd September 2010.

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 ongoing 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 ongoing 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.

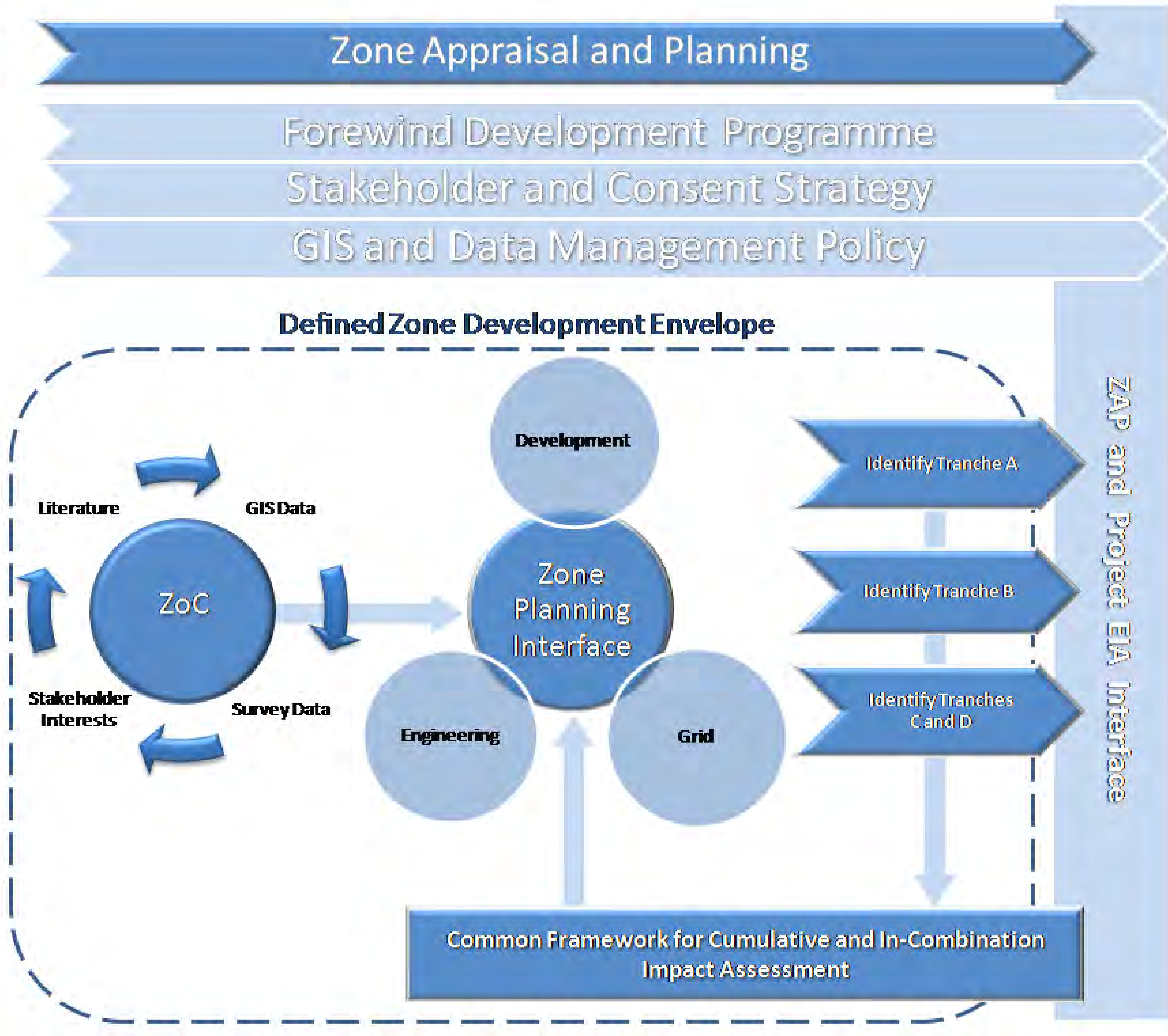

Figure 1: The principle factors comprising Forewind's ZAP strategy.

Dogger Bank Zone Development Envelope (ZDE)

The Dogger Bank Zone Development Envelope (ZDE) incorporates the Dogger Bank Zone, as defined by The Crown Estate, 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 kilometres 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.

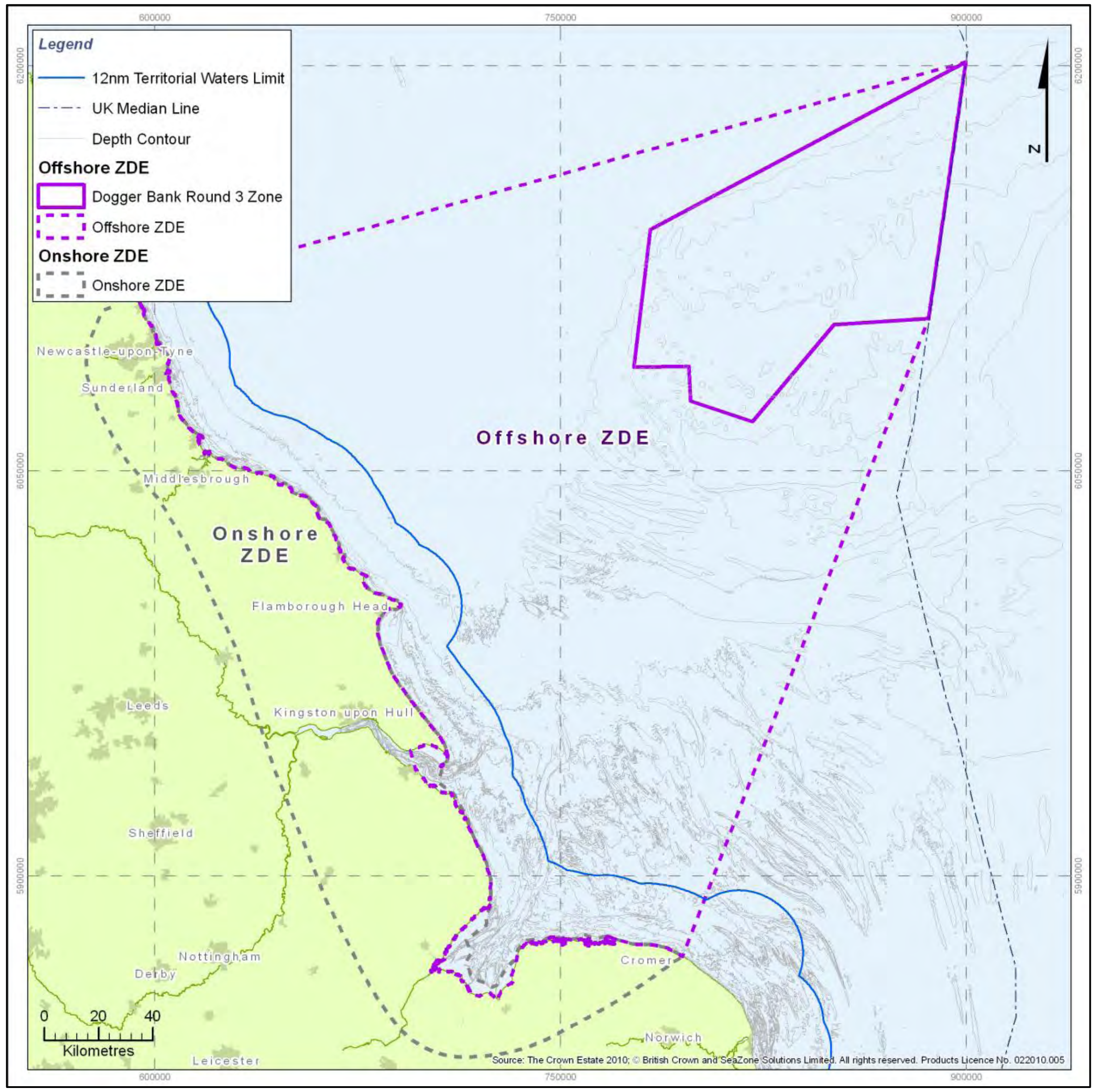

Figure 2: The Dogger Bank Zone Development Envelope.

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 The Crown Estate, 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 ongoing 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 The Crown Estate ZAP framework document[2].

The ZoC is essentially an ongoing 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 first interim ZoC Document has been produced to support the identification of Tranche A.

Zone Planning Interface

Iterative and ongoing 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 required 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 A 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 and in-combination impact assessment methodology which determines the “acceptable impact threshold” that receptors and other users within the ZDE can tolerate for a given Zone layout. The ZoC Document provides a common framework and the information necessary for project level cumulative and in-combination impact assessments.

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. Further, it is important to ensure that there is a coherent spatial relationship between each Tranche area in order to accommodate all potential Zone layouts. 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 essential 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 July 2010 to describe the ZDE and support the identification of the first Tranche location (Tranche A). In addition, this report acknowledges the more recent advancement to the status of sites identified for potential designation under the European Commission"s Birds and Habitats Directives, including the progression in status of the Dogger Bank from a draft Special Area of Conservation (dSAC) to a possible SAC (pSAC).

While this document deals with the data used to support the identification of Tranche A, 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 ZoC 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 Ordnance Survey"s 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 Zonal Characterisation 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 Zonal Characterisation 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:

- 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 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 and surveillance systems;
- Marine Aggregates and Disposal
- Cables and Pipelines; and
- Other Marine Users – Renewable energy, underground coal gasification, carbon capture and storage, tourism and recreation.

It is acknowledged that this interim 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 stakeholder at Forewind"s April 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 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

A data gap analysis was undertaken (Emu Ltd, 2010a) which identified the key data and additional work required (and achievable within the ZAP programme) to:

- Enhance current understanding of the ZDE to complete a Zonal Characterisation in support of Tranche A delineation in 2010;
- Complete a full Zonal Characterisation exercise by the end of the Zone Appraisal and Planning process in 2012.

Essentially, three categories of data are considered:

1. Digital and spatial datasets that can be mapped;
2. Literature and data in paper form that can provide further quantitative and qualitative detail;
3. Input from regulator and stakeholder workshops, and one-to-one consultation.

It was recognised that information drawn from consultation with regulators and stakeholders was and essential to inform the ZoC where existing information did not provide the complete picture. Constraints were mapped by stakeholders during Forewind"s stakeholder workshops, held in April 2010 (Emu Ltd, 2010b, 2010c, 2010d; Forewind, 2010). These 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.

The second chapter (Chapter 17 – *Creyke Beck Substation Study Area*) of the Onshore ZoC will be updated and added to as additional grid connections are accepted by Forewind during the course of the project development and 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 (Emu Ltd, 2010b, 2010c, 2010d; Forewind, 2010).

The datasets have further been sub-divided into 4 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 Zonal Characterisation, Emu Ltd has worked with other consultancies to achieve a characterisation of a broad range of environmental topics, *viz*:

- SKM Enviros, for producing a thorough Zonal 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;
- Cork Ecology, for a description of bird and mammal species occurring in the Offshore ZDE; and
- Anatec UK Ltd, for their characterisation of navigation and shipping in the Offshore ZDE, and their ongoing analysis of AIS ship data.
- 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

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 Holocene sea level rise, 7,500 years BP.

This chapter summarises the present physical and geological conditions present across the Dogger Bank Zone and the corresponding Offshore Cable Area and also attempts to correlate these with the interpreted evolution of the Dogger Bank and surrounding area based on known data.

The key sedimentological and geological considerations addressed in this chapter, and used in 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 2.6.1.

2.2 Data Sources and Analyses

The following data sets have been reviewed in order to derive the conclusions set out in this chapter of the Zonal Characterisation Document:

- British Geological Survey (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; and
- RPS in-house geophysical and geotechnical database.

As a result of the review of the BGS geophysical data set, errors were identified with the published interpretation when compared with the information presented in the original 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).

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 has been performed 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 has been commissioned and is being conducted in order to obtain high resolution Zone-wide data. The line spacing for the reconnaissance survey is a 2.5 km x 2.5 km grid (Figure 2.2).

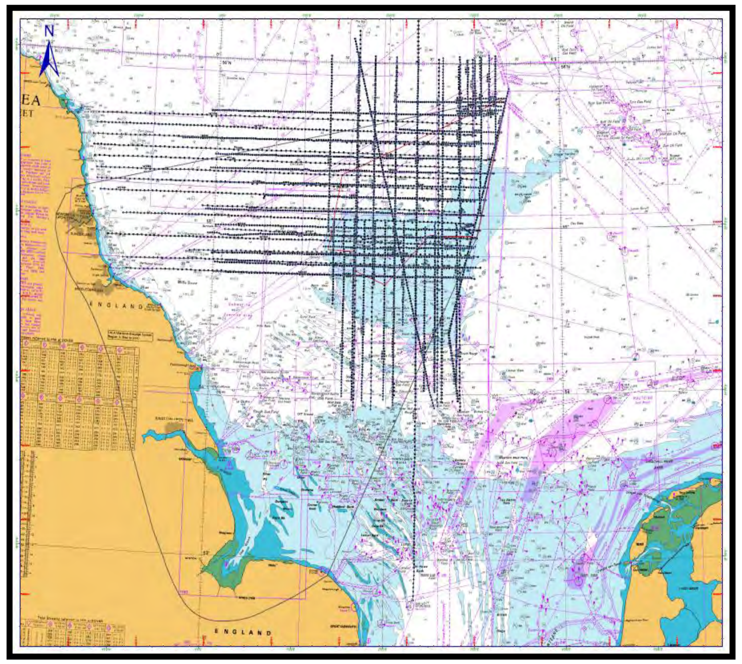


Figure 2.1: Geophysical data reviewed.

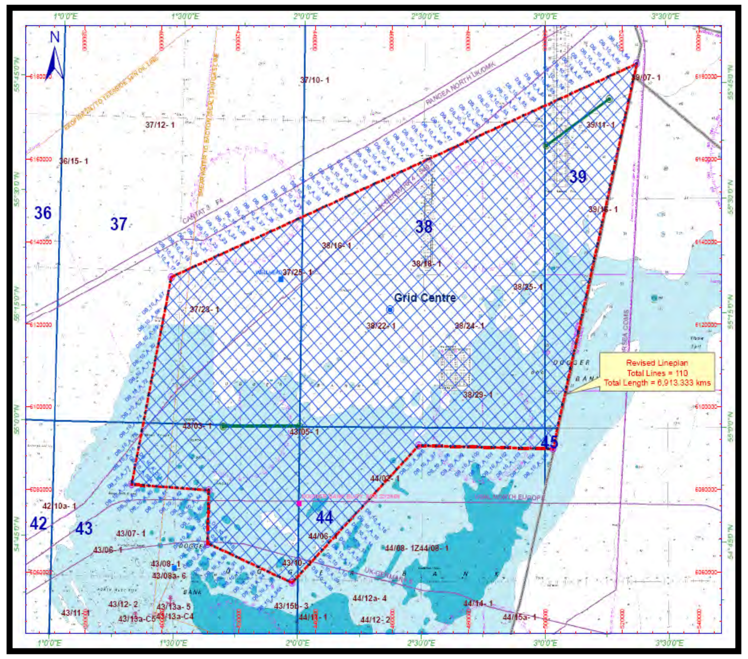


Figure 2.2: Reconnaissance geophysical survey lineplan.

These data, once interpreted and incorporated into a 3D model, will be used to inform later work. Thereafter, detailed Tranche specific geophysical surveys will be performed in order to construct detailed Zone-wide and Tranche specific 3D geological models.

A reconnaissance geotechnical investigation is planned for Q3 2010, the results of which would be integrated with the reconnaissance geophysical data in order to perform first order refinement to the 3D geological model. Detailed geotechnical surveys will be performed across each Tranche 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.

2.2.1 Uncertainty / data gaps

Data gaps exist in the BGS data set. These are significant and the interpretation of formations within the Dogger Bank Zone should be treated as an initial assessment until data can be obtained with closer geophysical line spacing and digital interpretation methods can be utilised. This will greatly enhance the mapping of surfaces and correlation between lines and cross lines, to more fully understand the three dimensional geometry of any features identified. To date this has proved very difficult due to the scanned nature of the geophysical data which cannot be rescaled and integrated easily. The line spacing is generally in the order of 5 to 15 kilometres leaving large areas without data.

It should be noted that, at this stage, a shallow geohazard assessment across the site has not been made and should be carried out on interpretation of the reconnaissance geophysical survey.

2.3 Overview

2.3.1 Dogger Bank Zone

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

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 very little shallow soils data are available at present with which to inform future decisions. The assessments which can be made rely on the use of soils data in similar formations from outside the Dogger Bank Zone.

2.3.2 Offshore Cable Area

The area outlined for 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 north-east, 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.

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 south-western 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 22) 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.

Tidal ranges are interpreted to be between 1 m 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 m/s 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 26).

The Dogger Bank dominates the bathymetry of the Offshore ZDE's north-east 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 north-west of Dogger Bank, towards the English coast, the sea floor is generally 40-90 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.

South-west 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 south-west of Dogger Bank.

Maximum tidal ranges of 3-6 m (mean neap and spring tides respectively) occur along the coast between Humber and The Wash. Offshore, to the north-east, 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 2.3). There is little variation in the near-bottom velocities due to the generally uniform bathymetry.

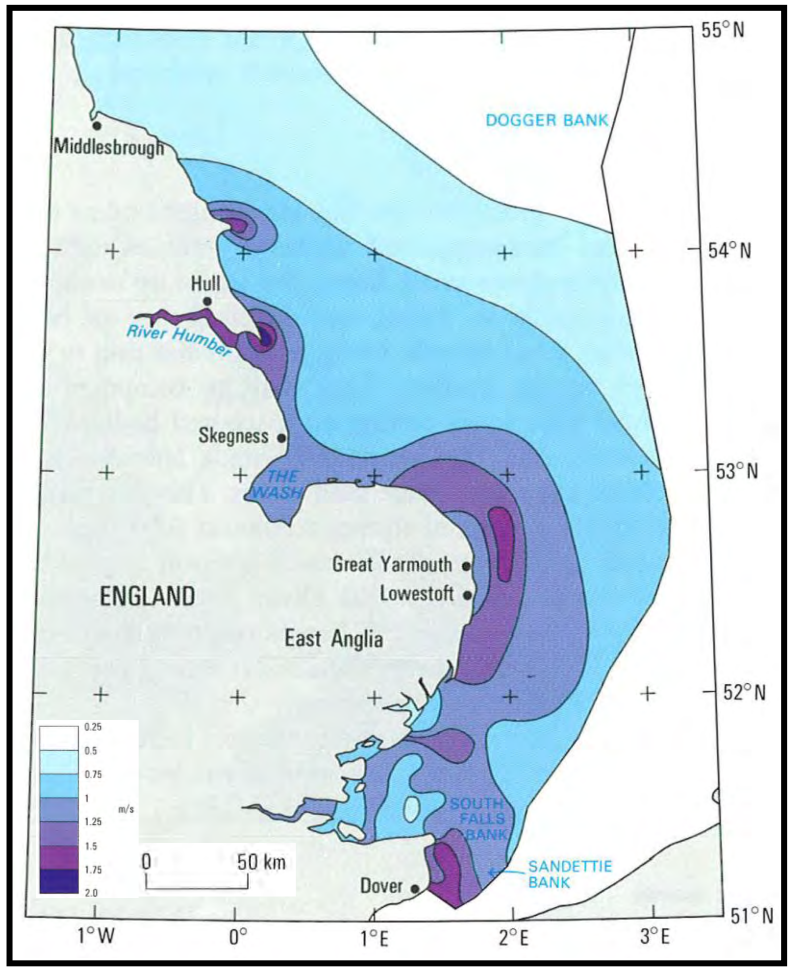


Figure 2.3: Maximum surface-current velocities for mean spring tide (modified from Cameron *et al*., 1992). IPR/130-28CT British Geological Survey. © NERC 2008. All rights reserved.

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 south west of the Dogger Bank Zone, the presence of the Dogger North Shoal may indicate a locally thicker cover of Holocene gravel and sandy gravel. 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: Yellow background – Present in Dogger Bank Zone. 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 draft Special Area of Conservation (dSAC)

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 2.4). 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.

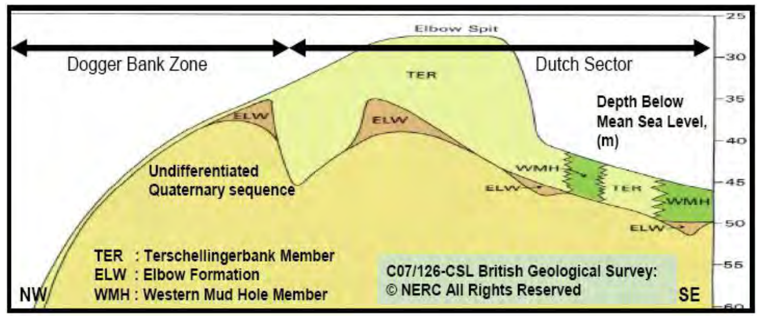


Figure 2.4: Seabed Profile of the Dogger Bank and Elbow Spit (after Jeffery *et al*., 1990). (Note accumulation of sand and bank morphology outside the Dogger Bank Zone). IPR/130-28CT British Geological Survey. © NERC 2008. All rights reserved.

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 south-east of, and outside, 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 south-easterly direction away from the south-eastern margin of Dogger Bank. Elbow Spit has a steeper south-eastern margin which can clearly be picked out on north-south trending BGS sparker profiles (Figure 2.5).

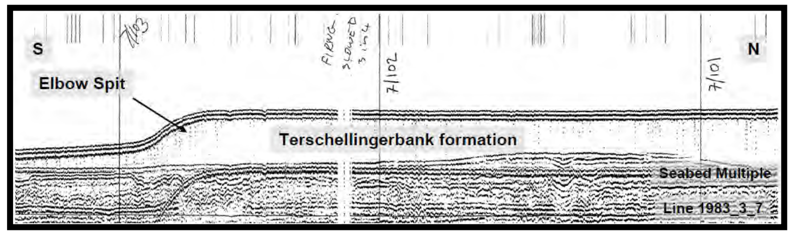


Figure 2.5: Line 1983_3_7: Interpreted to be Terschellingerbank Bank formation south to the left of image. The sand unit is interpreted to be 10-15m thick.

The JNCC (2010) includes this area to the south-east of the Dogger Bank as part of the dSAC, 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 2.4) 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 2.6). 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.

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 Bank Zone in the region of the Dogger North Shoal (Chart 2, page 23).

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 south-west 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.

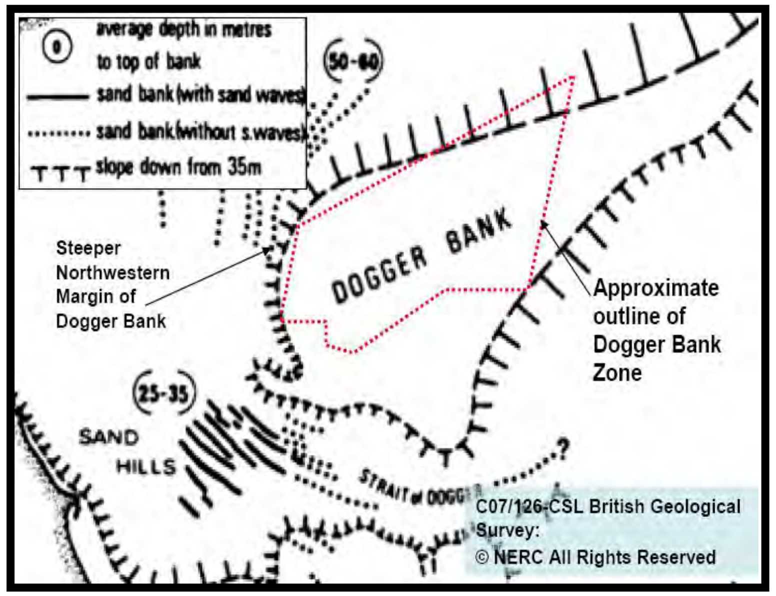


Figure 2.6: Seabed features of the Dogger Bank and the surrounding area (after Cameron et al., 1992). IPR/130-28CT British Geological Survey. © NERC 2008. All rights reserved.

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 2.7).

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 27), which have been used for this characterisation of the Offshore Cable Area.

Coarse Gravelly Deposits

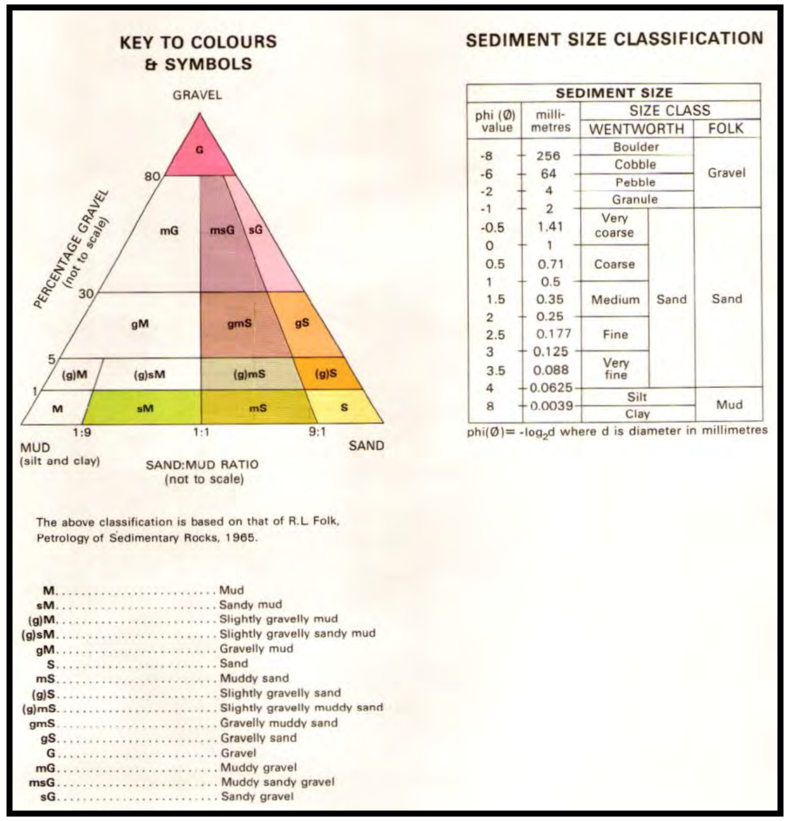
Gravel dominated sediments are widespread across the region and generally occur as static lag deposits. The polymitic gravels contain flint, sandstone, limestone and chalk. A minor biogenic component of mollusc shells is found at localised centres of carbonate production (Pantin, 1991). Sediment size generally varies from sandy gravel to gravel with patches of muddy sandy gravel (Chart 6, page 27).

The largest concentration of gravels is present along the coast, from Happisburgh to Flamborough Head, where a thin layer, tens of cm’s 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 km’s 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 27), 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).



SEDIMENT SIZE			
phi (Ø) value	milli-metres	SIZE CLASS WENTWORTH	FOLK
-8	256	Boulder	Gravel
-6	64	Cobble	
-2	4	Pebble	
-1	2	Granule	
-0.5	1.41	Very coarse (Sand)	Sand
0	1		
0.5	0.71	Coarse (Sand)	
1	0.5		
1.5	0.35	Medium (Sand)	
2	0.25		
2.5	0.177	Fine (Sand)	
3	0.125		
3.5	0.088	Very fine (Sand)	
4	0.0625	Silt	Mud
8	0.0039	Clay	

phi(Ø)= $-\log_2 d$ where d is diameter in millimetres

Figure 2.7: Sediment classification used by the BGS to describe seabed sediments (after Folk 1954). IPR/130-28CT British Geological Survey. © NERC 2008. All rights reserved.

Muds

Intertidal zones associated with estuaries are dominated by muddy sediment (a mixture of silt and clay). Mud deposits exceed 15 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 and 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 28). 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 28).

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 2.3) sand ribbons are a relatively minor bedform, which have only been recorded over small areas of Flamborough Head (BGS Tyne-Tees and California Seabed Sediment sheets).

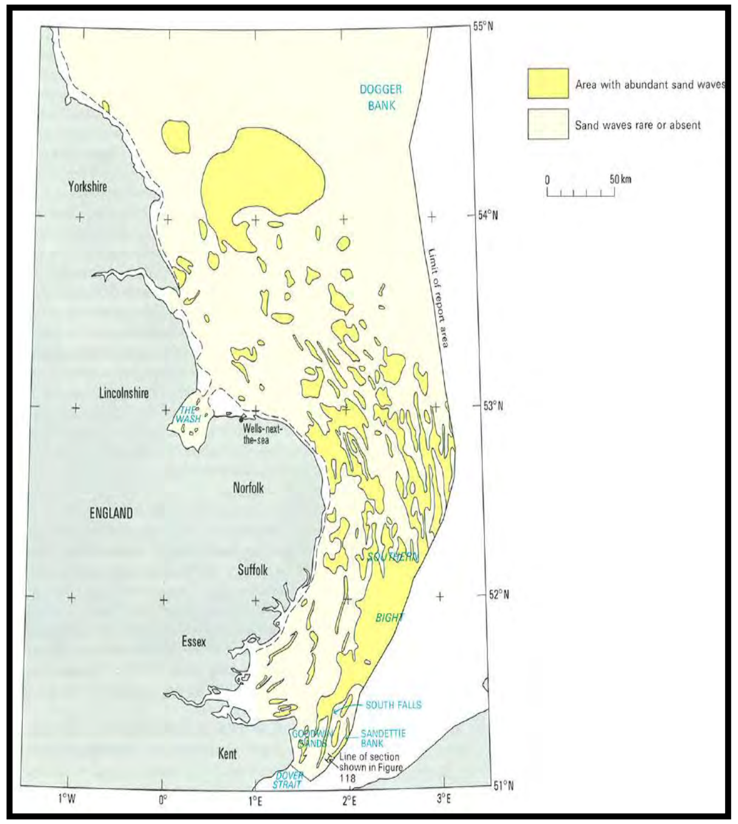


Figure 2.8: Area with abundant sand waves across the Offshore Cable Area (Cameron *et al*., 1992). IPR/130-28CT British Geological Survey. © NERC 2008. All rights reserved.

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 2.8). Typically consisting of fine to medium grained sand there is a large variation in their morphology (Cameron *et al*., 1992). The largest sandwaves 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 1-2 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 wider Offshore Cable Area, including the Sand Hills, East Bank Ridges and the western edge of the Norfolk Banks (Figure 2.9).

The Sand Hills group is found in the centre of the Offshore Cable Area to the south-west of Dogger Bank (Figure 2.9). These sandbanks occur in water depths of ~50 m and have heights of 12-21 m, placing the crests of the banks at ~10 - 30m 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).

The western edge of the Norfolk Banks extends into the south-east corner of the Offshore Cable Area. They occur in shallower water with banks up to 42 m high, the crests at up to 10 - 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 north-west, in the direction of net sand transport, with some evidence for lateral migration to the north-east (Caston, 1972).

A series of Holocene tidal sand ridges that are considered to be relict are situated on East Bank immediately to the north-west of

Dogger Bank (Gatliff *et al.,* 1994). They are found in water depths of 45-60 m and occur over an area ~ 30 km wide. Orientated north-east to south-west, 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 10-30 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).

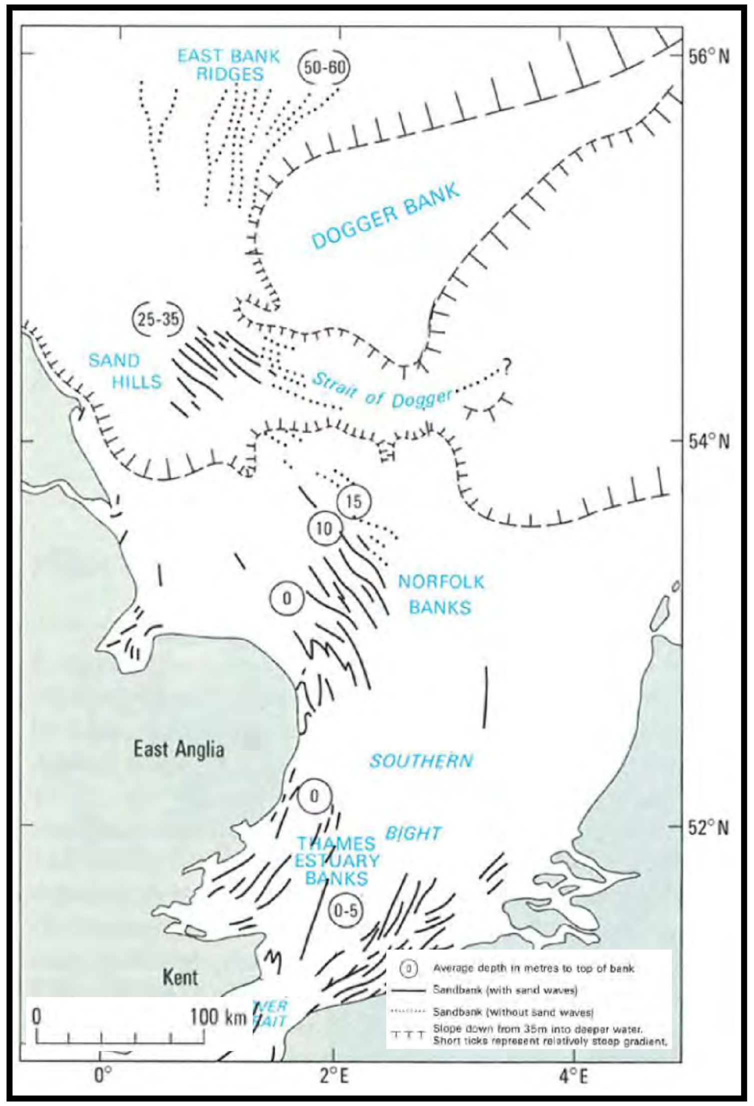


Figure 2.9: Distribution of major sandbanks in the southern North Sea (After Cameron *et al.*, 1992). IPR/130-28CT British Geological Survey. © NERC 2008. All rights reserved.

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 24), 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 2.10 and Figure 2.11. The plan view shown in Figure 2.11 is composed of two BGS map excerpts.

Very little geotechnical data are available for the Dogger Bank Zone. The data presented and used as an initial point of reference for geotechnical properties are based on regional data from sites outside the zone. As such the geotechnical properties in Table 2.3 are only indicative of the interpreted range of conditions. The actual values at specific sites may differ from the interpreted values.

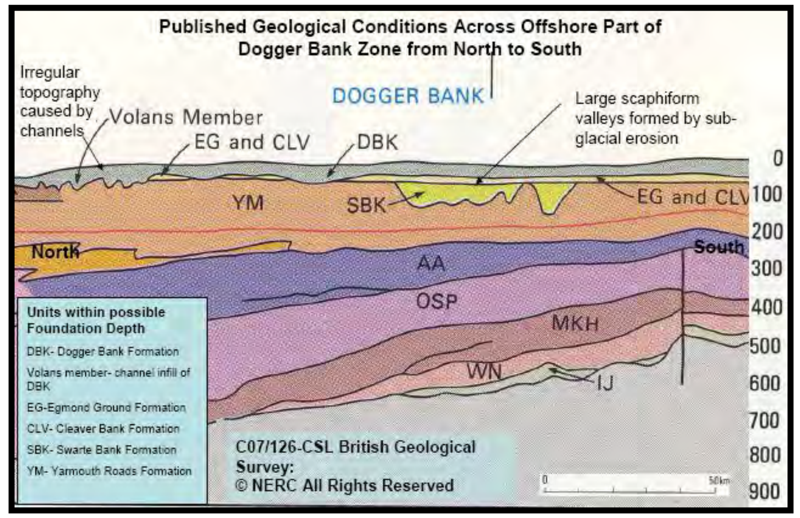


Figure 2.10: Published Quaternary profile across the Dogger Bank Zone (Gatliff *et al*., 1994). IPR/130-28CT British Geological Survey. © NERC 2008. All rights reserved.

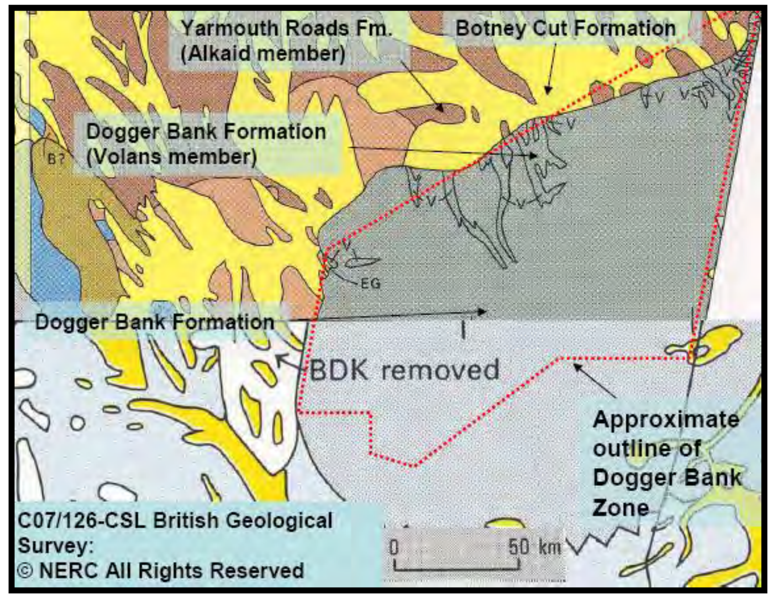


Figure 2.11: Published Quaternary sequence across the Dogger Bank Zone, (Gatliff *et al*., 1994, Cameron *et al*., 1992). IPR/130-28CT British Geological Survey. © NERC 2008. All rights reserved.

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	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.
			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	Cleaver Bank	**Proglacial:** Stiff laminated dark grey clays with scattered angular chert and chalk gravel.
			Tea Kettle Hole	**Periglacial:** Aeolian deposits of fine grained sands with organic detritus.
		Holsteinian	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.
		Elsterian / Cromerian	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	Batavier	
		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

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	-	-	-	-	-	-	<1 m, (up to ~10 m)
Botney Cut	7.0 - 10.0	-	-	40 - 130	0.8 - 1.4	0.60 - 0.75 @ 1 m to 2 - 3 @ 40 m	Present in channels generally 20 - 30 m deep
Dogger Bank	8.3 - 11.6	-	25	150 - 400	-	4 - 20	Generally tabular between 20 - 40 m thick
Cleaver Bank	8.1 - 9.5	-	-	70 - 650	-	-	Interpreted to be <10 m where present
Egmond ground	7.8 - 10.9	-	30 - 35	-	-	15 - 40	Interpreted to be <10 m where present
Swarte Bank	10.1 - 10.8	65+ 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	70 - 100	35 - 40	200 - 500	2.0 - 3.0	15 - 40 in sand	Generally from 40 m to beyond foundation depth

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 2.12). The interpreted distributions are presented in Table 2.4.

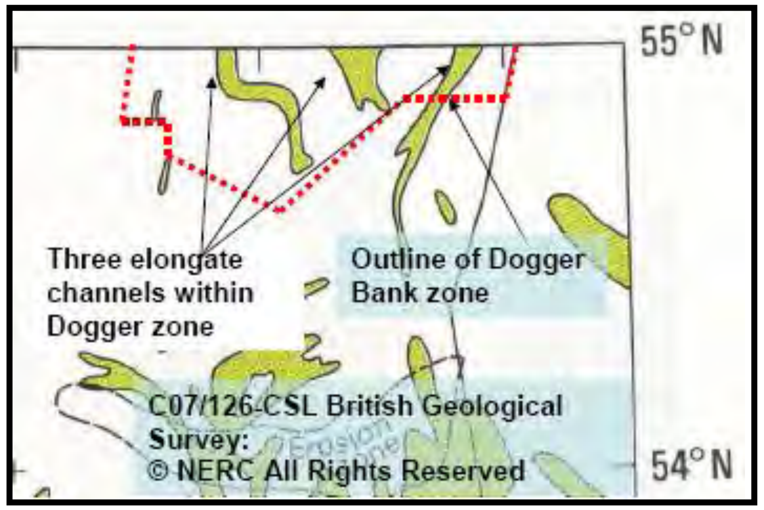


Figure 2.12: Published occurrence of Swarte Bank channels. IPR/130-28CT British Geological Survey. © NERC 2008. All rights reserved.

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 south east 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

Revised interpretation

Initial review of the BGS sparker data indicates a more complex system of channels than initially interpreted by the BGS. 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 30-40 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.

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.

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 2.13 and Figure 2.14.

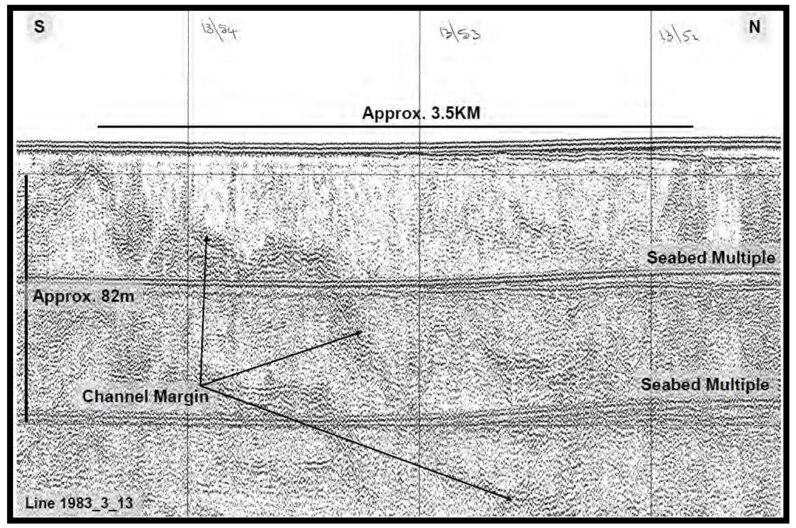


Figure 2.13: Line 1983_3_13: Deep channel in the Northwest of the site Scale lines approx 82 m apart, channel approx. 3.5 km wide.

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 2.13 appears to have an orientation consistent with that interpreted by the BGS.

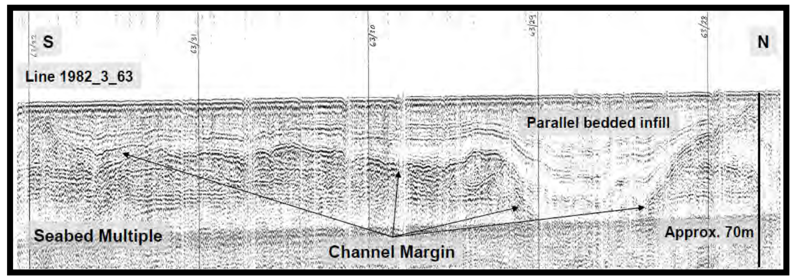


Figure 2.14: Line 1982_3_63: deepest part of channel approx. 70m deep. Parallel bedded possible BCT.

The parallel bedded nature of the channel fill material illustrated in Figure 2.15 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. An alternative interpretation is that the less distinct channels with an indication of parallel bedding could be filled by more sandy sediments infilling a paleo-landscape subsequent to late glacial transgression. Multiple channels of this character are often present which can cross cut each other as illustrated in Figure 2.16.

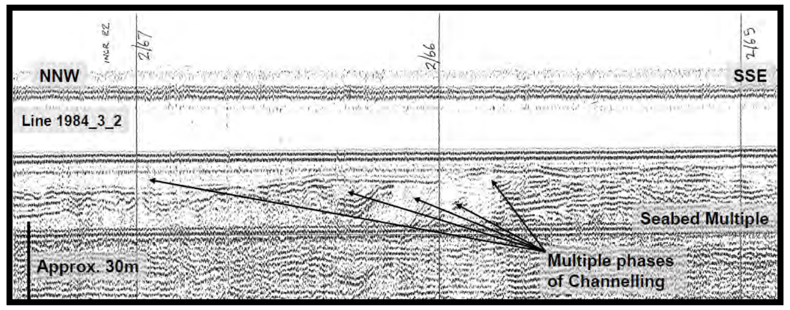


Figure 2.15: Line 1984_3_2: complex multi phases of channelling with dipping parallel bedded fill. Depth of channel approx. 25-30m.

Channels of this character have been picked out in the centre of the Dogger Bank Zone and are generally 15-20 m deep (Chart 4, page 25). The general orientation of these channels cannot be traced from line to line due to the line spacing run by the BGS. Fill material is generally deposited in a north to south direction and may indicate sediment transport in that general direction.

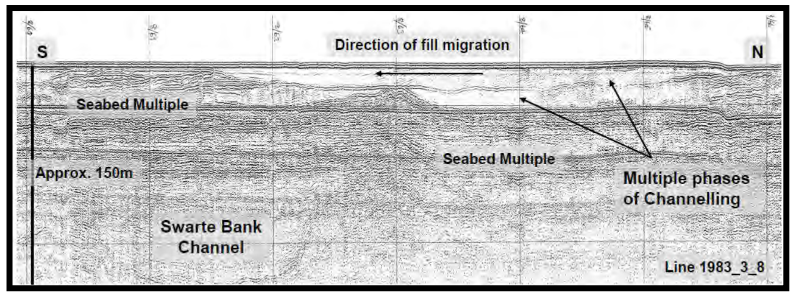


Figure 2.16: Line 1983_3_8: North South section showing complex nature of units in the Dogger Bank Zone.

The locations of identified channel features and their associated interpreted maximum depths are indicated in Chart 4 (page 25). This clearly shows 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 are interpreted to be a buried palaeo-landscape (Figure 2.17). 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.

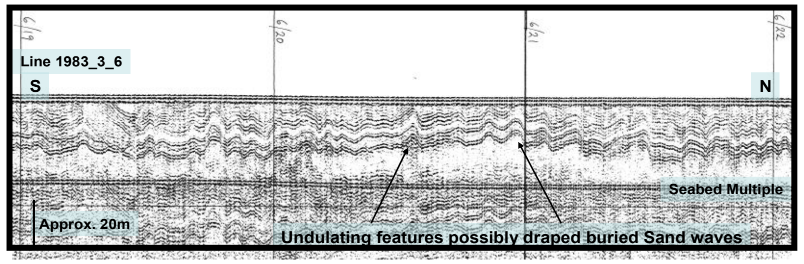


Figure 2.17: Line 1983_3_6: Acoustic character seen rarely elsewhere in zone. Possible sand features (Sand waves) draped by fine material (depth to base of strong undulating reflector approx. 20m).

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 29). 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 2.18). The units have been defined on the basis of seismic character with lithological information gathered from borehole data. 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 wider Offshore Cable Area is presented below.

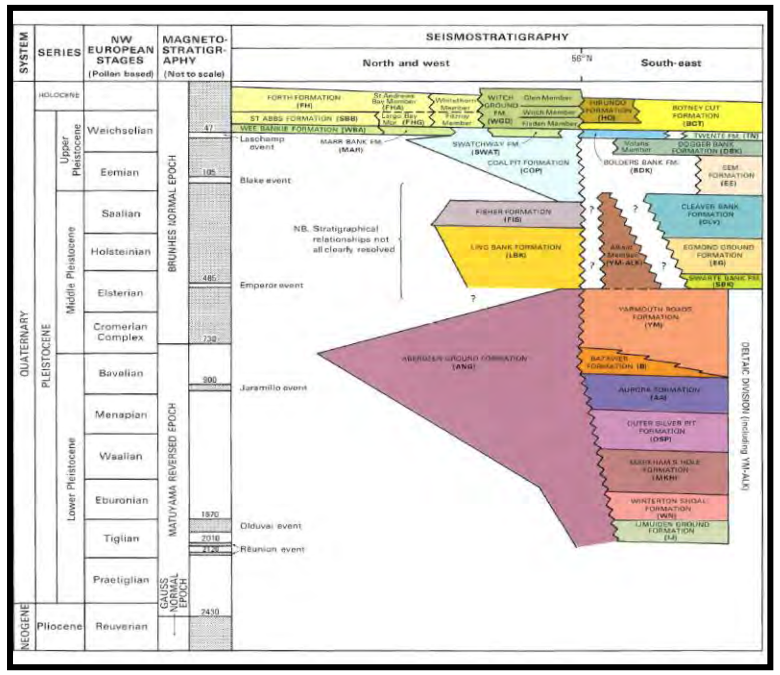


Figure 2.18: Quaternary stratigraphy of the North Sea as relates to the geology of the Offshore Cable Area (modified from Gatliff *et al.*, 1994). IPR/130-28CT British Geological Survey. © NERC 2008. All rights reserved.

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 Jurassic have been omitted from the summary. Events are detailed in Cope *et al.* (1992) and summarised below:

- 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;
- Erosion of the solid strata associated with glacial activities during the Pleistocene (ice age); 1.5 Ma-present.

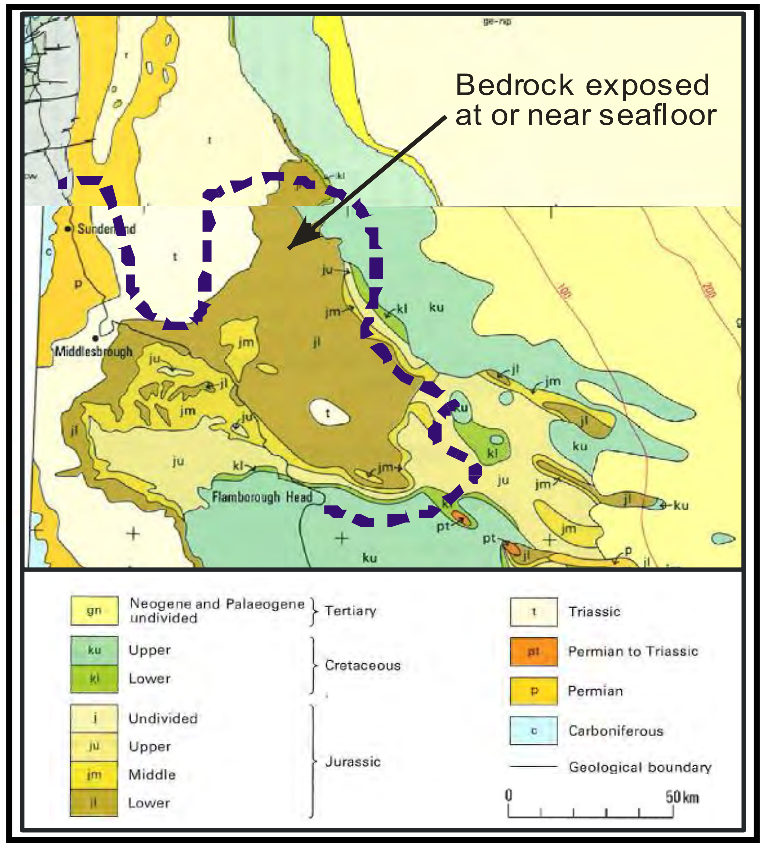


Figure 2.19: Generalised bedrock geology exposed at or near the sea bed across the Offshore Cable Area (modified from Gatliff *et al.*, 1994 and Cameron *et al.*, 1992). IPR/130-28CT British Geological Survey. © NERC 2008. All rights reserved.

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 30). Bedrock exposure is confined to the north-western sector, extending ~ 50 km offshore from Flamborough Head and trending north parallel to the coast (Figure 2.19).

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 2.19). 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 – 250kPa 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: 70kPa where weathered to +1MPa).
- Triassic Strata**:** Continental mudstone facies with sandstones and thin beds of dolomite, anhydrite sandstone and widespread halite.
- 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 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 2.20).

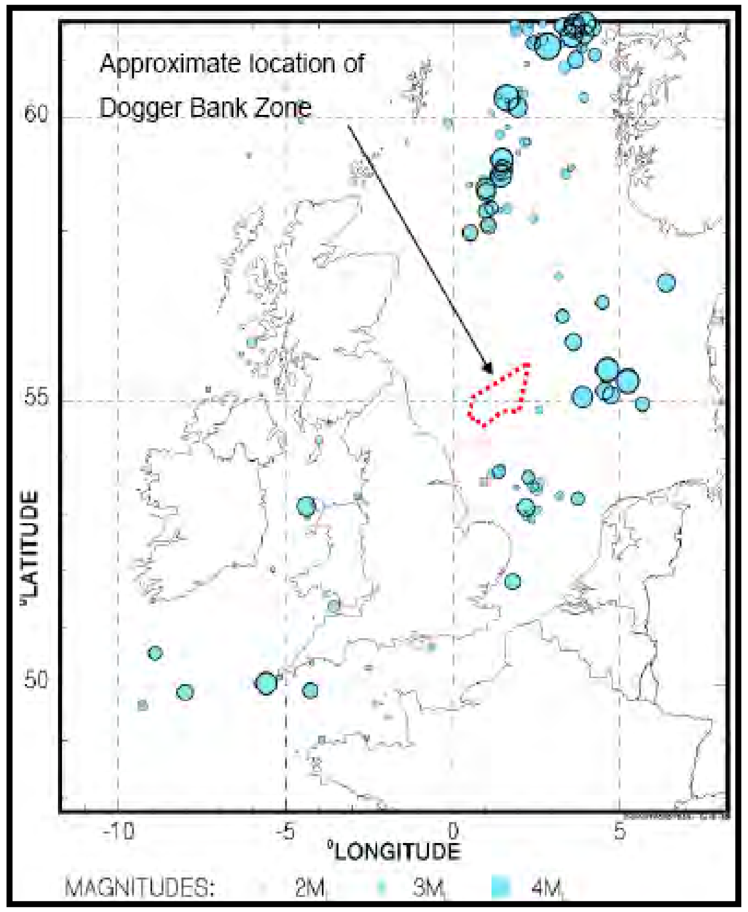


Figure 2.20: Magnitude of events and epicentres in the UK and in coastal waters (after HSE, 2002) 1990-1996, Magnitude >2M.

The seismic activity in this area is generally attributed to the South Hewittt 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 2.21 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 m/s^2 and 0.16 m/s^2. For the 10,000 year event ground accelerations are between 0.8 m/s^2 and 1 m/s^2 (HSE, 2002).

The recorded magnitude 4 and 5 events suggest that the effects of seismic activity should be taken into consideration at the design stage of any projected wind farm development across the Dogger Bank Zone.

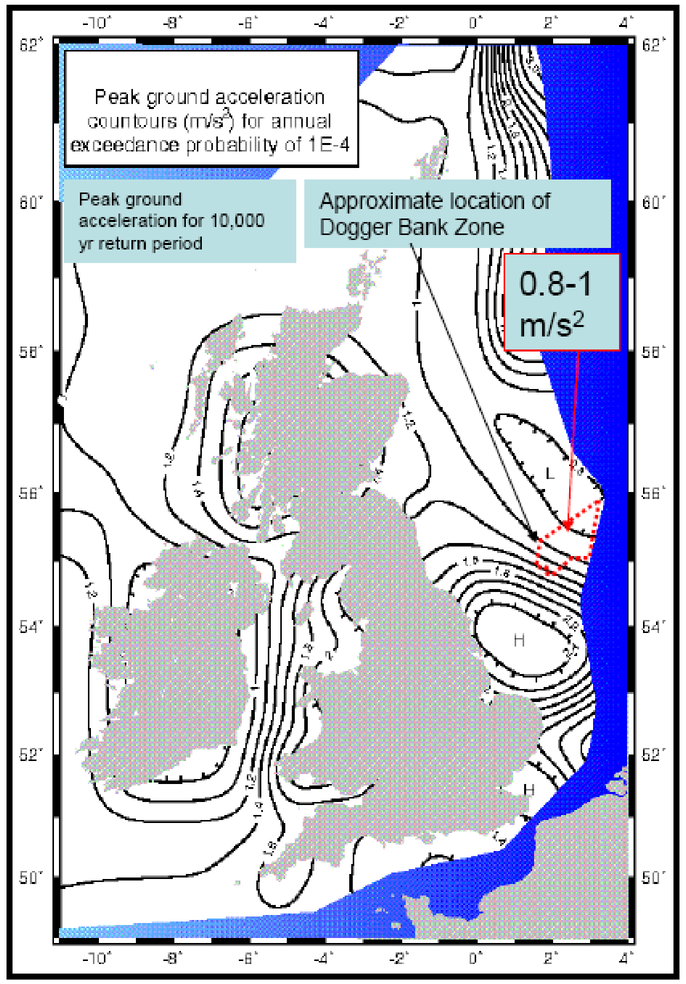


Figure 2.21: Diagrams of peak ground accelerations for a 10,000 year event, Accelerations highlighted are in the approximate area of the Dogger Bank zone. (after HSE, 2002).

2.8.1 Summary 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 25).

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 25) along the western margin of the Dogger Bank Zone, and a larger area in the south-western 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 25).

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 25) 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-north-east to west-south-west and across the south western 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, however, 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, however, are not interpreted to be prevalent and deeper channels are less common.

2.8.2 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 5m depth (Chart 9, page 30). 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 30; Figure 2.22). Generally the bedrock exposure occurs as a band in the north-west 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 (< 1m) on top of bedrock of varying strengths (see Section 2-7 for details).

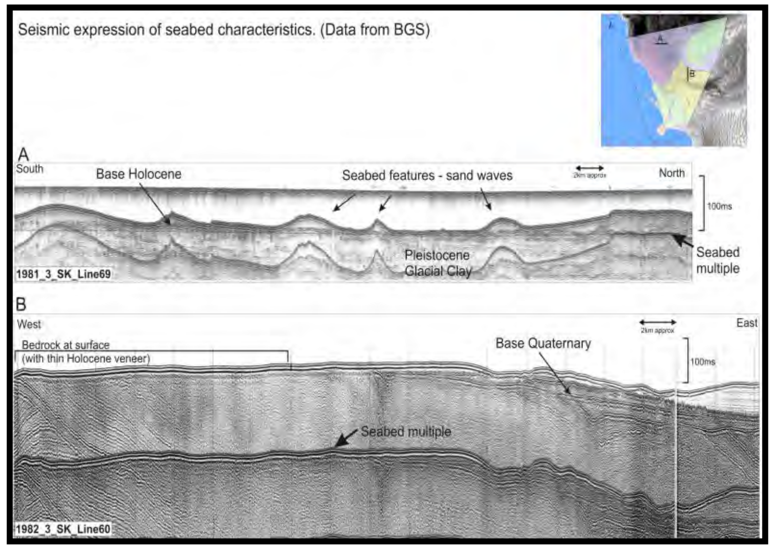


Figure 2.22: Seismic expression of seabed and sub seafloor characteristics that may be encountered by trenching. (Geophysical data from BGS).

Area B

This area covers the Offshore Cable Area as it approaches the coast to the south-west of the development 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 2.22). 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.

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 30) 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 0.9m/year (Clayton, 1989).

2.8.3 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

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.
- 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.

2.8.4 Shallow Geology of the Offshore ZDE

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 30). These areas take into account the presence, distribution and type of Holocene seabed sediments, their mobility and the underlying Quaternary and bedrock geology.

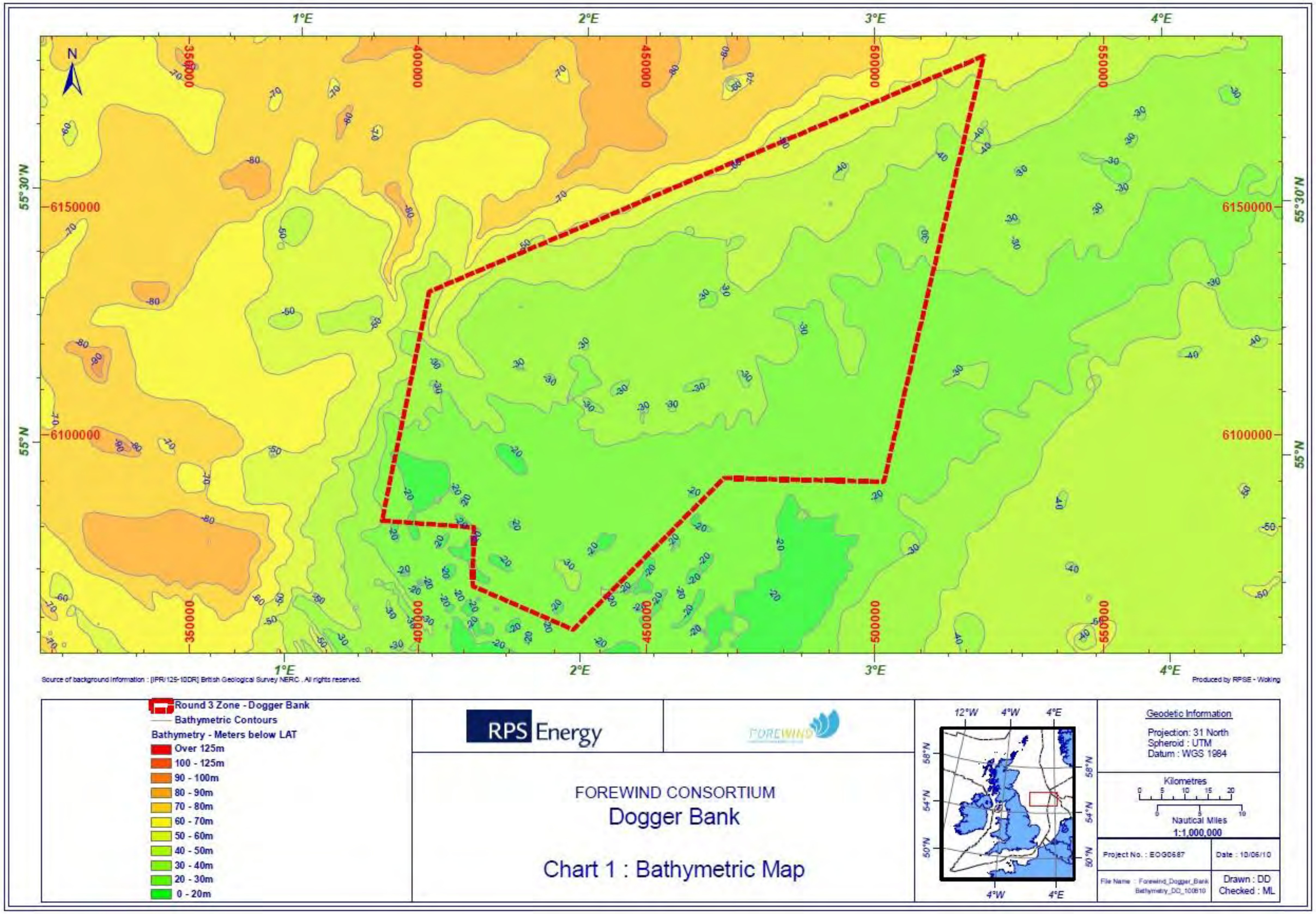


Chart 1: Bathymetric Map. Derived from BGS geological digital data. British Geological Survey © NERC 2010. All rights reserved. IPR/130-28CT.

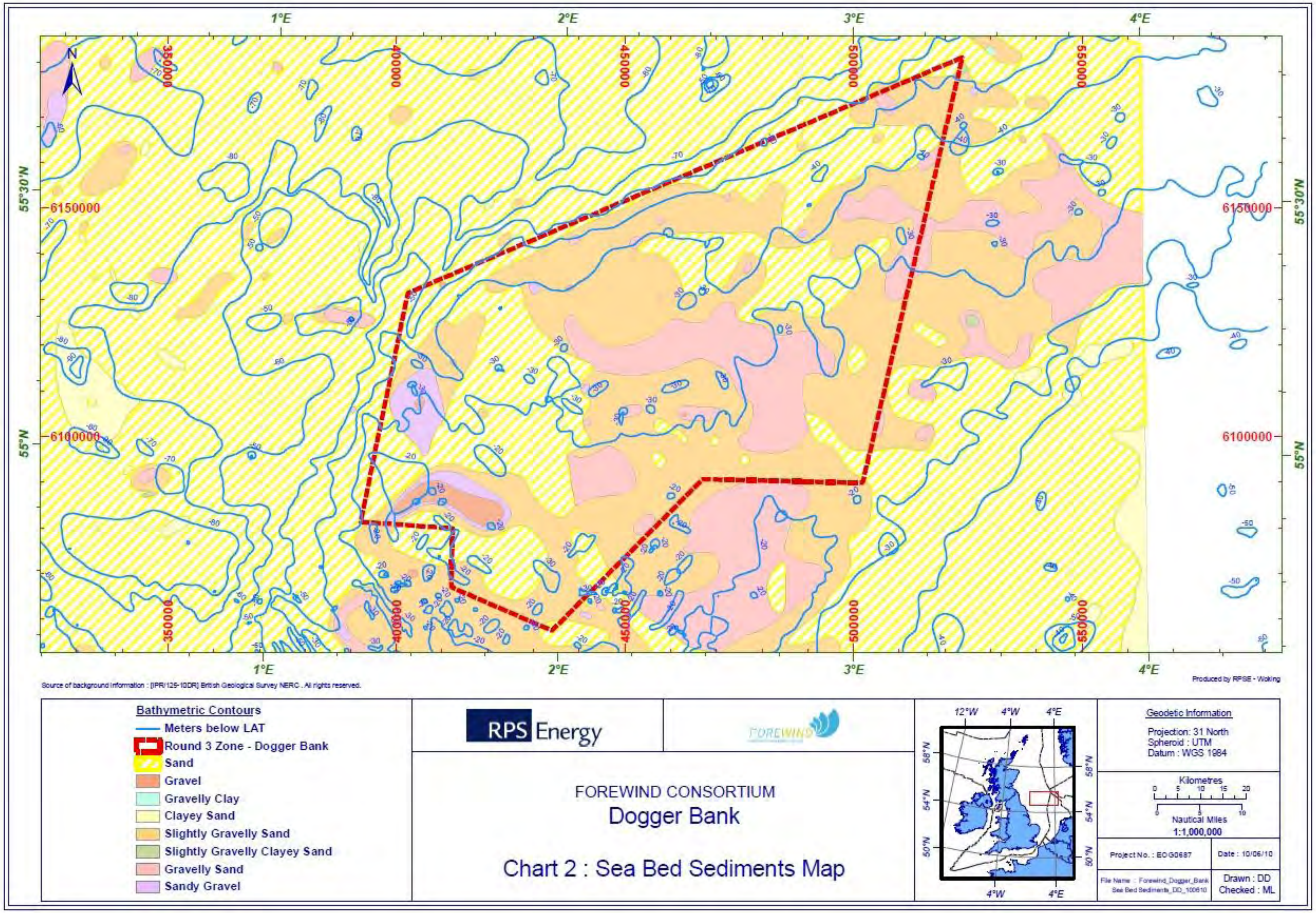


Chart 2: Sea Bed Sediments Map Derived from BGS geological digital data. British Geological Survey © NERC 2010. All rights reserved. IPR/130-28CT.

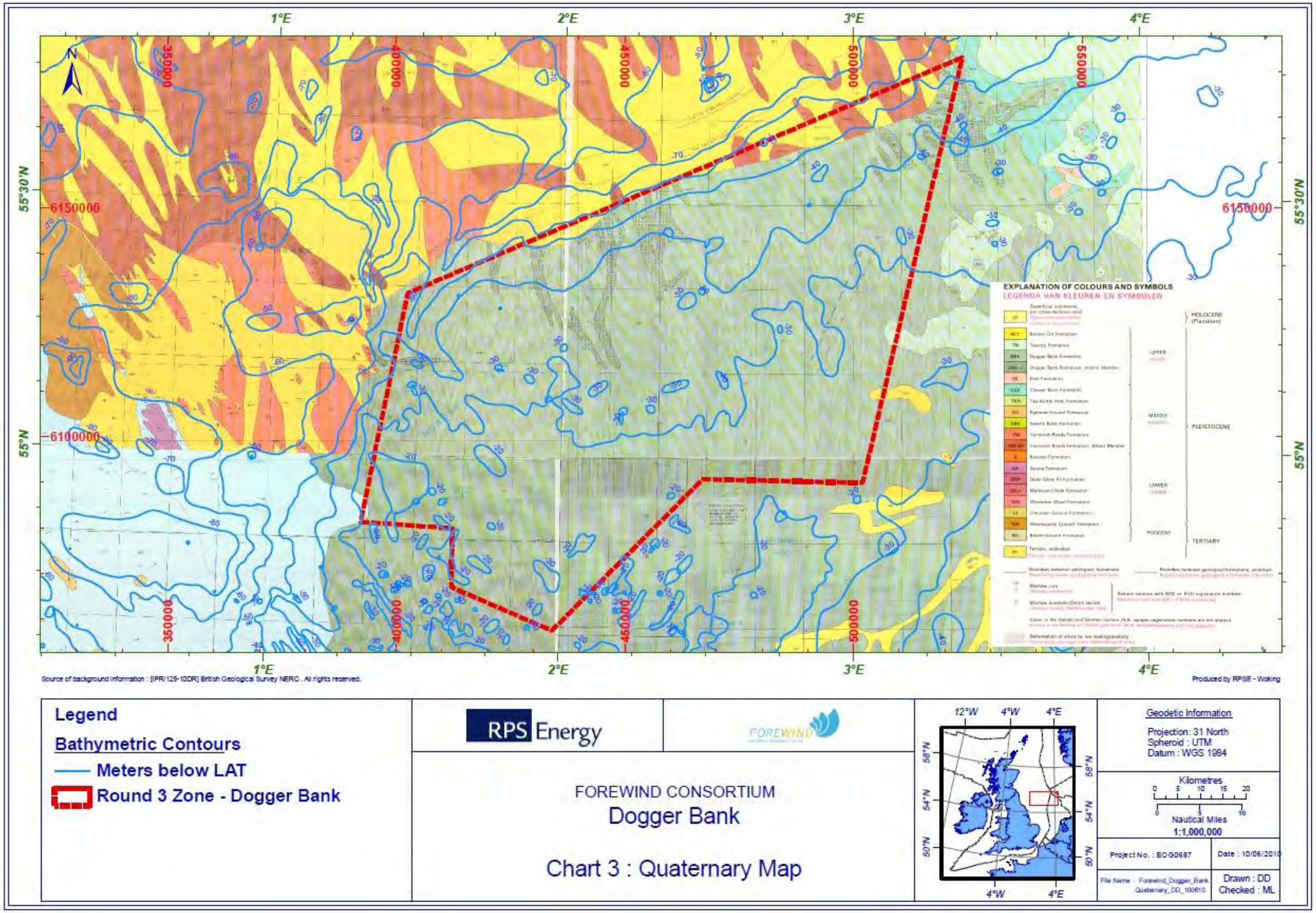


Chart 3: Quaternary map showing the Dogger Bank Round 3 Zone. Derived from BGS geological digital data. British Geological Survey © NERC 2010. All rights reserved. IPR/130-28CT.

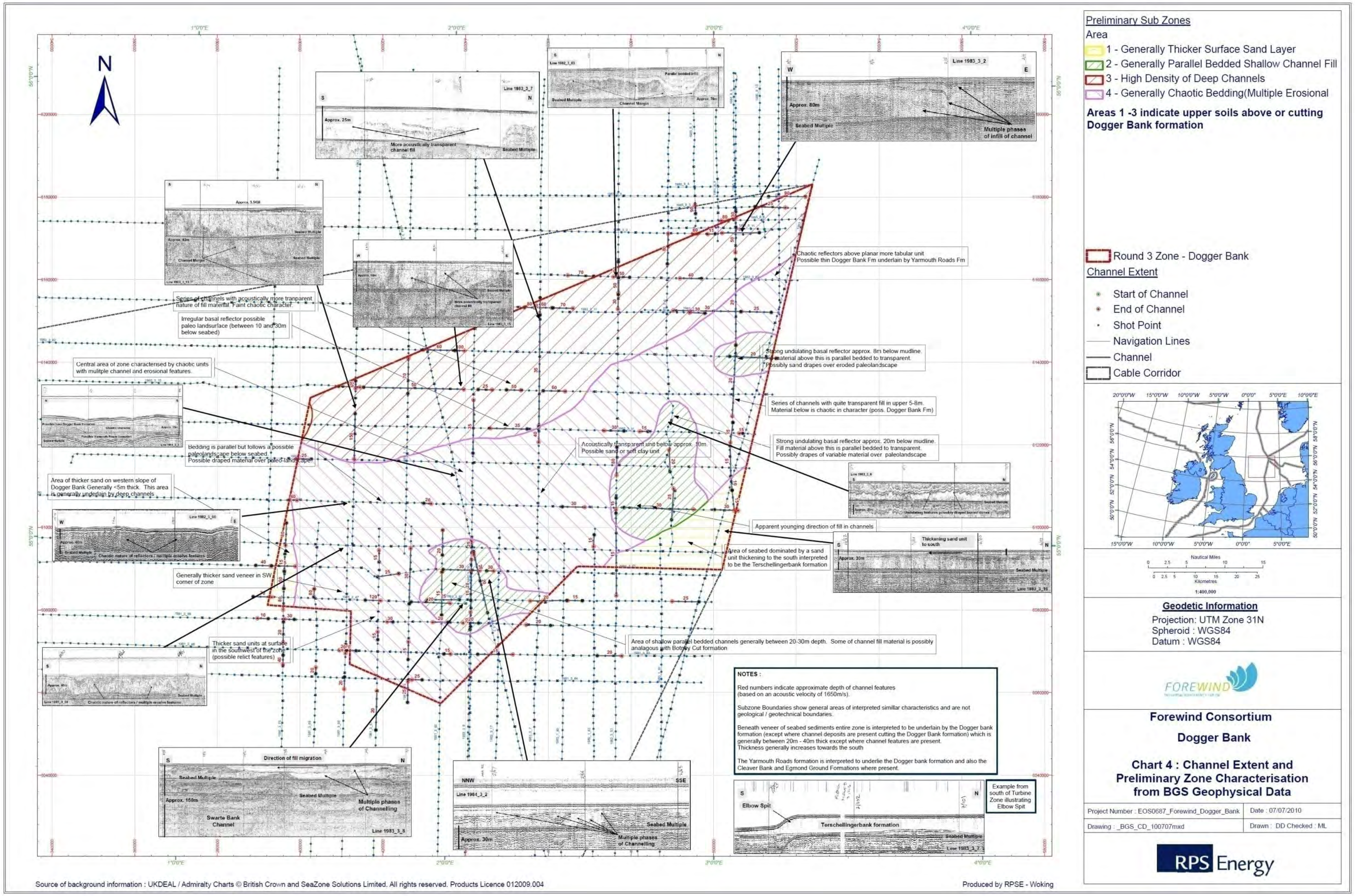


Chart 4: Channel Extent and Preliminary Zone Characterisation from BGS Geophysical Data. Source: UKDEAL/ Admiralty Charts British Crown and SeaZone Solutions Limited. Products Licence 012009.004

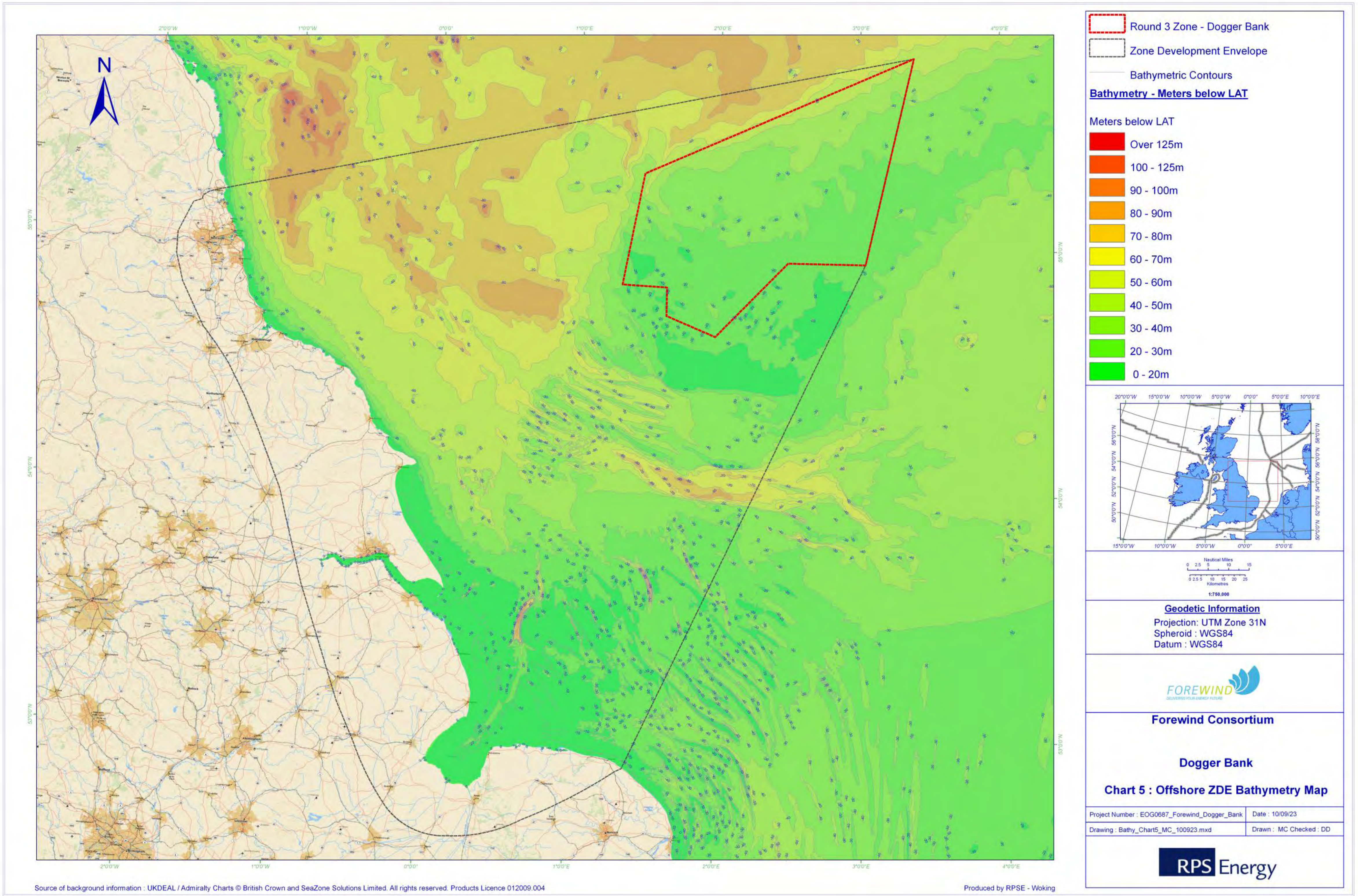


Chart 5: Offshore ZDE Bathymetry. Source:UKDEAL/ Admiralty Charts British Crown and Seazone Solutions Limited. All rights reserved. Products Licence 012009.004

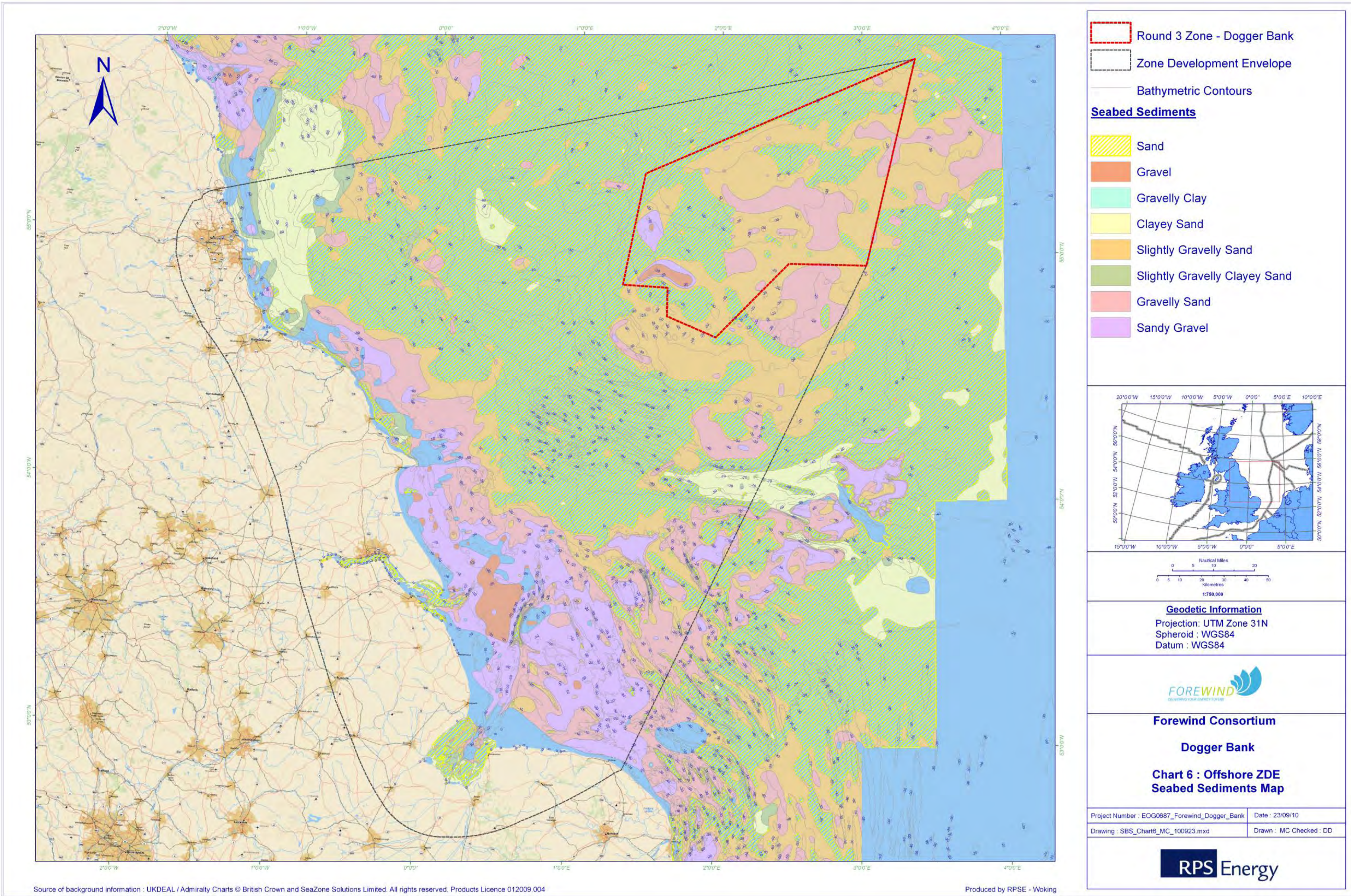


Chart 6: Offshore ZDE Seabed Sediments map. Source: UKDEAL/ Admiralty Charts British Crown and Seazone Solutions Limited. All rights reserved. Products Licence 012009.004

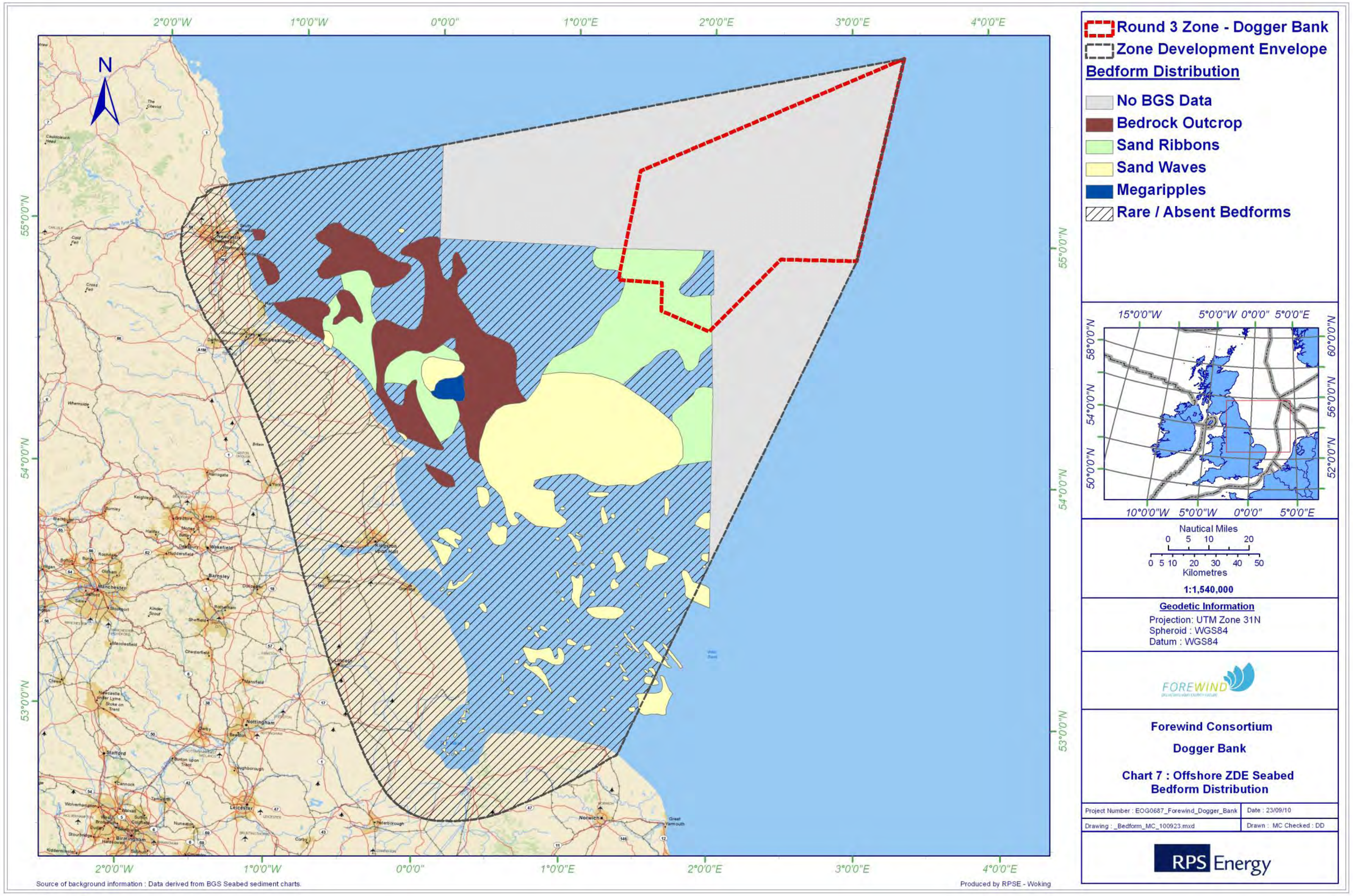


Chart 7: Offshore ZDE Seabed Bedform Distribution. Source: Data derived from BGS Seabed Sediment Charts. Derived from BGS geological digital data. British Geological Survey © NERC 2010. All rights reserved. IPR/130-28CT.

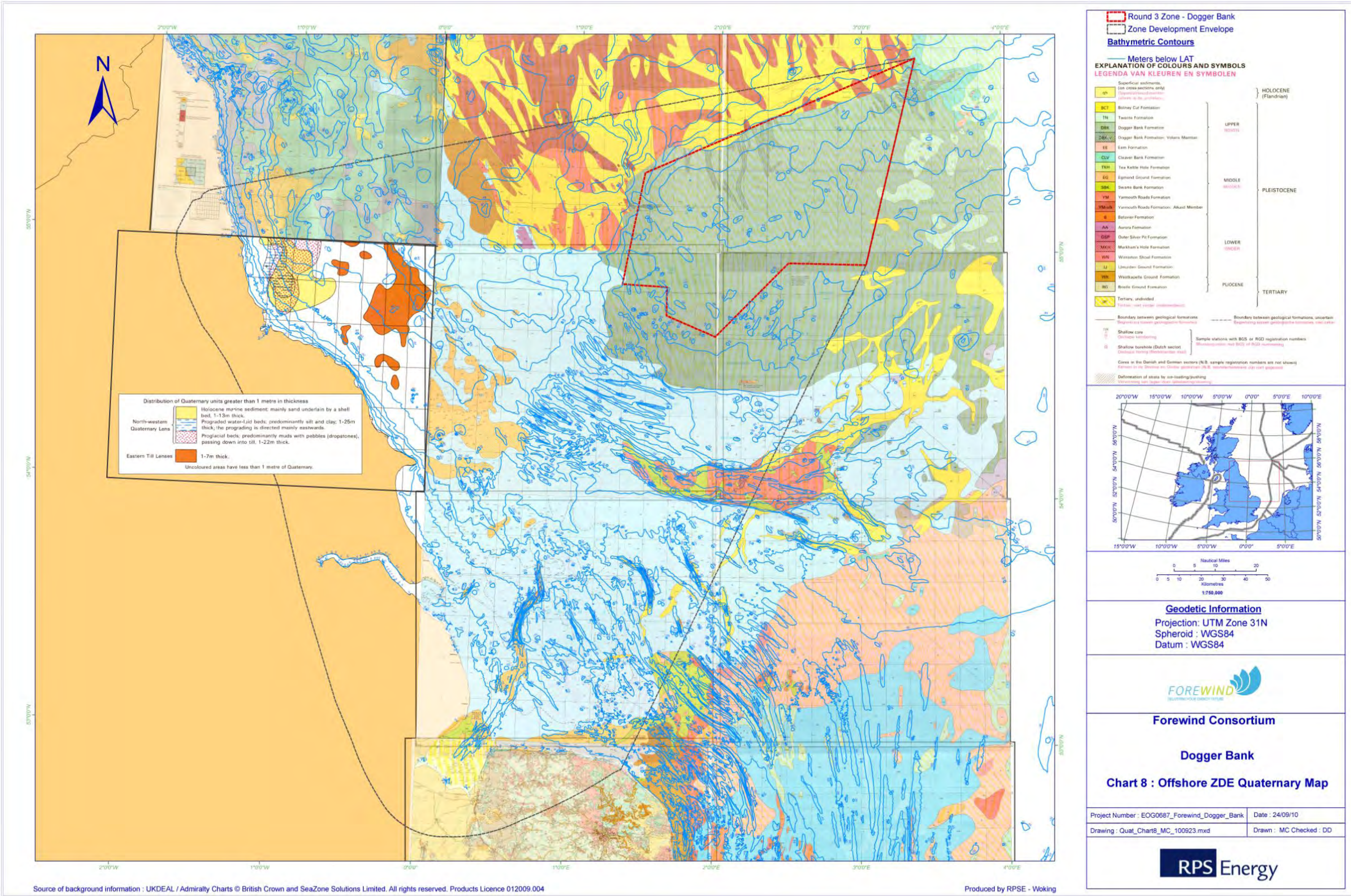


Chart 8: Offshore ZDE Quaternary Map. Source: UKDEAL/ Admiralty Charts British Crown and SeaZone Solutions Limited. All rights reserved. Products Licence 012009.004 Derived from BGS geological data. British Geological Survey © NERC 2010. All rights reserved. IPR/130-28CT.

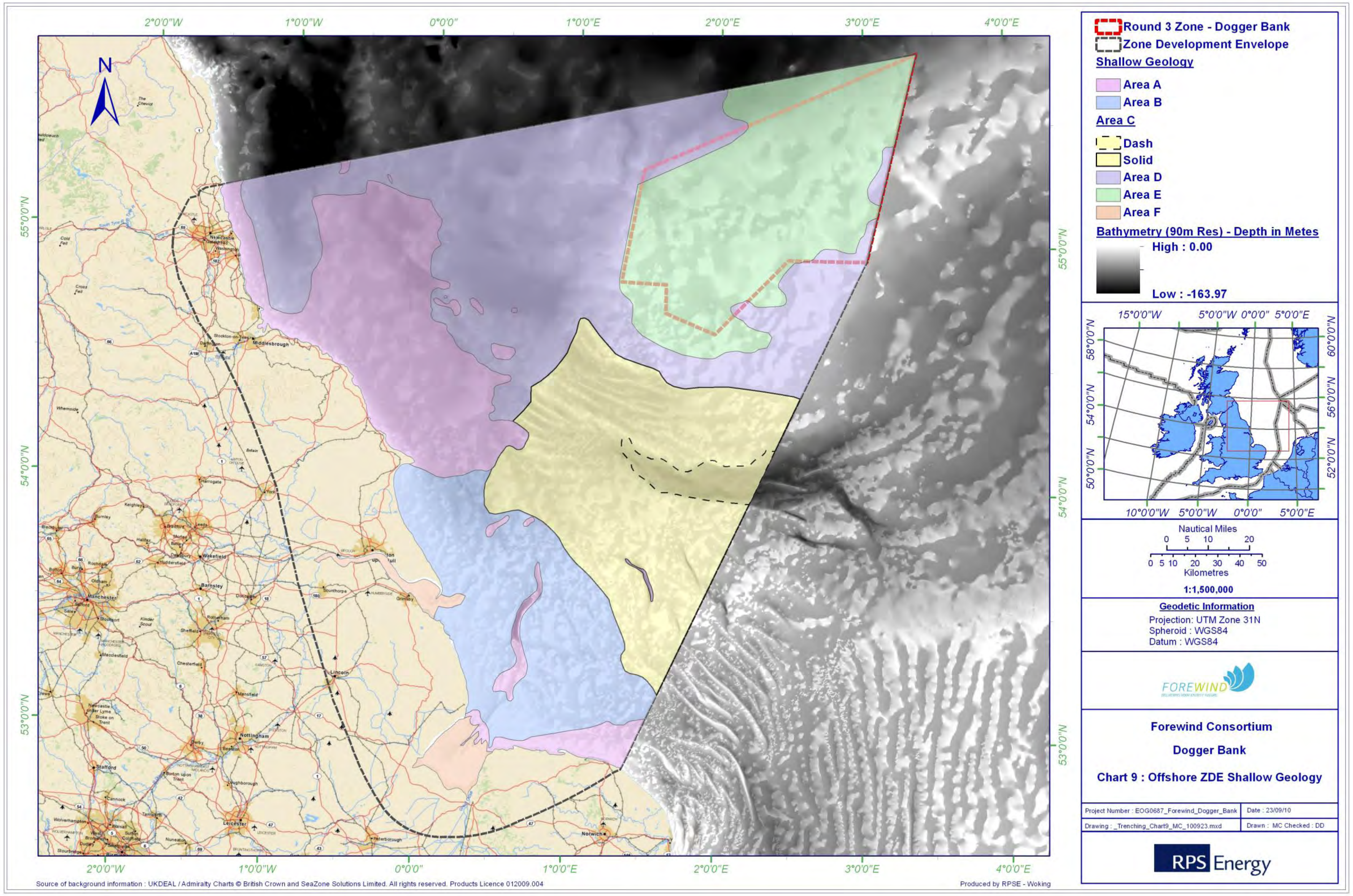


Chart 9: Offshore ZDE Shallow Geology. Source: UKDEAL/ Admiralty Charts British Crown and SeaZone Solutions Limited. All rights reserved. Products Licence 012009.004

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3. Benthic Ecology

3.1 Introduction

This Chapter provides a broad scale characterisation of the benthic ecology in the Offshore Zonal Development Envelope (ZDE). The Offshore ZDE can be split into the Dogger Bank Zone and the Offshore Cable Area. This 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;
- It 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. North-east 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 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 0.078m^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 6 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 0.1m^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 Southermost Roughs (Area 482) (Emu Ltd, 2005). Data were used to characterise seabed habitats and communities to inform respective EIAs.

A multinational, collaborative survey using 2m beam trawl was conducted in the North Sea, in 2000 (Callaway, *et al.* 2002). Examination of samples which coincide with the Dogger Bank possible SAC (pSAC) identified three variant and geographically distinct epibenthic communities characterised by the Common Starfish (*Asterias rubens*), the Sand Star (*Astropecten irregularis*), hermit crab (*Pagurus bernhardus*), infaunal brittlestar (*Ophuira* spp.), the 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.

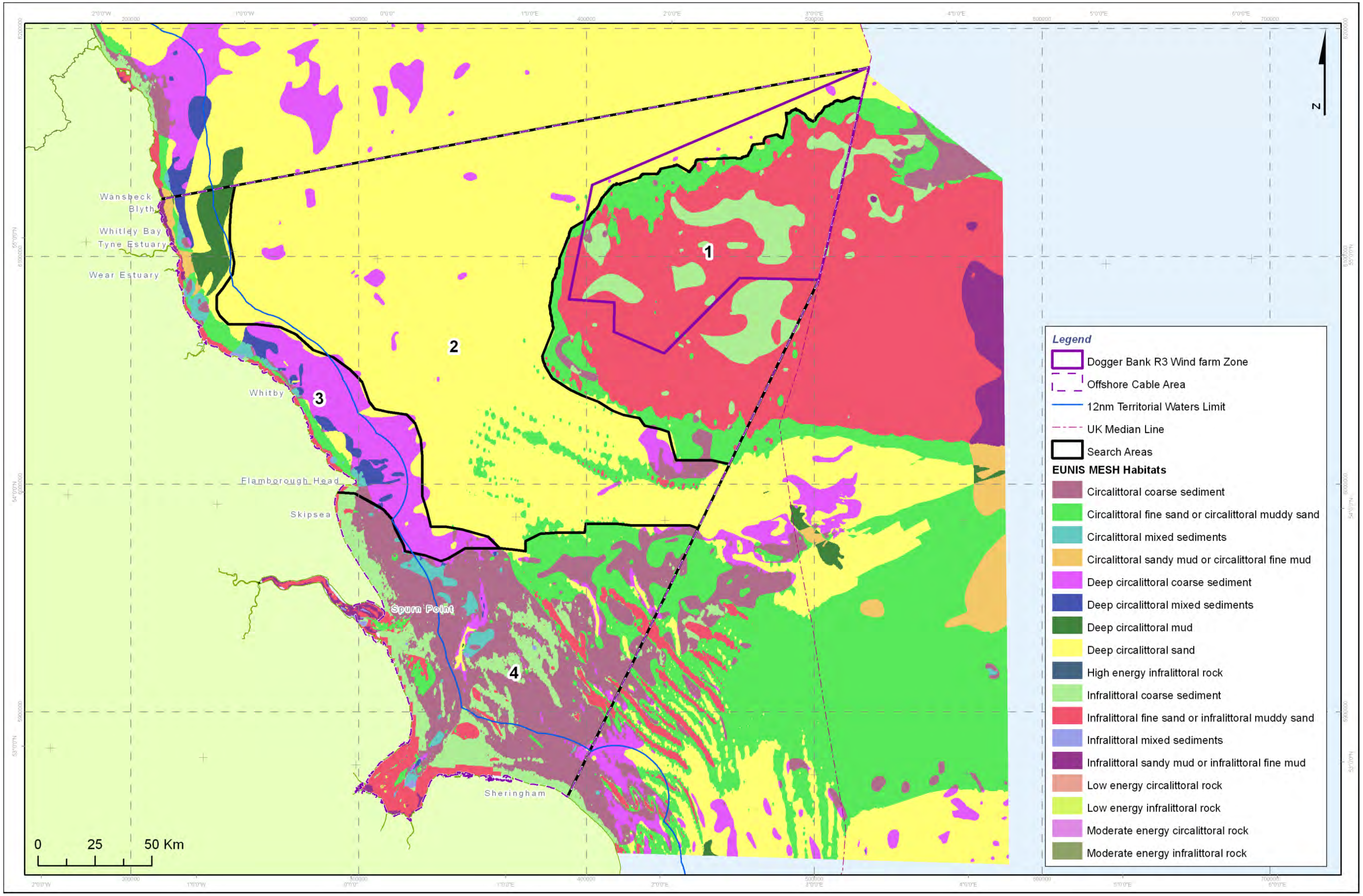

Figure 3.1: EUNIS habitat map for the Offshore Cable Area and Dogger Bank Zone with Search Areas 1-4 indicated.

3.2.1 Data limitations

Both infauna and epifauna broad scale survey information is relatively comprehensive, but not recent 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 a 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 north-east 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 north-west 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 North-east offshore shallow waters associated with the Dogger Bank (Area 1)

Habitats and Communities

The EUNIS habitat classification identifies the following five different types (order 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 pSAC 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 global assessment this feature was found to be Grade A 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 20m or less are protected, although where sand banks extend below 20m 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

& 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 & Krönke (2001) distinguished a "North-Eastern 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 gravely sand substrates in the north-western 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 north west 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). This project is a work in progress so the maps are not finalised.

Northern areas, below the 30m contour, were characterised by the Green Sea Urchin, hermit crabs and infaunal brittlestars (*Ophiura* spp.). North-west and western flank areas of the Dogger Bank were characterised by the Sand Star, Dab, Common Starfish, Flying Crab, (*Liocarcinus holsatus)* and hermit crabs (Paguridae). Shallow central and south eastern areas were dominated by Solenette, Common Starfish, Sand Star and hermit crabs. Abundant Sand Gobies (*Pomatoschistus minutus*) were recorded over south eastern flank areas of the bank.

Site specific 2m trawl sampling and seabed video surveying at North West Rough and Southermost Rough (Emu Ltd. 2002, 2005) identified commonly occurring epibenthic species within the boundaries of the draft SAC. These included the soft coral, Dead Men"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 400m. 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 north east 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 Southermost 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 pSAC 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 sea pens *Virgularia mirabilis* and *Pennatula phosphorea* (UKBAP, 2008). The associated burrowing fauna includes crustaceans such as The 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 (>55m) 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 north-west corner of the Dogger Bank Zone as well as the Norway Lobster. It also has a record of *C. subterranea* in the north east corner 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 pSAC, 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 has records of the sea pen *P. phosphorea* and Norway lobster from the same location at two sites in the north of this area offshore of Sunderland and the Tyne.

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 30m 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 subaerial 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).

„*Modiolus modiolus* horse mussel 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 beds (*Mytilus edulis*) 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).

Sabellaria spinulosa reefs can provide a biogenic habitat that allows many other associated species to become established and acts to stabilize 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

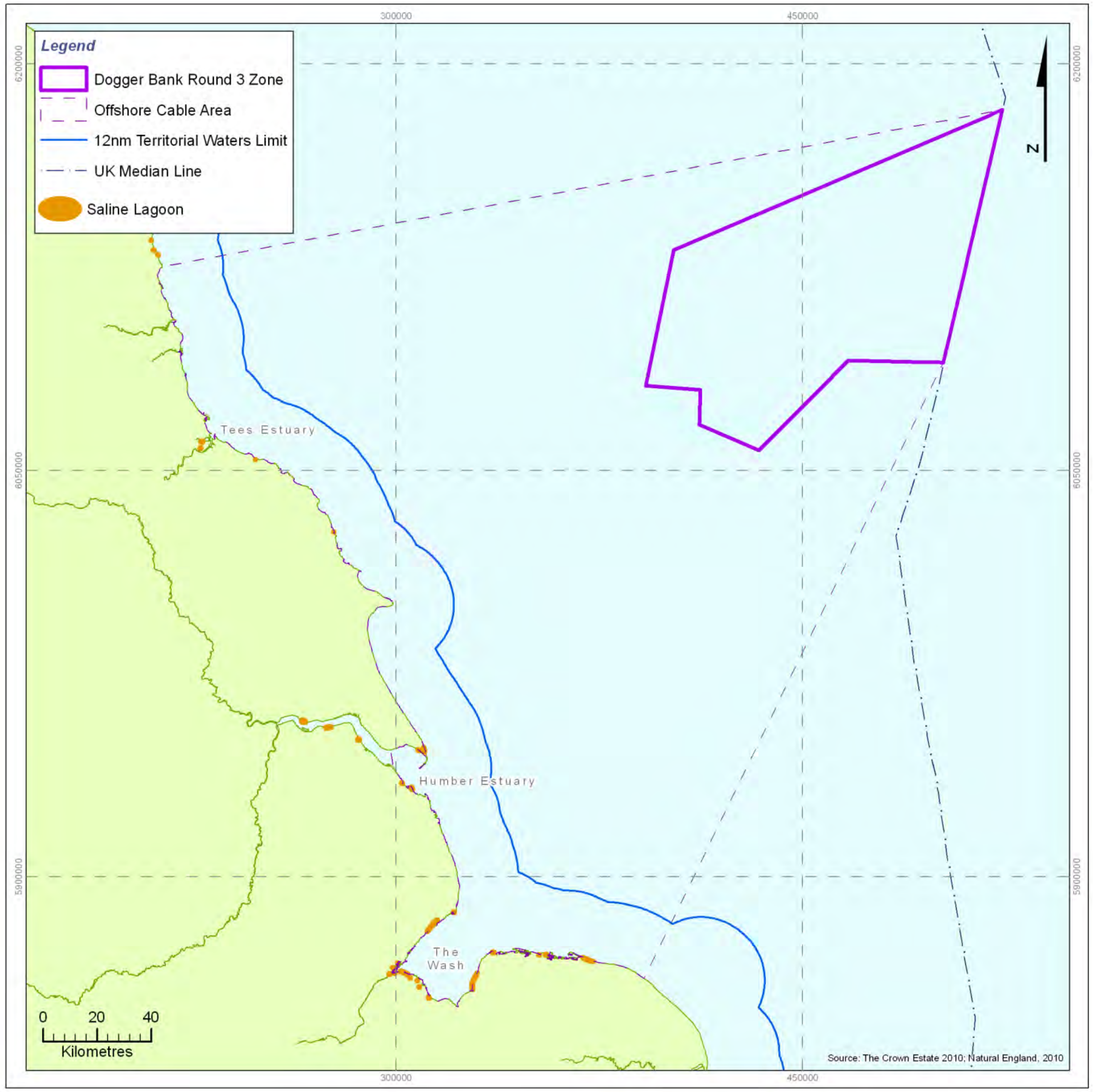

Figure 3.2: Distribution of the UK BAP priority habitat saline lagoons in the coastal area of the Offshore ZDE.

of poor water quality *S. spinulosa* is common in the north-east 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
- Annex 1 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 north west 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 in eleven 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

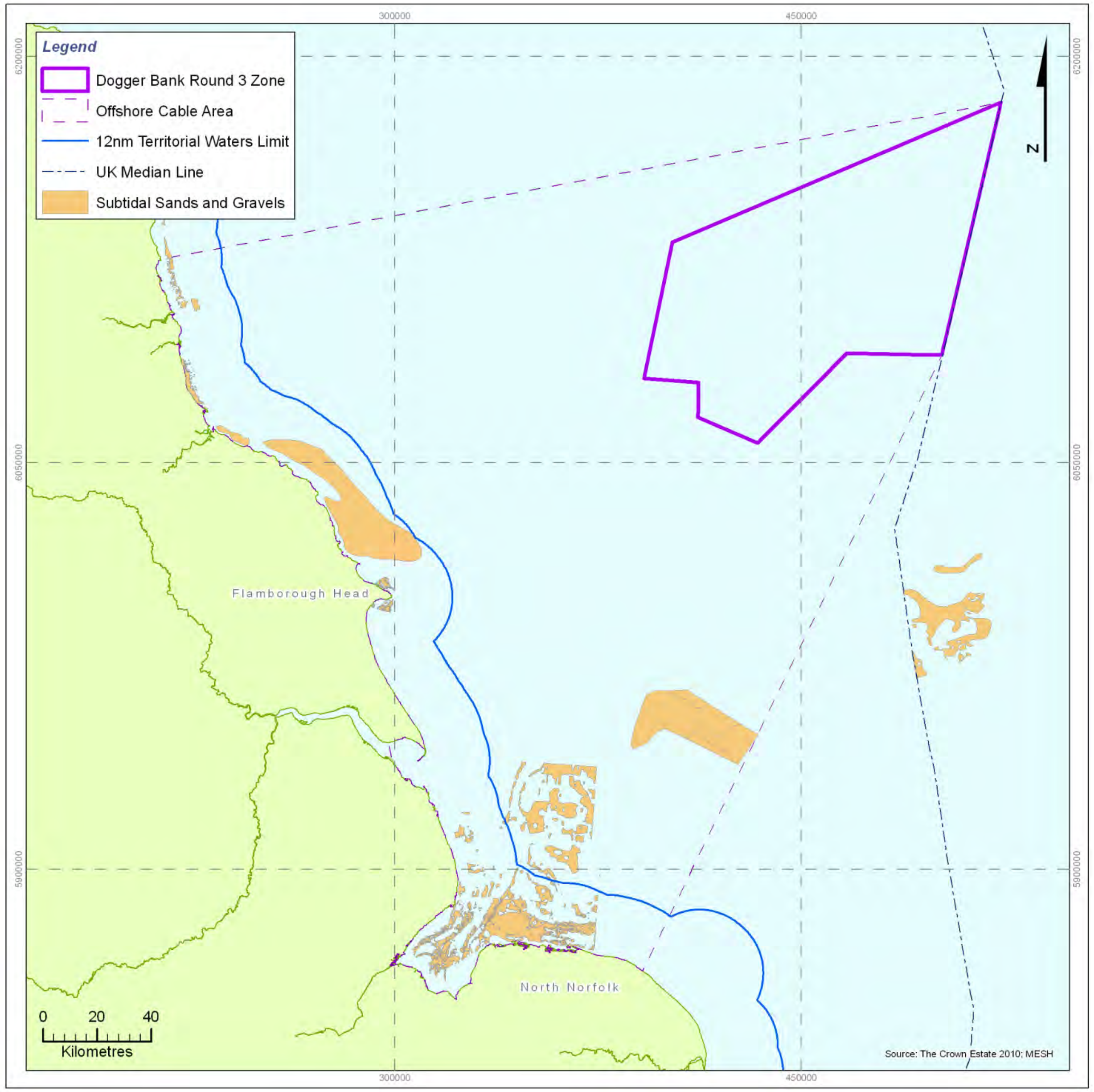

Figure 3.3: The distribution of subtidal sands and gravels as mapped from EUNIS and MCZ data sources.

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 1 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 1: 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 1 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 north west 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 1 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 1 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 North west coastal shallows, two molluscs and two red algae. The molluscs are the Ocean Quahog, the Dog Whelk (*Nucella lapillus*), and the red algae are the Common Maërl (*Phymatolithon calcareum*) and the red crutose alga *Cruoria cruoriaeformis*.

The Ocean Quahog has been recorded from numerous locations within the north west 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 1 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. In fact, in 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 south-western British Isles and northern France, and possibly the Mediterranean. Whereas *Cruoria pellita* (Lyngbye) Fries (the type species for the genus) is widely distributed in the north-eastern 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 location (JNCC, 2007) and, therefore, the record must be viewed with a degree of scepticism. *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 1 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 1 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 1 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 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 (*Mytilus edulis*), 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 (*Pholas dactylus*), the White (*Barnea candida*) and the 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).

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 marine conservation zone 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).

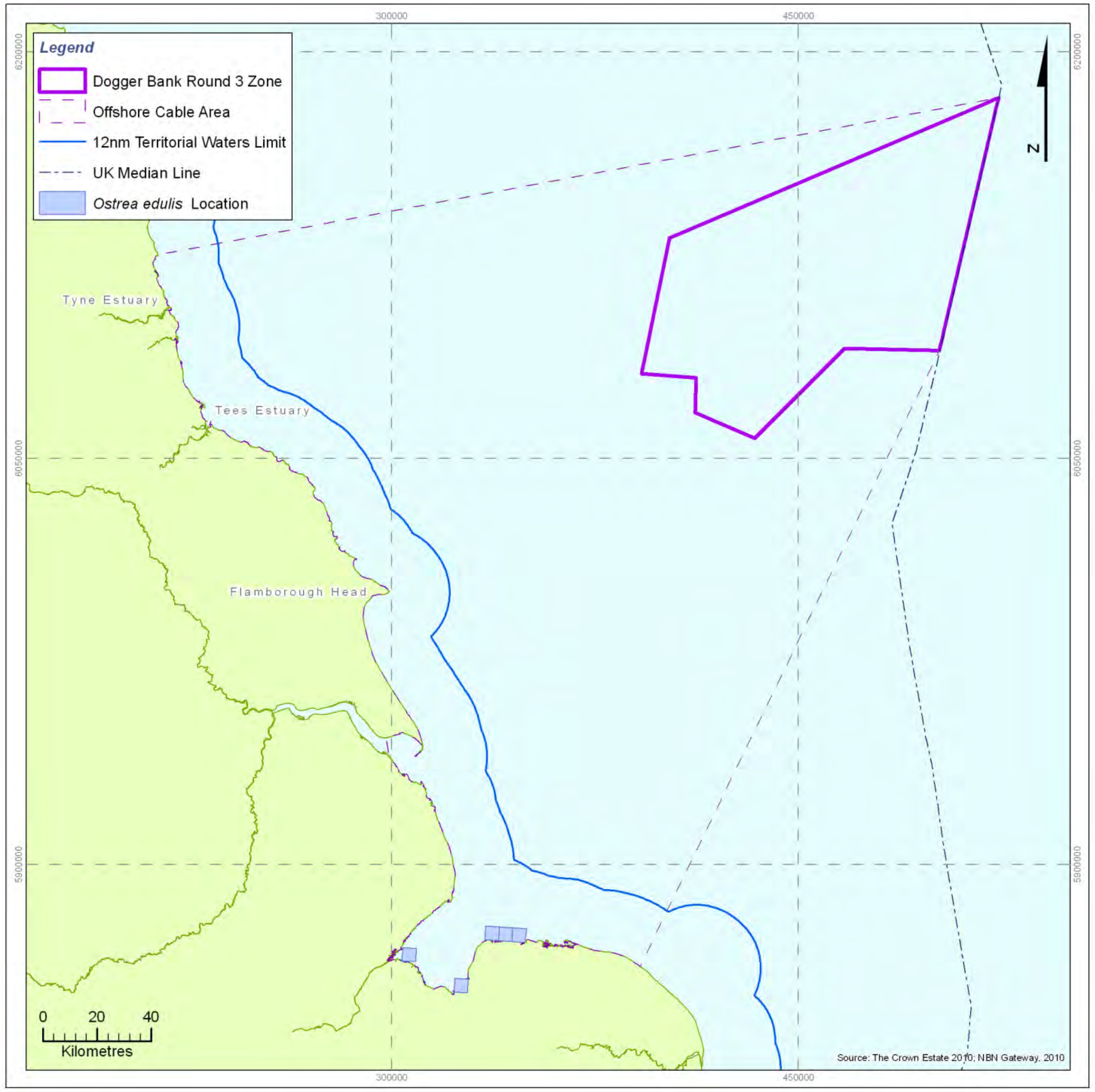

Figure 3.4: The distribution of the native oyster (*Ostrea edulis*) within the Offshore ZDE (NBN Gateway data).

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 318km^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

The 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)
- Cooden Beach to Bexhill in 1975 (Central Grid Ref. TF646278)

The Native Oyster 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).

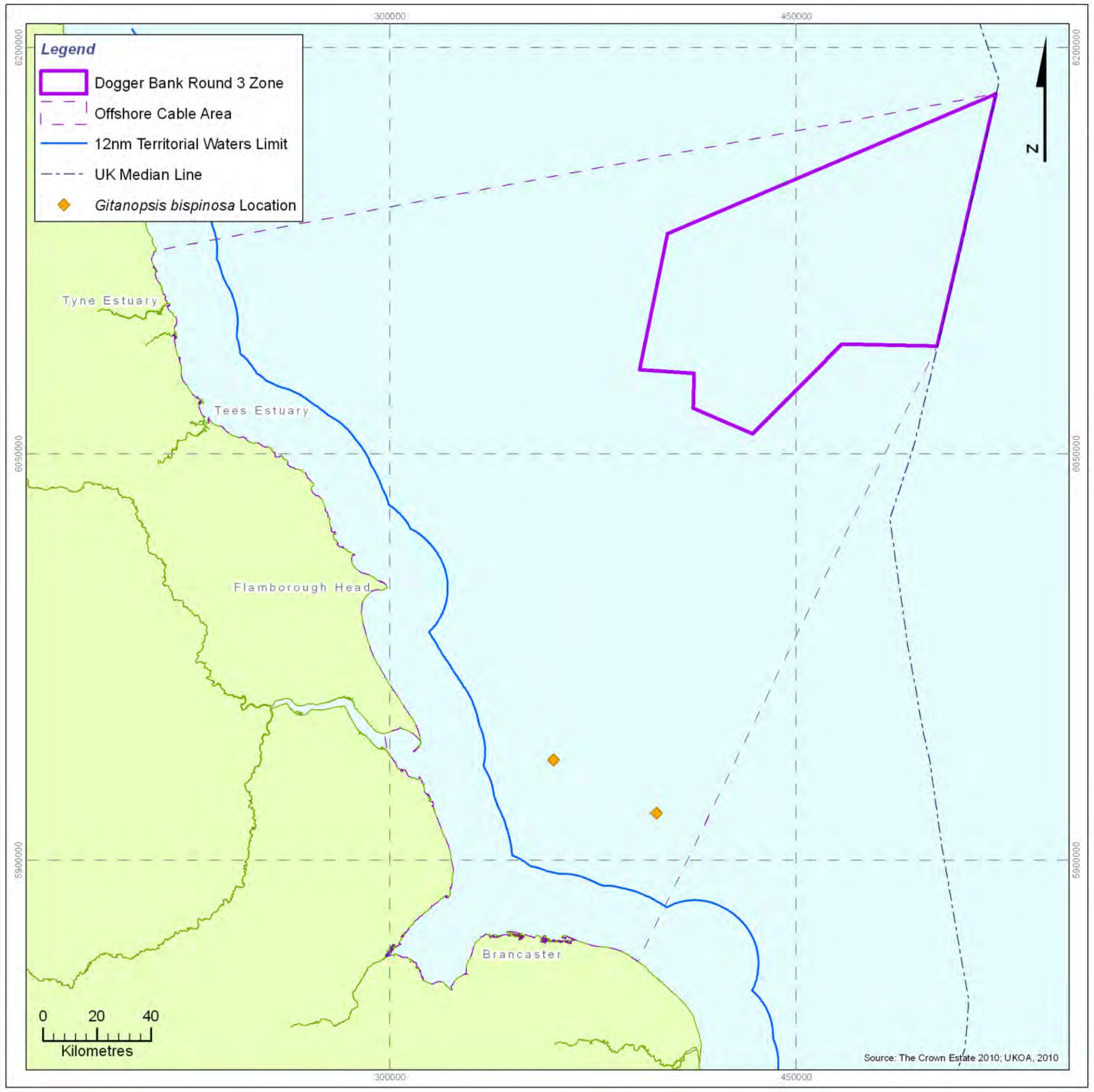

Figure 3.5: Location of the two records of the UK BAP species *Gitanopsis bispinosa* (UKOOA database v3.01).

The Ocean Quahog, as in all other areas, is found in a number of locations in Area 4, particularly in the north east 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 100-200m. 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 22-25m 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 5-20 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 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).

2. Further consideration should be given to the habitat along the northern edge of the Dogger Bank Zone as this area is critical 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.

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. *Cruoria cruoriaeformis,* the crustose red alga found on Flamborough Head, is unlikely to be found there 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*) like the Ocean Quahog has no statutory protection currently but is listed by OSPAR. It"s a rocky shore species which 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).

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 will 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;

- Site specific fisheries surveys (Emu Ltd, 2008);
- Fisheries sensitivity maps (Coull *et al*., 1998);
- International Council for the Exploration of the Sea (ICES) web resources (ICES, 2006); and
- Vessel Monitoring System data (Lee *et al*., 2009).

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

Part of the overview of Dogger Bank fish resource is derived from surveys and consultation conducted in support of applications for aggregate extraction at two sites, Northwest Rough (NW Dogger Bank) and Southernmost Roughs (South west Dogger Bank) (Emu Ltd., 2008). Samples were collected using a commercial [Whitby Jet] otter trawl (40 mm net) towed from a chartered commercial fishing vessel. Coinciding with the aggregate application areas to assess the wider distribution of fish, samples were collected from the south-western and north-west bank margins and on top of and to the west of the bank in deeper water. Surveys were conducted 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, overlain with the Cod nursery area as defined by local fishermen following a period of consultation.

Wider area 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 and CEFAS, 2008) and adults and juvenile distributions were collated from ICES web resources (e.g. ICES, 2006).

Finally, a study based on Vessel Monitoring System (VMS) data (Lee *et al.,* 2009) was used to highlight the presence of sensitive habitats (sea pen and burrowing communities) which support potentially important exploitable shellfish communities and act as nursery areas for certain species.

Data collated for this section are considered to be of high quality coming from databases or the most recent publications produced by ICES and CEFAS. The data used are, in general, part of an historic series of studies up to 2004, mostly including surveys carried out in the last decade, or reviews of data aiming to identify possible gaps. Although they were not meant to be read too literally the maps produced by Coull *et al.,* in 1998, and used in this report, are considered to be the best available indication of the likely common spawning and nursery areas.

4.2.1 Data limitations and gaps

Most of the Coull *et al.,* (1998) data are in map format, thus they can be overlain on the Offshore ZDE to highlight potential overlap with protected or endangered species. Although considered a valid reference, for identification of sea areas relevant to life stages of the species included in this report, it is important to keep in mind that these maps are only indicative of potential sensitivities. Furthermore they were produced in 1998 and potentially in need of updating. In particular, recent evidence has been presented of climate change affecting the distribution of important fish species (Perry *et al.,* 2005).

The following describes identified gaps in current knowledge for which further investigation would improve confidence and understanding.

- The potential areas where Herring (*Clupea harengus*) may spawn based on seabed characteristics needs to be clarified.
- Fox et al., (2008) have reviewed the spawning grounds for Cod and highlighted a lack of cod eggs off Flamborough Head within the Offshore ZDE. Mature Cod have been caught in the area (historically this has been a spawning ground).
- It is unclear as to 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, previous representation from the UK fishing industry to the aggregate industry (see Emu Ltd., 2008) has indicated that the margins and slope areas of the Dogger Bank are potentially sensitive fish and fish habitat areas. In particular south western margins of the Dogger Bank and coastal areas, included in the Offshore ZDE, are considered to be nurseries for juvenile Cod (*Gadus morhua*) and Plaice (*Pleuronectes platessa*) as well as grounds for skates and rays.

Emu Ltd (2008) in a study focussed on the western and north western margins identified important Plaice spawning grounds and nursery grounds for immature Cod, Haddock (*Melanogrammus aeglefinus*) and Whiting (*Merlangius merlangus*). The north-western area was highlighted as an important fishing ground or as a feeding ground for various commercial fish species, marine mammals and seabirds and is consequently a foci of commercial fishing effort (Emu Ltd, 2008).

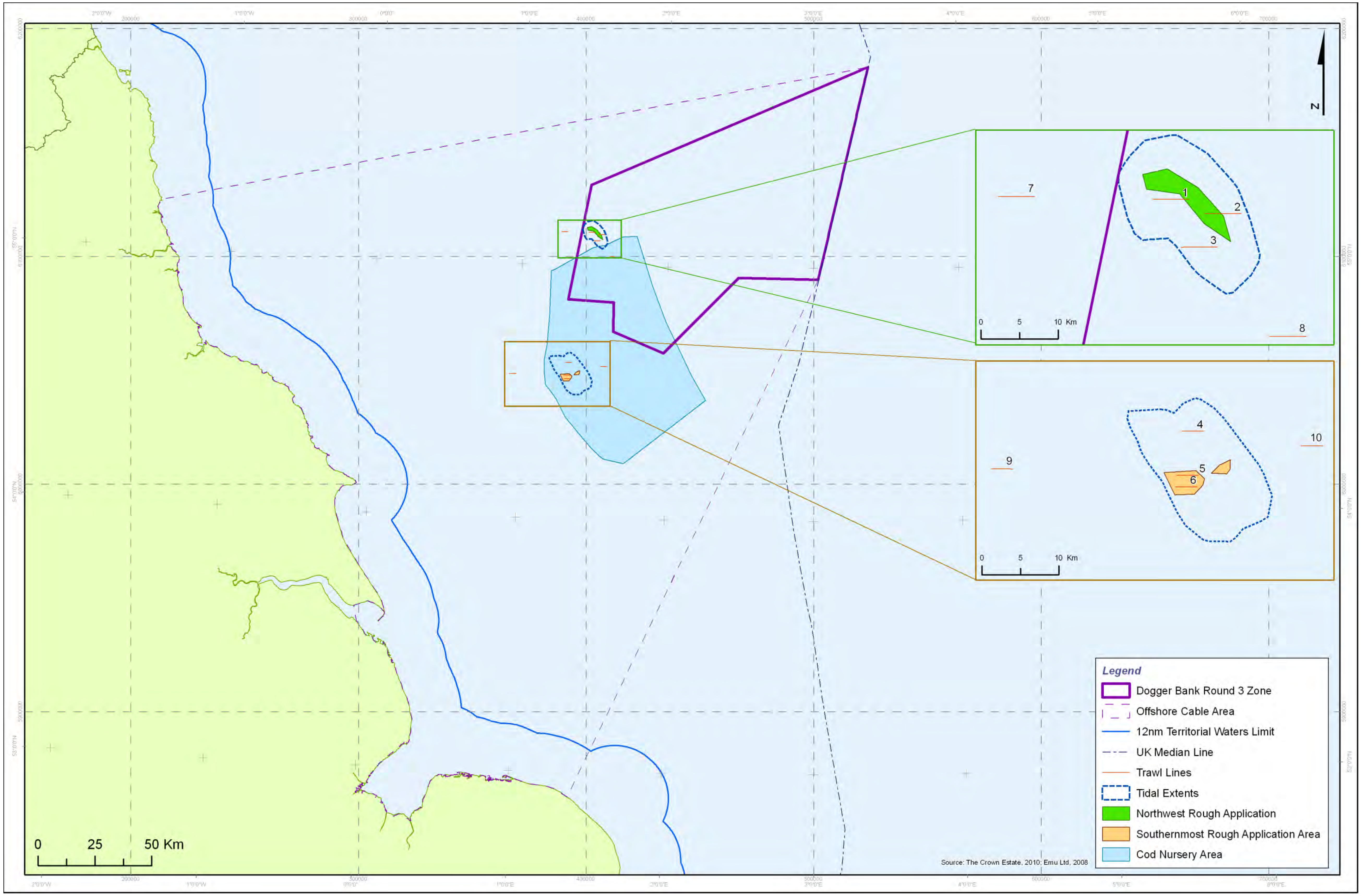


Figure 4.1: Location of previous fish sampling surveys at Dogger Bank using commercial fishing gears, with possible Cod nursery area indicated (Emu Ltd, 2008).

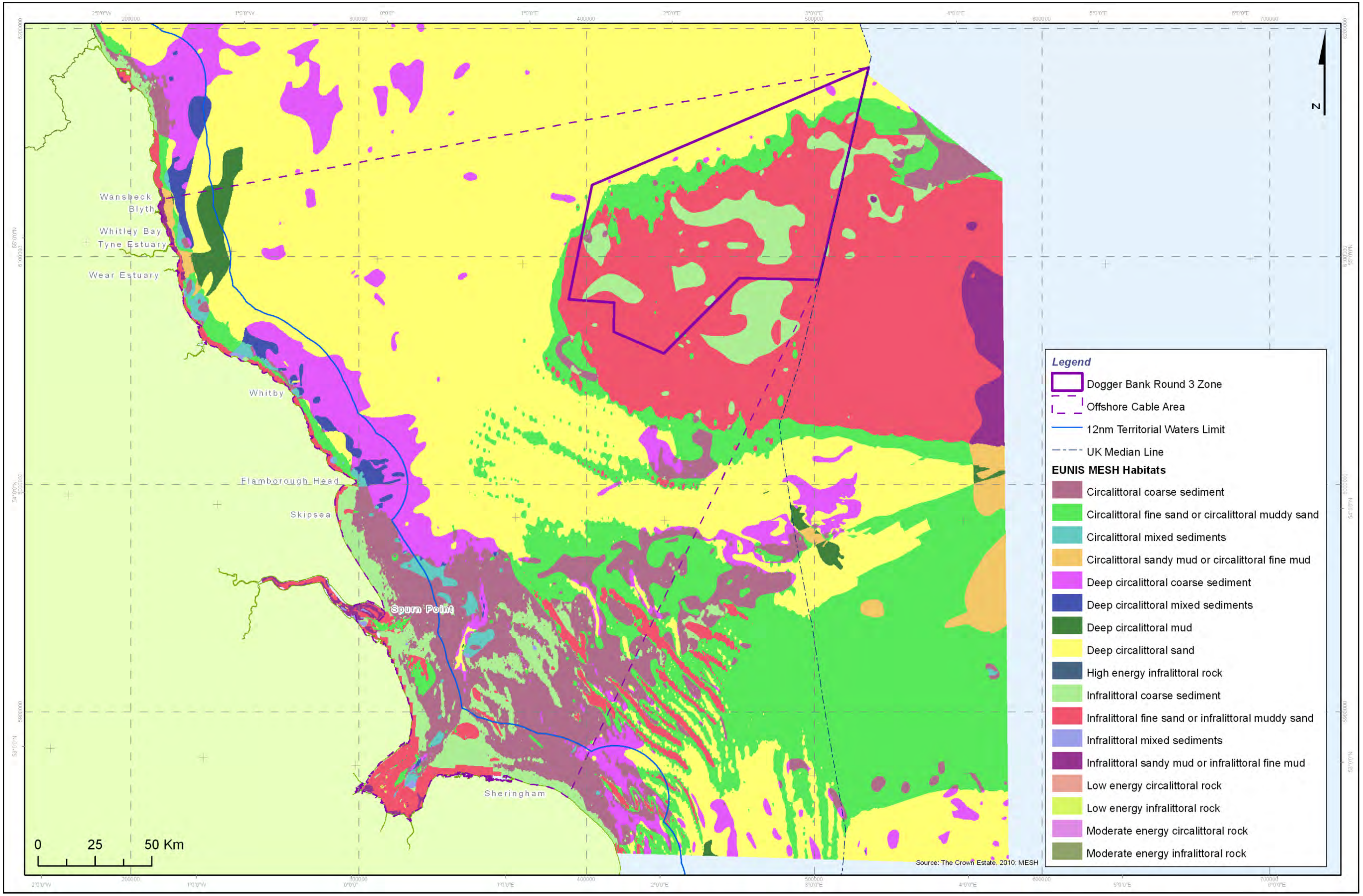


Figure 4.2: Modelled EUNIS habitat types in the Greater Wash, within the Offshore ZDE.

A valid consideration for the identification and assessment of potential effects to seabed habitats and their potential relevance to fish ecology, especially if identified as sensitive. Sensitivities may include response to direct physical seabed disturbance, scour and modification to close seabed current regime and predator prey interaction. Of particular relevance is the possible "seapen and burrowing megafauna communities" on the northern margin of the Dogger Bank, just on the northern edge of the Dogger Bank Zone. These are known to be nursery areas for a number of fish species including the UK BAP priority species Hake (*Merluccius merluccius*) (OSPAR, 2010). Hake are 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.

4.4 Fish Resource

Fisheries 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 but that are relevant to both the Dogger Bank Zone and the Offshore ZDE. Dogger Bank Zone specific data from Emu Ltd (2008) surveys are also included.

The Offshore ZDE encompasses a large part of the central western North Sea, including the Dogger Bank Zone, which is a shallow region well known for its productive fisheries (Nielsen *et al.,* 1993). This area has been proposed for the conservation of its habitats (Lee *et al.,* 2009), many of which may have specific fish species associated with them. The Offshore ZDE also encompasses the Greater Wash region in the south west of the area, which 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). The EUNIS habitats can be seen in Figure 4.2. The range of habitats present on the Dogger Bank and within the Offshore ZDE has the potential to support a variety of, generally, demersal

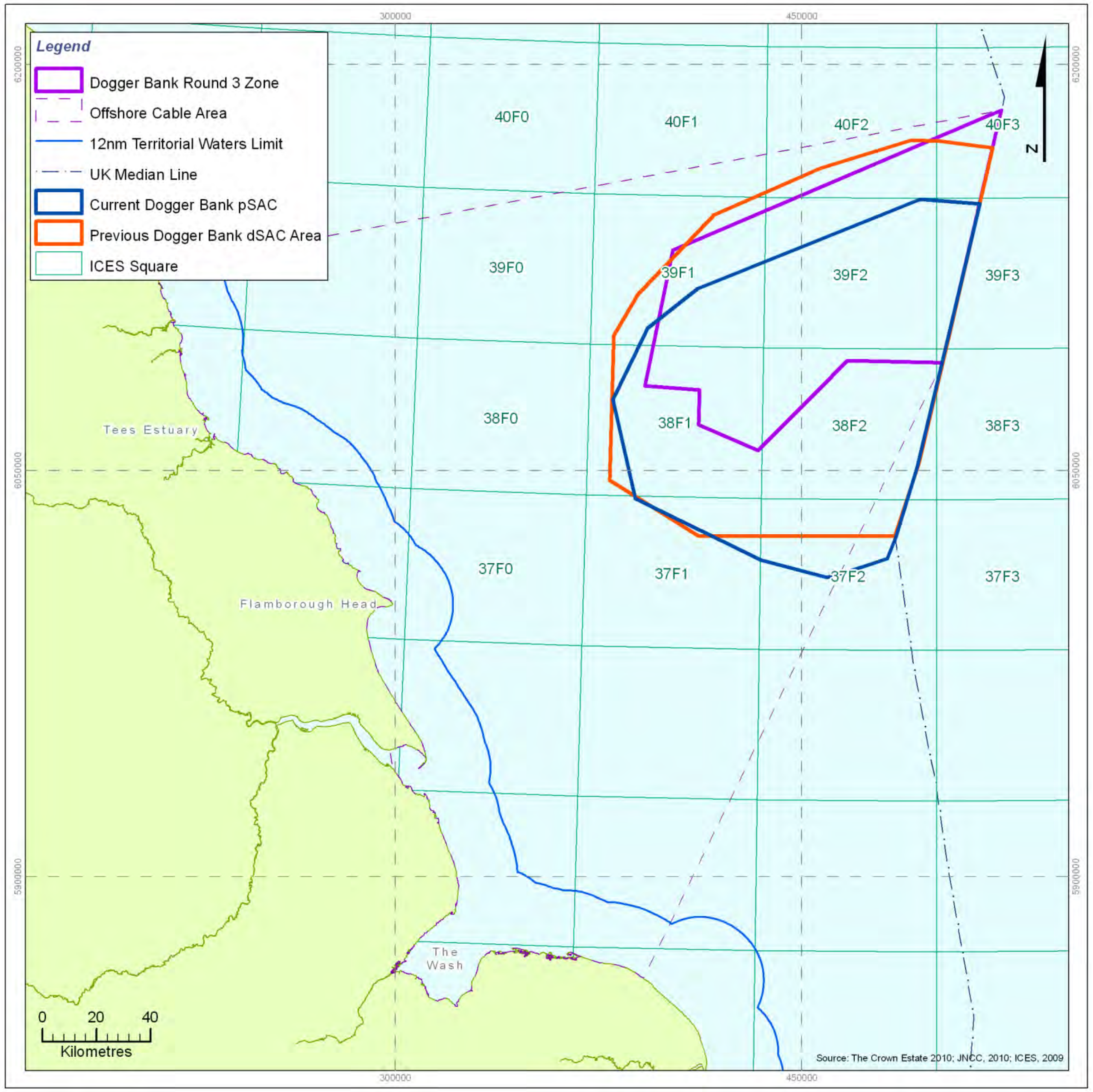


Figure 4.3: ICES rectangles present in the area of the Dogger Bank.

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 Commercial species

VMS data used by Lee *et al.,* (2009) have shown that for 2006 and 2007, landings coming from the ICES rectangles (Figure 4.3) within and adjacent to the Dogger Bank pSAC (the boundary was subsequently modified) were both dominated by flatfish. However for the adjacent rectangles the composition differed with Cod, *Nephrops* and skates having greater prominence to the south and Megrim, Hake and Anglerfish increasing to the north and east. This helps to illustrate the diversity of habitats available within the region. It should be noted that during 2006 and 2007 there was a ban on Sandeel fishing.

The presence of Hake in the catches from the north and the east of the pSAC 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, 2010), and is known to overlap the northern portion of the Dogger Bank Zone (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, 2010). The habitat is listed by OSPAR as threatened/declining and is on the UK BAP priority list.

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). However, its north-east Atlantic fishery is almost exclusively in the North Sea (Jensen and Christensen, 2008). 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 Zone to indicate the likely distribution of these fish within the Offshore ZDE

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 4.6 for Cod – note that the data presented from de Oliveira and Elliot, 2010 in this figure and Figure 4.5, Figure 4.7 and Figure 4.8 falls 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).

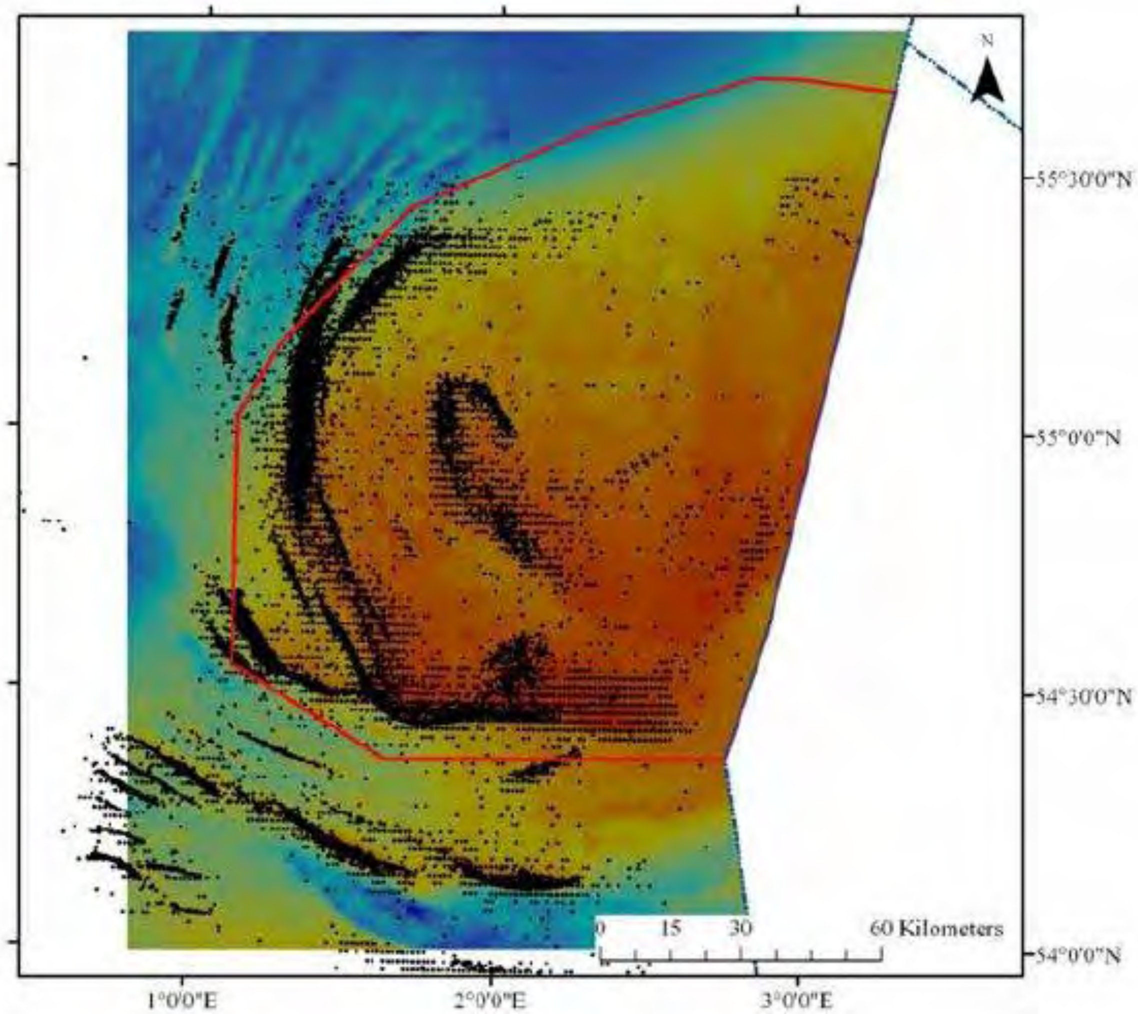


Figure 4.4: Spatial distribution of Sandeel fishing effort in the water column on the Dogger Bank for 2008 (Engelhard et al., 2008, taken from Diesing *et al.,* 2009).

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 ZDE is presented in Figure 4.5 as catch rate.

Whiting (Figure 4.7 and Appendix B) is widely distributed throughout the North Sea, Skagerrak and Kattegat. 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 indicates 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).

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 flat fish 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 ZDE.

In the North Sea Sprat are most abundant south of the Dogger Bank and in the Kattegat, but the 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). It is an important food resource for many top predators including some bird populations (Frederiksen *et al.,* 2006).

Norway Lobster (*Nephrops norvegicus*) is widely distributed on muddy substrata throughout the north-east Atlantic from Iceland in the north to Morocco in the south. The species is found in the Mediterranean and is abundant in the Adriatic (Sabatini and Hill, 2008). This species is also 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 4.9 shows an important *Nephrops* fishing ground in a coastal area of the Offshore ZDE at Farns Deep. 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".

Brown crab occurs around all British and Irish coasts. Its global distribution goes from Norway throughout the North Sea and English Channel to the coast of Portugal (Roger and Stock, 2001). Figure 4.10 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.

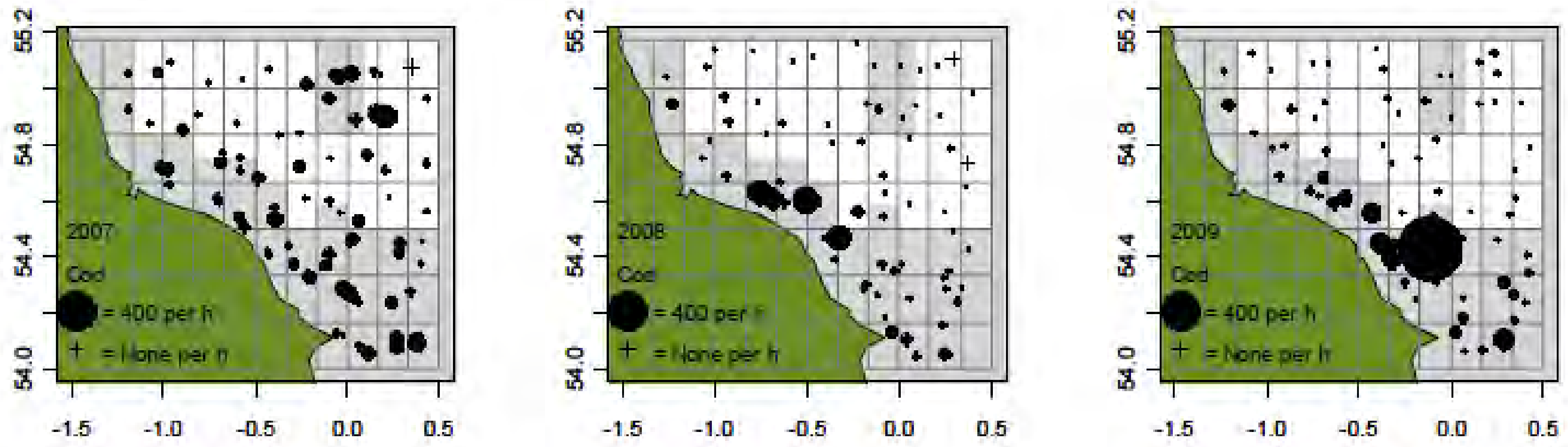


Figure 4.5: Distributions of Cod within and around the offshore ZDE 2007-2009 (numbers caught per hour). Shading within the grid lines indicates area with coarse seabed type (de Oliveira and Elliot, 2010).

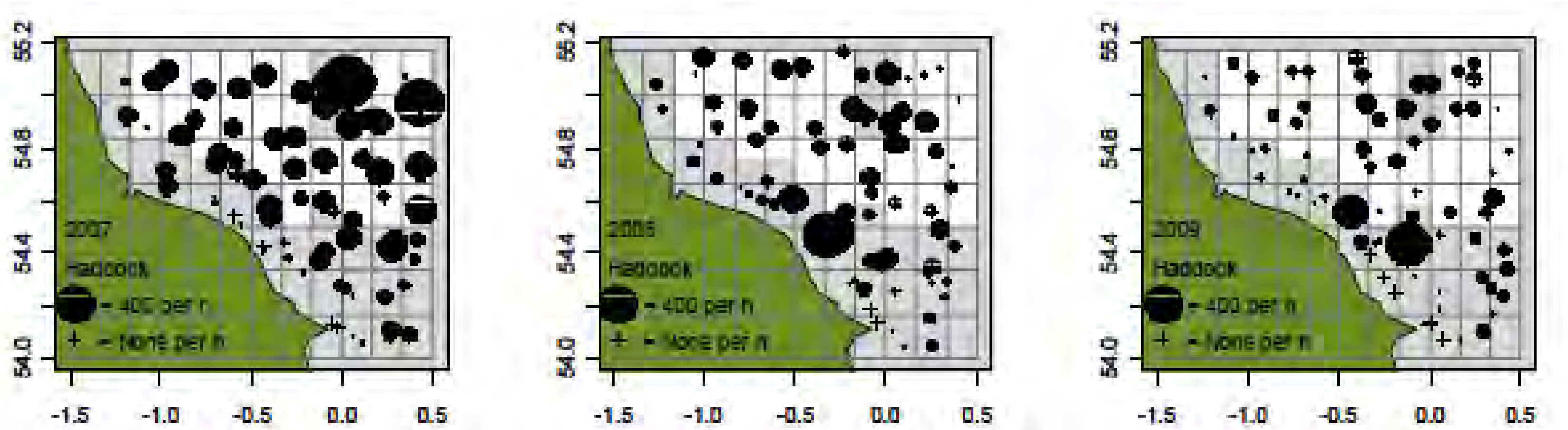


Figure 4.6: Distributions of Haddock within and around the offshore ZDE 2007-2009 (numbers caught per hour). Shading within the grid lines indicates area with coarse seabed type (de Oliveira and Elliot, 2010).

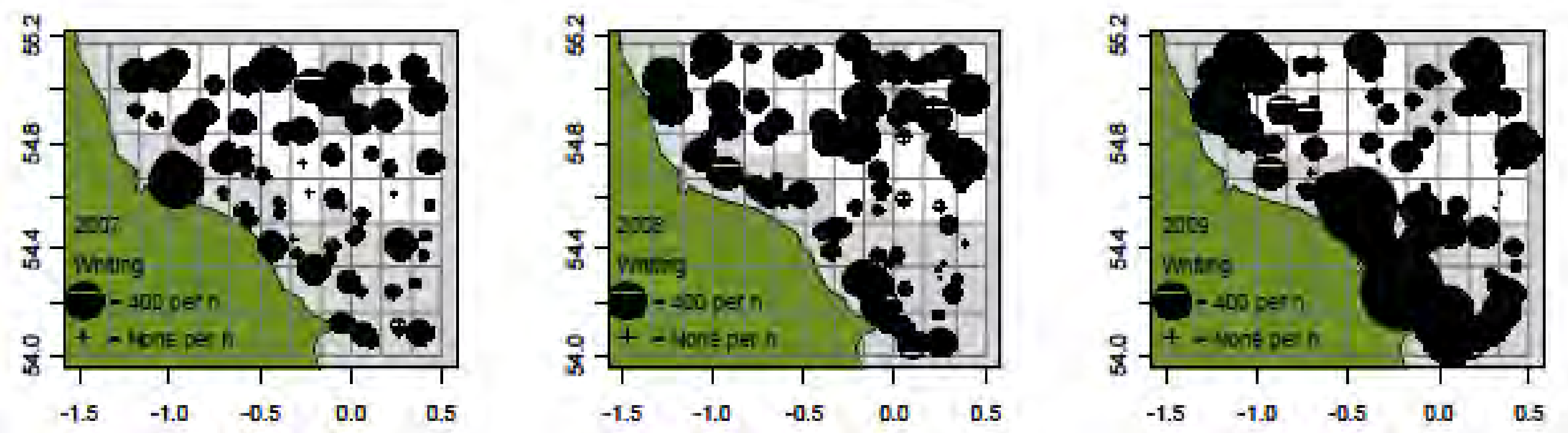


Figure 4.7: Distributions of Whiting within and around the offshore ZDE 2007-2009 (numbers caught per hour). Shading within the grid lines indicates area with coarse seabed type (de Oliveira and Elliot, 2010).

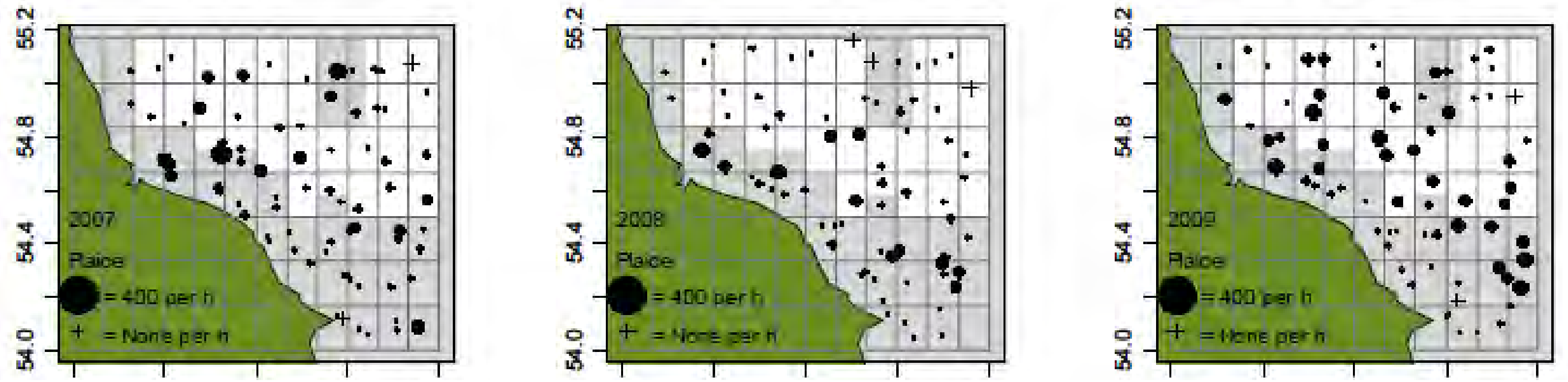


Figure 4.8: Distributions of Plaice within and around the offshore ZDE 2007-2009 (numbers caught per hour). Shading within the grid lines indicates area with coarse seabed type (de Oliveira and Elliot, 2010).

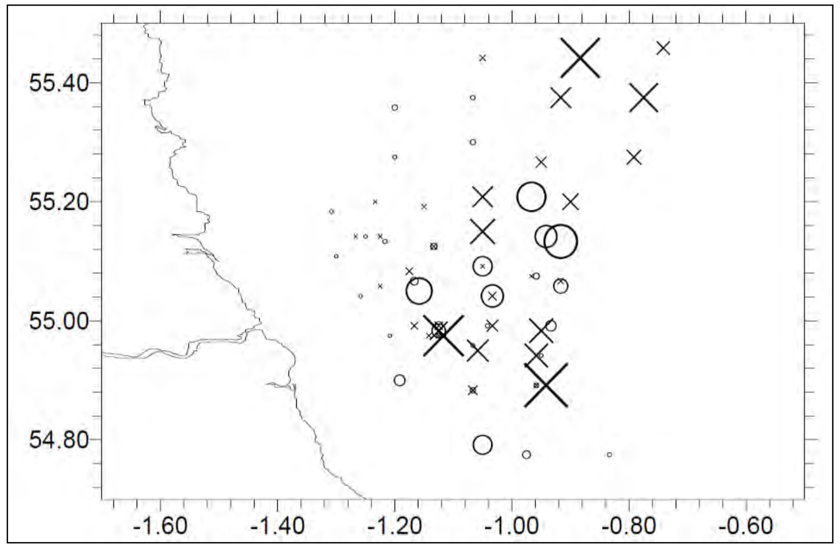


Figure 4.9: Distribution of Norway lobster, Farn Deeps FSP survey, spring 2004. Symbols X and O represent two different fishing vessels with largest symbol equal to a catch of 5228 per hour (Cotter *et al.*, 2004).

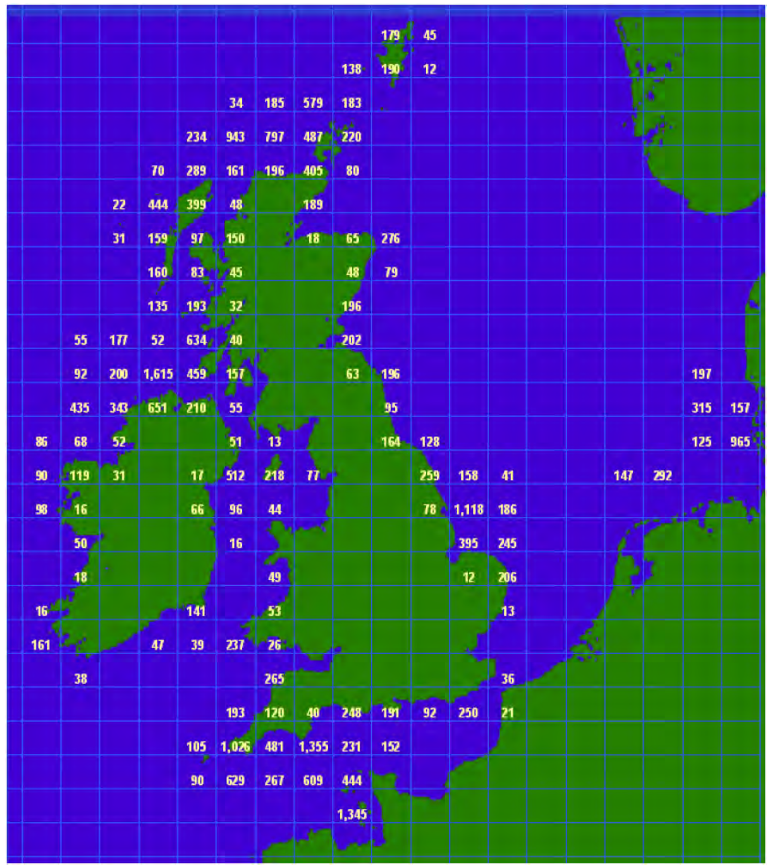


Figure 4.10: Brown crab catches per ICES rectangle for UK (incl. IoM & CI) and RoI fleet, 2008 (tonnes), as modified in Nautilus Consultants Ltd (2009) report to CEFAS. Source: MFA, Marine Scotland, & Marine Institute Ireland, as in Nautilus Consultants Ltd (2009) report to CEFAS

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

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 Elasmobranchii. Dramatic declines in the numbers of Elasmobranchs, particularly of the larger species, and the associated habitat degradation reported in the scientific literature has 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). As a consequence, formerly important fisheries species belonging to this group, e.g. the Common Skate (*Dipturus batis*) are now absent or locally rare in UK areas (Gill and Kimber, 2005). This species has been identified, (Gills and Kimber, 2005) as being particularly vulnerable to some of the phases of offshore renewable energy development. An important ground for juvenile elasmobranchs in general has been highlighted within the Offshore ZDE (Figure 4.11) 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 (MarBEF, 2010).

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

4.4.2 Other species of interest

Although of only limitedcommercial value in the Offshore ZDE Ling (*Molva molva*) is considered to be of conservation importance. Appendix B provides summary ecological information for selected species including the Grey gurnard, Saithe, Spurdog and Norway pout. Commonly encountered species during trawl fisheries surveys (Emu Ltd., 2008) included weever fish in the localised area studied for the Emu report. These were found in relatively high abundance within sandy substrata on the top of the bank suggesting a particular habitat preference. Saithe, pout, dragonet, gurnards and pogge were also frequently recorded although no discernable distribution pattern was noted.

Ling (*Molva molva*), live 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, 2010). They spawn in deep water (100m +) from March to July/August and the juveniles remain in coastal areas for 2-3 years (MarLIN, 2010).

Species	Protection / designation	Threat
Bony Fish		
Sandeel *Ammodytes marinus*	England NERC S.41	Nationally scarce/Marked decline in the UK
Herring *Clupea harengus*	England NERC S.41	Nationally scarce/International threat
Cod *Gadus morhua*	England NERC S.41	Outside safe biological limits/International threat
Mackerel *Scomber scombrus*	England NERC S.41	International threat
Haddock *Melanogrammus aeglefinus*	Red List IUCN, 2007	Vulnerable
Whiting *Merlangius merlangus*	England NERC S.41	Marked as decline in the UK
Horse Mackerel *Trachurus trachurus*	England NERC S.41	International threat
Saithe *Pollachius virens*	Listed for Scotland only	UK priority species
Dover sole *Solea solea*	England NERC S.41	Outside safe biological limits/International threat
Plaice *Pleuronectes platessa*	England NERC S.41	Unsustainable fishing mortality/International threat
Norway Pout *Trisopterus esmarkii*	Listed for Scotland only	25% decline
Hake *Merluccius merluccius*	England NERC S.41	Below safe biological limits/Marked decline in UK
Ling *Molva molva*	England NERC S.41	Outside safe biological limits (caught primarily as by-catch)
Elasmobranchii (each of which is also on the OSPAR list of threatened/declining species)		
Thornback ray *Raja clavata*	Scotland & Wales only	>25% decline
Spiny dogfish *Squalus acanthias*	England NERC S.41 & IUCN Red List 02-06	International threat/Vulnerable
Common Skate *Dipturus batis*	England NERC S.41	International threat
Crustacea		
Norway lobster *Nephrops norvegicus*	N/A/Indirect	(Found in seapen and burrowing megafauna habitat)

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

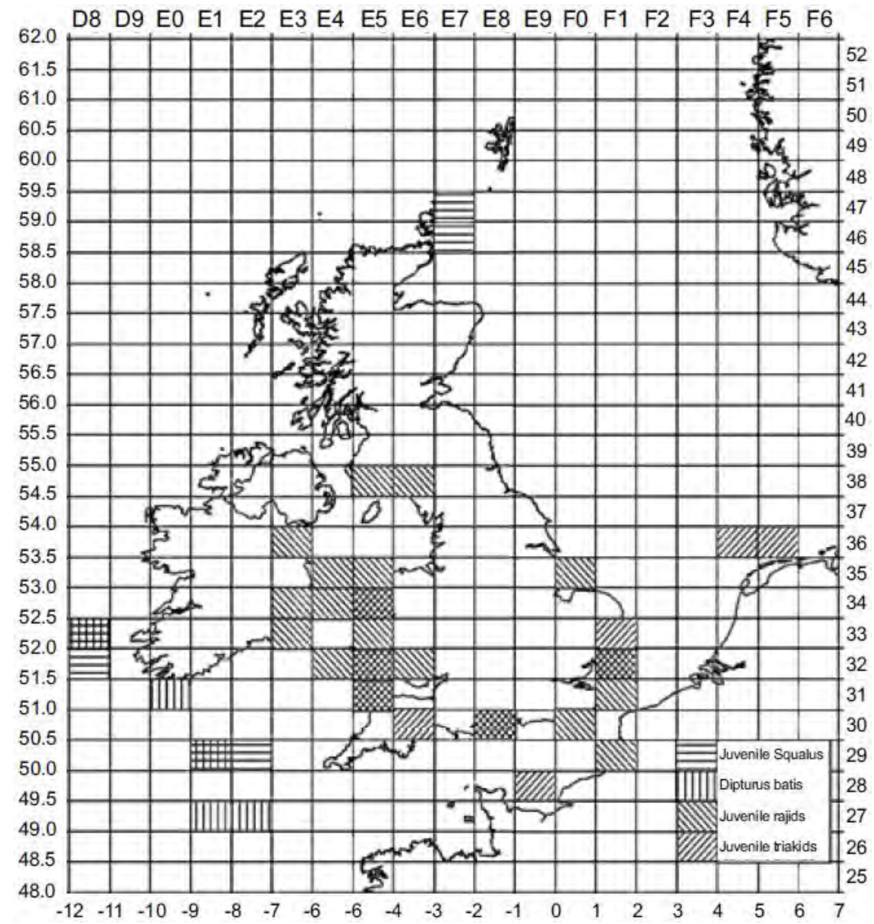


Figure 4.11: ICES rectangles that contain important grounds for the elasmobranchii species including: Dipturus batis (Common Skate) and juvenile Rajids (skates), triakids (hound sharks) and Squalus acanthias (Spiny dogfish). (Ellis et al., 2005).

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

Two species of note with particularly southern distributions are also detailed here as they are occasional visitors to the Offshore ZDE area. These are the Red mullet (*Mullus surmulentus*) and the Grey gurnard (*Eutrigla gurnardus*). With increasing ocean temperatures due to global warming, records of these species 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).

4.4.3 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) and again were associated with slope areas of the Dogger Bank Zone and were only present in low numbers or 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.

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 4.2. These surveys recorded approximately 50 fish species, 9 commercial shellfish species and approximately 20 benthic invertebrate species.

Figure 4.12 (a & 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.

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)	*Trisopterus luscus*	Bib/Pouting
Merlangius merlangus	Whiting	*Cancer pagurus*	Brown crab)	*Zoarces viviparous*	Eelpout
Melanogrammus aeglefinus	Haddock	*Maja squinado*	Spider crab	Syngnathidae	Snake Pipefish
Pollachius pollachius	Pollack	*Sepia officinalis*	Cuttlefish	Triglidae	Gurnards indet.
Trisopterus minutus	Poor Cod	Loliginidae	Squid	Cottidae	Seascorpions
Mullus surmuletus	Red mullet	*Buccinum undatum*	Common whelk	*Agonus cataphractus*	Pogge
Trachurus trachurus	Horse Mackerel	*Pecten maximus*	King scallop	Liparidae	Seasnails
Scomber scombrus	Mackerel	*Aequipecten opercularis*	Queen scallop	Trachinidae	Weevers
Clupea harengus	Herring	*Molva molva*	Ling	Callionymidae	Dragonet
Pleuronectes platessa	Plaice				
Limanda limanda	Dab				
Arnoglossus laterna	Scaldfish				
Microstomus kitt	Lemon sole				
Ammodytidae	Sandeels				
Pollachius virens	Saithe/ Coley				

Table 4.3: Conspicuous fish, shellfish and other fish species at Dogger Bank (Emu Ltd, 2008).

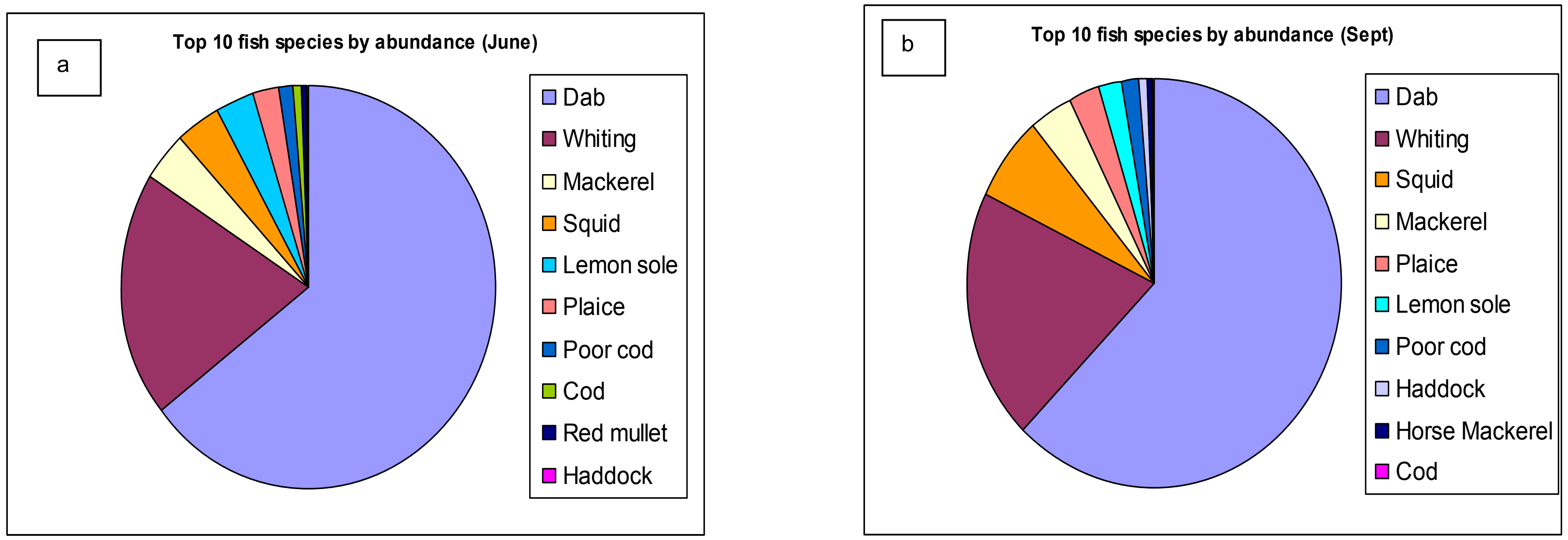


Figure 4.12 a & b. Relative abundance of conspicuous fish species as detected during the a) June and b) September 2007 surveys. (Emu Ltd, 2008)

4.4.4 Fisheries 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 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. *Alcyonium digitaum* (Dead Man"s Fingers) or sea pens, which may be favoured by particular species (such as burrowing species) compared to simpler homogenous finer grained sediment habitats on top of the bank as favoured by species such as flatfish.

4.4.5 Predator-Prey Relationships between Fish and Shellfish Species

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 4.4 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).

Table 4.4: Key prey items of the main fish and shellfish species.

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.
Stripped	Mainly feed on benthic organisms such as shrimps, amphipods,
Red mullet	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.

4.4.6 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 4.5a, Table 4.5b and Appendix B, with some illustrated examples included in Figure 4.13 (Mackerel, Herring, Cod and Haddock), Figure 4.14 (Whiting, Sandeel, Sole and Plaice) and Figure 4.15 (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. Whilst these datasets provide indicative areas for spawning, they should not be considered definitive, as areas utilised for spawning are likely to be subject to significant variation from year to year, dependant on a wide range of environmental conditions e.g. sea temperature. Changes in these conditions can lead to considerable variation in the spawning areas and may explain some of the differences in the Herring spawning areas as defined by Coull *et al.,* (1998) and Cefas (2008) (Figure 4.13b).

Data included in Figure 4.13 to Figure 4.15 are drawn from Coull *et al.,* (1998) or Cefas (2008). Mackerel are shown to utilise the entire Dogger Bank Zone and the Offshore Cable Area beyond ~60 km of the coast for spawning (Figure 4.13a). Similarly, Sprat spawning occurs across the Dogger Bank Zone and much of the Offshore ZDE, excluding coastal areas (< ~25 km of the coast) and near to The Wash (Figure 4.15a). Whiting spawning is limited to the north east of the Offshore ZDE (Figure 4.14a) with most activity occurring within the north, east and central areas of the Dogger Bank Zone.

Plaice, Herring and Sandeel spawning occurs over wide areas of the Offshore ZDE. Plaice utilise a small part of the western Dogger Bank Zone for spawning (Figure 4.14d). Sandeel have been noted to spawn within the southern half of the Dogger Bank Zone and tend to remain in the same areas as juveniles (Figure 4.14b). 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 4.14c). Known Cod spawning is patchy, occurring to the north east and south west of the Dogger Bank Zone, while Haddock spawning is considered to be absent from the Dogger Bank Zone and the Offshore Cable Area.

Table 4.5: This table includes spawning times and migration behaviour of species which are relevant to the ecology of the 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.

<table>
<tr><th>Species</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td rowspan="3">Ammodytes marinus
Sandeel</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Spawning: It occurs throughout much of the southern and central North Sea, but especially near sandy sediments off the coasts of Denmark, northeastern England (including the all ZDE area), eastern Scotland, and the Orkney Islands. 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).</td></tr>
<tr><td colspan="12">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)</td></tr>
<tr><td rowspan="3">Clupea harengus
Herring</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Spawning: 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 of eggs that adheres to the substratum (generally on coarse sand, gravel, shells and small stones). Hatching is driven by sea bottom temperature (Russel, 1976, as cited in ICES, 2006). A recent update (CEFAS, 2008) of the spawning area for this species in the central North Sea has highlighted extension and movement of the spawning areas, some of which are highly relevant to the Dogger Bank Zone and the Offshore Cable Area.</td></tr>
<tr><td colspan="12">Migration: Diurnal vertical movement (Harden-Jones, 1968). Move offshore after two years in coastal spawning grounds (MacKenzie, 1985, as in ICES, 2006)</td></tr>
<tr><td rowspan="3">Gadus morhua
Cod</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Spawning: a recent study applying DNA-techniques for species identification (Fox et al., 2005, as cited in ICES, 2006) showed that the most important concentration of larval stage I, is found in a limited area to the north-west of the Dogger Bank</td></tr>
<tr><td colspan="12">Migration: It 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 north-westerly direction over deeper parts of the central North Sea in summer (Heessen, 1983, as cited in ICES, 2006).</td></tr>
<tr><td rowspan="3">Merlangius merlangus
Whiting</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Spawning: The main area is in the central northern North Sea between the Shetland Islands and the Norwegian Deep and southwards towards the Fladden Ground (ICES, 2001; Knijn et al., 1993, as in Rogers and Stocks, 2001). Spawning takes place from January in the southern North Sea to July in the northern North Sea (Coull et al., 1998 and ICES 2006)</td></tr>
<tr><td colspan="12">Migration: Movements are mainly along the Scottish coast and form 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)</td></tr>
<tr><td rowspan="3">Eutrigla gurnardus
Grey gurnard</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">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 Henderson, 2009).</td></tr>
<tr><td colspan="12">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.</td></tr>
<tr><td rowspan="3">Solea solea
Sole</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Spawning: There are five major spawning areas, one, the Norfolk banks, falls within the 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).</td></tr>
<tr><td colspan="12">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).</td></tr>
<tr><td rowspan="3">Pleuronectes platessa
Plaice</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Spawning: Generally occurs in coastal area, but tending to be concentrated in depths of 20-40m (Maitland and Herdson, 2009).</td></tr>
<tr><td colspan="12">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).</td></tr>
<tr><td rowspan="3">Nephrops norvegicus
Norway lobster</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">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).</td></tr>
<tr><td colspan="12">Migration: This species do not migrate, and spends its life in the area in which they settle as larvae (Rogers and Stocks, 2001).</td></tr>
<tr><td rowspan="3">Cancer pagurus
Brown crab</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">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).</td></tr>
<tr><td colspan="12">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 in inshore movement in spring when the eggs are hutched (Eaton et al., 2003)</td></tr>
</table>

<table>
<tr><th>Species</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td rowspan="3">Scomber scomber
Mackerel</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Spawning: In spring, they migrate south to spawn in the North Sea, but they may also spawn along the southern coast of Norway and in the Skagerrak (Lockwood, 1978; Dawson, 1991, as cited in Rogers and Stocks, 2001). The pelagic eggs can be found in the central North Sea at depths to 60m below the surface, but the majority are found in the upper mixed layer above 26m (Coombs et al., 1981, as cited in Rogers and Stocks, 2001)</td></tr>
<tr><td colspan="12">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).</td></tr>
<tr><td rowspan="3">Mullus surmuletus
Red mullet</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">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).</td></tr>
<tr><td colspan="12">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).</td></tr>
<tr><td rowspan="3">Melanogrammus aeglefinus
Haddock</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Spawning: Generally occurs at depths of 100 - 150m (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).</td></tr>
<tr><td colspan="12">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).</td></tr>
<tr><td rowspan="3">Trachurus trachurus
Horse Mackerel</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Spawning: Horse Mackerel is 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 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).</td></tr>
<tr><td colspan="12">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).</td></tr>
<tr><td rowspan="3">Pollachius virens
Saithe</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">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).</td></tr>
<tr><td colspan="12">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).</td></tr>
<tr><td rowspan="3">Raya clavata
Thornback ray</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">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., 2005).</td></tr>
<tr><td colspan="12">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).</td></tr>
<tr><td rowspan="3">Dipturus batis
Common Skate</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Spawning: The Celtic Sea has been highlighted as an area where relevant grounds for this species occur (Ellis et al., 2005).</td></tr>
<tr><td colspan="12">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).</td></tr>
<tr><td rowspan="3">Squalus acanthias
Spurdog</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Spawning: 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 & 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 & Dipper, 2009).</td></tr>
<tr><td colspan="12">Migration: It may migrate all around the British Isles (ICES, 2006). This species in the area is believed to exist in a single North-East Atlantic stock., thus the North Sea component is considered to represent part of a much larger stock (ICES 2006)</td></tr>
<tr><td rowspan="3">Trisopterus esmarkii
Norway pout</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="12">Spawning: The southern distribution border extends from north-east 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 indicates that spawning grounds are not within the ZDE, however it encompasses an area where this species is important commercially (ICES, 2006)</td></tr>
<tr><td colspan="12">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).</td></tr>
</table>

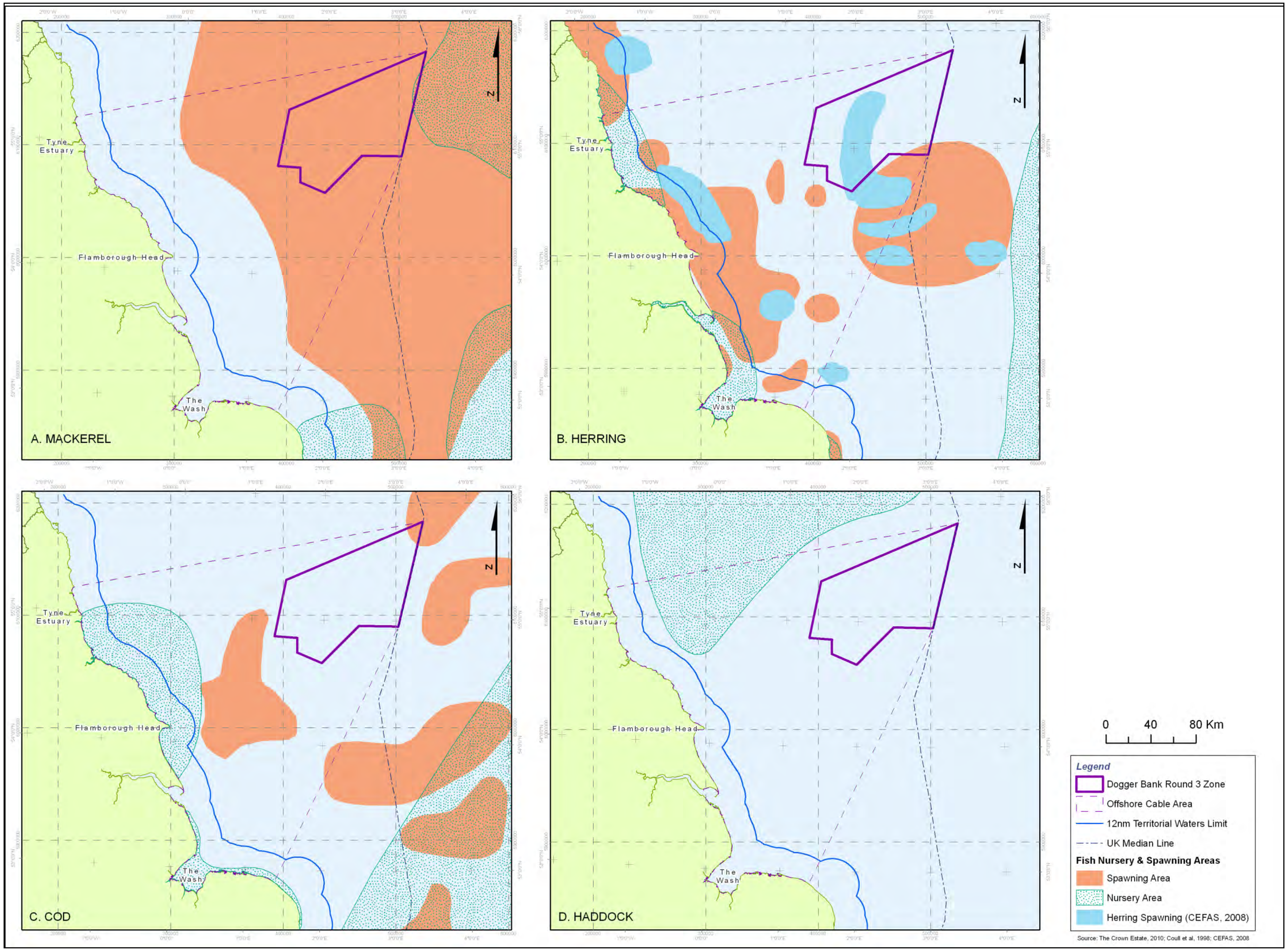


Figure 4.13: Nursery and spawning areas for Mackerel, Herring, Cod and Haddock, within the offshore ZDE (Coull *et al.*, 1998 and CEFAS, 2008).

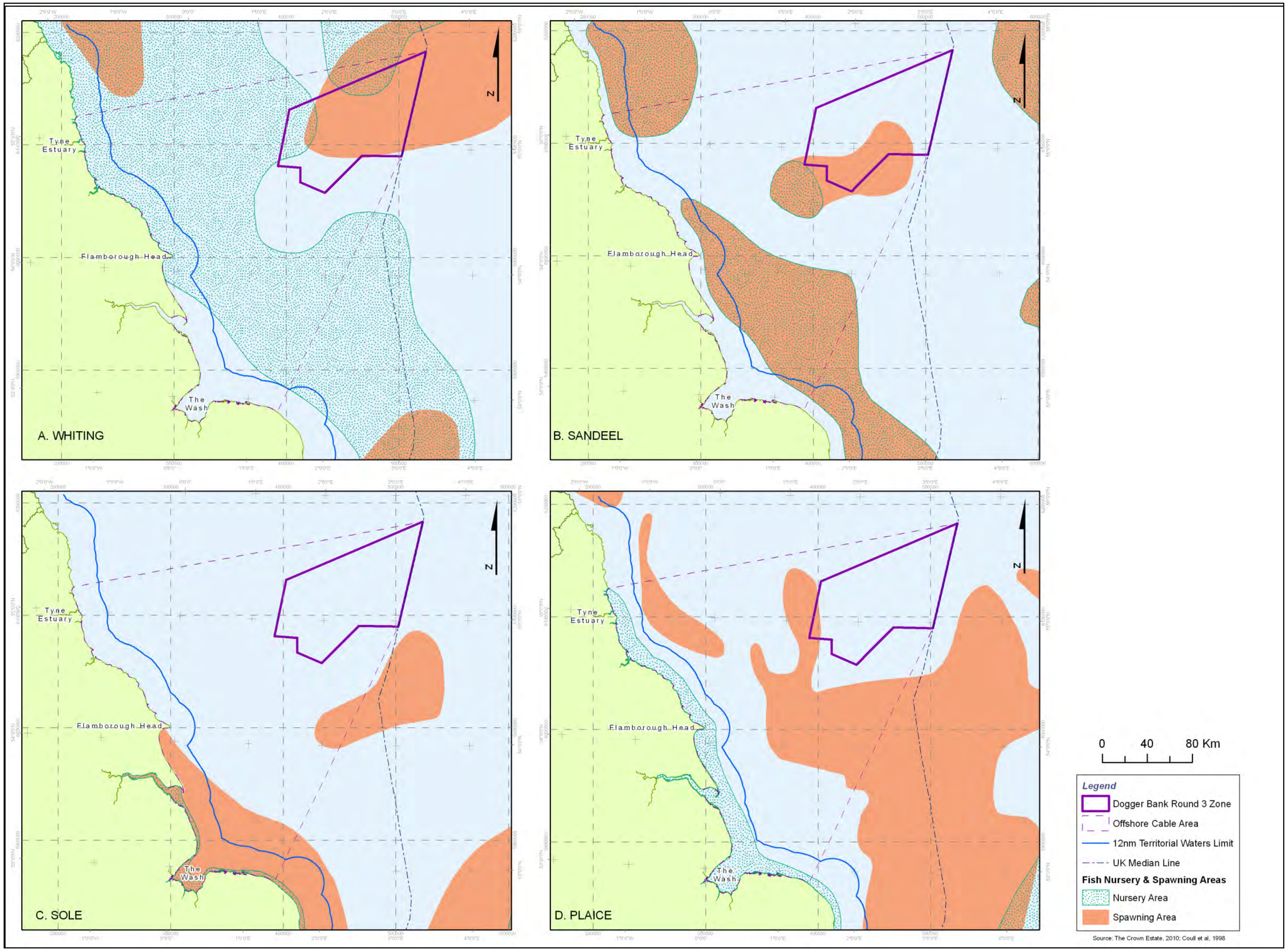


Figure 4.14: Nursery and spawning areas for Whiting, Sandeel, Sole and Plaice, within the Offshore ZDE (Coull *et al.*, 1998).

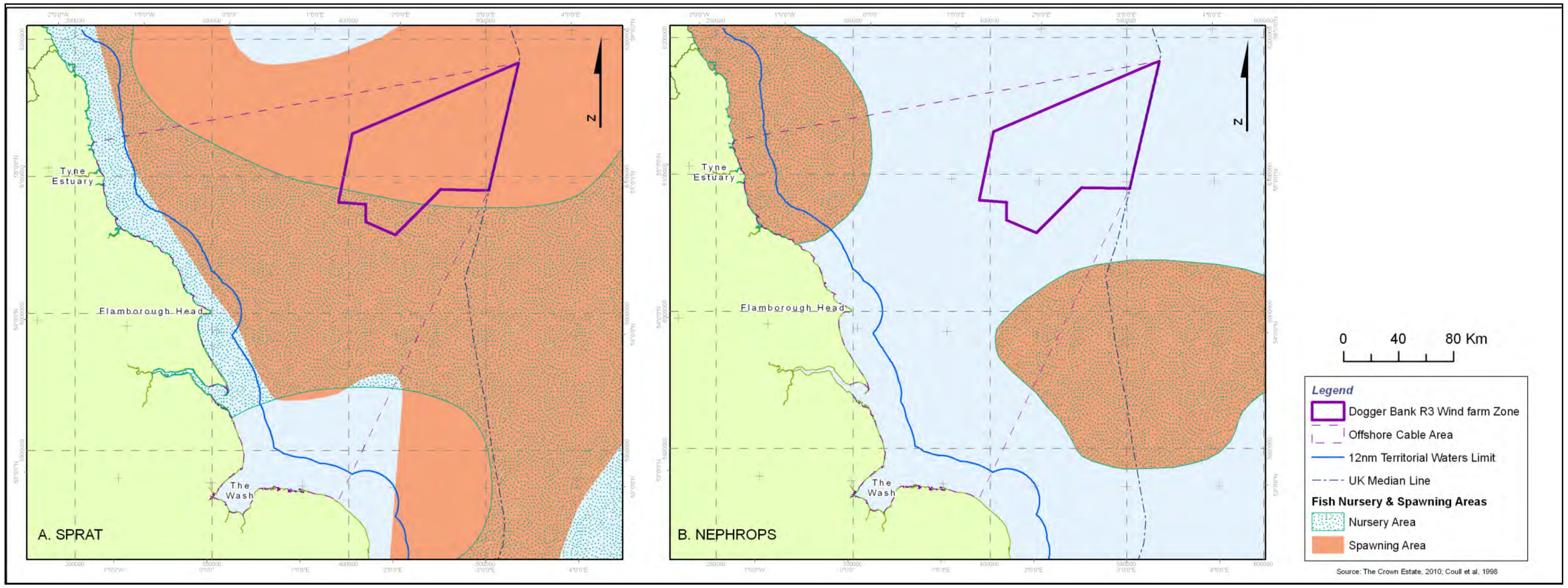


Figure 4.15: Nursery and spawning areas for Sprat and *Nephrops*, within the Offshore ZDE (Coull *et al.,* 1998).

Nephrops are shown to spawn in discrete areas to the north west of the Offshore ZDE and to the south of the Dogger Bank Zone (Figure 4.15b).

In general, the Offshore ZDE area includes grounds which have been described as spawning grounds for various finfish species (e.g. Cod and Whiting) (Figure 4.16).

Table 4.5a and Table 4.5b present summary data on spawning times and migratory behaviour of fish species, which occur within the Offshore ZDE. These data highlight the period February – June as peak spawning activity for the majority of species identified.

It is not currently known if there are any specific migration routes which might occur within the Offshore ZDE. Consultation with Cefas and local commercial fisheries representatives may be required to identify any specific migration routes and their relative importance to the development.

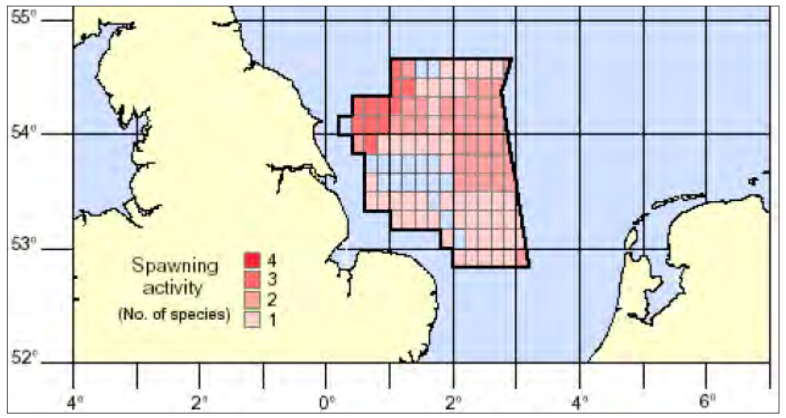


Figure 4.16: Spawning intensities of finfish (Cod, Haddock, Whiting, Saithe, Norway pout, Plaice, Sole and Mackerel) by licence block, during February to June (adapted from Rogers and Stocks (CEFAS, 2001)).

Figure 4.17 summarises observations of Brown crab (*Cancer pagurus*) spawning within the Offshore ZDE and shows the concentration of larval stage zoeae 1 (considered a spawning indicator) for this species has 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).

Eaton *et al.* (2003) suggested that the main spawning may be localised at the Offshore site 54°N, 1°E, extending towards the south east. 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". The 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 4.18), 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).

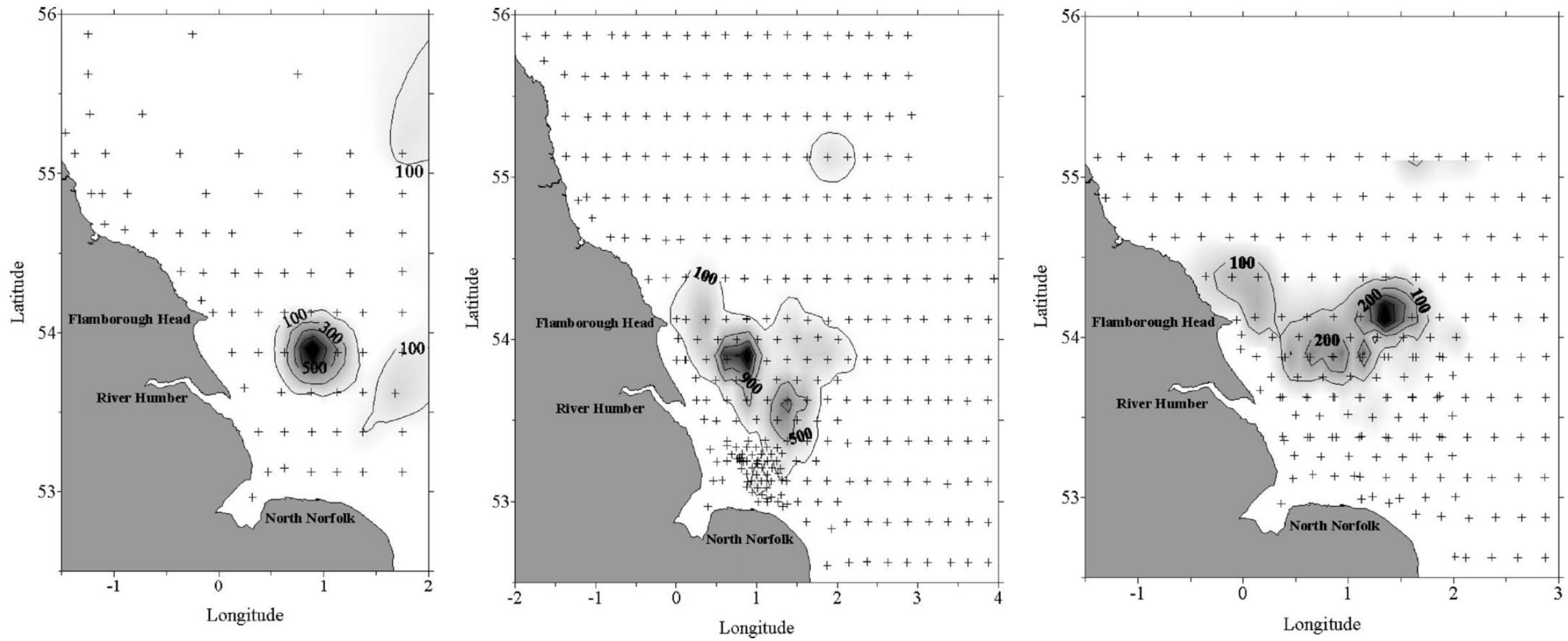


Figure 4.17: Sampling positions (+), as processed in Eaton *et al*., 2003) and distribution of the Edible crab zoea I *Cancer pagurus* larval stage in 1976, 1993 and 1999. (Eaton *et al*., 2003).

Cod spawning in the North Sea was investigated by Fox *et al*. (2008). In the spring of 2004 the authors carried out the first ichthyoplankton survey to cover the whole North Sea. The work included a map of the historic distribution of Cod eggs throughout the North Sea (Figure 4.19a). The blank areas shown on the historic map are due to areas not being surveyed.

However, Harding and Nichols (1987) recorded concentrations of stage 1 Cod eggs off the western edge of the Dogger Bank as well as off Flamborough Head (Fox *et al*., 2008). Further investigation following the spring 2004 survey in the Dogger Bank area, applying DNA-techniques for species identification (Fox, *et al*., 2008), showed that the most important Cod egg concentration was found in a limited area partially within the Offshore Cable Area (Figure 4.19b). In fact the main concentrations of stage I cod eggs were found around the southern and eastern edges of the Dogger Bank. This distribution was confirmed by trawl survey data 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 4.19b were still active in 2004 and the failure of finding significant numbers of Cod eggs off Flamborough Head required further investigation.

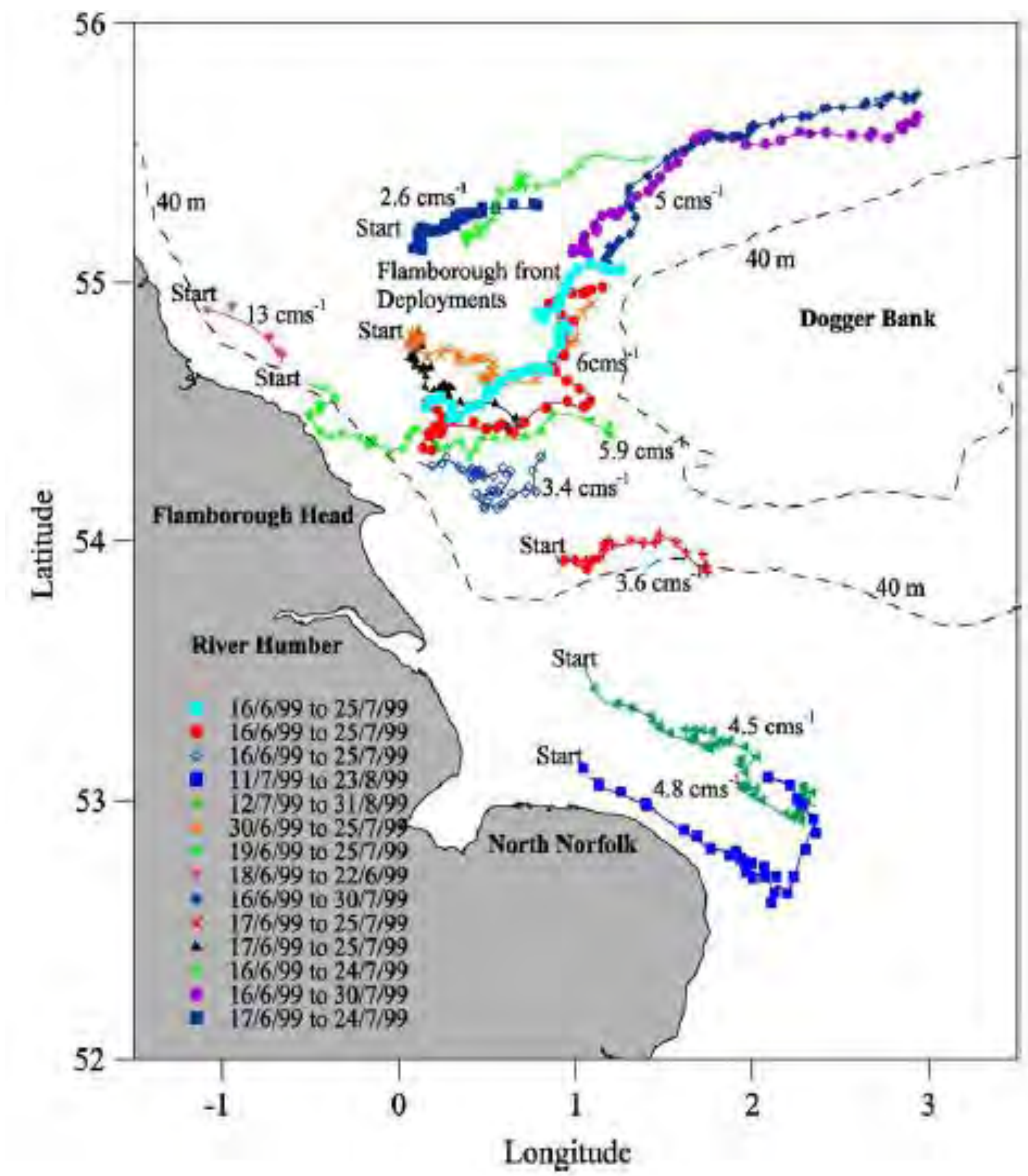


Figure 4.18: Tidally filtered trajectories of satellite-tracked Argos buoys in 1999. The daily positions at 00:00 GMT are plotted, together with the mean velocity for each trajectory (Eaton *et al.,* 2003).

4.4.7 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. Coull *et al.,* (1998) provides indicative locations for these nursery areas, as illustrated in Figure 4.13, Figure 4.14 and Figure 4.15.

The coastal regions of the Offshore Cable Area are used as nursery areas by Plaice (Figure 4.14), Sole (Figure 4.14), Cod (Figure 4.13) and Herring (Figure 4.13). Plaice and Cod utilise almost the entire coastal region of the Offshore Cable Area, Herring utilise the northern and southern coasts and Sole are limited to the southern coastal areas.

Sprat (Figure 4.15) and Whiting (Figure 4.14) use much of the Offshore Cable Area including parts of the Dogger Bank Zone as a nursery area, although the area to the south west, near to the Wash is not used. Whiting and Sprat juveniles are thought to utilise the west and north of the Dogger Bank Zone and the south of the Dogger Bank Zone respectively.

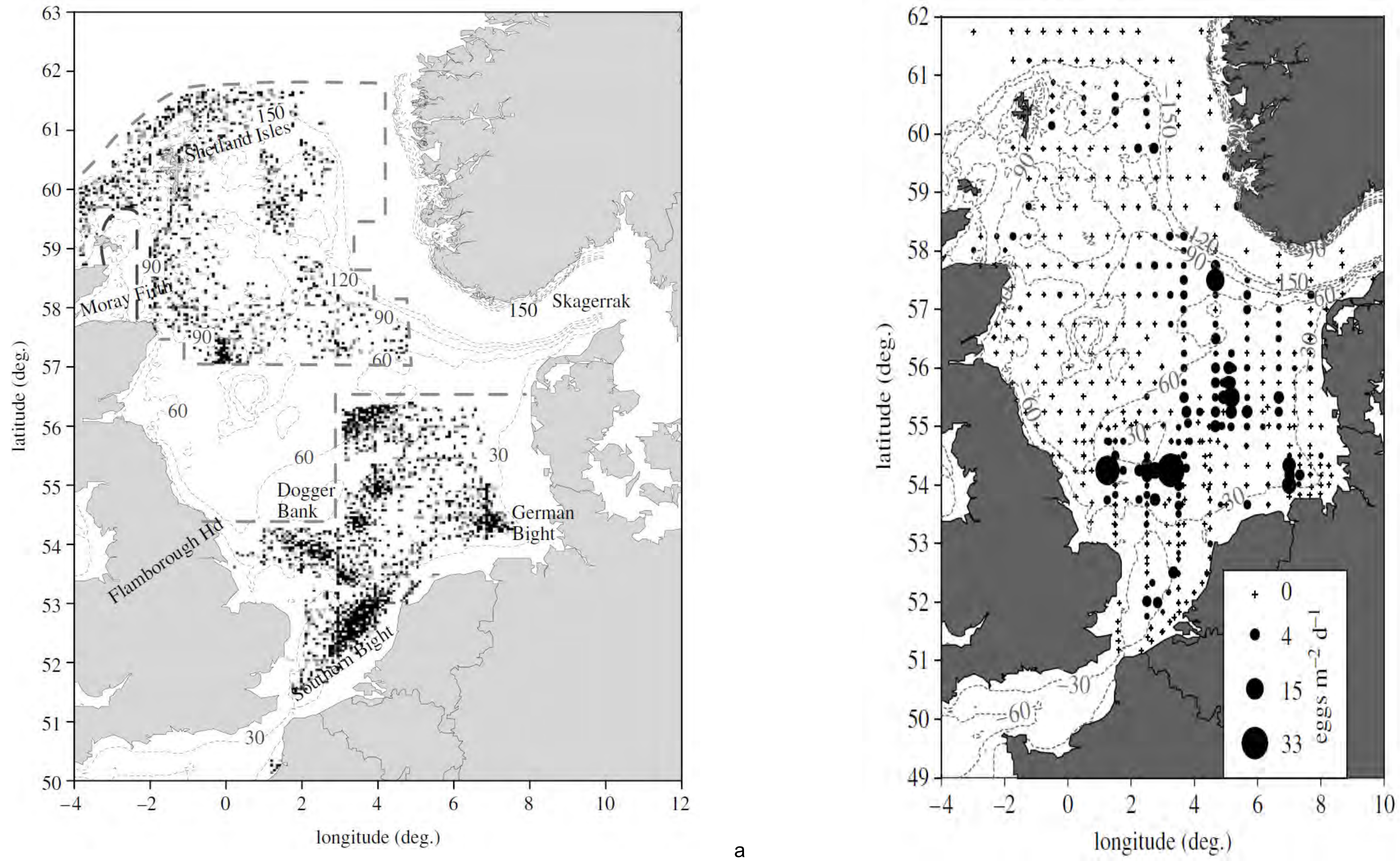


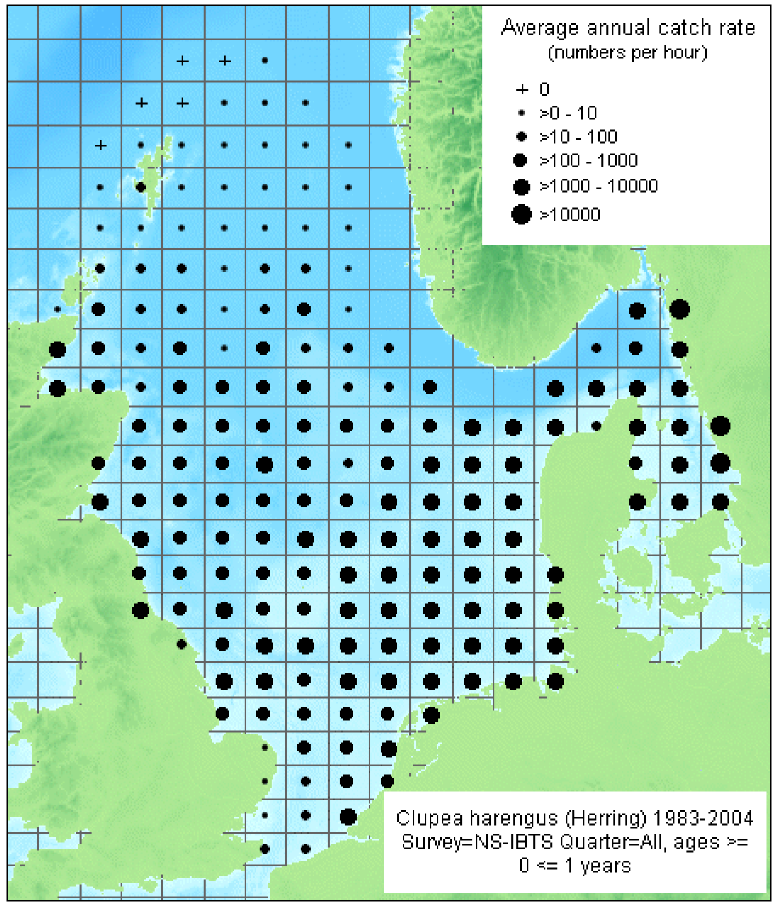
Figure 4.19: Distribution of Cod eggs stage 1 in the North Sea from 1945 ('A') and 2004 ('B'). The scale ('B') indicates no. of eggs per m^2 of sea surface and crosses indicate where a plankton sample was collected but no stage 1 Cod eggs were found (Fox *et al.,* 2008).

Mackerel (Figure 4.13) nursery areas are shown to occur to the east of the Dogger Bank Zone and Offshore Cable Area. The northern part of the Offshore Cable Area is shown to be a nursery area for Haddock (Figure 4.13), but this does not include Dogger Bank Zone itself. Sandeel nursery areas (Figure 4.14) demonstrate a close association with their spawning areas, though Coull *et al.,* (1998) has shown that the nursery areas occur to the south west of the Dogger Bank Zone and more extensively near the coastline.

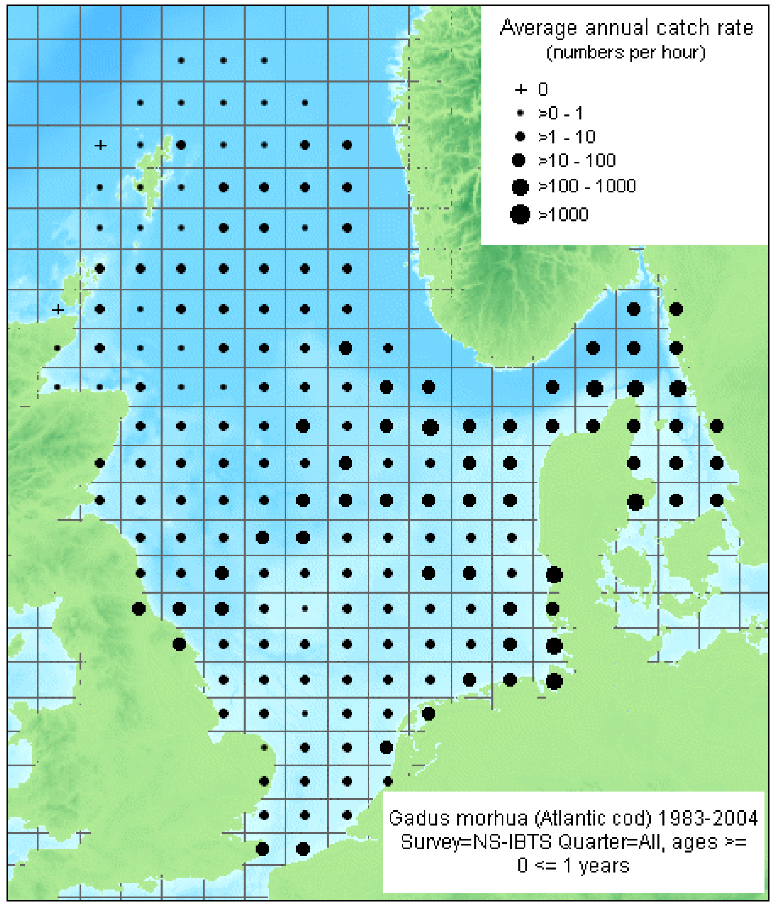
Nephrops (Figure 4.15) utilises an area offshore from the Northumberland Coast and an area to the south of the Dogger Bank Zone.

Additional potential nursery areas for fish, as identified by the distribution of juvenile stages (0 - <1 years) (ICES, 2006), are presented in Figure 4.20. These show the relative importance of the northern flanks of the Dogger Bank Zone with regard to juvenile Herring, Cod, Haddock, Whiting and 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. A discrete Cod nursery area was identified over western areas of the Dogger Bank during consultation with fisheries representatives as part of historic fisheries surveys (Emu Ltd, 2008).

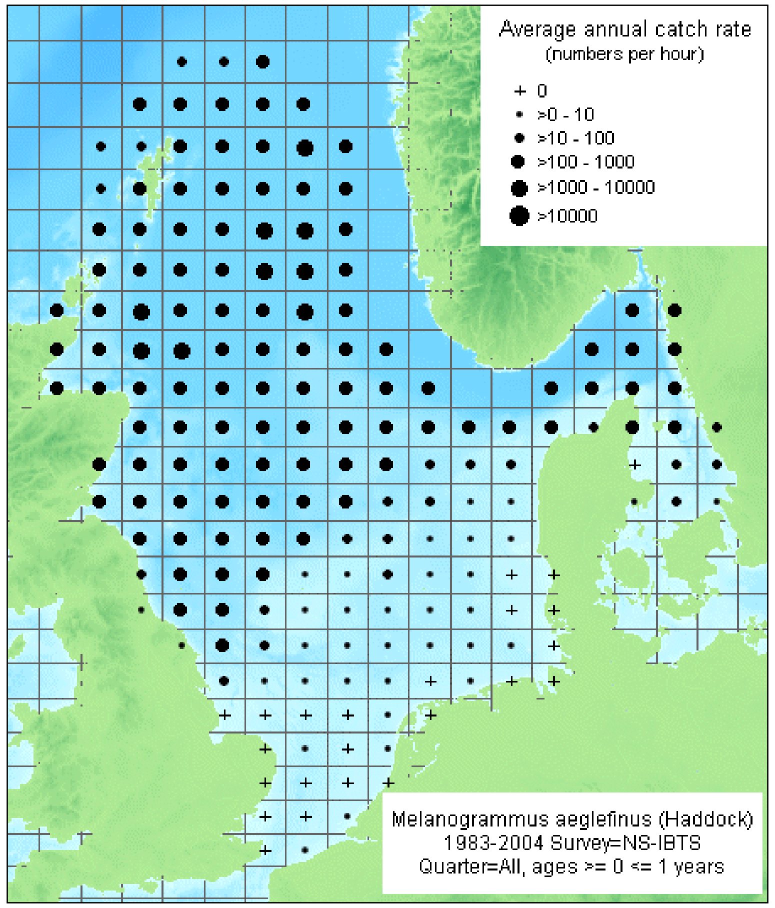
Seapen and burrowing megafauna communities suspected to occur on the northern margin of the Dogger Bank Zone, just on the northern edge of the Dogger Bank Zone (Diesing *et al.,* 2009) are considered to be nursery areas for a number of fish species including the UK BAP priority species Hake (OSPAR, 2010).



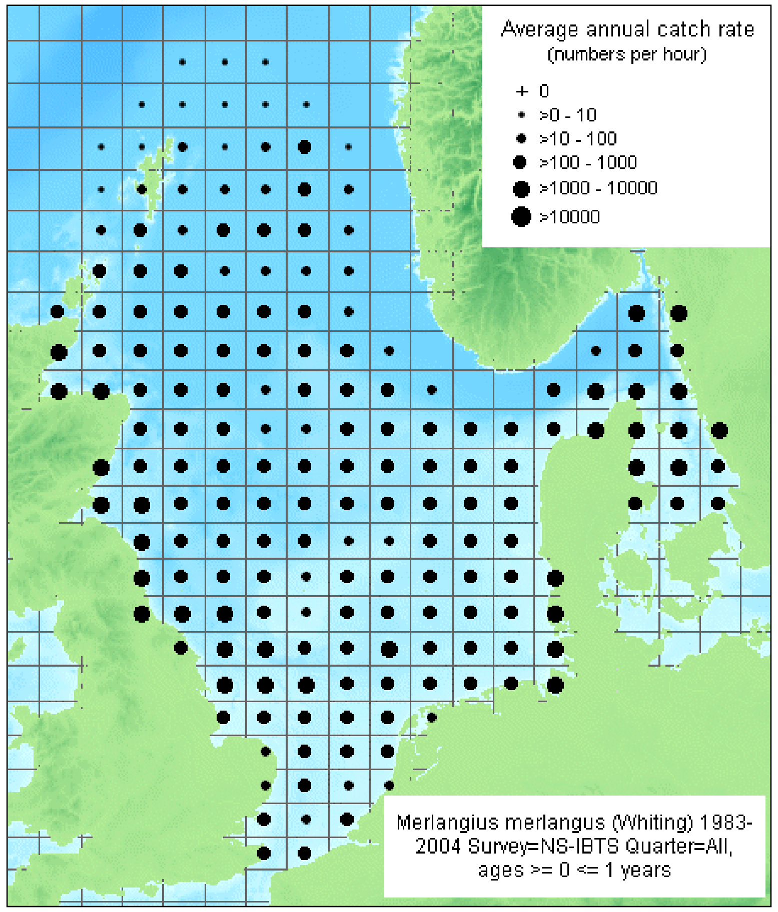
Clupea harengus (Herring) 1983-2004 Survey=NS-IBTS Quarter=All, ages >= 0 <= 1 years



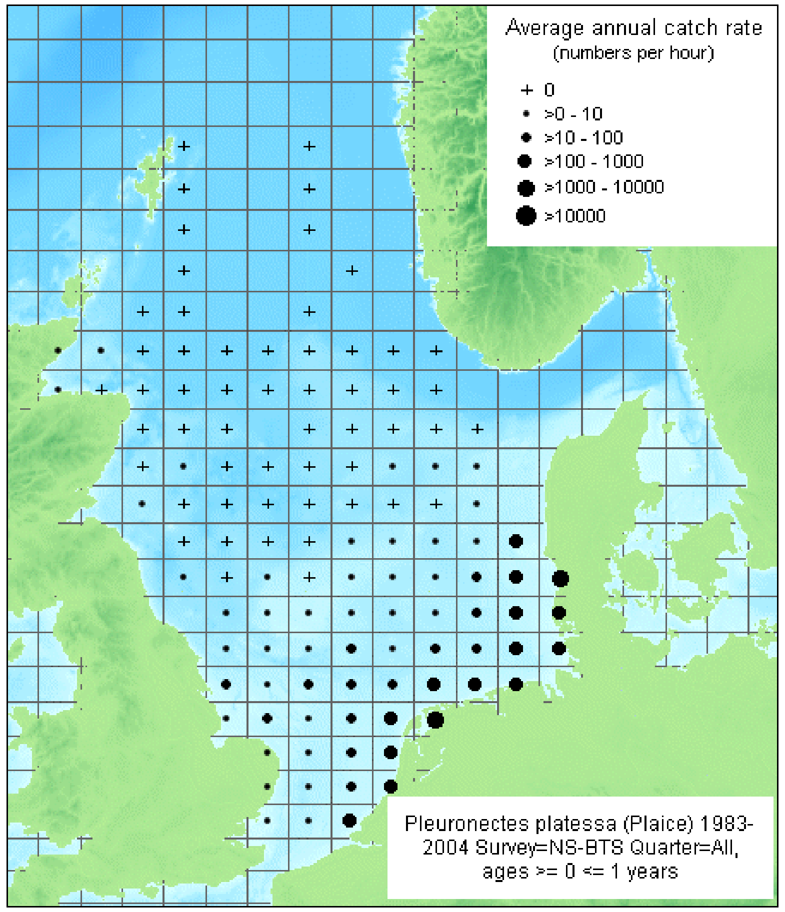
Gadus morhua (Atlantic cod) 1983-2004 Survey=NS-IBTS Quarter=All, ages >= 0 <= 1 years



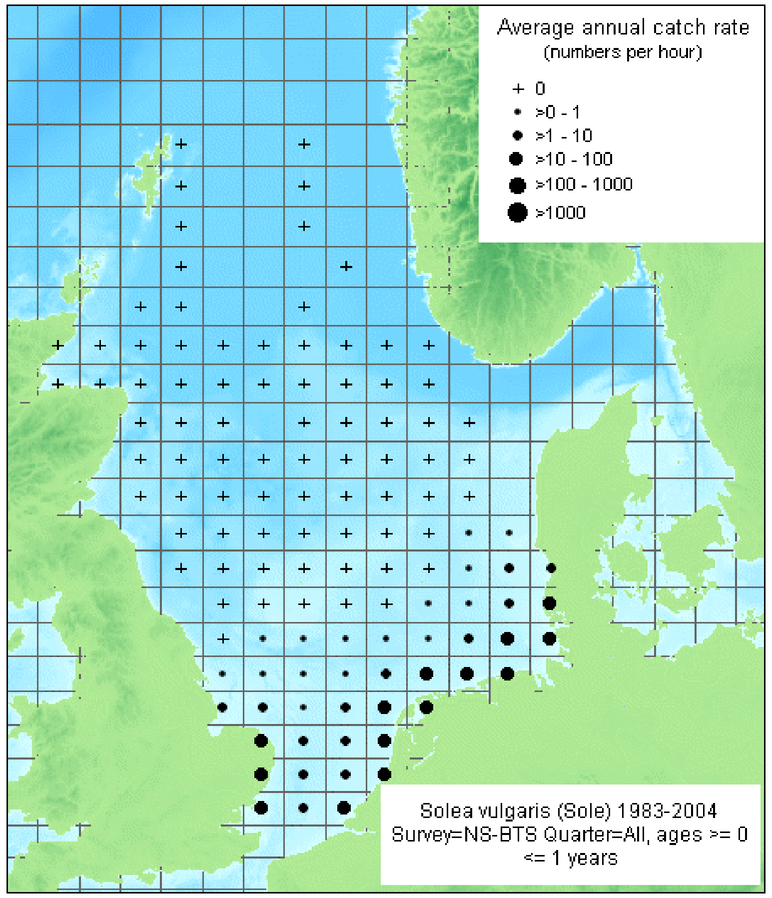
Melanogrammus aeglefinus (Haddock) 1983-2004 Survey=NS-IBTS Quarter=All, ages >= 0 <= 1 years



Merlangius merlangus (Whiting) 1983-2004 Survey=NS-IBTS Quarter=All, ages >= 0 <= 1 years



Pleuronectes platessa (Plaice) 1983-2004 Survey=NS-BTS Quarter=All, ages >= 0 <= 1 years



Solea vulgaris (Sole) 1983-2004 Survey=NS-BTS Quarter=All, ages >= 0 <= 1 years

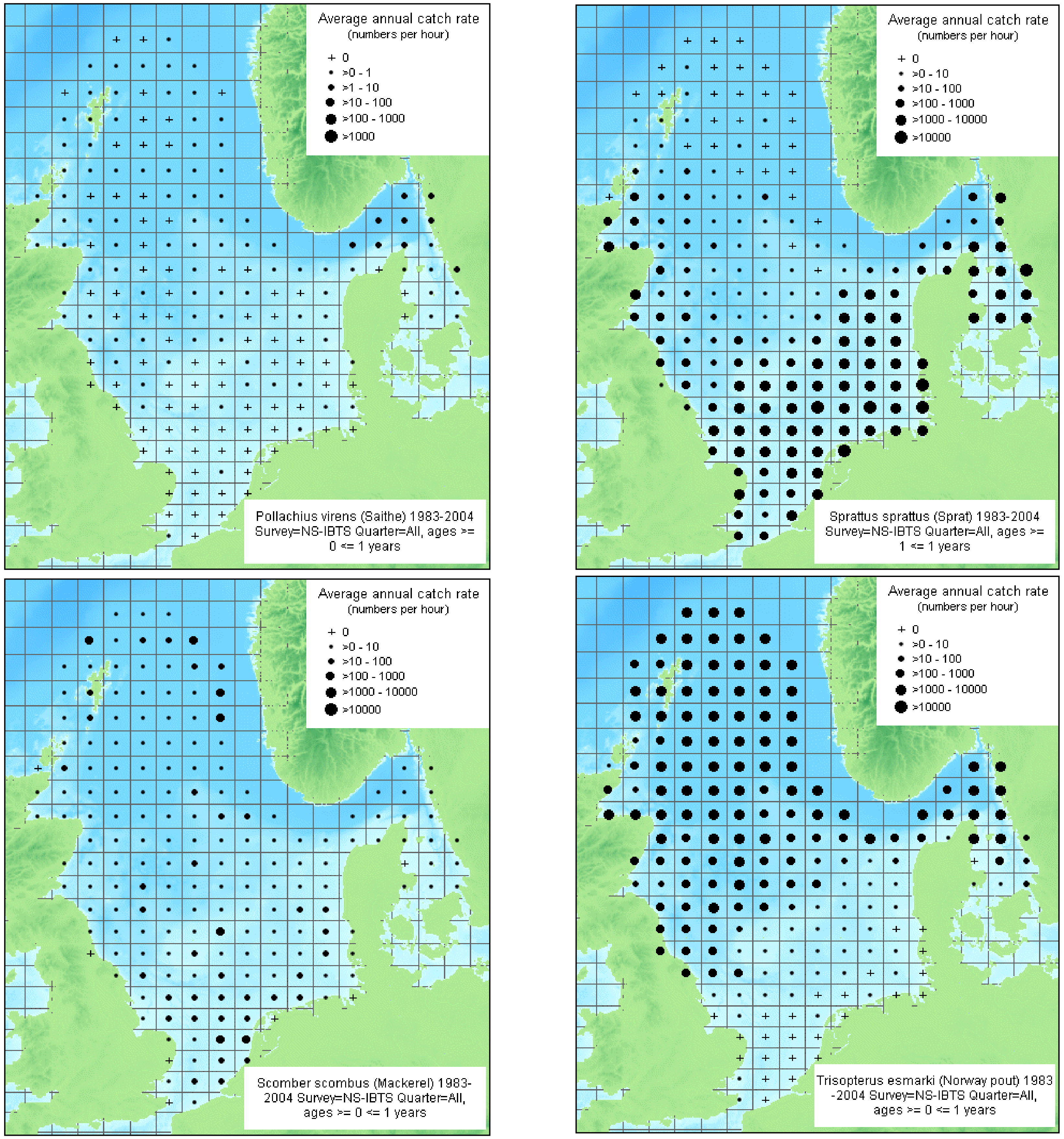


Figure 4.20: Distribution of juvenile stage 1 for the species of fish encountered in this report (ICES website, 2006).

4.5 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. Although not definitive potential spawning and nursery areas have been outlined as indicated by Coull, *et al*. (1998). More recent work by Fox, *et al*. (2008) showed important Cod spawning areas just south of the Dogger Bank and in an arc, stretching outside the ZDE, to the northeast.

The wide range of seabed habitats encountered within the 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, „Sea pen and burrowing megafauna" within the northern areas of the Dogger Bank Zone and it"s relative importance as nursery habitat for various species of fish was noted. Previous consultations with fisheries representatives (Emu Ltd., 2008) have identified important nursery areas associated with the southern, western and north-western flanks of the bank.
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. Further more isolated concentrations are found to either side of this arc, within the Dogger Bank Zone and outside of the

pSAC boundary. Sandeel in particular, in the North Sea, occupies a crucial ecological position and as a link between zooplankton and the top predators is a key species. Those predators include many bird, mammal and fish species in the area (Frederiksen *et al.,* 2006).

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 *Nephrops norvegicus* are also found near to the coast and in the sea pen and burrowing mega fauna habitats potentially present at Dogger Bank.
6. Ling, 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 the possible need to clarify potential herring spawning areas based on seabed characteristics, the lack of cod eggs reported by Fox, *et al*. (2008) off Flamborough Head and a lack of specific information on fish migration movements which may occur in the ZDE.

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5. Birds

5.1 Introduction

This chapter presents a high level review of the distribution and abundance of seabirds and movements of other birds in the Dogger Bank Zone and Offshore Cable Area.

This Zonal Characterisation for birds aims to:

- Address the extent to which the distribution and abundance of seabirds and movements of other birds within the Dogger Bank Zone and Offshore Cable Area is known and understood;
- Map important breeding colonies and wintering or migration areas within the Offshore ZDE;
- Flag the limitations of current knowledge of seabird 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 seabird distribution and abundance and movements of other birds within the Offshore ZDE.

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

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 Dogger Bank Zone and Offshore Cable Area. 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 ongoing, together with monthly high definition video camera aerial surveys. Data from these surveys will add to the existing knowledge of the distribution and abundance of seabirds and other bird species within the Zone.

5.2 Data and Literature

5.2.1 Key publications

This Zonal Characterisation chapter used several sources of information on the distribution and abundance of seabirds and other bird species in the North Sea (including the Dogger Bank Zone and Offshore Cable Area).

Breeding seabirds

- Seabird populations of Britain and Ireland (Mitchell *et al.,* 2004), which published results of Seabird 2000, a seabird census of breeding seabirds in Britain and Ireland conducted between 1998 and 2002.

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 north-west European waters (Stone *et al.,* 1995). This report also utilised the ESAS database, with data collected between 1980 and 1993.
- Final report on seabird and marine mammal surveys in the North Sea between February 2008 and March 2009 for DECC (Cork Ecology, 2009).
- 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 utilized 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.6 of the recent Offshore Energy SEA (DECC, 2009), which contains baseline descriptions of breeding seabirds and the distribution of seabirds at sea, as well as information on migrating wildfowl, waders and terrestrial birds.
- 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

A programme of boat-based surveys in the North Sea between February 2008 and March 2009 for DECC, 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 south-east 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).

Aerial surveys of the Dogger Bank Zone were conducted at the request of the Crown Estate 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. 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 2010. Figures showing relative abundance (birds/km) for each month for fulmar, gannet, kittiwake and all auks combined are shown in Appendix D. A programme of monthly high definition video camera aerial surveys is ongoing.

Monthly boat-based seabird and marine mammal surveys of the Dogger Bank Zone commenced in January 2010 and are ongoing. Relevant information from monthly summary reports from January to June 2010 (Gardline, 2010a-f) has been included in this report. The January 2010 survey was only conducted over two days, however coverage in the Dogger Bank Zone between February and June 2010 has been more complete, so totals for these months give a better indication of the numbers of each species present. Key species sightings for January to March 2010 are presented in Appendix D.

Other bird species

The Wetland Bird Survey (WeBS)[1] 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. Relevant information from the 2007/08 report (Holt *et al.,* 2009) on wildfowl and wader numbers at major sites on the east coast of Britain is included here.

5.2.3 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 changed in the intervening years.

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 ¼ 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 ongoing monthly boat-based, and aerial, seabird and marine mammal surveys in the Dogger Bank Zone.

5.3 Overview

At least fifteen species of seabirds are likely to occur regularly in the Dogger Bank Zone and Offshore Cable Area, although the distribution and abundance of these species varies throughout the year. 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 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 Dogger Bank Zone and Offshore Cable Area during these periods. 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. These species are discussed in detail in Section 5.5.

5.4 Seabirds

A brief outline of the breeding numbers, at-sea density and distribution of the regularly occurring seabird species within the Dogger Bank Zone and Offshore Cable Area 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 ,2010a-f).

5.4.1 Divers and grebes

ESAS surveys between 1980 and 1994 recorded very low densities of divers and grebes in the Dogger Bank Zone (Table 5.1) and Offshore Cable Area between October and May (Skov *et al.,* 1995).

Boat-based surveys between January and June 2010 have recorded low numbers of red-throated diver, black throated diver and great northern diver in the Dogger Bank Zone (Table 5.1).

Sixteen white-billed divers were recorded between February and April, with a peak of nine birds in March. 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-June. Some birds may winter off the Dutch coast (Birdguides, 2010).

Table 5.1: Monthly totals of divers recorded on boat-based surveys within the Dogger Bank Zone between January and June 2010. Source: Gardline (2010a-f).

Species	Jan	Feb	Mar	Apr	May	Jun
Red-throated diver	0	0	2	1	0	0
Black-throated diver	0	0	0	2	0	0
Great Northern Diver	0	0	0	1	1	1
White-billed Diver	0	1	9	6	0	0
Unidentified divers	0	0	0	0	3	0

Based on the above, all four diver species are likely to occur occasionally in low numbers in the Dogger Bank Zone, particularly in late winter and early spring.

5.4.2 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). Small numbers of fulmars breed at coastal sites bordering the Offshore Cable Area, with Flamborough Head and Bempton Cliffs containing the largest fulmar colony in the Offshore ZDE, with 878 apparently occupied sites (AOS) in 2008 (Table 5.2), which is approximately 0.2 % of the UK breeding population (Mitchell *et al.,* 2004). There are no designated SPAs for fulmars within the Offshore ZDE (JNCC, 2010). Fulmars have a wide-ranging diet including fish and offal, and can forage over 600 km from colonies, although 70 km is the mean distance (Table 5.3).

Foraging distances for the regular seabird species in relation to designated conservation sites in the UK and Europe are discussed in Chapter 7 – *Nature Conservation*.

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

[1] WeBS is a joint scheme of the British Trust for Ornithology (BTO), The Wildfowl and Wetlands Trust (WWT), Royal Society for the Protection of Birds (RSPB) and JNCC.

Table 5.2: Summary of important coastal breeding seabird colonies on east coast of England bordering Offshore ZDE (See also Figure 5.3).

Colony	Main Species	Total [1]	Percentage of UK breeding population [1]	Breeding seabirds SPA qualifying interest [4]
Teesmouth and Cleveland Coast SPA	Little Tern	37 pairs	1.9 %	Little Tern
Marsden Rock	Cormorant	248 AON	1.6 %	N/A
Flamborough Head and Bempton Cliffs SPA	Fulmar	878 AOS 5	0.2 %	Kittiwake, Puffin, Razorbill, Guillemot, Herring Gull, Gannet
	Herring Gull	533 AON 5	0.4 %	
	Kittiwake	42,659 AON	11.6 %	
	Guillemot	46,685 Inds	3.5 %	
	Razorbill	8,539 Inds	5.2 %	
	Gannet	3,940 AOS 2	1.8 % 2	
	Puffin	2,615 Inds	0.5 %	
Humber flats, marshes and coast SPA	Little Tern	63 pairs	3.2 %	Little Tern
Gibraltar Point SPA	Little Tern	23 pairs	1.2 %	Little Tern
The Wash SPA	Little Tern	33 pairs	1.7 %	Common Tern, Little Tern
	Lesser Black-backed Gull	1,378 AON	1.6 % 3	
	Common Tern	152 pairs	1.5 %	
	Herring Gull	1,003 AON	0.7 % 3	
North Norfolk coast SPA	Sandwich Tern	3,457 pairs	32.8 %	Sandwich Tern, Common Tern, Little Tern
	Little Tern	377 pairs	19.4 %	
	Common Tern	460 pairs	4.5 %	
	Roseate Tern	2 pairs	3.8 %	
	Mediterranean Gull	2 pairs	1.9 %	
Teesmouth	Little Tern	37	1.9 %	Little Tern

Colony	Main Species	Total [1]	Percentage of UK breeding population [1]	Breeding seabirds SPA qualifying interest [4]
and Cleveland Coast SPA		pairs		
Marsden Rock	Cormorant	248 AON	1.6 %	N/A
Flamborough Head and Bempton Cliffs SPA	Fulmar	878 AOS 5	0.2 %	Kittiwake, Puffin, Razorbill, Guillemot, Herring Gull, Gannet
	Herring Gull	533 AON 5	0.4 %	
	Kittiwake	42,659 AON	11.6 %	
	Guillemot	46,685 Inds	3.5 %	
	Razorbill	8,539 Inds	5.2 %	
	Gannet	3,940 AOS 2	1.8 % 2	
	Puffin	2,615 Inds	0.5 %	
Humber flats, marshes and coast SPA	Little Tern	63 pairs	3.2 %	Little Tern
Gibraltar Point SPA	Little Tern	23 pairs	1.2 %	Little Tern
The Wash SPA	Little Tern	33 pairs	1.7 %	Common Tern, Little Tern
	Lesser Black-backed Gull	1,378 AON	1.6 % 3	
	Common Tern	152 pairs	1.5 %	
	Herring Gull	1,003 AON	0.7 % 3	
North Norfolk coast SPA	Sandwich Tern	3,457 pairs	32.8 %	Sandwich Tern, Common Tern, Little Tern
	Little Tern	377 pairs	19.4 %	
	Common Tern	460 pairs	4.5 %	
	Roseate Tern	2 pairs	3.8 %	
	Mediterranean Gull	2 pairs	1.9 %	

[1] Seabird 2000 data, taken from DECC (2009) and Mitchell et al. (2004). AON = Apparently Occupied Nest, AOS = Apparently Occupied Site, Inds = Individuals; [2] Wanless et al., (2005); [3] Coastal colonies only; [4] JNCC (2010); [5] SMP (2010).

Table 5.3: Summary of diet and feeding behaviour of regular seabird species within the Dogger Bank Zone. Sources: Snow and Perrins (1998), Stone et al., (1995), Camphuysen et al., (2005), Langston (2010).

Species	Diet	Feeding behaviour
Fulmar	Sandeels, sprat, zooplankton, squid, fish discards and offal	Feeds on surface and occasionally shallow plunge dives to c. 4m. Mean foraging range of approx. 70 km, up to a maximum of 664 km.
Gannet	Mackerel, haddock, sandeels, fish discards	Plunge dives from heights up to 40m. Mean foraging range of approx. 140 km, up to a maximum of 640 km.
Lesser Black-backed Gull	Omnivorous, fish, discards, offal	Feeds on surface or shallow plunge dives. Mainly coastal foraging range in summer.
Herring Gull	Omnivorous, fish, discards, offal	Feeds on surface or shallow plunge dives. Mainly coastal foraging range in summer.
Great Black-backed Gull	Fish, discards, seabirds	Feeds on surface. Mainly coastal foraging range in summer.
Kittiwake	Sandeels, sprats, young herring, discards	Feeds on surface or shallow plunge dives. Mean foraging range of approx. 25 km, up to a maximum of 200 km.
Guillemot	Sprats, herring, gobies, whiting, haddock, sandeels	Dives from surface to depths of c. 60 m. Mean foraging range of approx. 25 km, up to a maximum of 200 km.
Razorbill	Sandeels, herring, sprats, molluscs, crustaceans	Dives from surface to depths of c. 15 m. Mean foraging range of approx. 10 km, up to a maximum of 51 km.
Little Auk	Planktonic crustaceans and fish fry	Dives from surface.
Puffin	Sandeels, sprat, herring, juvenile gadoids	Dives from surface to depths of c 15 m. Mean foraging range of approx. 30 km, up to a maximum of 200 km.

ESAS surveys recorded fulmars in moderate density in all months in the Dogger Bank Zone (Table 5.4), with 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).

Table 5.4: Monthly mean density and numbers of fulmar recorded on ESAS surveys and 2010 boat-based surveys within the Dogger Bank Zone.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density [1] (birds/km^2)												
Numbers [2]	11	640	800	508	2,608	1,638	-	-	-	-	-	-
Relative abundance* (birds/line km)	< 0.1	0.6	0.5	0.2	1.9	1.5	-	-	-	-	-	-

1 after Skov *et al.* (1995)
2 Gardline (2010a-f)
* Monthly total divided by total number of km surveyed each month

Very low density (<0.1 birds/km^2)
Low density (0.1 – 0.9 birds/km^2)
Moderate density (1.0 – 9.9 birds/km^2)
High density (≥ 10.0 birds/km^2)

Surveys between January and June 2010 recorded moderate numbers of fulmars, with a peak of 2,608 birds in May (Table 5.4) (Gardline, 2010a-f), which is equivalent to approximately 0.3 % of the UK breeding population (Mitchell *et al.,* 2004). When related to survey effort, this gave a relative abundance of 1.9 birds/km travelled for May (Table 5.4).

Relative abundance of fulmars recorded on aerial surveys of the Dogger Bank Zone between May 2009 and April 2010 was very low (less than 0.5 birds/km) (Appendix D) (TCE, 2010).

Although not analysed in detail, recent 2010 survey data appears to broadly match the pattern of existing ESAS data. Based on this, fulmars are likely to occur across the Dogger Bank Zone throughout the year in moderate densities.

5.4.3 Gannet

Gannets are widespread throughout the North Sea in all months, with most adults remaining all year, while 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 Flamborough Head and Bempton Cliffs, with 3,940 AOS in 2004, which is approximately 1.8 % of the UK breeding population (Table 5.2). This site is the only SPA for breeding gannets in the Offshore ZDE (JNCC, 2010). Gannets eat a wide variety of fish, including discards from fishing vessels, and can forage over 600 km from colonies, although 140 km is the mean distance (Table 5.3).

In the Dogger Offshore ZDE, 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 density between May and August (Table 5.5), when the highest average density was 1.00 birds/km^2 in the south-west corner 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).

Table 5.5: Monthly mean density and numbers of gannets recorded on ESAS surveys and 2010 boat-based surveys within the Dogger Bank Zone.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density [1] (birds/km^2)												
Numbers [2]	26	518	2,261	2,063	174	343	-	-	-	-	-	-
Relative abundance* (birds/line km)	0.2	0.4	1.3	0.9	0.1	0.3	-	-	-	-	-	-

1 after Skov *et al.* (1995)
2 Gardline (2010a-f)
* Monthly total divided by total number of km surveyed each month

Very low density (<0.1 birds/km^2)
Low density (0.1 – 0.9 birds/km^2)
Moderate density (1.0 – 9.9 birds/km^2)
High density (≥ 10.0 birds/km^2)

Surveys between January and June 2010 recorded moderate to high numbers of gannets, with a peak of 2,261 birds in March (Table 5.5) (Gardline, 2010a-f), which is equivalent to approximately 0.5 % of the UK breeding population (Wanless *et al.,* 2005). When related to survey effort, this gave a relative abundance of 1.3 birds/km in March (Table 5.5), 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).

Relative abundance of gannets recorded on aerial surveys of the Dogger Bank Zone between May 2009 and April 2010 was very low (less than 0.5 birds/km) (Appendix D) (TCE, 2010).

Based on the above, it is likely that gannets occur in the Dogger Bank Zone at low to moderate density throughout the year.

5.4.4 Cormorant and Shag

Both cormorants and shags are predominantly coastal species (Tasker *et al.,* 1987). 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 density 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 and June 2010 have recorded no cormorants and just one shag, in March (Gardline, 2010a-f).

Based on the above, cormorants are unlikely to occur, and there are likely to only be occasional shags in the Dogger Bank Zone.

5.4.5 Seaduck

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

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 on 2008 surveys (Cork Ecology, 2009). Recent 2010 boat-based surveys in the Dogger Bank Zone recorded four common scoter flying south-east in March, and seven sightings, totalling 28 birds in flight in April (Gardline, 2010a-f). No other seaducks were recorded between January and June.

Based on these results, it is likely that small groups of common scoter may pass through the Dogger Bank Zone on migration.

5.4.6 Great Skua

As almost two thirds of the world population of great skuas breed in Orkney and Shetland (Mitchell *et al.,* 2004), the North Sea is of great importance to this species. In summer, birds are concentrated at their breeding colonies but 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 density (0.6 birds/km^2) offshore from Flamborough Head in September and October (Skov *et al.,* 1995). Despite the low density, 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 density was very low in all other months.

Low densities (0.1 birds/km^2) of great skuas were also recorded in September and October over the Outer Dowsing Shoal, (including the south-west corner of the Dogger Bank Zone) (Table 5.6). 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 density elsewhere in the Dogger Bank Zone at this time, and in very low density 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 density (Cork Ecology, 2009).

Recent boat-based surveys in the Dogger Bank Zone have recorded low numbers of great skuas between January and June 2010, with a peak of eight birds in April and six in June (Table 5.6) (Gardline, 2010a-f).

Based on the above, it is likely that low to moderate numbers of great skuas may be expected in the Dogger Bank Zone, with peak numbers likely to occur in the autumn months.

Table 5.6: Monthly mean density and numbers of great skuas recorded on ESAS surveys and 2010 boat-based surveys within the Dogger Bank Zone.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density [1] (birds/km^2)												
Numbers [2]	0	1	0	8	1	6	-	-	-	-	-	-
Relative abundance * (birds/line km)	0	< 0.1	0	< 0.1	< 0.1	< 0.1	-	-	-	-	-	-

1 after Skov *et al.* (1995)
2 Gardline (2010a-f)
* Monthly total divided by total number of km surveyed each month

- Very low density (<0.1 birds/km^2)
- Low density (0.1 – 0.9 birds/km^2)
- Moderate density (1.0 – 9.9 birds/km^2)
- High density (≥ 10.0 birds/km^2)

5.4.7 Little Gull

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

A recent JNCC statistical analysis of ESAS data investigating possible marine SPAs, highlighted the south-west corner of the Dogger Bank Zone as part of an area categorised as "near-qualifying" for little gulls in winter (Kober *et al.,* 2010) (see Section 5.4.7). 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), or on boat-based surveys in the Dogger Bank Zone between January and June 2010 (Gardline, 2010a-f).

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 (Holt *et al.,* 2009).

Based on the above, little gulls are likely to occur occasionally in low numbers in the Dogger Bank Zone, particularly in autumn.

5.4.8 Black-headed Gull

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).

ESAS surveys recorded black-headed gulls in very low density 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 density (Cork Ecology, 2009). Recent boat-based surveys in the Dogger Bank Zone have recorded low numbers of black-headed gulls between January and June 2010, with a peak of 13 birds in February (Gardline, 2010a-f).

Based on the above, low numbers of black-headed gulls are likely to occur within the Dogger Bank Zone occasionally.

5.4.9 Common Gull

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 density between Flamborough Head and The Wash from December to February, with very low density 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 density across the Dogger Bank Zone (Cork Ecology, 2009). Recent boat-based surveys in the Dogger Bank Zone recorded low numbers of common gulls between January and June 2010, with a peak of 19 birds in April (Gardline, 2010a-f).

Based on the above, low numbers of common gulls are likely to occur within the Dogger Bank Zone occasionally.

5.4.10 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 (AON), which is approximately 1.6 % of the UK breeding population (Table 5.2). There are no designated SPAs for the species in the Offshore ZDE (JNCC, 2010). 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).

In the Offshore ZDE, lesser black-backed gulls were recorded at low density 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 density from March to June (Table 5.7), 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 density occasionally throughout the Dogger Bank Zone (Cork Ecology, 2009).

Table 5.7: Monthly mean density and numbers of lesser black-backed gulls recorded on ESAS surveys and 2010 boat-based surveys within the Dogger Bank Zone.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density [1] (birds/km^2)												
Numbers [2]	0	3	17	606	215	386	-	-	-	-	-	-
Relative abundance* (birds/line km)	0	< 0.1	< 0.1	0.3	0.2	0.4	-	-	-	-	-	-

1 after Skov *et al.* (1995)
2 Gardline (2010a-f)
* Monthly total divided by total number of km surveyed each month

(white)	Very low density (<0.1 birds/km^2)
(light pink)	Low density (0.1 – 0.9 birds/km^2)
(pink)	Moderate density (1.0 – 9.9 birds/km^2)
(red)	High density (≥ 10.0 birds/km^2)

Results from recent 2010 boat-based surveys in the Dogger Bank Zone also followed this pattern, with very low numbers of lesser black-backed gulls recorded in February and March, with an increase to 606 birds in April (Table 5.7) (Gardline, 2010a-f), which is equivalent to approximately 0.5 % of the UK coastal breeding population (Mitchell *et al.,* 2004). When related to survey effort, this gave a relative abundance of 0.3 birds/km travelled for April (Table 5.7).

Based on the above, highest density of lesser black-backed gulls in the Dogger Bank Zone would be likely in spring and early summer.

5.4.11 Herring Gull

Numbers of herring gulls in the North Sea are highest during winter, when birds are widely dispersed. There are large breeding colonies of 533 AON at Flamborough Head and Bempton Cliffs, (0.4 % of the UK breeding population), and 1,003 AON at Outer Trial Bank in The Wash (0.7 % of the UK breeding population) (Table 5.2). Flamborough Head and Bempton Cliffs is the only SPA for breeding herring gulls in the Offshore ZDE (JNCC, 2010). 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).

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 density in the Dogger Bank Zone between November and February (Table 5.8), with highest average density of 1.7 birds/km^2 recorded in the south west corner of the Dogger Bank Zone (Skov *et al.,* 1995). Low density was recorded in March and April, with very low density recorded between May and October. Surveys in the Dogger Bank Zone in August and September 2008, recorded birds occasionally at very low to moderate density (Cork Ecology, 2009).

Recent 2010 boat-based surveys recorded herring gulls in low to moderate numbers between January and June 2010, with a peak of 225 birds in February (Table 5.8) (Gardline, 2010a-f), which is less than 0.1 % of the UK breeding population (Mitchell *et al.*, 2004). When related to survey effort, this gave a relative abundance of 0.2 birds/km for February (Table 5.8).

Based on the above, highest density of herring gulls in the Dogger Bank Zone would be likely in winter months. In summer, the majority of adult birds would be expected to move to their coastal breeding colonies.

Table 5.8: Monthly mean density and numbers of herring gulls recorded on ESAS surveys and 2010 boat-based surveys within the Dogger Bank Zone.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density [1] (birds/km^2)												
Numbers [2]	48	225	49	32	54	18	-	-	-	-	-	-
Relative abundance* (birds/line km)	0.3	0.2	< 0.1	< 0.1	< 0.1	< 0.1	-	-	-	-	-	-

1 after Skov *et al.* (1995)
2 Gardline (2010a-f)
* Monthly total divided by total number of km surveyed each month

(white)	Very low density (<0.1 birds/km^2)
(light pink)	Low density (0.1 – 0.9 birds/km^2)
(pink)	Moderate density (1.0 – 9.9 birds/km^2)
(red)	High density (≥ 10.0 birds/km^2)

5.4.12 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; JNCC, 2010). 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, highest density of great black-backed gulls (7.8 birds/km^2) was 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 density between August and October and at very low density in all other months (Table 5.9) (Skov *et al.,* 1995). Surveys in August and September 2008 recorded birds at very low to moderate density in the south-west of the Dogger Bank Zone and occasionally elsewhere in the Offshore ZDE (Cork Ecology, 2009).

Table 5.9: Monthly mean density and numbers of great black-backed gulls recorded on ESAS surveys and 2010 boat-based surveys within the Dogger Bank Zone.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density [1] (birds/km²)												
Numbers [2]	26	416	249	136	64	26	-	-	-	-	-	-
Relative abundance* (birds/line km)	0.2	0.4	0.1	< 0.1	< 0.1	< 0.1	-	-	-	-	-	-

1 after Skov *et al.* (1995)

2 Gardline (2010a-f)

* Monthly total divided by total number of km surveyed each month

Very low density (<0.1 birds/km²)

Low density (0.1 – 0.9 birds/km²)

Moderate density (1.0 – 9.9 birds/km²)

High density (≥ 10.0 birds/km²)

Recent 2010 boat-based surveys recorded great black-backed gulls in low to moderate numbers in the Dogger Bank Zone between January and June 2010, with a peak of 416 birds in February (Table 5.9) (Gardline, 2010a-f), which is equivalent to approximately 1.2 % of the UK breeding population (Mitchell *et al.*, 2004). When related to survey effort, this gave a relative abundance of 0.4 birds/km travelled for February (Table 5.9).

Based on the above, highest density of great black-backed gulls in the Dogger Bank Zone would be likely in winter months. In summer, the majority of adult birds would be expected to move to their coastal breeding colonies.

5.4.13 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 Flamborough Head and Bempton Cliffs, with 42,659 AON, which is approximately 11.6 % of the UK breeding population (Table 5.2). This colony is the only designated SPA for the species in the Offshore ZDE (JNCC, 2010). Kittiwakes eat a variety of fish, and can forage up to 200 km from colonies, although 25 km is the estimated mean range (Table 5.3).

Low to moderate kittiwake density was 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 density in all months (Table 5.10), with a peak mean density of 1.1 birds/km² recorded between April and September, and 1.6 birds/km² recorded between October and March (Skov *et al.*, 1995). Surveys in March 2008 recorded kittiwakes at high density (between 20.0 – 49.9 birds/km²) in the south-west of the Dogger Bank Zone, while surveys in August and September 2008, recorded kittiwakes at very low to moderate density over the southern half of the Dogger Bank Zone, and more sporadically in the northern half (Cork Ecology, 2009).

Table 5.10: Monthly mean density and numbers of kittiwakes recorded on ESAS surveys and 2010 boat-based surveys within the Dogger Bank Zone.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density [1] (birds/km²)												
Numbers [2]	100	2,164	3,180	3,099	854	1,879	-	-	-	-	-	-
Relative abundance* (birds/line km)	0.6	1.9	1.8	1.4	0.6	1.7	-	-	-	-	-	-

1 after Skov *et al.* (1995)

2 Gardline (2010a-f)

* Monthly total divided by total number of km surveyed each month

Very low density (<0.1 birds/km²)

Low density (0.1 – 0.9 birds/km²)

Moderate density (1.0 – 9.9 birds/km²)

High density (≥ 10.0 birds/km²)

Kittiwakes were regularly recorded on surveys between January and June 2010, with a peak of 3,180 birds in March (Table 5.10) (Gardline, 2010a-f), which is equivalent to approximately 0.4 % of the UK breeding population (Mitchell *et al.*, 2004). When related to survey effort, this gave a relative abundance of 1.8 birds/km for March (Table 5.10).

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 (Table 5.1) (TCE, 2010).

Based on the above, kittiwakes are likely to occur at moderate to occasionally high density in the Dogger Bank Zone throughout the year.

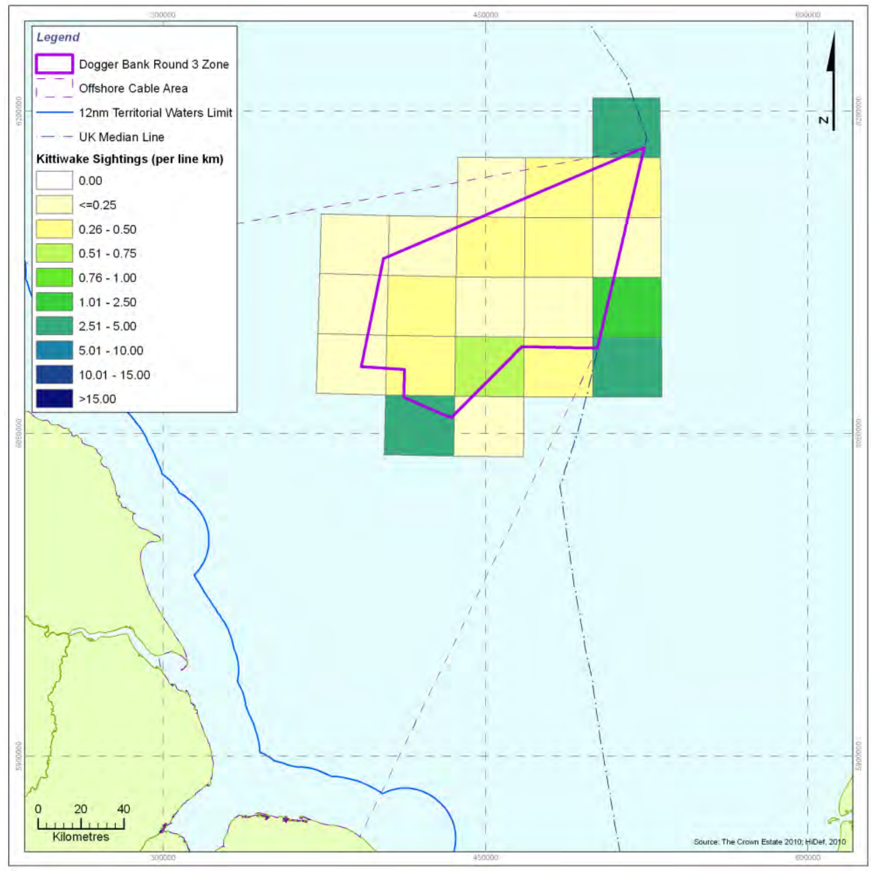

Figure 5.1 Relative abundance of kittiwake sightings based upon high definition aerial surveys between December 2009 and February 2010.

5.4.14 Terns

Terns are summer visitors to the North Sea (Tasker *et al.*, 1987). Within the Offshore ZDE, five nationally important colonies of little terns, support approximately 27.4 % of the UK breeding population (Table 5.2, Figure 5.3). There are also two nationally important colonies of common terns (6.0 % of UK breeding population) and one nationally important colony of sandwich terns (32.8 % of UK breeding population) and roseate terns (3.8 % of UK breeding population (Table 5.2). Very low numbers of arctic terns also breed within these colonies each year (Mitchell *et al.*, 2004). All of these colonies are designated SPAs for these species (JNCC, 2010).

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 density in the south-west 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 2010 boat-based surveys in the Dogger Bank Zone recorded low numbers (less than 10 birds) of common and arctic terns in April and May 2010 (Gardline, 2010a-f).

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. Numbers involved are likely to vary between seasons and years.

5.4.15 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 north-east England in July and August. The largest guillemot breeding colony within the Offshore ZDE is at Flamborough Head and Bempton Cliffs, with 46,685 individuals, which is approximately 3.5 % of the UK breeding population (Table 5.2). This colony is the only designated SPA for the species in the Offshore ZDE (JNCC, 2010). Guillemots eat a variety of fish, and can forage up to 200 km from colonies, although 25 km is the estimated mean range (Table 5.3).

In the Dogger Offshore ZDE, highest density of guillemots (34.7 birds/km^2) on ESAS surveys was recorded offshore from Teeside 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 density of guillemots were also recorded around Flamborough Head from March to June (Skov *et al.,* 1995).

On ESAS surveys in the Dogger Bank Zone, highest guillemot density was recorded between November and February in the south-west of the Dogger Bank Zone (Table 5.11), with a peak mean density of 10.9 birds/km^2 in the south-west corner of the Dogger Bank Zone. A recent JNCC statistical analysis investigating possible marine SPAs included this area as part of an area categorised as "near-qualifying" for guillemots in winter (Kober *et al.,* 2010) (see Section 5.4.15).

Moderate density was 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 density (20.0 – 49.9 birds/km^2) in the south-west of the Dogger Bank Zone, while very low to moderate density of guillemots was recorded sporadically across the Dogger Bank Zone in August and September 2008 (Cork Ecology, 2009).

Table 5.11: Monthly mean density and numbers of guillemots recorded on ESAS surveys and 2010 boat-based surveys within the Dogger Bank Zone.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density [1] (birds/km^2)												
Numbers [2]	145	2,134	4,389	1,045	468	236	-	-	-	-	-	-
Relative abundance* (birds/line km)	0.9	1.8	2.5	0.5	0.3	0.2	-	-	-	-	-	-

1 after Skov *et al.* (1995)

2 Gardline (2010a-f)

* Monthly total divided by total number of km surveyed each month

	Very low density (<0.1 birds/km^2)
	Low density (0.1 – 0.9 birds/km^2)
	Moderate density (1.0 – 9.9 birds/km^2)
	High density (≥ 10.0 birds/km^2)

Peak guillemot numbers on recent 2010 boat-based surveys in the Dogger Bank Zone occurred in March, when 4,389 birds were recorded (Table 5.11) (Gardline, 2010a-f). This is equivalent to approximately 0.3 % of the UK breeding population (Mitchell *et al.,* 2004). When related to survey effort, this gave a relative abundance of 2.5 birds/km in March (Table 5.11). 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.

Aerial surveys of the Dogger Bank Zone between May 2009 and April 2010 observed a similar distribution pattern. Auks were widespread across the Dogger Bank Zone at moderate abundance (5.01 to 10.0 birds/km) in January 2010, while highest abundance was recorded in February 2010 in the south-west corner (> 15 birds/km) (Figure 5.2) (TCE, 2010). 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 in 2010 (Gardline 2010a-f).

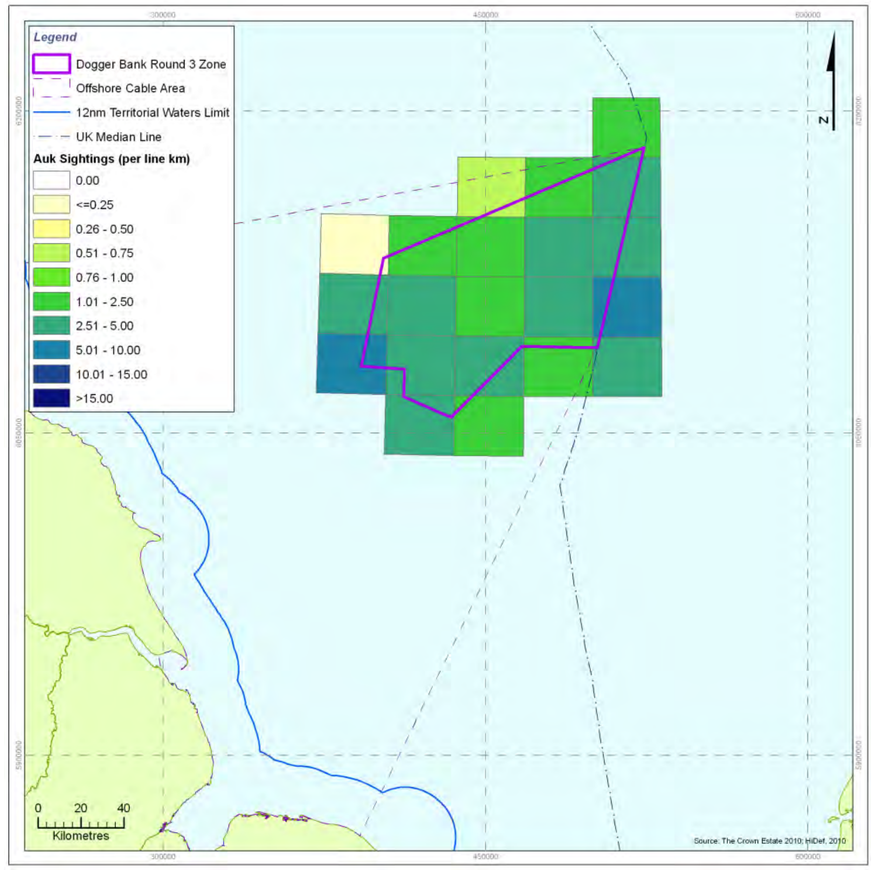

Figure 5.2 Relative abundance of Auk sightings based upon high definition aerial surveys between May 2009 and April 2010.

Based on the above, highest densities of guillemots in the Dogger Bank Zone are likely to occur in mid to late winter, with the south-west of the Dogger Bank Zone likely to support highest densities of guillemots at this time.

5.4.16 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 Flamborough Head and Bempton Cliffs, with 8,539 individuals, which is approximately 5.2 % of the UK breeding population (Table 5.2). This colony is the only designated SPA for the species in the Offshore ZDE (JNCC, 2010). Razorbills eat a variety of fish, and can forage up to around 50 km from colonies, although 10 km is the estimated mean range (Table 5.3).

In the Offshore ZDE, highest density of razorbills (6.35 birds/km^2) on ESAS surveys was recorded between Tees Bay 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 density throughout the year (Table 5.12) (Skov *et al.,* 1995). In March 2008 razorbills were recorded at high density (10.0 – 19.9 birds/km^2) in the south-west of the Dogger Bank Zone, while very low to moderate density of razorbills was recorded in August and September 2008 (Cork Ecology, 2009).

Table 5.12: Monthly mean density and numbers of razorbills recorded on ESAS surveys and 2010 boat-based surveys within the Dogger Bank Zone.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density [1] (birds/km^2)												
Numbers [2]	234	750	1,317	465	58	39	-	-	-	-	-	-
Relative abundance* (birds/line km)	1.5	0.6	0.8	0.2	< 0.1	< 0.1	-	-	-	-	-	-

1 after Skov *et al.* (1995)
2 Gardline (2010a-f)
* Monthly total divided by total number of km surveyed each month

- Very low density (<0.1 birds/km^2)
- Low density (0.1 – 0.9 birds/km^2)
- Moderate density (1.0 – 9.9 birds/km^2)
- High density (≥ 10.0 birds/km^2)

Recent 2010 boat-based surveys regularly recorded razorbills between January and June 2010, with a peak of 1,317 birds in March (Table 5.12) (Gardline, 2010a-f). This is equivalent to approximately 0.8 % of the UK breeding population (Mitchell *et al.,* 2004). When related to survey effort, this gave a relative abundance of 0.8 birds/km in March (Table 5.12). Relative abundance was higher in January, but survey effort was very low in this month.

Based on the above, razorbills are likely to occur within the Dogger Bank Zone in generally low densities throughout the year, with peak density likely to be recorded in mid to late winter. The south-west of the Dogger Bank Zone may support highest densities of guillemots at this time.

5.4.17 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 density 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 5.13), 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 south-west corner of the Dogger Bank Zone as part of an area categorised as "near-qualifying" for little auks in winter (Kober *et al.,* 2010) (see Section 5.4.17).

Little auks were recorded at very low to low density in the south-west of the Dogger Bank Zone in March 2008 (Cork Ecology, 2009).

Table 5.13: Monthly mean density and numbers of little auks recorded on ESAS surveys and 2010 boat-based surveys within the Dogger Bank Zone.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density [1] (birds/km^2)			-	-	-	-	-	-	-			
Numbers [2]	0	157	3	0	0	0	-	-	-	-	-	-
Relative abundance* (birds/line km)	0	0.1	< 0.1	0	-	-	-	-	-	-	-	-

1 after Skov *et al.* (1995)
2 Gardline (2010a-f)
* Monthly total divided by total number of km surveyed each month

- \- Not present at this time of year
- Very low density (<0.1 birds/km^2)
- Low density (0.1 – 0.9 birds/km^2)
- Moderate density (1.0 – 9.9 birds/km^2)
- High density (≥ 10.0 birds/km^2)

Recent 2010 boat-based surveys in the Dogger Bank Zone recorded 157 little auks in February, with just three birds in March and none in subsequent months (Table 5.13) (Gardline, 2010a-f). When related to survey effort, this gave a relative abundance of 0.1 birds/km in February (Table 5.13).

Based on the above, little auks are likely to occur in low to moderate densities within the Dogger Bank Zone in winter months, with February likely to be the peak month.

5.4.18 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 Flamborough Head and Bempton Cliffs, with 2,615 individuals, which is approximately 0.5 % of the UK breeding population (Table 5.2). This colony is the only designated SPA for the species in the Offshore ZDE (JNCC, 2010). Puffins eat a variety of fish, and can forage up to 200 km from colonies, although 30 km is the estimated mean distance (Table 5.3).

On ESAS surveys in the Offshore ZDE, puffins were recorded in moderate density 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 density of puffins in all months (Table 5.14) (Skov *et al.,* 1995). Surveys in March, August and September 2008 recorded very low to low density of puffins in the Dogger Bank Zone (Cork Ecology, 2009).

Table 5.14: Monthly mean density and numbers of puffins recorded on ESAS surveys and 2010 boat-based surveys within the Dogger Bank Zone.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Density [1] (birds/km^2)												
Numbers [2]	4	153	106	112	40	113	-	-	-	-	-	-
Relative abundance* (birds/line km)	< 0.1	0.1	< 0.1	< 0.1	< 0.1	0.1	-	-	-	-	-	-

1 after Skov *et al.* (1995)
2 Gardline (2010a-f)
* Monthly total divided by total number of km surveyed each month

- Very low density (<0.1 birds/km^2)
- Low density (0.1 – 0.9 birds/km^2)
- Moderate density (1.0 – 9.9 birds/km^2)
- High density (≥ 10.0 birds/km^2)

Recent 2010 boat-based surveys in the Dogger Bank Zone regularly recorded puffins between January and June 2010, with a peak of 153 birds in February (Table 5.14) (Gardline, 2010a-f). When related to survey effort, this gave a relative abundance of 0.1 birds/km for February (Table 5.14).

Based on the above, puffins are likely to occur in low densities within the Dogger Bank Zone throughout the year.

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 wildfowl, waders, and terrestrial (or land) birds.

5.5.1 Important sites for wildfowl and waders

Within the Offshore ZDE, there are five sites on the east coast of England that regularly hold important numbers of wildfowl and waders (Table 5.15) (Holt *et al.*, 2009). 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 (Holt *et al.*, 2009). Several species are qualifying interest features for the SPA status of the sites (see also Chapter 7 – *Nature Conservation*).

Table 5.15: Summary of important coastal sites for wintering/migrating wildfowl and waders within the Offshore ZDE.

Site	Average number of birds [1]	Main Species [2]	SPA qualifying interest [3]
The Wash SPA	371,308	**Pink-footed Goose, Dark-bellied Brent Goose, Shelduck, Pintail, Oystercatcher, Ringed Plover, Golden Plover, Grey Plover, Lapwing, Knot, Sanderling, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Curlew, Redshank**, Wigeon, Teal, Eider, Cormorant, Avocet, Greenshank, Lesser Black-backed Gull, Great Black-backed Gull, Mallard	Winter: Bewick's Swan, Bar-tailed Godwit, Pintail, Wigeon, Gadwall, Pink-footed Goose, Turnstone, Dark-bellied Brent Goose, Goldeneye, Sanderling, Dunlin, Knot, Oystercatcher, Black-tailed Godwit, Common Scoter, Whimbrel, Grey Plover, Shelduck Redshank
North Norfolk Coast SPA	206,703	**Pink-footed Goose, Dark-bellied Brent Goose, Wigeon, Pintail, Ringed Plover, Knot, Black-tailed Godwit, Bar-tailed Godwit**, European White-fronted Goose, Gadwall, Teal, Shoveler, Common Scoter, Red-breasted Merganser, Red-necked Grebe, Cormorant, Oystercatcher, Avocet, Golden Plover, Grey Plover, Sanderling, Ruff, Curlew, Redshank, Greenshank, Turnstone, Great Black-backed Gull, Sandwich Tern	Winter: Wigeon, Pink-footed Goose, Dark-bellied Brent Goose, Knot
Humber Estuary SPA	174,780	**Pink-footed Goose, Dark-bellied Brent Goose, Shelduck, Ringed Plover, Golden Plover, Grey Plover, Lapwing, Knot, Dunlin, Black-tailed Godwit, Bar-tailed Godwit, Redshank**, Teal, Goldeneye, Oystercatcher, Avocet, Ringed Plover, Grey Plover, Sanderling, Ruff, Curlew, Turnstone, Common Gull, Great Black-backed Gull, Mallard	Winter: Bar-tailed Godwit, Golden Plover, Avocet, Dunlin, Knot, Black-tailed Godwit, Shelduck, Redshank Passage: Ruff, Dunlin, Knot, Black-tailed Godwit, Redshank
Tees Estuary SPA	23,988	Shoveler, Cormorant, Sanderling, Ruff, Redshank, Great Black-backed Gull	Winter: Knot, Passage: Sandwich Tern, Redshank

Source: Holt *et al.*, (2009)

[1] Average number taken from WeBS data collected between winter 2003/04 and 2007/08

[2] Species occurring in internationally important numbers are highlighted in blue.

[3] SPA qualifying interest from www.jncc.gov.uk

Waders and other 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 and wildfowl 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 East Atlantic Flyway, as they are listed as regularly supporting more than five wader species recorded in internationally important numbers (Delaney *et al.*, 2009).

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 ducks, geese, waders, 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.

Ongoing boat-based surveys in the Dogger Bank Zone recorded 10 different species of wildfowl and waders and 33 different terrestrial (or land) bird species between January and June 2010 (Table 5.16 and Table 5.17).

Most species of wildfowl and wader were recorded in low numbers, with geese accounting for 40.0 % of the numbers to date (Table Table 5.16). The majority of birds were recorded in February (40.0 %), while the highest number of different species (5) was recorded in April.

Just over half (50.7 %) of all land birds recorded were starlings (Table 5.17), with the majority of these recorded in March. All other species were recorded in low numbers, with 15 redwings and 12 fieldfare the next highest numbers recorded. Both species are thrushes which migrate to the UK in large numbers for the winter months. The majority of birds were recorded in March, and the highest number of species was recorded in April.

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).

Table 5.16: Numbers of waders and wildfowl recorded on surveys in the Dogger Bank Zone between January and June 2010.

Species	January	February	March	April	May	June
Mallard	0	0	0	2	0	0
Pintail	0	0	2	0	0	0
Tufted Duck	0	0	0	0	1	0
Goldeneye	0	0	0	0	0	1
Goosander	0	0	0	2	0	0
Bean Goose	2	0	0	0	0	0
Greylag Goose	0	0	0	1	0	0
Goose species	0	14	0	0	0	0
Oystercatcher	0	2	0	0	0	0
Curlew	0	0	0	9	1	0
Whimbrel	0	0	0	1	3	1
Woodcock	0	1	0	0	0	0
Total birds	**2**	**17**	**2**	**15**	**5**	**2**
Total species	**1**	**2**	**1**	**5**	**3**	**2**

Source: Gardline (2010a-f)

Table 5.17: Land birds recorded on surveys in the Dogger Bank Zone between January and June 2010.

Species	January	February	March	April	May	June
Osprey	0	0	0	1	0	0
Kestrel	0	0	1	0	0	1
Wood Pigeon	0	1	1	2	4	0
Collared Dove	0	0	0	1	3	1
Swift	0	0	0	0	1	
Skylark	0	0	0	1	0	0
Swallow	0	0	0	4	10	7
House Martin	0	0	0	1	0	2
Meadow Pipit	0	0	4	7	0	0
Pipit species	0	0	0	0	1	0
Pied/White Wagtail	0	1	2	1	1	1
Yellow Wagtail	0	0	0	1	0	0
Waxwing	0	1	0	0	0	0
Bluethroat	0	0	0	0	1	0
Black Redstart	0	0	5	0	0	0
Wheatear	0	0	0	3	0	0
Song Thrush	0	1	1	0	0	0
Redwing	8	0	7	0	0	0
Fieldfare	3	6	3	0	0	0
Blackbird	0	2	6	1	0	0
Thrush species	0	1	0	0	0	0
Garden Warbler	0	0	0	2	0	0
Blackcap	0	0	0	3	0	0
Lesser Whitethroat	0	0	0	0	1	0
Reed Warbler	0	0	0	0	0	2
Marsh Warbler	0	0	0	0	0	1
Sedge Warbler	0	0	0	1	0	0
Grasshopper Warbler	0	0	0	4	0	0
Willow Warbler	0	0	0	2	1	0
Chiffchaff	0	0	4	7	0	0
Warbler species	0	0	1	2	0	0
Starling	1	0	152	0	0	0
Carrion Crow	0	0	0	3	0	0
Chaffinch	0	0	1	0	0	0
Finch species	0	0	0	2	0	0
Dark-eyed Junco	0	0	0	0	1	0
Pallas's Reed Bunting	0	0	0	0	0	1
Total birds	**12**	**13**	**188**	**49**	**24**	**16**
Total species	**3**	**6**	**12**	**18**	**10**	**8**

Source: Gardline (2010a-f)

5.5.3 Likely key species in Dogger Bank Zone

A recent report by Langston (2010) highlighted the species most likely to be of particular concern with regard to wind farm construction due to their perceived interaction with offshore wind farms. Species likely to be of concern in the Dogger Bank Zone, as well as the main likely area of concern are listed below (Table 5.18).

Fulmar

Of the species listed in Table 5.18, fulmars are considered to be at low risk of possible collision impacts, displacement issues and barrier affects 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, 2010a-f), fulmars are likely to occur in the Dogger Bank Zone throughout the year at moderate density.

Table 5.18: Species likely to be of particular concern in the Dogger Bank Zone.

Species	Likely area of concern
Fulmar	Potential collision
Gannet	Potential collision
Gulls (Lesser black-backed Gull, Herring Gull and Great black-backed Gull)	Potential collision
Kittiwake	Potential collision
Auks (Guillemot, Razorbill and Puffin)	Possible displacement
Migrating waterbirds	Potential collision

Source: Langston (2010)

Although fulmars do breed at coastal colonies within the Offshore ZDE, there are no designated SPAs for the species within the Offshore ZDE. Beyond the Offshore ZDE boundary, the nearest SPA for breeding fulmars is the Firth of Forth Islands SPA (JNCC, 2010). With an estimated maximum foraging range of over 600 km, it is possible that fulmars from this SPA and more distant SPAs could forage within the Dogger Bank Zone. Further research would be required to ascertain the degree that this occurs.

Gannet

Gannets are considered to be at moderate risk of possible collision impacts, and low risk of displacement issues, barrier affects 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, 2010a-f), gannets are likely to occur at low to moderate density in the Dogger Bank Zone throughout the year.

There is one designated SPA for breeding gannets (Flamborough Head and Bempton Cliffs) (JNCC, 2010) within the Offshore ZDE, which is also England's largest onshore gannetry (Wanless *et al.,* 2005). With an estimated maximum foraging range of over 600 km, it is possible that gannets from this SPA and more distant SPAs outside the Offshore ZDE such as the Bass Rock (Firth of Forth Islands SPA) could forage within the Dogger Bank Zone. Further research would be required to ascertain the degree that this occurs.

Gulls

Gulls are listed by Langston (2010) as being at risk of possible collision impacts in the Dogger Bank Zone. Based on species density 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 affects 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, 2010a-f), lesser black-backed gulls are likely to occur in the Dogger Bank Zone at low density in spring and summer months, while herring gull and great black backed gulls are likely to occur at moderate density 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 breeding herring gulls within the Offshore ZDE (JNCC, 2010). 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), so would not be expected to forage in the Dogger Bank Zone during the breeding season.

Kittiwake

Kittiwakes are considered to be at moderate risk of possible collision impacts, and low risk of displacement issues, barrier affects 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, 2010a-f), kittiwakes are likely to occur at moderate to occasionally high density 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 (JNCC, 2010), which supported 11.6 % of the UK breeding population during the Seabird 2000 census (Mitchell *et al.,* 2004). With an estimated maximum foraging range of approximately 200 km, it is possible that kittiwakes from this SPA and SPAs outside the Offshore ZDE such as the Farne Islands or Firth of Forth Islands could forage within the Dogger Bank Zone. Further research would be required to ascertain the degree that this occurs.

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 affects 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, 2010a-f) compared to numbers and densities of razorbills, puffins and little auks, it is considered that guillemot is more likely to be at risk of these potential impacts. 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 little auk does not breed in the UK, there is one designated SPA within the Offshore ZDE (Flamborough Head and Bempton Cliffs) for breeding guillemots, razorbills and puffins (JNCC, 2010), which supported 3.5 % of the UK breeding population of guillemots, 5.2 % of razorbills and 0.5 % of puffins during the Seabird 2000 census (Mitchell *et al.,* 2004). Both guillemots and puffins have an estimated maximum foraging range of approximately 200 km, so it is possible that birds from this SPA and other east coast SPAs outside the Offshore ZDE such as the Farne Islands, Firth of Forth Islands or Coquet Island (puffin) could forage within the Dogger Bank Zone. Further research would be required to ascertain the degree that this occurs.

Waterfowl

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

5.5.4 Marine SPAs

A recent JNCC statistical analysis investigating possible marine SPAs using a series of qualifying features, included part of the south-west 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 (Kober *et al.,* 2010).

5.6 Summary

It can be seen from this review that at least fifteen species of seabirds are likely to occur regularly in the Dogger Bank Zone and Offshore ZDE, although the distribution and abundance of these species varies throughout the year. At least seven of these species are likely to be key seabird species within the Dogger Bank Zone, based on the likely distribution within the Dogger Bank Zone and their potential response to offshore wind farms. The seven highlighted species are fulmar, gannet, lesser black-backed gull, herring gull, great black backed gull, kittiwake and guillemot. In addition, razorbill, little auk and puffin may also be important species in the Dogger Bank Zone, depending on the time of 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 wildfowl, waders, and terrestrial (or land) birds.

Ongoing 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 wildfowl, waders and land birds.

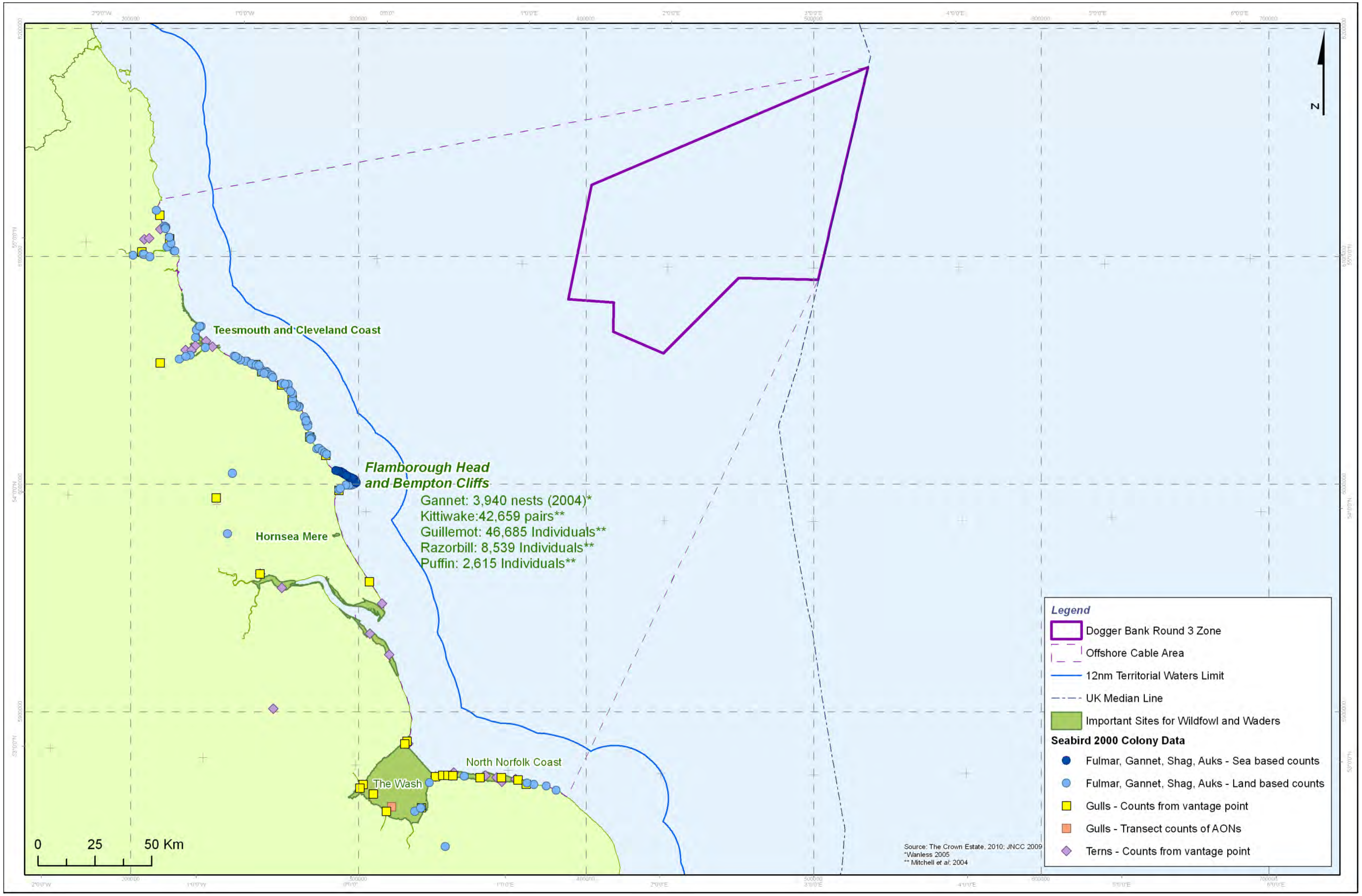

Figure 5.3: Seabird colonies within the Offshore ZDE. Source: JNCC, 2009; Wanless, 2005; Mitchell *et al.*, 2004)

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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 varies throughout the year. The main factors affecting marine mammal distribution is the availability of their food and location of breeding areas (DECC, 2009).

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 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 likely 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).

- Atlas of cetacean distribution in north-west 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 and data from the first 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.7 of the recent Offshore Energy SEA (DECC, 2009), which contains 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) and on movements and foraging areas of grey seals in the North Sea (McConnell *et al.,* 1999).
- Final report on seabird and marine mammal surveys in the North Sea between February 2008 and March 2009 for DECC (Cork Ecology, 2009).
- Data from recent aerial surveys of the Dogger Bank Zone conducted by WWT at the request of the Crown Estate. The first four surveys (May 2009 to August 2009) were visual aerial surveys carried out by the Wildfowl & Wetlands Trust (WWT). The following six surveys (November 2009 to April 2010) were high definition video camera aerial surveys carried out by HiDef Limited. Survey coverage in May to August 2009 was not complete across the whole Dogger Bank Zone. Figures showing relative abundance (animals/km) for harbour porpoise are shown in Appendix F.
- Summary reports from monthly surveys of the Dogger Bank Zone conducted by Gardline for Forewind. Boat-based surveys commenced in January 2010 and are ongoing (Gardline, 2010a-f).

6.2.2 Data limitations and gaps

The JNCC Cetacean Atlas (Reid *et al.,* 2003) utilised data from the 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 is now quite old, it is still useful to provide an overview of marine mammal distribution and abundance. While the data from SCANS I is more recent than some of the ESAS data, and was analysed using Distance software to produce population estimates, it was limited to surveys during July only, and so does not take seasonal variation into account. Data from the Sea Watch Foundation was mostly collected from land, and so is predominantly focussed 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 is summarised in Section 5.2.3 of Chapter 5 - *Birds*.

The programme of boat-based surveys in the North Sea 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 south-east 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 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 and June 2010 (Gardline, 2010a-f) 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, Risso's dolphin and common seal may occur occasionally (Reid *et al.*, 2003).

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 regularly in the Dogger Bank Zone, as it is generally a more coastal species (Sharples *et al.*, 2005; McConnell *et al.*, 1999).

A summary of the likely occurrence of marine mammal species within the Dogger Bank Zone and Offshore ZDE is shown in Table 6.1.

Table 6.1: Summary of likely occurrence of marine mammals in the Offshore ZDE

Species	Dogger Offshore ZDE	Dogger Bank Zone
Minke Whale	Regular, occurs throughout the year, mainly between May and September	Regular, occurs throughout the year, mainly between May and September
White-beaked Dolphin	Common, occurs throughout the year, mainly between June and October	Common, occurs throughout the year, mainly between June and October
Bottlenose Dolphin	Occasional	Occasional
Common Dolphin	Occasional	Occasional
Atlantic white-sided Dolphin	Occasional	Occasional
Risso's Dolphin	Occasional	Occasional
Harbour Porpoise	Common, occurs throughout the year, with peak numbers between June and October	Common, occurs throughout the year, with peak numbers between June and October
Grey Seal	Regular, all year	Regular, all year
Common Seal	Regular, all year	Occasional

Sources: Reid *et al.*, (2003); Sharples *et al.*, (2005); McConnell *et al.*, (1999).

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.

Table 6.2: Summary of diet, distribution and breeding seasons of regular marine mammal species within the Dogger Bank Zone and Offshore Cable Area.

Species	Diet	Distribution	Breeding season
Minke Whale	Wide variety of fish including herring, cod, capelin, haddock, siathe & 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

Sources: Reid *et al.*, (2003); Hayden and Harrington (2000); Evans (1987)

A summary of survey effort on boat-based surveys in the Dogger Bank Zone between January and June 2010 is presented in Table 6.3.

Table 6.3: Summary of survey effort on boat-based surveys in the Dogger Bank Zone between January and June 2010.

Species	January	February	March	April	May	June
Marine mammal species seen	0	5	4	4	4	4
Total hours effort	12.6	94.7	141.2	194.7	116.7	112.2
Percentage survey effort recorded in sea states 0 - 3	100 %	52 %	65 %	91 %	91 %	95 %
Total km travelled	157.65	1,164.78	1,734.23	2,252.79	1,368.22	1097.9

Source: Gardline (2010a-f)

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 below. These accounts are based on information presented in Reid *et al.*, (2003) and SCANS II (2008), as well as other more recent surveys (Cork Ecology 2009; Gardline, 2010a-f).

6.4.1 Minke Whale

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 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 6.4) (Gardline, 2010a-f). Three of the May sightings involved adults and juvenile animals (Gardline, 2010a-f).

Table 6.4: Monthly totals of minke whales recorded on boat-based surveys in the Dogger Bank Zone between January and June 2010.

	January	February	March	April	May	June
Number of animals	0	0	0	0	20	48+
Animals/hour	0	0	0	0	0.2	0.4
Animals/ km	0	0	0	0	< 0.1	< 0.1

Source: Gardline (2010a-f).

The hourly encounter rate (number of animals divided by number of hours of survey effort) for May was 0.2 animals/hour, which increased to 0.4 animals/hour (or 0.04 animals/km) in June, although this included data recorded in all sea states (Table 6.4).

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

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. Fewer animals were recorded in June (Table 6.5) (Gardline, 2010a-f).

Table 6.5: Monthly totals of white-beaked dolphins recorded on boat-based surveys in the Dogger Bank Zone between January and June 2010.

	January	February	March	April	May	June
Number of animals	0	18	14	38	141	45
Animals/hour	0	0.2	0.1	0.2	1.2	0.4
Animals/ km	0	< 0.1	< 0.1	< 0.1	0.1	< 0.1

Source: Gardline (2010a-f).

The hourly encounter rate for May was 1.2 animals/hour (or 0.1 animal/km) (Table 6.5), although this included data recorded in all sea states.

Based on these results, it is likely that white-beaked dolphins occur regular in the Dogger Bank Zone, in varying numbers.

6.4.3 Harbour Porpoise

Harbour porpoise is the most common cetacean species in UK waters, including the Dogger Bank Zone and Offshore Cable Area. There are currently no designated SACs for harbour porpoise in the UK. However, harbour porpoise is listed as a non-qualifying feature of the Dogger Bank pSAC. In addition, the species is listed as resident on the Dutch and German Dogger Bank SCIs, and on the Dutch Claverbank SCI (Natura 2000, 2006, 2008a and 2008b). Information on conservation designations for other European countries is contained in Chapter 7 – *Nature Conservation*.

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).

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 using a high definition video camera between December 2009 and April 2010 also recorded very low relative abundance of harbour porpoise (less than 0.25 animals/km) (Appendix F) (TCE, 2010).

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, when 58 animals were recorded. Numbers dropped again in June, with only six animals recorded (Table 6.6) (Gardline, 2010a-f).

Table 6.6: Monthly totals of harbour porpoise recorded on boat-based surveys in the Dogger Bank Zone between January and June 2010.

	January	February	March	April	May	June
Number of animals	0	3	9	2	58	6
Animals/hour	0	< 0.1	< 0.1	< 0.1	0.5	< 0.1
Animals/ km	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

Source: Gardline (2010a-f).

The hourly encounter rate in May was 0.5 animals/hour or 0.04 animals/km, although this included data recorded in all sea states (Table 6.6). Detection rate per km in May 2010 was broadly similar to 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 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 (Table 6.3) (Gardline, 2010a-f).

These results indicate that the generally low numbers of harbour porpoises recorded to date on the 2010 surveys may be an accurate reflection of numbers present in the Dogger Bank Zone.

6.4.4 Atlantic White-sided Dolphin

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). There were no positively identified sightings of white-sided dolphins on boat-based 2010 surveys in the Dogger Bank Zone, although three animals, which were probably this species, were seen at distance during the March survey (Gardline, 2010a-f).

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, common dolphin, and Risso's dolphin (Reid *et al.,* 2003).

6.4.6 Grey Seal

Over 90 % of the UK 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 6.1). There is one SAC (Humber Estuary) within the Offshore ZDE for which grey seal is a qualifying feature but not a primary reason for site selection (JNCC, 2010). In addition, the species is listed as resident on the Dutch Dogger Bank SCI, and on the Dutch Claverbank SCI (Natura 2000, 2006, 2008a & 2008b). See Chapter 7 – *Nature Conservation* for additional SAC information, including conservation designations for other European countries.

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 km 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 2010 surveys have recorded low numbers of grey seals in the Dogger Bank Zone between February and June, with a peak of 15 animals in March and May (Table 6.7) (Gardline, 2010a-f).

Table 6.7: Monthly totals of grey seals recorded on boat-based surveys in the Dogger Bank Zone between January and June 2010.

	January	February	March	April	May	June
Number of animals	0	6	15	6	15	1
Animals/hour	0	< 0.1	0.1	< 0.1	0.1	< 0.1
Animals/ km	0	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1

Source: Gardline (2010a-f).

The hourly encounter rate in both March and May was 0.1 animals/hour, although this included data recorded in all sea states (Table 6.7).

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.

6.4.7 Common Seal

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 (Table 6.1). Common seals are widespread in the coastal waters around these colonies and haul-out sites (DECC, 2009). 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). In addition, the species is listed as resident on the Dutch Dogger Bank SCI, and on the Dutch Claverbank SCI, and is listed as occurring on migration on the German Dogger Bank SCI (Natura 2000, 2006, 2008a & 2008b). See Chapter 7 – *Nature Conservation* for additional SAC information, including conservation designations for other European countries.

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. Densities at sea are therefore likely to be lower during this period than at other times of the year (DECC, 2009).

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 surveys recorded seven common seals in the Dogger Bank Zone in February, but no sightings between March and June (Gardline, 2010a-f). The hourly encounter rate for February was 0.07 animals/hour, although this included data recorded in all sea states.

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 range offshore.

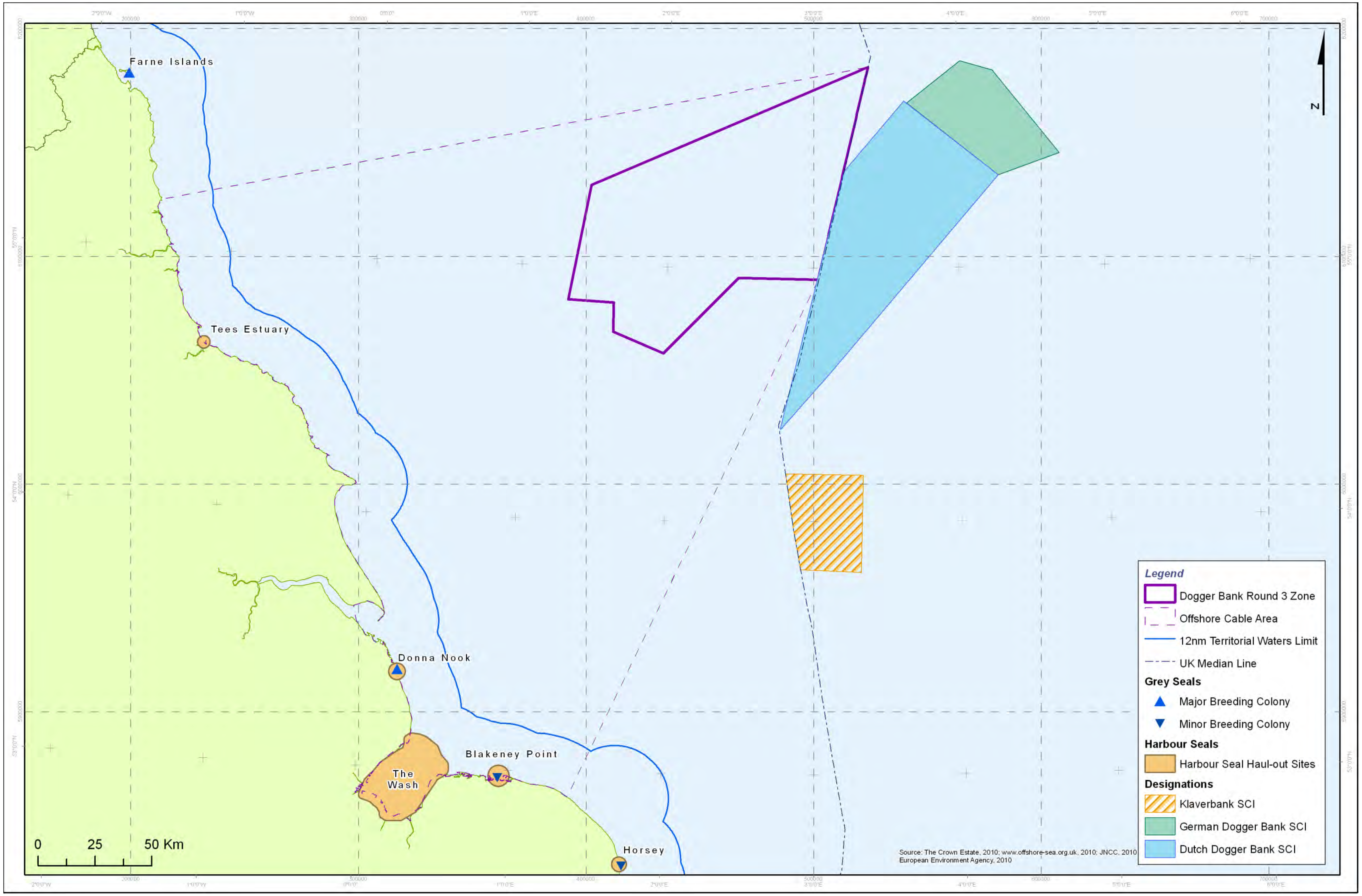

Figure 6.1 Grey seal breeding colonies and harbour seal haul-out sites within and in the vicinity of the Offshore ZDE. Source: www.offshore-sea.org.uk, 2010; JNCC, 2010; European Environment Agency,2010.

6.5 Summary

It can be seen from this review that, based on current available published data, 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, bottlenose dolphin, common dolphin, Atlantic white-sided dolphin, Risso's dolphin and common seal may occur occasionally.

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.

Ongoing 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 data 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 habitat and species features they support constitute one of the most important consenting issues for the development and as such this chapter draws upon a number of site specific and general studies to provide the wider context for designated sites.

The chapter includes background context on appropriate conventions and legislation related to nature conservation. It also provides a description of offshore designations (UK and other coastal North Sea nations and the key inshore designations determined from international, national and local legislation. Consideration is given to requirements for appropriate assessment, transboundary issues and areas for development within the Dogger Bank Zone.

Designated sites which have a marine and/or coastal element and which fall within the Dogger Bank Zone and Offshore Cable Area have all been considered within this chapter. Land based sites are covered within the Onshore Zonal Characterisation and will be found in Chapters 16 and 17. International, national and local nature conservation sites are located within the wider ZDE. International sites include Special Areas of Conservation (SACs), Special Protection Areas, (SPAs) and Ramsar sites supporting habitat features (or habitats supporting bird interest features); SAC and Ramsar sites with mobile species (i.e. marine mammals) interest features, and SPAs and Ramsar sites with migratory bird interest features. All of which require assessment for impacts arising from the construction, operation and decommissioning of the proposed wind farm.

The coastlines of Northumbria, Yorkshire, Lincolnshire and North Norfolk also support numerous, national and local designations with coastal features that require consideration for cable route and associated infrastructure.

In addition to the suite of designated sites that fall within the wider ZDE, SACs outside the ZDE that support mobile marine species (i.e. marine mammals) have been included to account for any likely effects on disturbance and displacement from foraging grounds and haul out sites, and changes in prey species. Migratory and foraging bird species designated under SPAs and Ramsar sites have been considered in the context of known migratory routes and foraging distances.

7.2 Data and Literature

The nature conservation designations (including Annex I habitats) have all been incorporated into GIS from JNCC and Natural England.

Information on the spatial distribution and qualifying features for designated sites and potential sites of nature conservation and their conservation objectives can be interpreted from these sources in GIS.

Data on the Dogger Bank pSAC have been reviewed from a number of sources, principally as part of the selection assessment and surveys and investigations being undertaken to support the designations commissioned by JNCC. Additional studies looking at the Dogger Bank Zone have been reviewed, including the Offshore Energy Strategic Environmental Assessment (SEA) (Department of Energy and Climate Change (DECC), 2009).

In the context of the Habitats Regulations and Offshore Habitats Regulations, where it cannot be shown that there will not be a 'likely significant effect' (LSE) on a European site, a competent authority undertakes an appropriate assessment (AA) before deciding to undertake or give any consent, permission or other authorisation for a plan. For Round 3, the report commissioned by The Crown Estate 'Habitats Regulations Assessment to inform TCE Appropriate Assessment' (Entec, 2009) has been used to identify designated sites and species that require consideration within this Zonal Characterisation and subsequent assessments.

In addition, the following Dogger Bank specific documents have also been incorporated into this chapter:

- JNCC Draft conservation objectives and advice on operations; and
- JNCC Understanding the marine environment -seabed habitat investigations of the Dogger Bank offshore draft SAC, Report no. 429.

To inform the Environmental Impact Assessment (EIA) process, geophysical, bird and marine mammal surveys are being undertaken by Forewind on a Zone-wide basis. These will be complemented by additional ecological surveys on a Tranche specific basis over the coming years. The results of these will be assessed to determine potential impacts on features of nature conservation interest.

7.3 Overview

The Dogger Bank Zone overlaps, in part, with the Dogger Bank possible Special Area of Conservation (pSAC) which lies within UK offshore waters and qualifies for the Annex I habitat; sandbanks which are slightly covered by seawater at all times. JNCC formally advised Defra on the Dogger Bank in 2005 and again in October 2008 following additional surveys. Updated advice was issued in March 2010 following a scientific review which resulted in a revised site boundary and re-grading of the harbour porpoise interest feature. The Dogger Bank pSAC is now in formal consultation which ends in November 2010 (JNCC, 2010a).

In addition, a number of international designations lie inshore of the Dogger Bank Zone, within the Offshore Cable Area, that support marine components. There are also numerous sites along the coast, including local, national and international sites supporting a range of nature conservation features. Figure 7.1 and Figure 7.2 present the nature conservation designations within the Dogger Bank Zone and Offshore Cable Area.

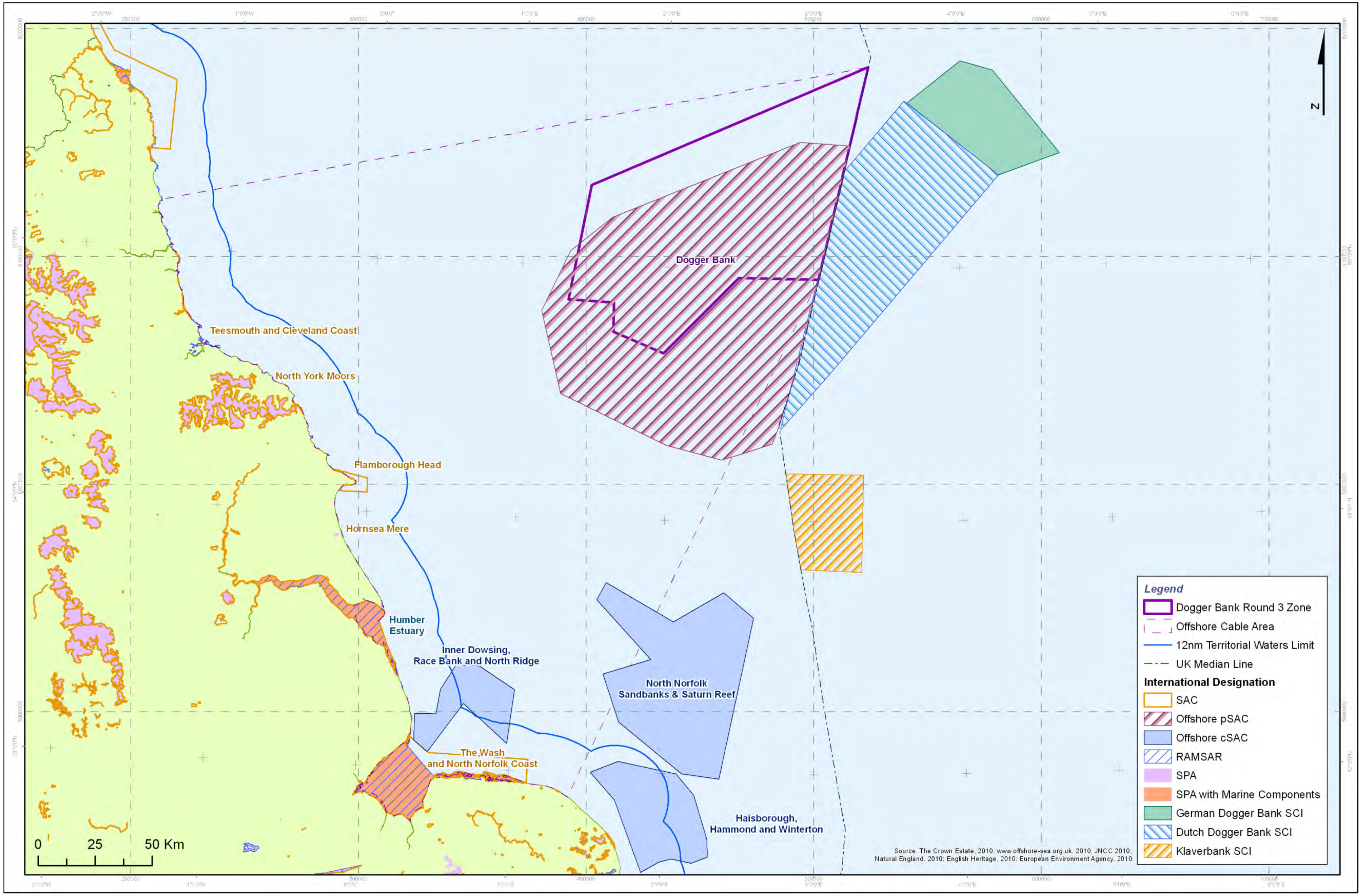

Figure 7.1: International and EU designations relevant to the Dogger Bank ZDE, Source: The Crown Estate, 2010; DECC, 2010; JNCC, 2010; Natural England, 2010; English Heritage, 2010; European Environment Agency, 2010.

Figure 7.2: UK east coast National designations relevant to the Dogger Bank ZDE, Source: The Crown Estate, 2010; Natural England, 2010.

7.4 Conventions and Legislation

7.4.1 International

The key International legislation that currently supports designated sites are the Wild Birds Directive (79/409/EC) and the Habitats Directive (92/43/EC). Within British waters the transposing national legislation for the 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.

Within British waters the provisions of the Birds Directive are implemented 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.

Under these regulations, JNCC is responsible for the designation of SACs and SPAs. Further information on the process for designation of offshore SACs and SPAs and the features for which they are designated is provided in Appendix G.

Sites of Community Importance (SCI) are sites that have been adopted by the European Commission but not yet formally designated by the government of each country (JNCC, 2010a).

Although the UK component of the Dogger Bank does not extend beyond UK waters there are a number of sites that are being considered for designation under both the Birds and Habitats Directives that will need to be considered for transboundary issues and taken into consideration under the Convention on Environmental Impact Assessment in a Transboundary Context (Espoo, 1991) - the 'Espoo (EIA) Convention'. The Espoo (EIA) Convention sets out the obligations of Parties to assess the environmental impact of certain activities at an early stage of planning. It also lays down the general obligation of States to notify and consult each other on all major projects under consideration that are likely to have a significant adverse environmental impact across boundaries.

In addition to these principal pieces of legislation the UK is committed to conserving habitats and species through a number of other international conventions, these include:

- The Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention or Wetlands Convention);
- 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);
- Convention on Biological Diversity (Biodiversity Convention or CBD); and
- Convention for the protection of the Marine Environment of the North East Atlantic (OSPAR).

More detailed information is given in Appendix G.

7.4.2 National and local

A number of national and local designated sites are present within the ZDE. These designations currently do not extend into subtidal waters and therefore are unlikely to interact with the Offshore ZDE however, for completeness, these sites have been charted on Figure 7.2, and have been considered (a complete list of National Parks, SSSI, NNR and LNR can be found in Appendix I. Interactions between land based designations and key bird species are considered in Chapter 5 – *Birds*. A summary of national and local designations have been listed below for completeness.

Within the UK, the main pieces of legislation that provide for designated sites within the coastal zone are the Wildlife and Countryside Act 1981 (as amended) which allows for the protection of Sites of Special Scientific Interest (SSSI) and National Nature Reserves (NNR). The provision for Local Nature Reserves (LNR) is made by local authorities under the UK National Parks and Access to the Countryside Act 1949 and amended by the Natural Environment and Rural Communities Act 2006.

NNRs are legally protected by the underlying designation of SSSIs and many LNRs are also SSSI. In England, more than 70% of designated SSSIs are also designated as SAC, SPA or Ramsar sites.

SSSIs may extend into intertidal areas. Draft Guidance (Defra, 2009) has been issued by Defra that incorporates the provisions of the Marine and Coastal Access Act, 2009 and looks at potential for extensions into subtidal areas in the context of Marine Conservation Zones (MCZs). Within UK waters, provision is also being made for the designation of Marine Conservation Zones through the Marine and Coastal Access Act, 2009. MCZs will protect nationally important marine wildlife, habitats, geology and geomorphology and can be designated anywhere in English and Welsh inshore and UK offshore waters. Site selection is underway with designations expected during 2012. 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 which includes the area of the ZDE, this will be considered more closely in the next stage of ZAP.

7.5 Special Areas of Conservation

7.5.1 UK Sites

SACs are designated for habitats under Annex I and species listed under Annex II of the Habitats Directive. Table 7.1 below provides a summary of the designated offshore sites within UK waters and their qualifying features which may be affected. Entec (2009) summarised sites which required further assessment and these features have been included within the table.

Table 7.1: Offshore and Marine SAC designations.

SAC Designation	General Site Character	Primary Reasons for Designation	Additional Qualifying Features	Non Qualifying Features
Dogger Bank possible SAC		Sandbanks which are slightly covered by sea water all the time**		Harbour porpoise (Phocoena phocoena) Common seal *Phoca vitulina* Grey seal Halichoerus grypus
North Norfolk Sandbanks and Saturn Reef candidate SAC (cSAC)		Sandbanks which are slightly covered by sea water all the time Reefs		Ross worm *Sabellaria spinulosa*
Inner Dowsing, Race Bank and North Ridges cSAC		Sandbanks which are slightly covered by sea water all the time Reefs (*Sabellaria spinulosa*)		Polychaete and nemertean worms and the ascidian *Molgula* sp. Bryozoans, hydroids, sponges and tunicates
Berwickshire and North Northumberland Coast	Sea inlets Tidal rivers, estuaries Mud flats, sand flats Lagoons Salt marshes. Salt pastures, Salt steppes Coastal sand dunes, Sand beaches, Machair Shingle, Sea cliffs, Islets Improved grassland	Mudflats and sandflats not covered by seawater at low tide Large shallow inlets and bays Reefs Submerged or partially submerged sea caves Grey seal Halichoerus grypus**		
Flamborough Head SAC		Reefs** Vegetated sea cliffs of the Atlantic and Baltic coasts Submerged or partially submerged sea caves	Kelp Laminaria hyperborea forests Northern alga Ptilota plumose Mesotrophic and acidic grassland communities Algal communities of: Hildenbrandia rubra, Pseudendoclonium submarinum, Sphacelaria nana and Waerniella lucifuga	
Humber Estuary SAC	Tidal rivers, Estuaries, Mud flats, Sand flats, Lagoons, Salt marshes, Salt pastures, Salt steppes, Coastal sand dunes, Sand beaches, Machair, Bogs. Marshes. Water fringed vegetation. Fens	Estuaries** Mudflats and sandflats not covered by seawater at low tide**	Sandbanks which are slightly covered by sea water all the time Coastal lagoons * Priority feature 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`) * Priority feature Dunes with Hippophae rhamnoides River lamprey Lampetra fluviatilis Sea lamprey Petromyzon marinus Grey seal Halichoerus grypus**	
North Norfolk Coast SAC	Tidal rivers. Estuaries. Mud flats. Sand flats. Lagoons Coastal sand dunes. Sand beaches. Machair Shingle. Sea cliffs. Islets Bogs. Marshes. Water fringed vegetation. Fens Improved grassland	Coastal lagoons * Priority feature Perennial vegetation of stony banks Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi) Embryonic shifting dunes Shifting dunes along the shoreline with Ammophila arenaria (`white dunes`) Fixed dunes with herbaceous vegetation (`grey dunes`) * Priority feature Humid dune slacks	Shingle ridge and saltmarsh Lagoonal mysid shrimp Paramysis nouveli Sea-blite Suaeda vera and sea-purslane Atriplex portulacoides Perennial glasswort Sarcocornia perennis Sand couch Elytrigia juncea Common whitlowgrass Erophila verna Forget-me-not Myosotis ramosissima Common cornsalad Valerianella locusta Marram Ammophila arenaria Red fescue Festuca rubra Sand sedge Carex arenaria Lichens such as Cornicularia aculeate Yorkshire-fog Holcus lanatus	Otter Lutra lutra Petalwort Petalophyllum ralfsii
The Wash and North Norfolk Coast SAC	Sea inlets Tidal rivers. Estuaries. Mud flats. Sand flats. Lagoons Salt marshes. Salt pastures. Salt steppes	Sandbanks which are slightly covered by sea water all the time Mudflats and sandflats not covered by seawater 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)	Brittlestars Ophiothrix fragilis Sand-mason worm Lanice conchilega Tellin Angulus tenuis Plaice Pleuronectes platessa Cod Gadus morhua Sole Solea solea Polychaetes, bivalves and crustaceans Eelgrass Zostera Ross worm Sabellaria spinulosa	Common seal Phoca vitulina Common tube-dwelling polychaete worm Sabellaria spinulosa Mysid shrimps Pink shrimp Pandalus montagui Common cord-grass Spartina anglica Sea-lavenders Limonium spp. Shrubby sea-blite Suaeda vera Sea-purslane Atriplex portulacoides Coastal lagoons * Priority feature Otter Lutra lutra

SAC Designation	General Site Character	Primary Reasons for Designation	Additional Qualifying Features	Non Qualifying Features
River Derwent SAC		Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation River lamprey Lampetra fluviatilis Petromyzon marinus Bullhead Cottus gobio Otter Lutra lutra		
Saltfleetby-Theddlethorpe Dunes and Gibralter Point SAC		Salt marshes Salt pastures Salt steppes Coastal sand dunes Sand beaches Machair Bogs Marshes Water fringed vegetation Fens	Shifting dunes within a complex site that exhibits a range of dune types. At this site the *Ammophila*-dominated dunes are associated with lyme-grass *Leymus arenarius* and sand sedge *Carex arenaria* Extensive areas of fixed dune vegetation within largely intact geomorphologically-active systems * Priority feature Red fescue *Festuca rubra* Pyramidal orchid *Anacamptis pyramidalis* Bee orchid *Orchis apifera* Sea-holly *Eryngium maritimum* Lesser meadow-rue *Thalictrum minus* Sea campion *Silene maritime* Dunes with *Hippophae rhamnoides* Humid dune slacks	
**Denotes sensitive habitats where an AA of the Round 3 sites cannot reasonably be assessed at plan level and where the plan level HRA is reliant at least in part upon project level HRA which can reach a conclusion that there will be no adverse effect on the integrity of the site that supports this interest feature (Entec, 2009).				

Annex I Habitats

This section will consider the sites designated for habitat features under the Habitats Directive as SACs that have been implemented by the UK Government.

The Dogger Bank Zone and Offshore Cable Area overlap with the Dogger Bank pSAC, which has been proposed for the following features:

- Sandbanks which are slightly covered by sea water all the time (qualifying feature);
- Harbour porpoise (*Phocoena phocoena*) (non-qualifying);
- Grey seal (*Halichoerus grypus*) (non-qualifying); and
- Common seal (*Phoca vitulina*) (non-qualifying).

The surface area of the site proposed for designation is 12,338 km^2 (JNCC, 2010b). The size of the Dogger Bank Zone is 8,660 km^2, with an overlap of 6,140 km^2. Entec (2009), as part of the Habitats Regulations Assessment (HRA) of the Round 3 plan to inform the Appropriate Assessment, screened in the Zone as having the potential for a likely significant effect on the Dogger Bank sandbank feature as a result of the installation and/or removal of turbines and cable, the physical presence of turbines and the presence of cable armouring or turbines leading to scour (Entec, 2009).

In addition to this site several offshore and coastal SAC designations exist that fall directly within the ZDE and will need to be considered for a number of habitat features including reefs, coastal lagoons, large shallow inlets and bays and mudflats and sandflats not covered by seawater at low tide.

Annex II species – marine mammals

In addition to sites that support habitats, some sites within the ZDE and beyond also support Annex II species. Principally mobile marine species that have an extensive range and are likely to interact with the ZDE have been considered. Designated mobile species are harbour porpoise *Phocoena phocoena*, bottlenose dolphin *Tursiops truncatus*, grey seal *Halichoerus grypus* and common seal *Phoca vitulina*.

When assessing mobile marine species, any assessment of impact will need to consider that under the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended) mobile marine species and wild birds (referred to as European Protected Species - EPS) are afforded protection from harmful activities. Consideration should be given to Guidance published in draft by JNCC (JNCC, 2010c). This guidance is intended to provide a resource for marine users, regulators, advisors and the enforcement authorities when considering whether an offence of deliberately disturbing or injuring/killing a marine EPS is likely to occur or to have occurred as a result of an activity.

Of particular relevance to the Offshore ZDE is the inclusion of harbour porpoise, grey and common seals within the SAC selection criteria (JNCC, 2010b) for the Dogger Bank pSAC as non qualifying features, all of which occur within the boundary of the SAC area. Further information on the presence of these species is provided in Chapter 6 – *Marine Mammals*.

Within the ZDE, other sites supporting mobile species include the Wash which supports a population of common seals. The extensive intertidal flats of the Wash and North Norfolk Coast provide ideal conditions for common seal *Phoca vitulina* breeding and hauling-out. This site is the largest colony of common seals in the UK, with some 7% of the total UK population. The Humber Estuary supports the Annex II species, grey seal which is present as a qualifying feature, but not a primary reason for site selection.

Outside of the ZDE, a number of sites along the East coast of England and Scotland support Annex II species. Berwickshire and the North Northumberland Coast support a grey seal population. As reported in Chapter 6 – *Marine Mammals*, grey seals are known to regularly travel hundreds of kilometres so it was thought appropriate to include given grey seals are regularly sighted within the Offshore ZDE. More information on the distribution, range and occurrence of marine mammals is provided within Chapter 6.

The Moray Firth supports a resident population of bottlenose dolphins. Animals are present all year round; however it is not known whether this population extends to the Dogger Bank region.

In addition to UK sites, the sites within German, Dutch and French waters supporting all four species have potential for impact and are considered further in 7.7.

Annex II species – Diadromous fish

The screening process for the Habitats Regulations Assessment referenced in Entec (2009) identified a number of sites which have diadromous fish species as interest features. An appropriate assessment has been undertaken for the River Derwent SAC which includes the interest features of sea lamprey *Petromyzon marinus* and river lamprey *Lampetra fluviatalis*. The site conclusions as outlined in Entec (2009) were that the AA at plan level shows no effects on the conservation status of the interest feature or integrity of the site from implementation of Round 3 plan, when plan level mitigation is employed.

7.6 Special Protection Areas and Ramsar

Special Protection Areas and Ramsar sites 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 seabirds are of particular relevance.

The likely effects on bird species are divided into two categories by Entec (2009) – turbine effects and cable effects. Turbine effects include: collision with turbines; displacement or disturbance associated with turbine construction; presence, operation or decommissioning; changes in prey availability, and habitat loss. Such effects are likely where species forage within an area where turbines are present, or where species pass through on route to other foraging areas or on migration (Entec, 2009). Cable effects are effects on species caused by disturbance, habitat loss or habitat change associated with the laying of cables,

The effects of turbines are restricted to the Dogger Bank Zone itself and therefore it was considered appropriate to look at the presence of key species recorded on the Dogger Bank itself. Chapter 5 of this document provides an overview of data on bird species. Langston (2010) and other data sources referenced in Chapter 5 – *Birds* identify a number of key species that have been recorded within the Offshore ZDE and which may be of greatest potential concern.

Bird species are sensitive to disturbance and collision with turbines within the Dogger Bank Zone, but species that have wide ranges for foraging and for migratory purposes will also be sensitive to disturbance both onshore and offshore; to any loss of intertidal and subtidal foraging habitat as a result of the laying of cables, and to changes in the supply and distribution of prey. Consideration was then given to the mean foraging ranges for these key species with a view to identifying designated sites within UK waters that support them which will require further assessment.

For the Dogger Bank, key species listed within Langston (2010) and summarised in Chapter 5 are:

- Northern fulmar;
- Northern gannet;
- Gulls;
- Black legged kittiwake;
- Auks (razorbills, guillemots and puffins); and
- Migrating waterbirds.

The known mean and maximum foraging ranges for these species are shown within Chapter 5 – *Birds* and summarised in Table 7.2 below.

Table 7.2: Important bird species and their associated foraging distances.

Species	Foraging range
Northern Fulmar	Mean foraging range of approximately 70 km up to a maximum of 664 km
Northern Gannet	Mean foraging range of approximately 140 km up to a maximum of 640 km
Kittiwake	Mean foraging range of approximately 25 km, up to a maximum of 200 km
Guillemot	Mean foraging range of approximately 25 km, up to a maximum of 200 km
Razorbill	Mean foraging range of approximately 10 km, up to a maximum of 51 km
Puffin	Mean foraging range of approximately 30 km, up to a maximum of 200 km
Herring gull*	Indicative maximum ranges of approximately 54 km
Lesser black backed gull*	Indicative maximum rages of approximately 135 km

*Mainly coastal foraging range in summer. Sources: Langston (2010) and Stone *et al.*, (1995).

Table 7.2 depicts the mean foraging distances for the species identified in Table 7.2 and the UK SPAs that include these species. The area of potential impact encompasses the Dogger Bank Zone and majority of the Offshore Cable Area. However, consideration has been given to the study undertaken by ESAS and zone specific surveys reported in Chapter 5, which recorded the presence on the Dogger Bank of all species listed in Table 7.2. Given the potential maximum ranges recorded for seabird species and the potential for migratory species on passage through the Dogger Bank, the sites identified in Table 7.3 for the East coast of UK have been noted as supporting significant seabird colonies and/or species.

Appendix H provides a summary of sites in Scotland and on the East coast of England, outside of the ZDE, that support migratory bird species or key species that may potentially be impacted by the development.

Sites designated within British waters (and approximate distances to the Dogger Bank Zone) include:

- Adle-Ore Estuary (294 km);
- Blackwater Esuary (337 km);
- Coquet Island (190 km); and
- Farne Islands (198 km).

Scottish sites include:

- Buchan Ness to Collieston (300 km);
- East Caithness Cliffs (441 km);
- Firth of Forth Islands (300 km);
- Fowlsheugh (320 km);
- North Caithness cliffs (554 km);
- St Abb's head to Fast Castle (245 km); and
- Troup, Pennan and Lion's Head (355 km).

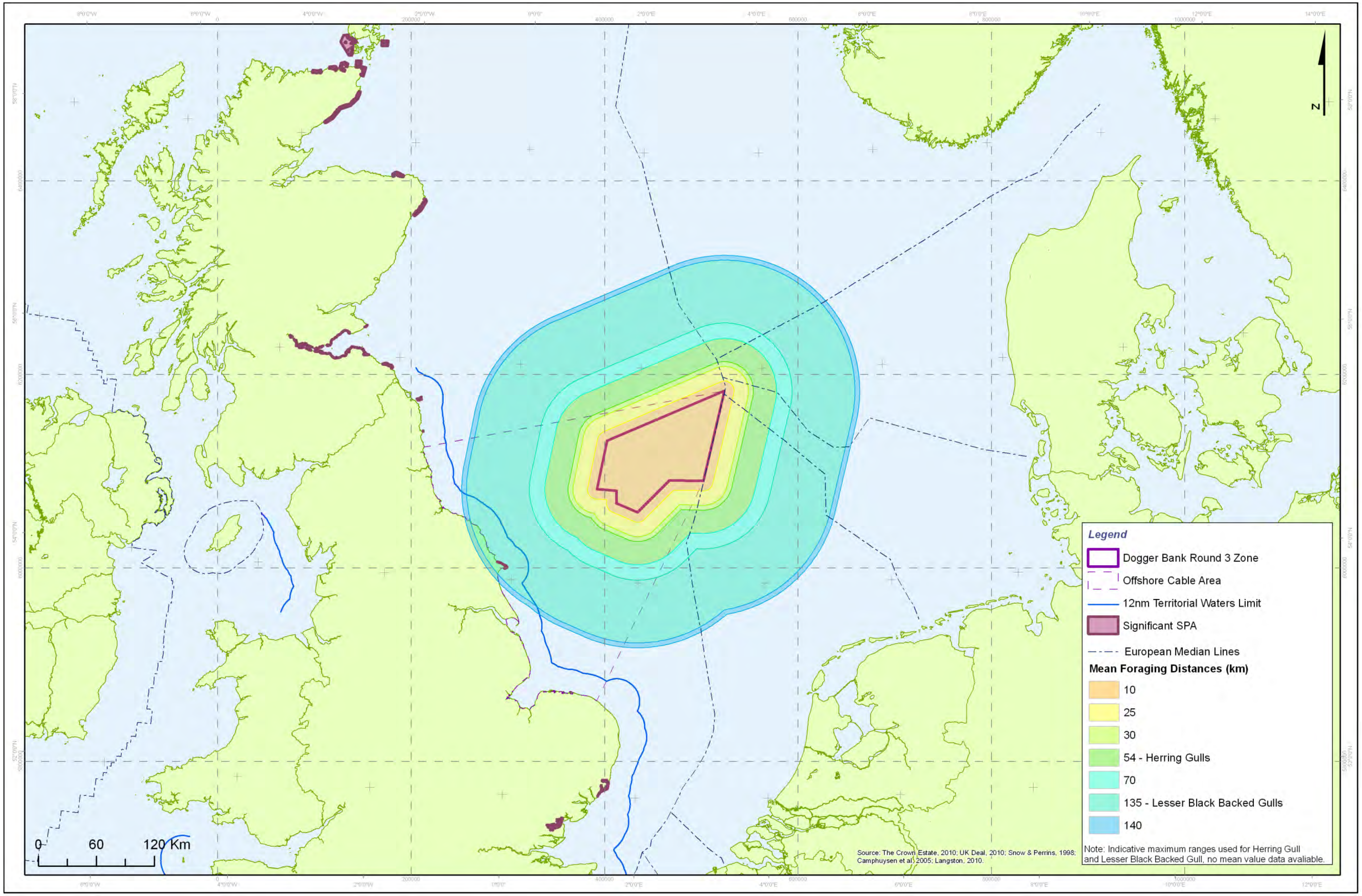

Figure 7.3: UK east coast SPAs and foraging distances relevant to the Dogger Bank ,Source: The Crown Estate, 2010; UK Deal, 2010; Snow & Perrins, 1998; Camphuysen *et al* 2005; Langston, 2010.

Table 7.3: SPA designations and their qualifying features.

SPA Designation	Qualifying Features			
Northumbria Coast SPA	**During the breeding season:** Little Tern *Sterna albifrons*	**Over winter:** Purple Sandpiper *Calidris maritima* Turnstone *Arenaria interpres*		
Coquet Island SPA	**During the breeding season:** Arctic Tern *Sterna paradisaea* Common Tern *Sterna hirundo* Roseate Tern *Sterna dougallii* Sandwich Tern *Sterna sandvicensis*	**Migratory during the breeding season:** Puffin *Fratercula arctica*	**Assemblage:** Black-headed Gull *Larus ridibundus* Puffin *Fratercula arctica* Arctic Tern *Sterna paradisaea* Common Tern *Sterna hirundo*	Roseate Tern *Sterna dougallii* Sandwich Tern *Sterna sandvicensis* Whimbrel *Numenius phaeopus*
Teesmouth and Cleveland Coast SPA	**During the breeding season:** Little Tern *Sterna albifrons*	**On passage:** Sandwich Tern *Sterna sandvicensis* **Migratory on passage:** Ringed Plover *Charadrius hiaticula*	**Over winter:** Knot *Calidris canutus;* Redshank *Tringa tetanus*	**Assemblage:** Sanderling *Calidris alba* Lapwing *Vanellus vanellus* Shelduck *Tadorna tadorna* Cormorant *Phalacrocorax carbo* Redshank *Tringa totanus* Knot *Calidris canutus*
The Wash SPA	**During the breeding season:** Common Tern *Sterna hirundo* Little Tern *Sterna albifrons* Marsh Harrier *Circus aeruginosus* **Over winter:** Avocet *Recurvirostra avosetta* Bar-tailed Godwit *Limosa lapponica* Golden Plover *Pluvialis apricaria* Whooper Swan *Cygnus cygnus* **Migratory on passage:** Ringed Plover *Charadrius hiaticula* Sanderling *Calidris alba*	**Migratory over winter:** 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*	**Assemblage:** 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*
Flamborough Head and Bempton Cliffs SPA	**During the breeding season:** Kittiwake *Rissa tridactyla*	**Assemblage:** Puffin *Fratercula arctica* Razorbill *Alca torda* Guillemot *Uria aalge* Herring Gull *Larus argentatus* Gannet *Morus bassanus* Kittiwake *Rissa tridactyla*		
Broadland SPA	**During the breeding season:** Bittern *Botaurus stellaris* Marsh Harrier *Circus aeruginosus* **Over winter:** Bewick's Swan *Cygnus columbianus bewickii* Bittern *Botaurus stellaris* Hen Harrier *Circus cyaneus* Ruff *Philomachus pugnax* Whooper Swan *Cygnus cygnus*	**Migratory over winter:** Gadwall *Anas strepera* Pink-footed Goose *Anser brachyrhynchus* Shoveler *Anas clypeata*	**Assemblage:** Cormorant *Phalacrocorax carbo* Bewick's Swan *Cygnus columbianus bewickii* Whooper Swan *Cygnus cygnus* Ruff *Philomachus pugnax* Pink-footed Goose *Anser brachyrhynchus* Gadwall *Anas strepera* Bittern *Botaurus stellaris* Great Crested Grebe *Podiceps cristatus*	Coot *Fulica atra* Bean Goose *Anser fabalis* White-fronted Goose *Anser albifrons albifrons* Wigeon *Anas penelope* Teal *Anas crecca* Pochard *Aythya ferina* Tufted Duck *Aythya fuligula* Shoveler *Anas clypeata*
Humber Flats, Marshes and Coast SPA	**During the breeding season:** Little Tern *Sterna albifrons* Marsh Harrier *Circus aeruginosus* **Over winter:** Bar-tailed Godwit *Limosa lapponica* Bittern *Botaurus stellaris* Golden Plover *Pluvialis apricaria* Hen Harrier *Circus cyaneus* **Migratory on passage:** Redshank *Tringa tetanus* Sanderling *Calidris alba*	**Migratory over winter:** Dunlin *Calidris alpina alpine* Knot *Calidris canutus* Redshank *Tringa tetanus* Shelduck *Tadorna tadorna* **Assemblage:** 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*
Hornsea Mere SPA	**Over winter:** Gadwall *Anas strepera*			

SPA Designation	Qualifying Features			
North Norfolk Coast SPA	**During the breeding season:** Avocet *Recurvirostra avosetta* Bittern *Botaurus stellaris* Common Tern *Sterna hirundo* Little Tern *Sterna albifrons* Marsh Harrier *Circus aeruginosus* Mediterranean Gull *Larus melanocephalus* Roseate Tern *Sterna dougallii* Sandwich Tern *Sterna sandvicensis* **Over winter:** Avocet *Recurvirostra avosetta* Bar-tailed Godwit *Limosa lapponica* Bittern *Botaurus stellaris* Golden Plover *Pluvialis apricaria* Hen Harrier *Circus cyaneus* Ruff *Philomachus pugnax*	**Migratory during the breeding season:** Redshank *Tringa totanus* Ringed Plover *Charadrius hiaticula* **Migratory on passage:** Ringed Plover *Charadrius hiaticula* ***Migratory over winter:*** Dark-bellied Brent Goose *Branta bernicla bernicla* Knot *Calidris canutus* Pink-footed Goose *Anser brachyrhynchus* Pintail *Anas acuta* Redshank *Tringa totanus* Wigeon *Anas penelope*	**Assemblage:** 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*
Broadland SPA	A variety of wintering and breeding raptors and waterbirds associated with extensive lowland marshes			
Great Yarmouth North Denes SPA	Little Tern *Sterna albifrons.*			

Sites within the Sheltand and Orkney Islands include Calf of Eday (529 km), Copinsay (487 km), Fair Isle (504 km), Hermaness, Saxa Vord and Valla Field (491 km), Fetlar (587 km), Foula (305 km), Hoy (490 km), Marwick Head (524 km), Noss (551 km), Rousay (508 km) and West Westray (522 km).

Other SPA's and seabird colonies outside the UK, in other North Sea nations, also have the potential to be affected if considering maximum foraging ranges and migration e.g. the Eastern German Bight SPA which is a protected area for northern gannet, northern fulmar, gulls, auks and migrating water birds.

In addition to existing designated sites, consideration was given to sites which the JNCC has recommended and which extend into adjacent marine waters. Within the ZDE, Flamborough Head and Bempton Cliffs are recommended as they qualify under existing seabird colonies (JNCC, 2010a). In addition the JNCC have identified areas which might be considered for extensions or new areas – these include Area of Search (AoS) for waterbirds, currently subject to further analysis, which exists for the stretch of coastline from Hornsea Mere and extends around North Norfolk coast; a breeding tern colony SPA within the Humber Estuary, and a near qualifying important seabird concentration that incorporates the Dogger Bank (Kober *et al*., 2010). Further information is provided in Chapter 5 - *Birds*.

7.6.1 Transnational Sites

This section considers sites and species outside of UK waters that will require further assessment. Entec (2009) identified a number of international sites where the plan level AA indicated the requirement for mitigation at a project level for marine mammal interest species. These sites and the sensitive interest features are summarised in Table 7.4. An additional attempt was made to identify Danish sites, however it was not possibly to obtain data. Danish sites were also omitted in the Entec (2009) report.

Beyond UK waters, the Dogger Bank straddles the continental shelf medians of Denmark, Germany and the Netherlands. Currently both Germany and the Netherlands have designated the Dogger Bank as a Site of Community Importance (SCI) and pSCI respectively.

The German Dogger Bank SAC has been designated for features including sandbanks which are slightly covered by sea water all the time, the harbour porpoise and the common seal. The Dutch site includes sandbanks which are slightly covered by sea water all the time, harbour porpoise, common and grey seal. Approximately 170,000 ha and 471,772 ha of the Dogger Bank's sandbank habitat has been designated in German and Dutch waters respectively (DECC, 2009)

Table 7.4: Belgian, German and Dutch sites and their interest features.

Site code	Site	Sensitive interest feature
BEMNZ0002	SBZ 1 / ZPS 1 SAC	*Phocoena phocoena*
BEMNZ0003	SBZ 2 / ZPS 2 SAC	*Phocoena phocoena*
BEMNZ0004	SBZ 3 / ZPS 3 SAC	*Phocoena phocoena*
BEMNZ0001	Trapegeer-Stroombank SAC	*Phocoena phocoena*
BEMNZ0005	Vlakte van de Raan SAC	*Phocoena phocoena*
DE1003301	Doggerbank SAC	*Phoca vitulina* *Phocoena phocoena*
DE0916391	NTP S-H Wattenmeer und angrenzende Kustengebiete SAC	*Tursiops truncates*
NL2003062	Noordzeekustzone SAC	*Tursiops truncates*
NL4000017	Voordelta SAC	*Tursiops truncates*
NL1000001	Waddenzee SAC	*Tursiops truncates*
NL2008002	Klaverbank	*Phoca vitulina* *Phocoena phocoena* *Halichoerus grypus*
NL2008001	Doggersbank	*Phoca vitulina* *Phocoena phocoena* *Halichoerus grypus*

BE – Belgium, DE – Germany, NL – Netherlands.

The western slopes of the Dogger Bank within the Dutch continental shelf have higher macrobenthic diversity than elsewhere in the designation. The slopes support important ecological features, predominantly between the 30 and 40 m depth contours (Natura 2000, 2008a). Fronts are encountered regularly in summer along the southern boundary of the bank; these can result in increased concentrations of fish and birds (Lindeboom *et al.,* 2005; cited in Natura 2000, 2008a).

In addition to the Dutch Dogger Bank pSCI, approximately 20 km south of the Dogger Bank abutting the UK-Netherlands median, an area of 123,764 ha over the 'Klaverbank' (Clover Bank) has been identified for designation for the Annex I reef habitat (Natura 2000, 2008b). The Dutch designations ('Doggersbank' and 'Klaverbank') (see Figure 7.1) include the presence of harbour porpoise and common seal in both designations.

Given the mobile nature of designated species, the potential for transboundary effects will need to be taken into consideration in the project EIAs to ensure that there is enough information available for an Appropriate Assessment (AA) to be undertaken. Consideration will also need to be given to the guidance provided by the JNCC, currently in draft form, which addresses the protection of marine European Protected Species from injury and disturbance (JNCC, 2010c).

Entec (2009) also identified a number of international sites not immediately adjacent to the Dogger Bank but where the plan level AA indicated the requirement for mitigation at a project level for marine mammal interest species. Table 7.4 has been adapted from Entec (2009) to identify sites that support mobile marine mammal species that are likely to be affected by the development within the Dogger Bank ZDE.

7.7 Summary

The Dogger Bank Offshore and Onshore ZDE support a number of internationally, nationally and locally designated sites 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 are likely to be affected by the development have been noted where possible.

The Dogger Bank Zone overlaps with the Dogger Bank pSAC; hence the competent authority determining an application for development consent within the area would be required to undertake an AA. Information collected and submitted to support an application for development should therefore be sufficient to inform that AA and any others which are found to be necessary following consultation with the relevant conservation authorities.

In addition to the Dogger Bank pSAC, a number of designated sites – international, national and local – are located within the wider ZDE, supporting habitat and species interest features identified in Table 7.1 and Table 7.2. National and local sites that lie within the intertidal zone (SSSIs, NNR, LNR and National Parks) have been included for completeness in Appendix I; however it is unlikely that any interaction will arise with the Round 3 development since these do not extend into subtidal waters.

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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.

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; Gafney *et al*., 2007, 2009). 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.

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.

8.4 Submerged Prehistory and Palaeolandscapes

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.* 700,000 years before the present (BP) (Parfitt *et al.,* 2005), 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 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. 700,000 to 478,000 BP);
- Lower Palaeolithic hominin occupation during the Wolstonian period (c. 350,000 to 170,000 BP);
- Middle and Upper Palaeolithic modern human occupation during the Devensian (c. 40,000 BP to 24,000 BP); and
- Late Upper Palaeolithic and Mesolithic modern human occupation during the Devensian late-glacial and early Holocene (c. 13,000 BP to 5,500 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.* 700,000 BP during the Cromerian interglacial (*c.* 700,000 to 478,000 BP) and comes from a site at Pakefield in Suffolk (Parfitt *et al.,* 2005). Other evidence from around this time has been found at Boxgrove, at Waverley Wood (Keen *et al*., 2006) and at Happisburgh in Norfolk (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 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 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 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 a potential for hominin occupation in the Offshore ZDE for those periods of the Hoxnian when the area was exposed above sea level. As already observed, some archaeologically significant material from this period can be expected in derived or secondary contexts, but 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 BP (Sumbler, 1995; Gibbard *et al*., 1992, 2009; White *et al*., in press) 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 (*c.* 350,000 BP) (Schreve *et al.*, 2002) and Stanton Harcourt (*c.* 170,000 to 180,000 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 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 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 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 120m 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 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 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 or by association. For example, a mammoth tusk dating to *c.*44,000 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 BP in the Offshore ZDE is low.

Table 8.1: Archaeological and Geological Chronology.

Age in years BC/BP	British Stages	Climate	Archaeological Period	Relative Sea Level
Present day	Holocene	Warm		0m
7,500 BP			Mesolithic	-5m
				-10m
				-15m
				-20m
				-25m
9,500 BP			Early Mesolithic	-30m
				-35m
10,000 BP	Younger Dryas (Loch Lomond Stadial)	Cold	Upper Palaeolithic	-40m
				-50m
11,000 BP	Windemere Interstadial	Warm		-60m
13,000 BP	Dimlington Stadial	Cold		
16,000 BP	Devensian	Mainly cold		
18,000 BP				-120m
25,000 BP				-50m
50,000 BP			Middle Palaeolithic	
70,000 BP				
110,000 BP	Ipswichian	Warm		+5m
130,000 BP	Wolstonian	Cold		Low?
186,000 BP		Warm		High?
245,000 BP		Cold	Lower Palaeolithic	Low?
303,000 BP		Warm		High?
339,000 BP		Cold		
380,000 BP	Hoxnian	Warm		High?
423,000 BP	Anglian	Cold		-120m+?
478,000 BP	Cromerian Complex	Warm		Varying
500,000 BP				
860,000 BP				

8.4.4 The Late-glacial and Holocene

Environmental changes in the Offshore ZDE between the Devensian glacial maximum (*c.* 18,000 BP) and the Holocene marine transgression (*c.* 6,000 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 BP (Late Mesolithic). Until about 13,000 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 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 BP (Coles, 1998). The effects of Holocene sea level rise would have first been felt in the Offshore Cable Area after *c*. 8,000 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 a large island in the North Sea (Coles, 1998).

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. 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 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 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. 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). 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 south west/north east 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 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 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 BC (c. 8,050 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.

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 shows the inferred presence of a drowned forest in an infilled river valley on the eastern end of the Dogger Bank.

8.4.6 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.
- 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.

8.5 Maritime Archaeology

The Dogger Bank Zone lies approximately 120 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 -15m 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 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 north-western 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 Zone. 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.

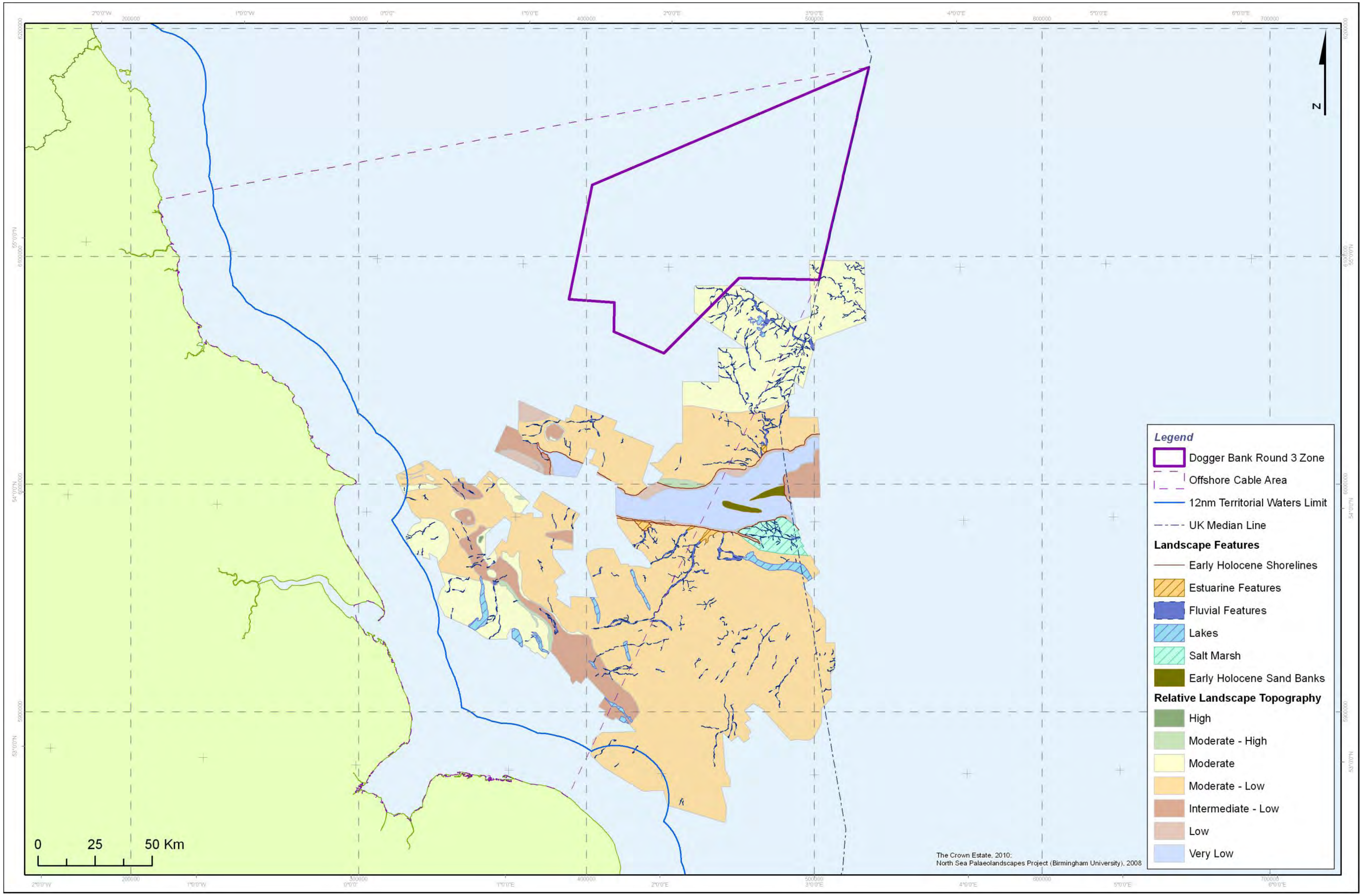

Figure 8.1: North Sea Palaeolandscape Project overlap with the Offshore ZDE.

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 Offshore ZDE became a more fragmentary terrestrial environment it is conceivable that watercraft became increasingly important, not only to exploit resources but also as a means of maintaining contact between human groups separated by growing bodies of water.

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; Clark, 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 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 for seafaring within the Offshore ZDE 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 north-western 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).

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 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 56 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 date to the 20th century. The exception is the wreck of the *William and John*, recorded as lost in 1648. The early date of this wreck means that it is of archaeological interest. A further wreck of interest is U66, a German u-boat sunk by gunfire from a British destroyer on 2 October 1917. This wreck is eligible for protection under the terms of the Protection of Military Remains Act (1986). The majority 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. Forty-three wrecks have been recorded in the Zone for which there is currently no positive identification. The over-representation in the UKHO records of these 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.

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.

In addition to the known wrecks, the UKHO Wreck Index also lists 103 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. There is a clear spatial element to the distribution of the obstructions, with a cluster in the far north-eastern corner and a second, larger cluster in the north-western 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 nearly 4,000 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 62 Royal Naval losses, the majority of which date to World War I. Although the second Battle of Dogger Bank on 10 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.

There are 1,396 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.

In addition to maritime archaeological material the Offshore Cable Area may also contain 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. These sites and remains 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).

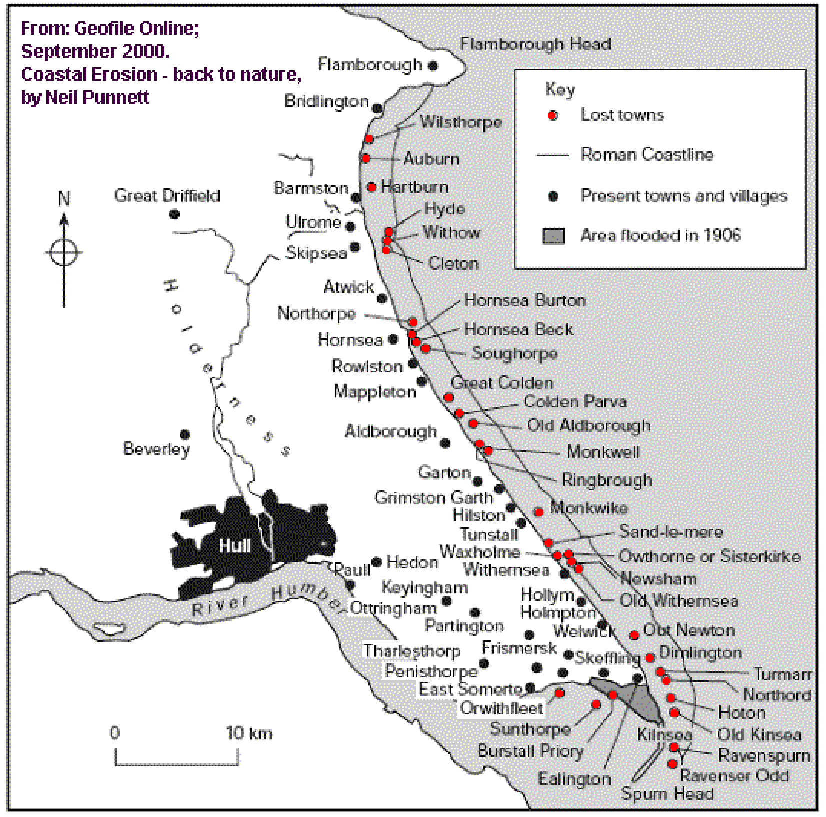

Figure 8.2: The Holderness coast, showing its retreat since Roman times (Source Punnett, N, 2000, Coastal Erosion: Back to Nature, Geofile Online September 2000).

8.5.3 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*.8,000BP 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 (1509-1815): 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.

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.

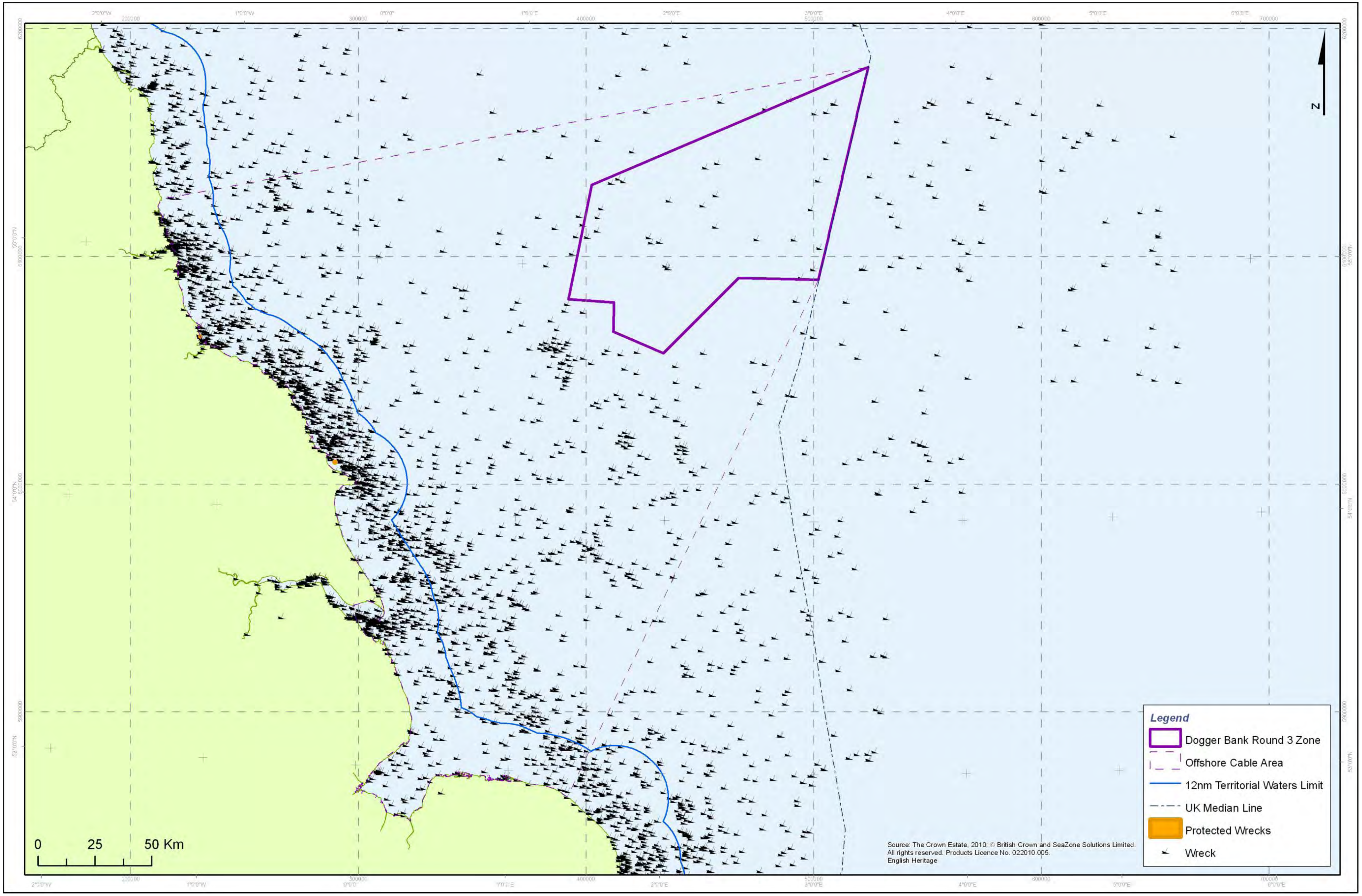

Figure 8.3: UKHO Known Wrecks and Protected Wrecks within the Offshore ZDE.

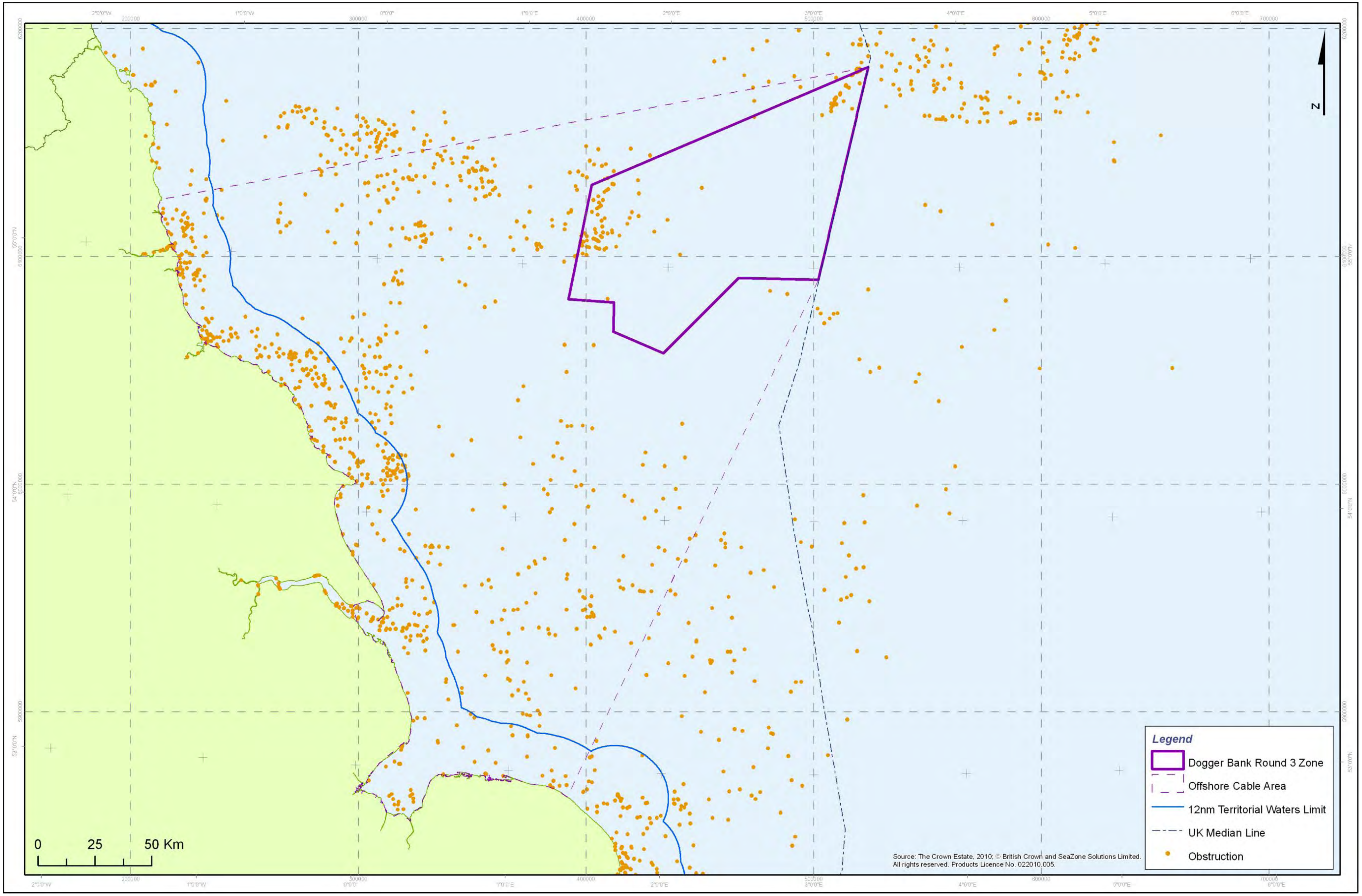

Figure 8.4: UKHO Seabed Obstructions within the Offshore ZDE.

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.

8.7 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 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.

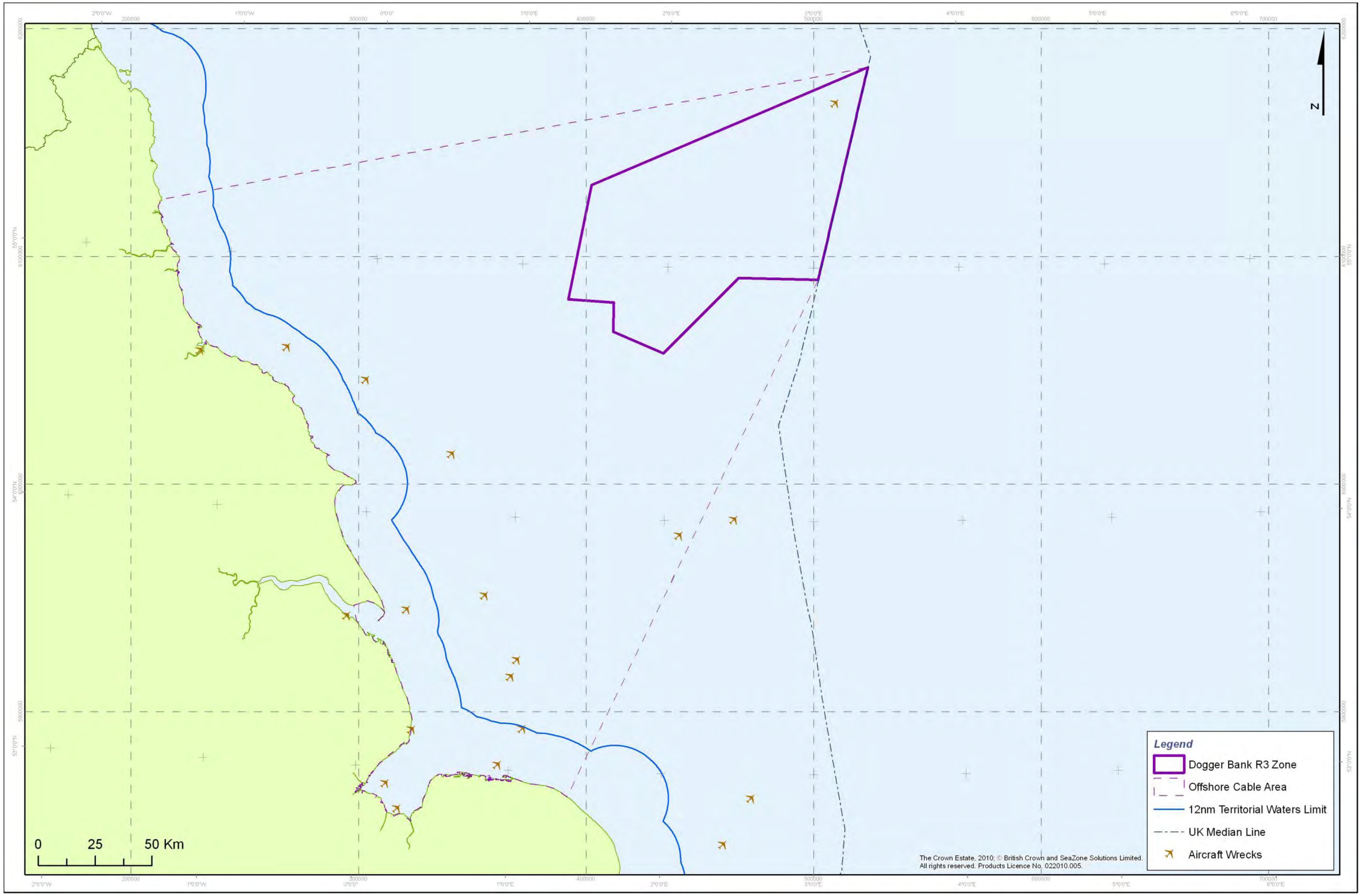

Figure 8.5: UKHO Known Aircraft Wrecks within the Offshore ZDE.

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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 ships, fishing vessels, recreational vessels, military vessels and marine aggregate dredgers.

This chapter discusses:

- Shipping density;
- Fishing vessel activity; and
- Key navigational features.

Navigation and shipping within the Dogger Bank Zone and Offshore Cable Area have been the subject of studies by Anatec Ltd (2010a, 2010b, 2010c), assessing pre-existing data and an ongoing Automatic Identification System (AIS) survey. The survey and studies consider relevant guidance, namely Marine Guidance Note (MGN) 371 (Maritime and Coastguard Agency (MCA), 2008) and guidance provided by the Department of Energy and Climate Change (DECC).

The current AIS survey was 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 54 days of survey coverage between April and June 2010, captured in this report, will be continually added to as more data become available throughout the duration of ZAP.

Consultation is taking place with stakeholders, and ultimately a radar survey of the Dogger Bank Zone will be carried out to collect data on smaller vessels not captured by AIS (Anatec Ltd, 2010a).

9.2 Data and Literature

The data sources used to inform the Dogger Bank Zone navigation and shipping study (Anatec Ltd, 2010a) were:

- AIS Survey data (54 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;
- The Crown Estate aggregate dredging maps; and
- Maritime incident data (MAIB).

To demonstrate the navigational issues occurring within the Dogger Bank Zone, this chapter applies a 10 nm buffer to the Zone to further include shipping movements and navigational issues within the immediate vicinity, though fishing vessel satellite data and the recent AIS survey data has been plotted within the Zone boundary.

Since the Offshore Cable Area is spatially extensive, there is 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's 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 help guide development.

9.3 Overview

The Dogger Bank Zone is located approximately 68 nm from the nearest land at Flamborough Head (Anatec Ltd, 2010a). The Offshore Zone Development Envelope (ZDE) includes the Dogger Bank Zone and the Offshore Cable Area 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).

Within the Dogger Bank Zone, the water depth (at Lowest Astronomical Tide (LAT)) ranges between 18 m and 62 m. Deeper draught ships avoid the shallow areas of the Bank, particularly at the southern end of the Bank, e.g. the South-West Patch where waves break in strong gales (Anatec Ltd, 2010a). There are no IMO routeing measures or offshore installations within 10 nm of the Zone. Anatec Ltd (2010a) also indicate that since the nearest coastline is more than 60 nm from the Zone, there are no local ports which influence traffic movements.

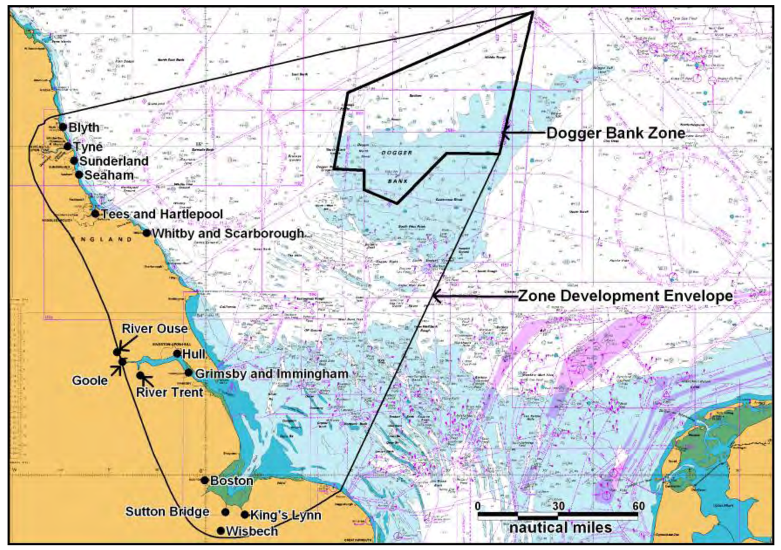

Figure 9.1: Chart overview of the Dogger Bank Zone Development Envelope in relation to major port areas and IMO routing measures (Anatec Ltd, 2010a).

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 28 day period in April and May, 2010 (Anatec Ltd, 2010a) combined with a further 26 days in May and June 2010 (Anatec Ltd, 2010c). 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 survey was carried out by the MV Sea Profiler and was supplemented by additional AIS data available from coastal and offshore stations.

An analysis of the ship types recorded as passing within the Dogger Bank Zone during the two 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 (60%), cargo ships (23%) and tankers (10%) (Anatec Ltd, 2010a, 2010c). Figure 9.2 below shows the tracks of commercial vessels within the Zone. Fishing vessel activity is described separately in Section 9.5 of this chapter, while commercial vessel activity is discussed here.

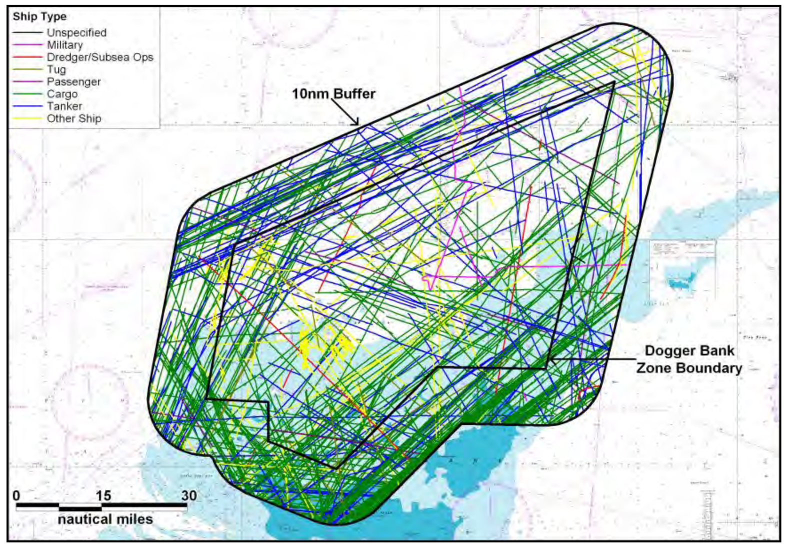

Figure 9.2: Vessel tracks within the Dogger Bank Zone based upon AIS survey data (Anatec Ltd, 2010c).

The AIS survey also measured the number of ships per day recorded within the Dogger Bank Zone, and these data show that there were, on average, 15 ships per day passing within the Zone boundary during the 54 days of the survey. The busiest day during the survey was 6th June 2010 when 34 ships were recorded. The quietest days were 21st April 2010 and 26th May 2010 when only 3 ships were recorded on both days (Anatec Ltd, 2010a; 2010c).

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 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 10 ships per year per nm^2;
- Low: 10 to 50 ships per year per nm^2;
- Moderate: 50 to 200 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 to high shipping density in the south-east and north-west parts of the Zone which will be explored further as more data becomes available.

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 ranges 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 in Figure 9.4 is less evident from the real AIS data shown in Figure 9.3.

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 9.5. In this instance, the grid was ranked specifically for the levels of traffic occurring in the Dogger Bank Zone and so shows 1km x 1km cells with densities equivalent to:

- 0 ships per day per nm^2;
- 1 ships per day per nm^2;
- 2 ships per day per nm^2;
- 3 ships per day per nm^2; and
- ≥ 4 ships per day per nm^2.

AIS is not, however, in operation on all fishing vessels less than 45 m in length so Anatec Ltd (2010a) 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. Satellite data for 2006 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 9.6 shows some discrete differences from the density plot obtained from AIS data (Figure 9.5). 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 (66%) followed by the UK (21%).

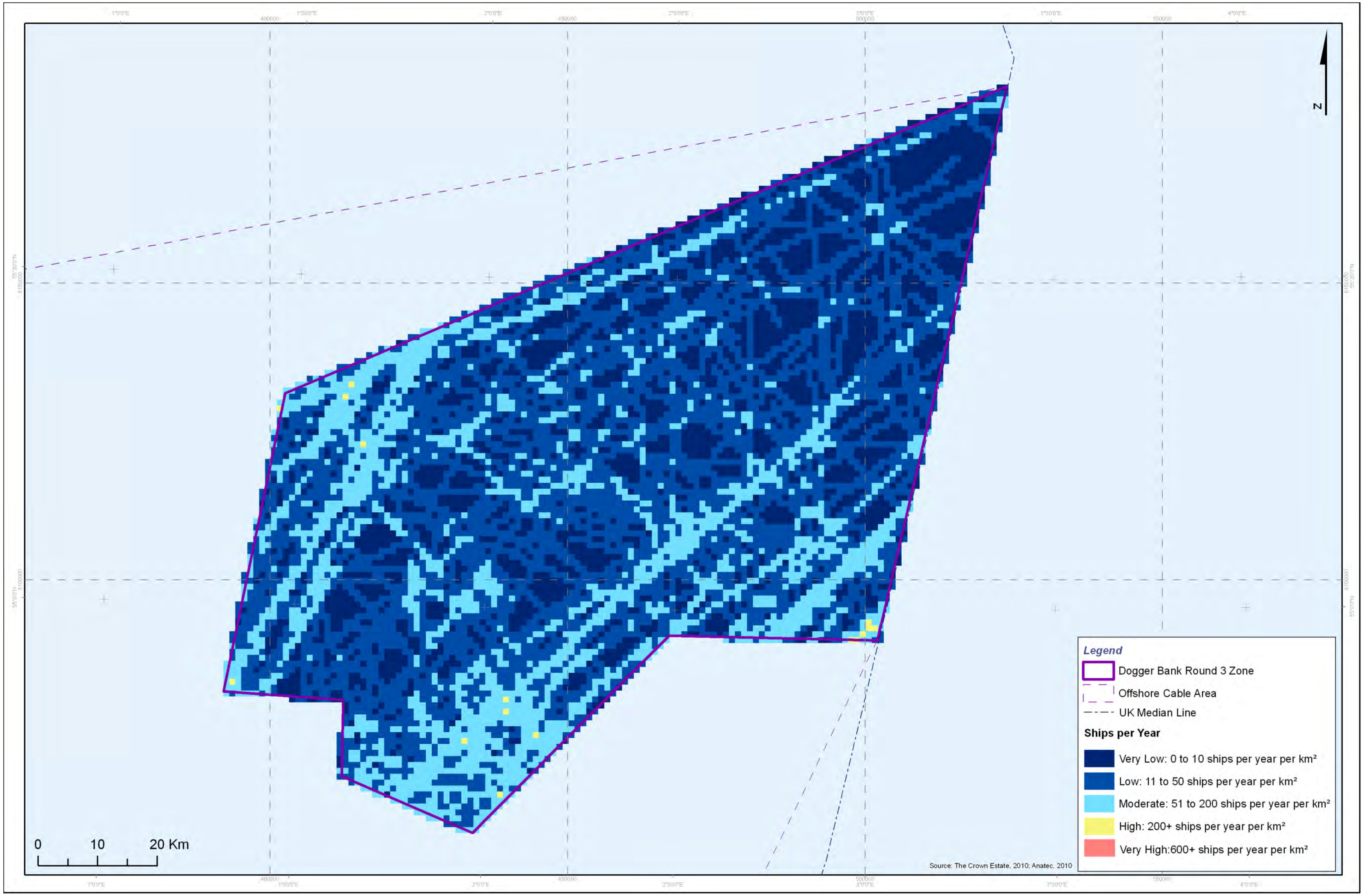

Figure 9.3: Shipping densities within the Dogger Bank Zone (excluding fishing vessels), derived from 54 days of AIS survey data (Anatec Ltd, 2010c).

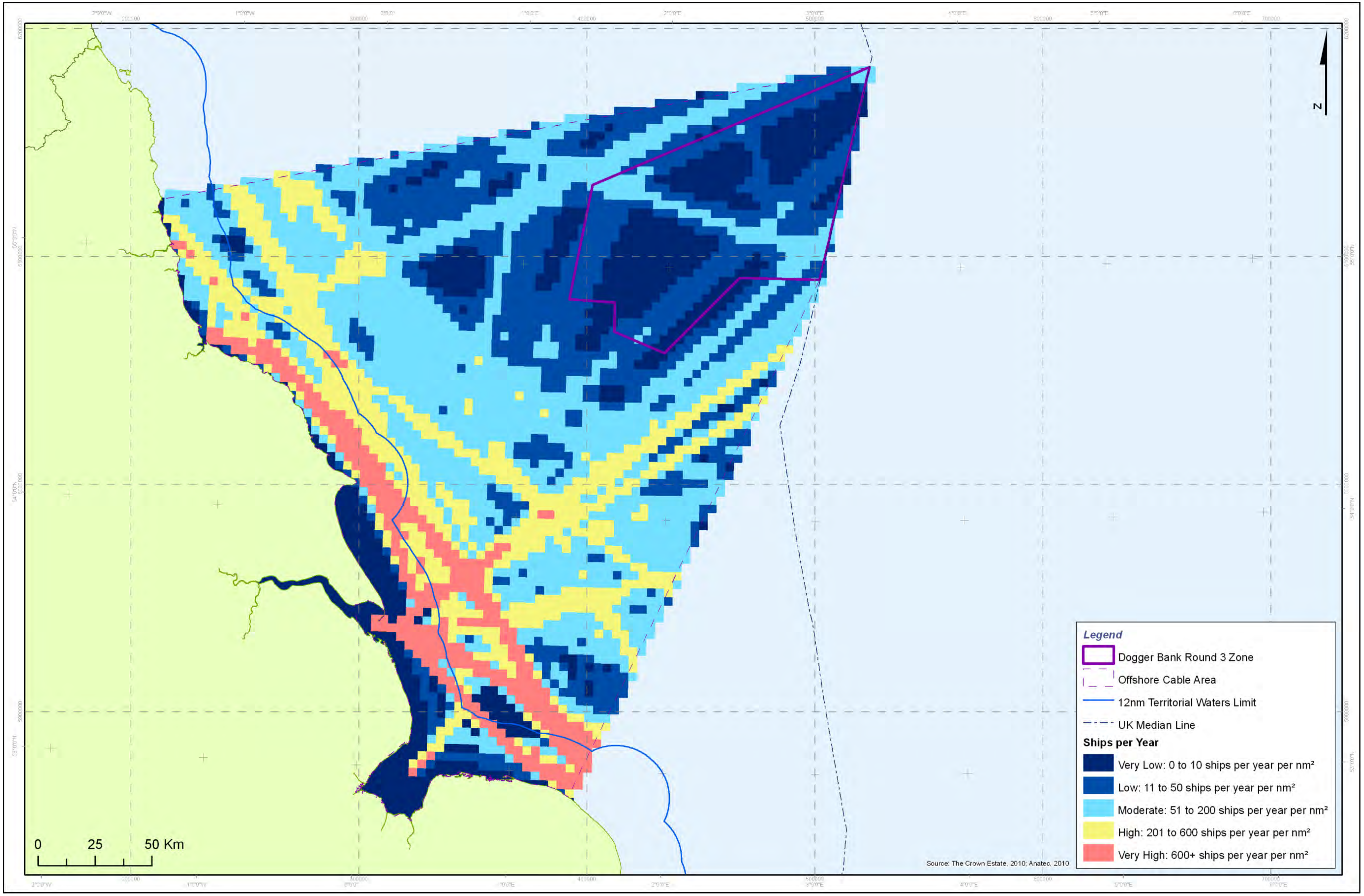

Figure 9.4: Shipping densities within the Offshore ZDE, derived from Ship Routes data (Anatec Ltd, 2010b).

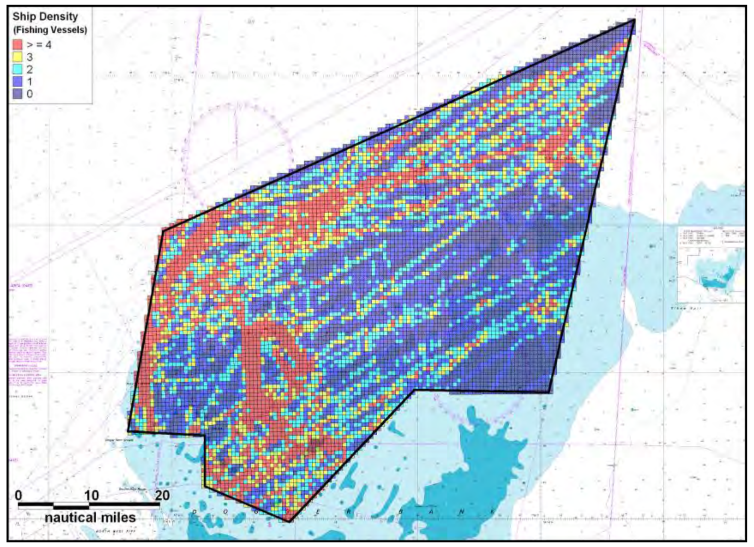

Figure 9.5: Fishing vessel density grid (April-June 2010) based on 54 days AIS survey data (Anatec Ltd, 2010c).

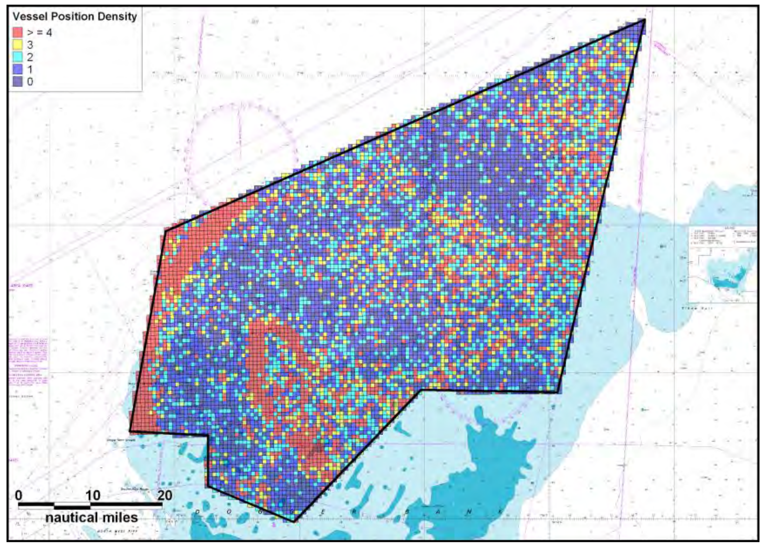

Figure 9.6: Fishing vessel density plot from 2006 satellite data (Anatec Ltd, 2010a).

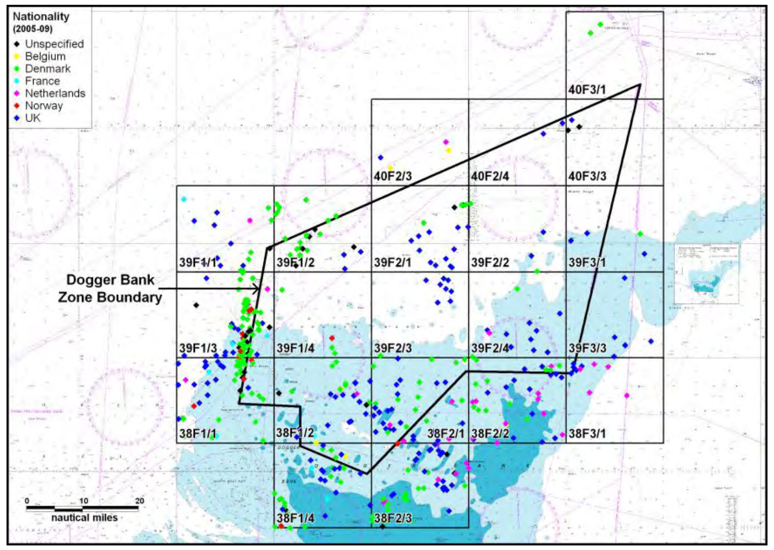

Figure 9.7: Fishing vessel aerial sightings by nationality (2005 – 09) in ICES subsquares encompassing the Dogger Bank Zone (Anatec Ltd, 2010a).

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 9.7. 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 9.7). 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).

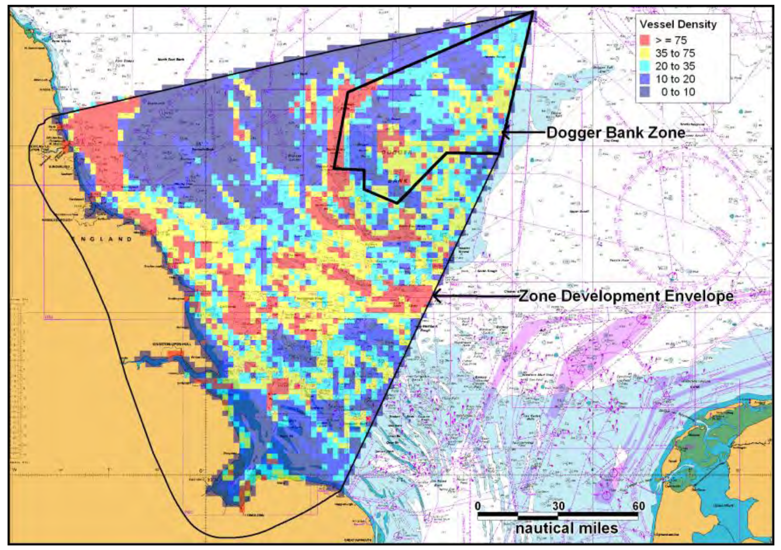

Figure 9.8: Offshore ZDE fishing vessel density plot from 2006 satellite data (Anatec Ltd, 2010b).

9.5.2 Offshore Cable Area

The fishing vessel density within the Offshore Cable Area has been estimated, based on satellite tracking data from 2006, 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 9.8. Due to differences in the magnitude of vessel densities occurring between the Dogger Bank Zone and the Offshore Cable Area, the rankings are classified differently. Anatec Ltd (2010b) report that the rankings correspond to the following ranges:

- 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 nearshore, 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 some 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, both under sail and power is highly seasonal and highly diurnal, and recreational craft routes are divided into Heavy, Medium and Light Use based on the following 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.
- Light Recreational Routes: Routes known to be in common use but which do not qualify for medium or heavy classification.

Figure 9.9 shows 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. In addition to yacht cruising, there is an annual North Sea Triangle race crossing the North Sea which may pass through the area.

9.7 Navigational Features

Within the Offshore ZDE there are a number of significant navigational features (Figure 9.10) 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 9.10).

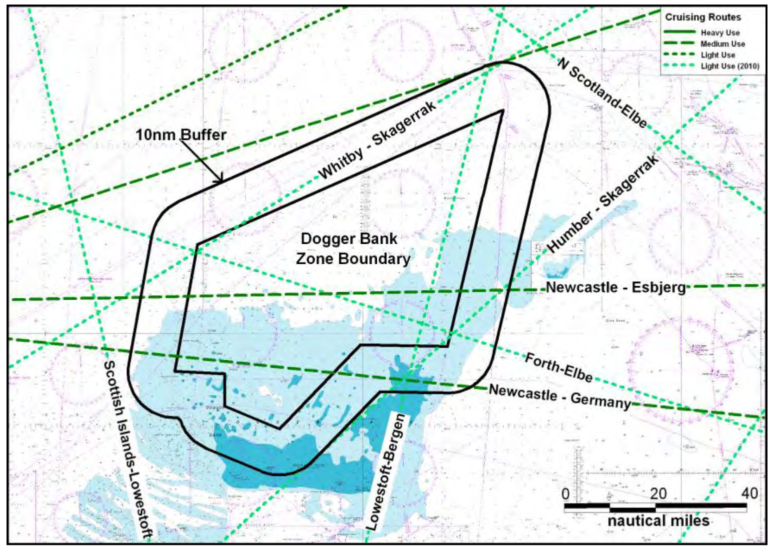

Figure 9.9: RYA cruising routes in the Dogger Bank Zone (Anatec Ltd, 2010 a).

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 9.11. 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.*

There are two military practice areas overlapping the Dogger Bank Zone and another within 10 nm, as shown in Figure 9.12. D412 Staxton, outside the Zone, and D323B, which overlaps the south-west part of the Zone, are RAF Danger Areas. A Submarine Exercise Area also intersects the south-west corner of the Zone.

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*.

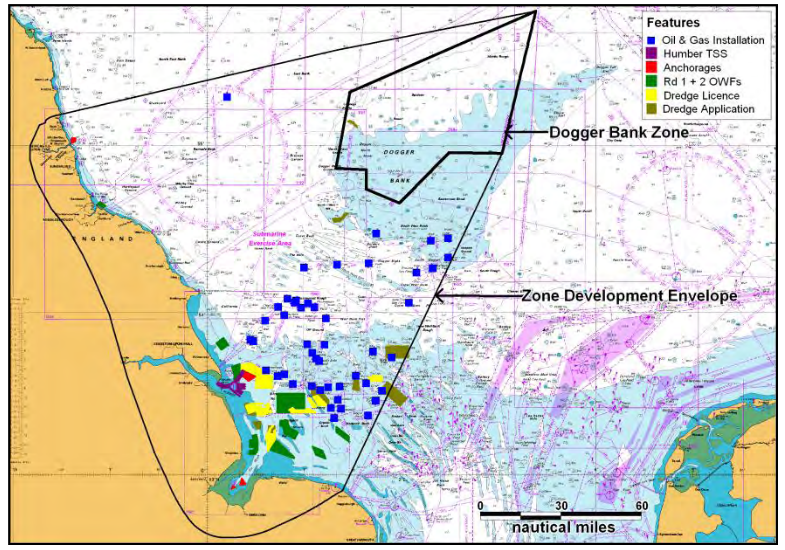

Figure 9.10: Navigational features within the Offshore ZDE (Anatec Ltd, 2010b).

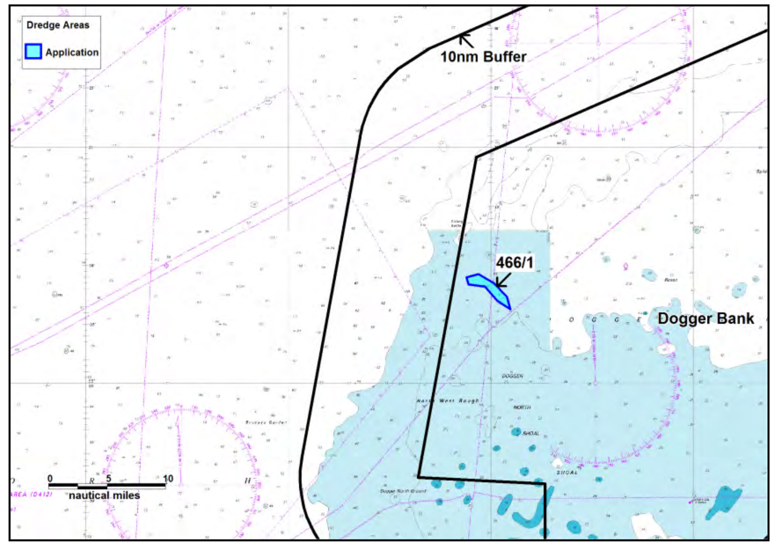

Figure 9.11: Dredging Application Area 466/1 within the Dogger Bank Zone (Anatec Ltd, 2010 a).

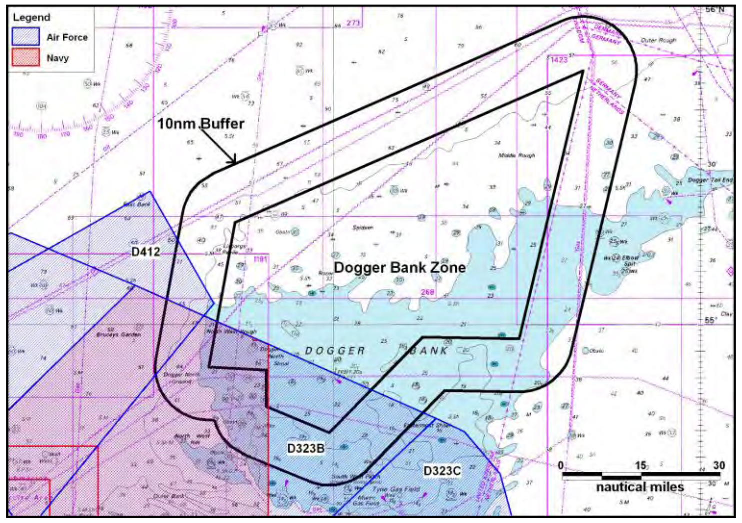

Figure 9.12: Military Practice Areas (shown in purple) within 10nm of the Dogger Bank Zone (Anatec Ltd, 2010 a).

9.8 Summary

The Dogger Bank Zone and the Offshore Cable Corridor 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 indicate 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 54 day AIS survey consists of fishing vessels (60%), cargo ships (23%) and tankers (10%). On average, 15 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 data indicates that the busiest areas are just off the east coast where shipping traffic transits between ports.

Fishing vessel densities and distributions in the Dogger Bank Zone recorded during the AIS survey and by 2006 satellite data demonstrate some general similarities, with the greatest concentrations of activity occurring along the western margin of the Zone and south-west 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 (66%) and the UK (21%).

Satellite data indicates that there is considerable variation in fishing vessel levels within the Offshore Cable Area. Vessels less than 15 m in length, which are likely to be particularly active nearshore, 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 highly 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 (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 south-west part of the Dogger Bank Zone: a RAF Danger Area and a Submarine Exercise Area.

The AIS survey, commissioned by Forewind, is ongoing. Additional data will be analysed along with imminent data from a planned radar survey in the Dogger Bank Zone to collect data on smaller vessels not captured by AIS (Anatec Ltd, 2010a). 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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10. Commercial Fisheries

10.1 Introduction

The following chapter provides a characterisation of the 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)
    - Landings Values and Effort (2000-2009)
    - Surveillance Sightings (2000-2009)
    - Satellite Tracking (VMS) (2005-2008)
- 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
- Brown & May Marine databases

10.2.1 Data Limitations, Gaps and Sensitivities

Fisheries Statistics by ICES Rectangle

ICES statistical rectangles (Figure 10.1) 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 km² 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. It should 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 12-14 nm in length and may cross rectangle boundaries, catches are often recorded in only one rectangle.

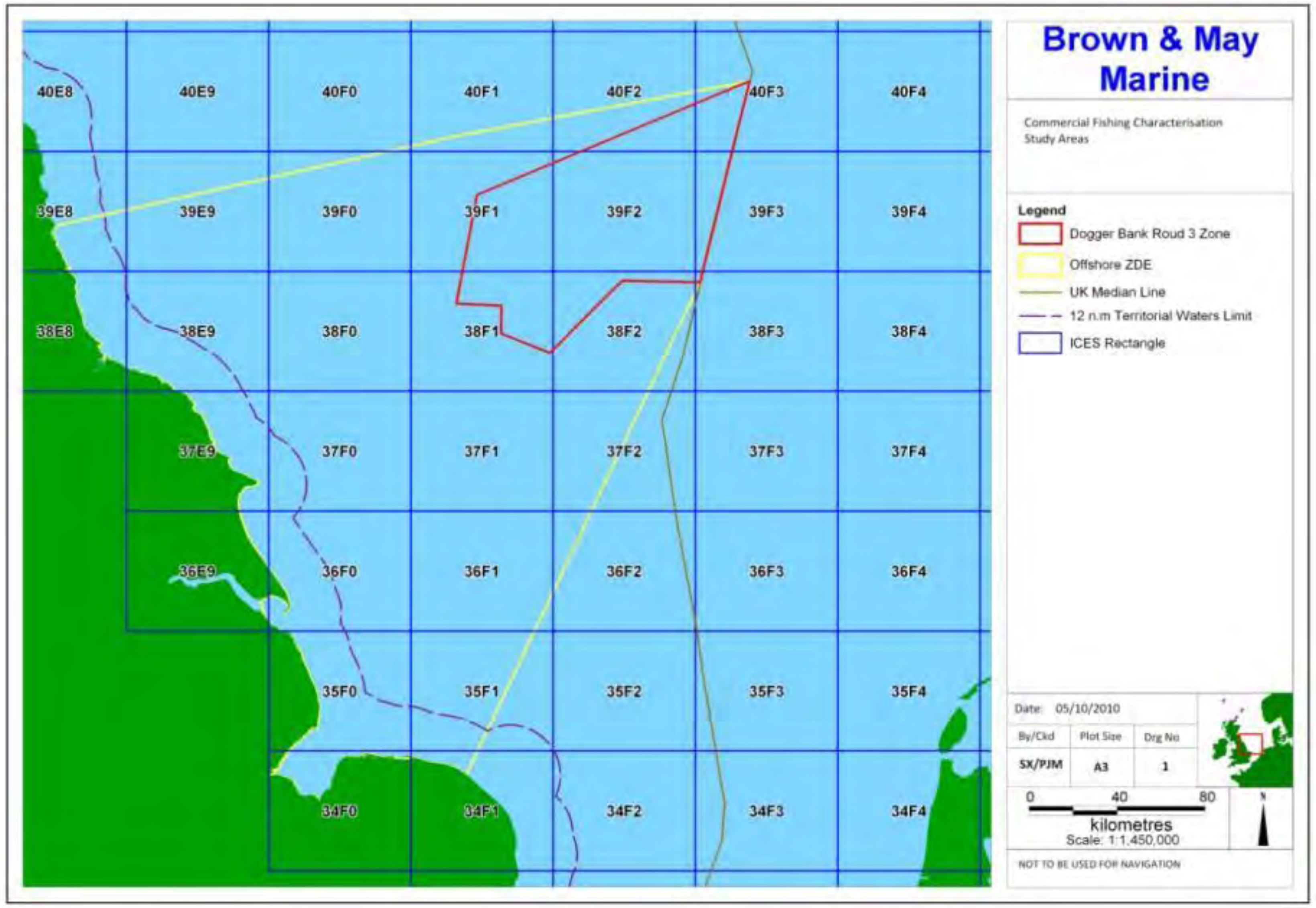

Figure 10.1: ICES rectangles in relation to the Dogger Bank Zone and Offshore Cable Area.

The fisheries data by ICES rectangle collected and collated by the MMO and other national data centres are principally derived from vessels' daily EC log sheets which over 10 m vessels 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. To date, the French authorities have been unwilling to release fisheries statistics and other national data centres only release data in significantly less detail than that provided by the MMO.

Satellite Tracking Data

Satellite tracking of EU registered fishing vessels of more than 15 metres in overall length was introduced in 2005. The positions of the vessels are transmitted approximately every 2 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 NFFO (the UK National Federation of Fishermen's Organisations) 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.

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.

10.2.2 Study Area

The overall study area used for the assessment of fishing activity, the Offshore Zone Development Envelope (ZDE), is shown in Figure 10.1. This includes the Dogger Bank Zone and the Offshore Cable Area.

10.3 Types and Relative Levels of Fishing Activity

10.3.1 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 is 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 Dogger Bank Zone.

The numbers and percentages of VMS sightings 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%).

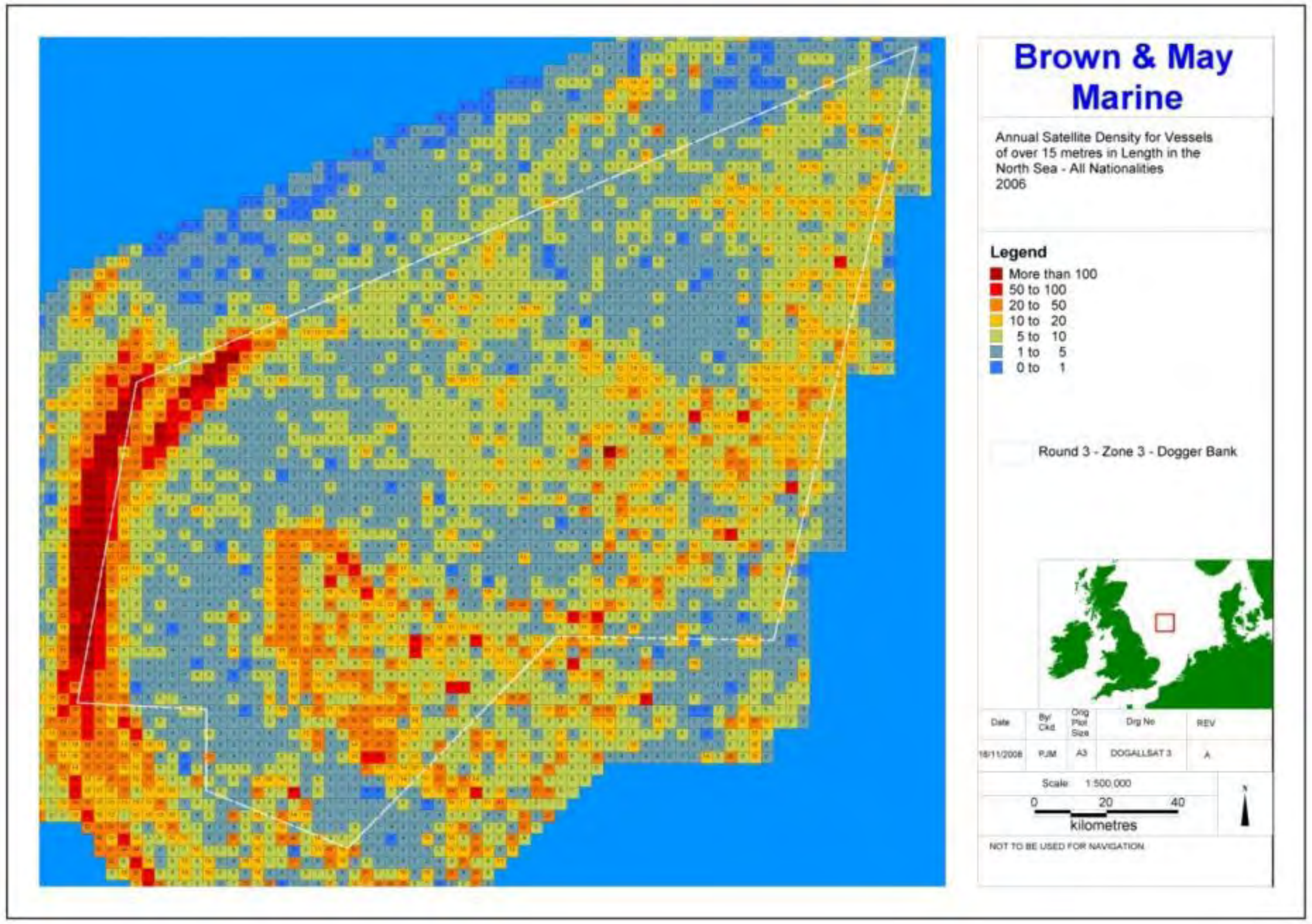

Figure 10.2: 2006 Average annual density of satellite tracked positions of vessels of over 15 m in length - all nationalities (MMO, 2006).

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 10.4) which also observed the highest proportion of vessels within the Zone to be Danish (Anatec, 2010).

The distribution of fishing within the entire Offshore ZDE by nationality is illustrated in Figure 10.3 overleaf based on MMO surveillance sightings (2000-2009). The Dogger Bank Zone records relatively low levels of activity in comparison to areas to the west and south of the Zone.

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 %

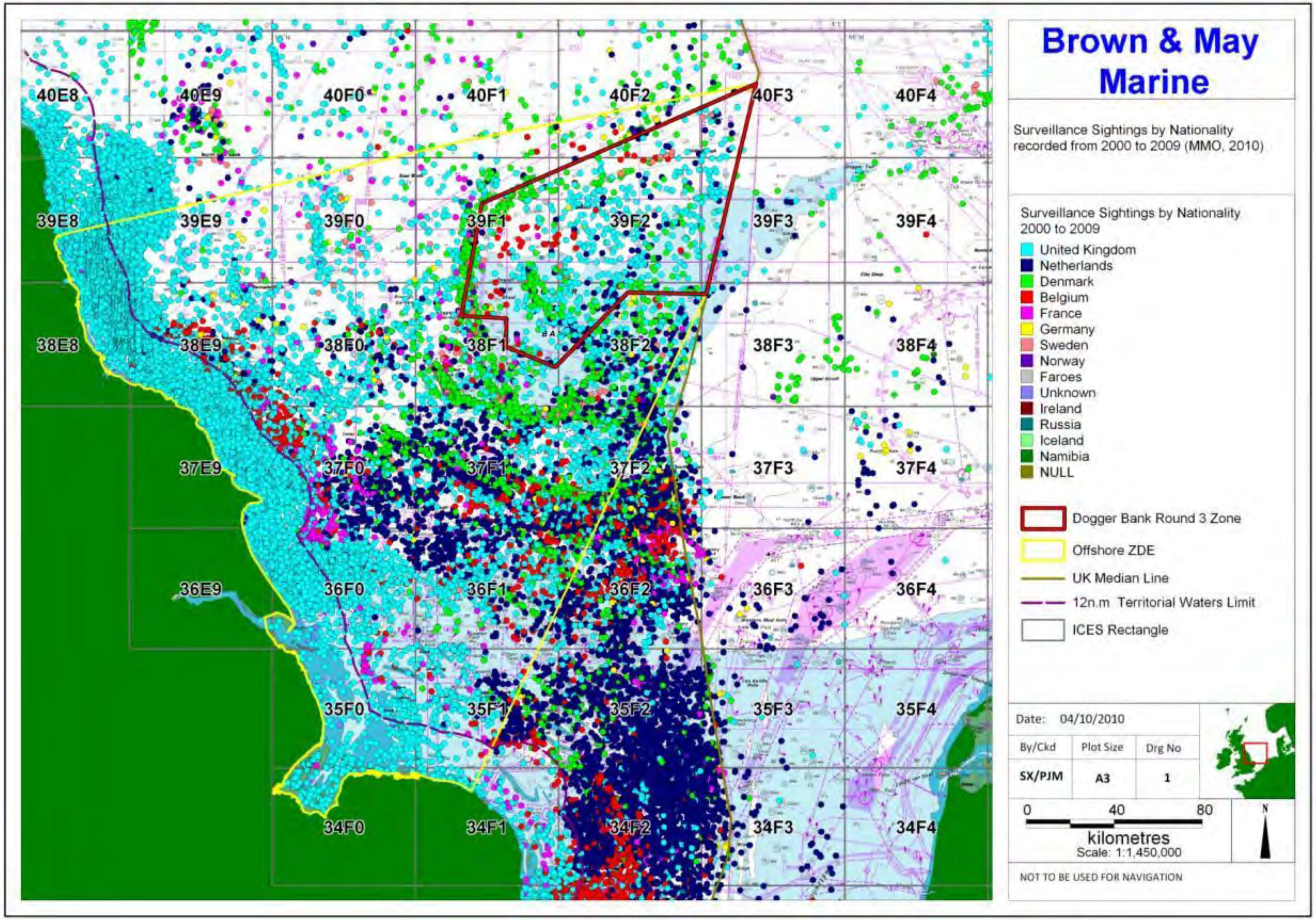

Figure 10.3: Surveillance sightings by nationality (2000-2009) (MMO, 2010)

Table 10.2: Surveillance sightings recorded within the boundary of the Dogger Bank Zone form 2000 - 2009 (MMO, 2010)

Nationality	Method	Year										Annual Average (2000-2009)	Percentage of Total No. of Sightings
		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009		
United Kingdom	Beam Trawler	75	41	41	67	56	24	9	22	3	13	35.1	34.5 %
	Trawler (all)	14	8	13	6	1	1	0	0	0	3	4.6	4.5 %
	Gill Netter	5	6	7	1	1	0	0	0	1	1	2.2	2.2 %
	Bottom Seiner	1	4	0	4	2	1	1	1	4	3	2.1	2.1 %
	Purse Seiner	4	2	5	2	2	0	0	2	0	0	1.7	1.7 %
	Other	3	2	0	3	1	2	3	0	1	0	1.5	1.5 %
	Total	**102**	**63**	**66**	**83**	**63**	**28**	**13**	**25**	**9**	**20**	**47.2**	**46.4 %**
Denmark	Trawler (all)	34	36	52	22	25	12	1	0	3	15	20	19.6 %
	Industrial trawler (sandeeler)	0	2	5	12	17	5	0	0	2	1	4.4	4.3 %
	Bottom Seiner	3	2	2	1	5	1	5	1	6	2	2.8	2.8 %
	Gill Netter	3	5	5	2	2	1	0	0	0	2	2	2.0 %
	Other	12	4	0	4	1	6	1	2	0	2	3.2	3.1 %
	Total	**52**	**49**	**64**	**41**	**50**	**25**	**7**	**3**	**11**	**22**	**32.4**	**31.8 %**
Netherlands	Beam Trawler	26	4	8	30	21	1	0	1	0	0	9.1	8.9 %
	Trawler (all)	1	2	5	0	0	0	1	0	0	1	1	1.0 %
	Other	0	0	1	1	0	0	0	0	0	2	0.4	0.4 %
	Total	**27**	**6**	**14**	**31**	**21**	**1**	**1**	**1**	**0**	**3**	**10.5**	**10.3 %**
Belgium	Beam trawler	11	17	12	3	2	2	0	0	0	1	4.8	4.7 %
	Stern Trawler (pel/dem)	0	0	0	0	0	0	2	0	0	0	0.2	0.2 %
	Total	**11**	**17**	**12**	**3**	**2**	**2**	**2**	**0**	**0**	**1**	**5**	**4.9 %**
Sweden	Trawler (all)	0	0	3	9	1	0	0	0	1	3	1.7	1.7 %
	Industrial trawler (sandeeler)	0	0	0	6	0	0	0	0	0	0	0.6	0.6 %
	Other	1	0	2	1	0	0	0	0	0	0	0.4	0.4 %
	Total	**1**	**0**	**5**	**16**	**1**	**0**	**0**	**0**	**1**	**3**	**2.7**	**2.7 %**
Norway	Trawler (all)	4	0	5	0	0	0	0	0	0	3	1.2	1.2 %
	Industrial trawler (sandeeler)	0	0	0	2	1	0	0	0	0	0	0.3	0.3 %
	Other	0	1	0	1	0	0	0	0	0	0	0.2	0.2 %
	Total	**4**	**1**	**5**	**3**	**1**	**0**	**0**	**0**	**0**	**3**	**1.7**	**1.7 %**
Germany	**Various**	**2**	**0**	**1**	**0**	**0**	**0**	**1**	**0**	**2**	**5**	**1.1**	**1.1 %**
Faroes	**Various**	**0**	**1**	**4**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**0.8**	**0.8 %**
France	**Various**	**0**	**1**	**1**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0.4**	**0.4 %**
	TOTAL (All Nationalities & Methods)	**199**	**138**	**172**	**178**	**138**	**58**	**24**	**30**	**23**	**58**	**101.8**	

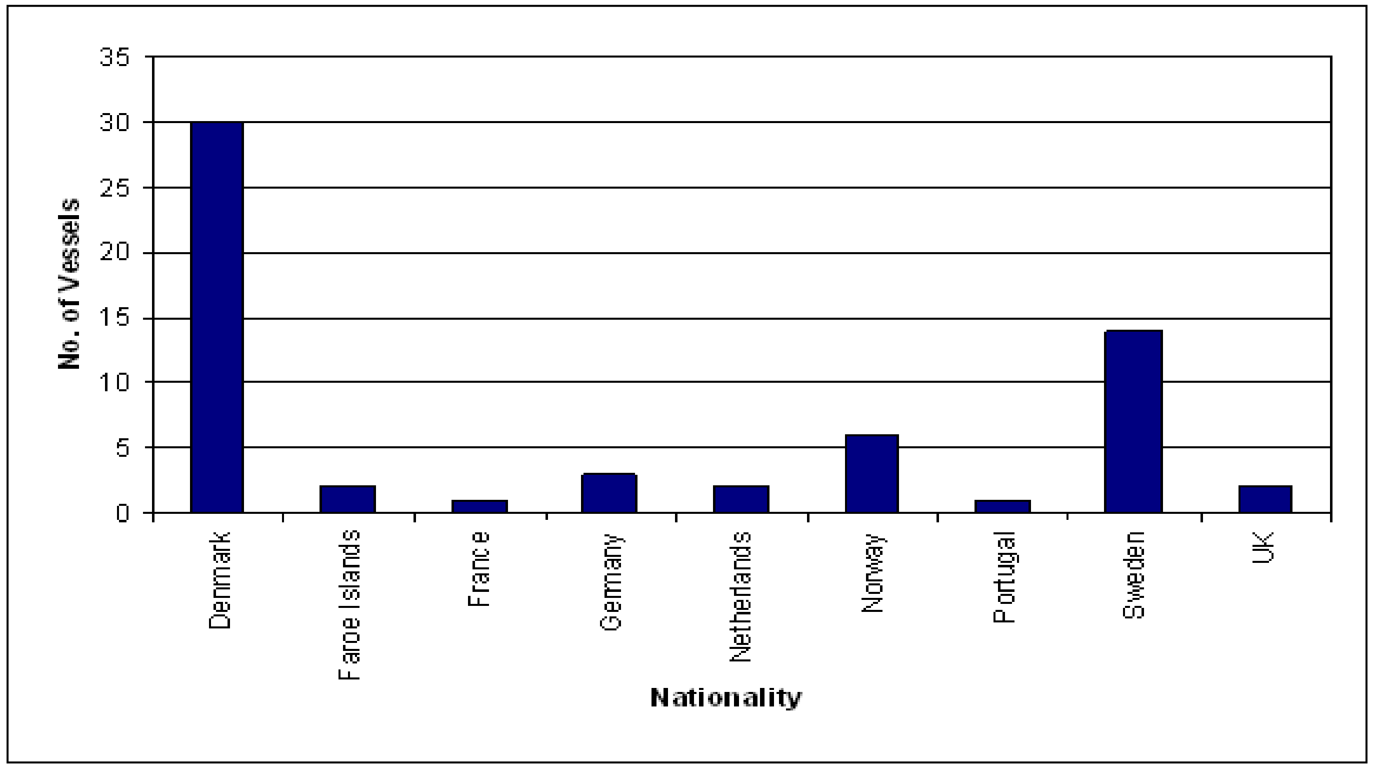

Figure 10.4: Number of fishing vessels within the Dogger Bank Zone by nationality observed from April to May 2010 Radar Surveys (Anatec, 2010).

The numbers and percentages of surveillance sightings by nationality and fishing method recorded from 2000 to 2009 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.

10.3.2 UK Activity

An overview of the principal species targeted by the UK fleet within the Offshore ZDE is given in Figure 10.5 expressed as annual landings values by species (average 2000-2009). 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 2000-2009) is illustrated in Figure 10.6. 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, 97.6 % of the landings by value are into Dutch ports, principally Harlingen (Table 10.3), again reflecting that the majority of UK activity in the Dogger Bank Zone is by UK registered but Dutch owned and operated vessels.

Table 10.3: Percentage of total landings values of Beam Trawlers by port of landing from 2000 to 2009 (MMO, 2010).

Port	Country	Percentage of Total Value by Beam Trawlers
Harlingen	Netherlands	77.8 %
Urk	Netherlands	8.7 %
Unspecified Dutch Port	Netherlands	5.5 %
Den Helder	Netherlands	3.3 %
Lowestoft	UK	2.1 %
Ijmuiden	Netherlands	1.7 %
Scheveningen	Netherlands	0.4 %
Delfzil	Netherlands	0.1 %
Grimsby	UK	0.1 %
Hartlepool	UK	0.1 %
Eemshaven	Netherlands	0.1 %
Peterhead	UK	0.1 %
Cove (Leith)	UK	0.0 %
Thyboron	Denmark	0.0 %

An overview of the distribution of UK vessels over 15 m in length within the Offshore ZDE is given in Figure 10.7 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 10.4. 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 10.4). This pattern is also reflected in the surveillance sightings data (Figure 10.9) which shows that the majority of UK vessels within the Dogger Bank Zone are beam trawlers.

Other 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.

Both the VMS tracking and surveillance sightings show lower levels of UK beam trawling activity in the western portion of the Dogger Bank Zone.

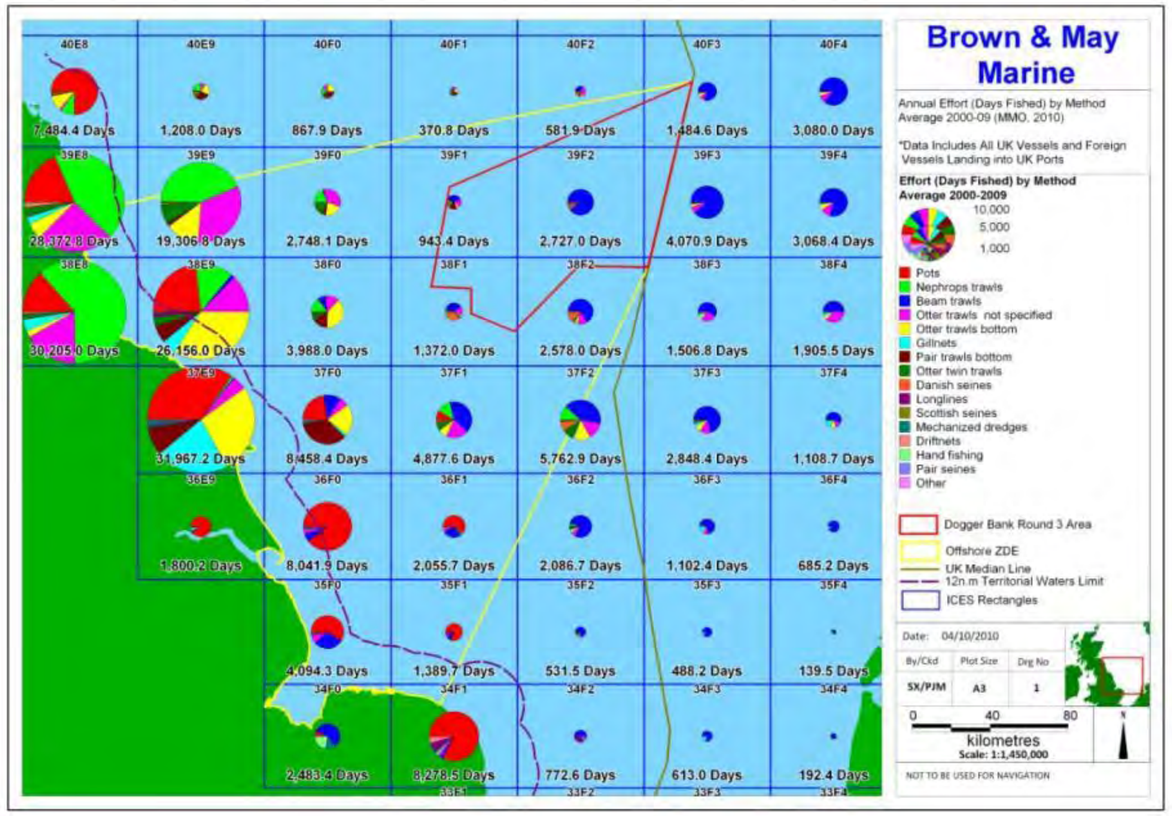

Figure 10.5: Annual landings by method for UK vessels and foreign vessels landing into UK Ports (average 2000-2009)(MMO, 2010).

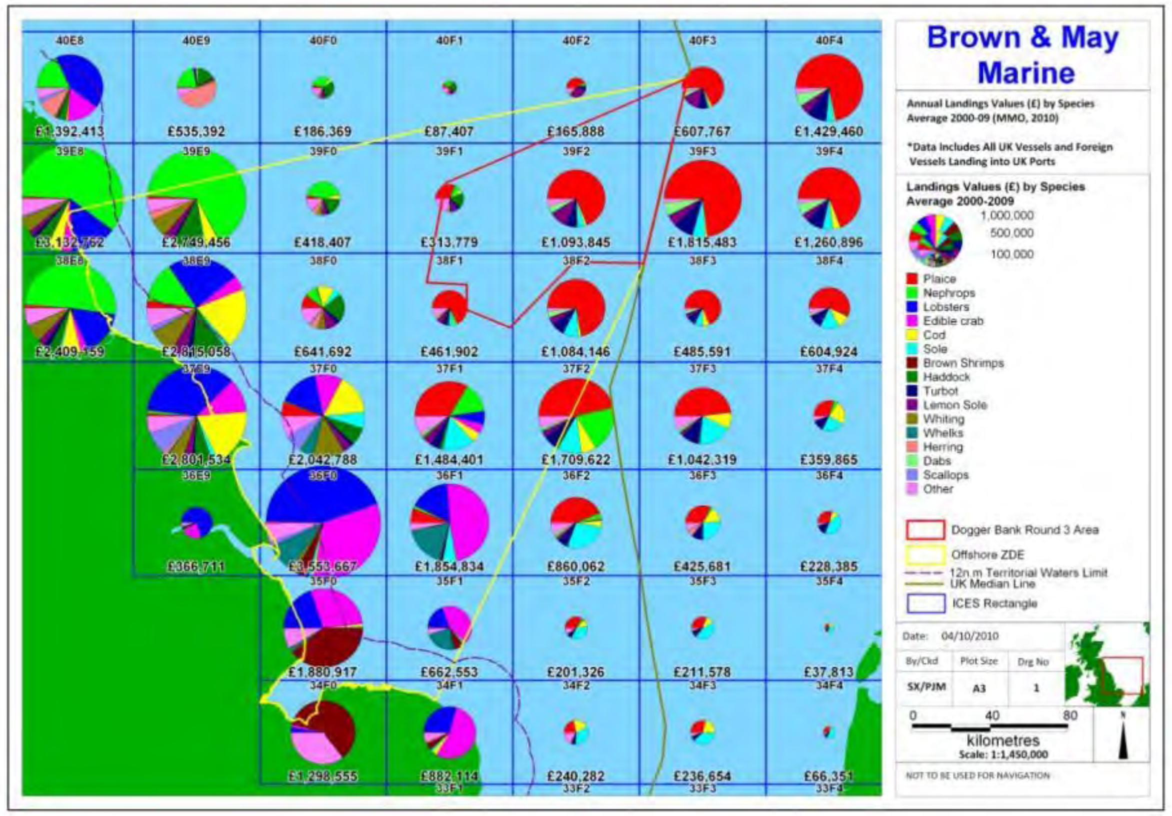

Figure 10.6: Annual effort (days fished) by method for UK vessels and foreign vessels landing into UK Ports (average 2000-09) (MMO, 2010).

Table 10.4: Number of UK Vessels VMS Position Plots recorded from 2005 to 2008 within the Dogger Bank Zone (MMO, 2009).

Vessel Type	Number 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%

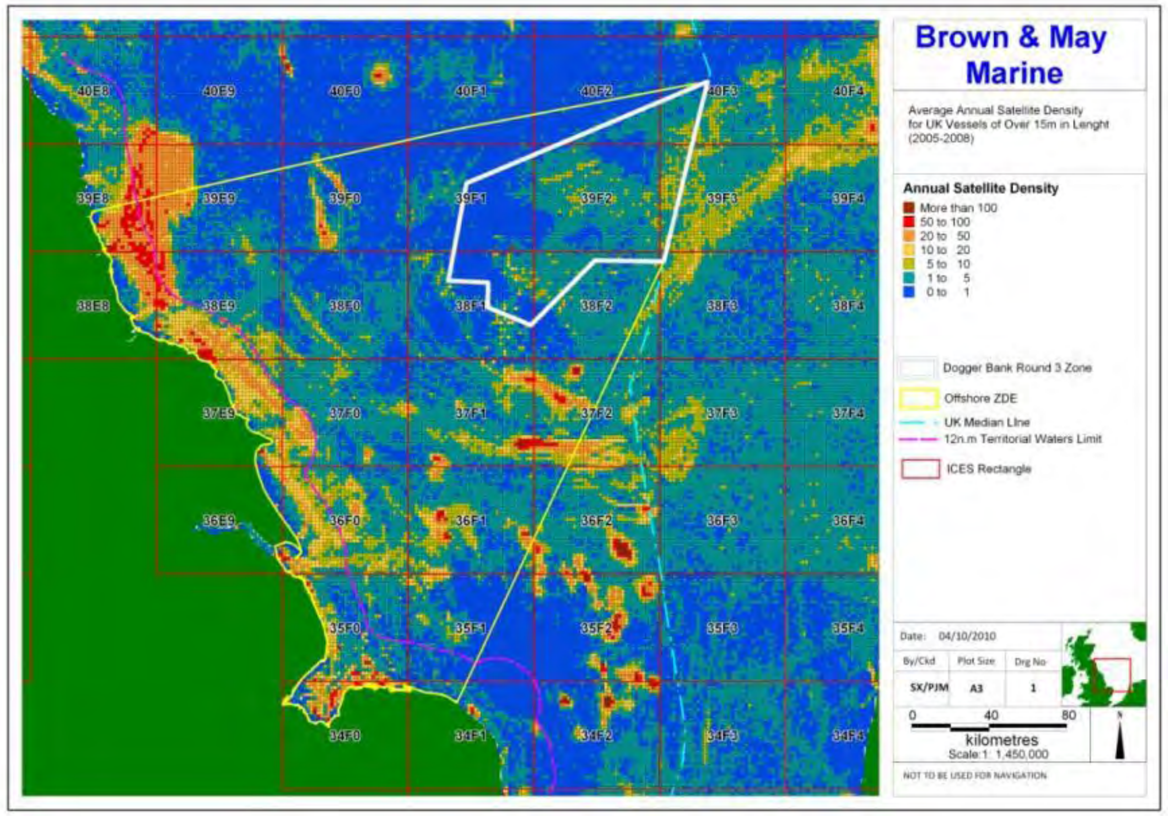

Figure 10.7: Average annual satellite density for UK Vessels of over 15m in length (2005-2008) (MMO, 2009).

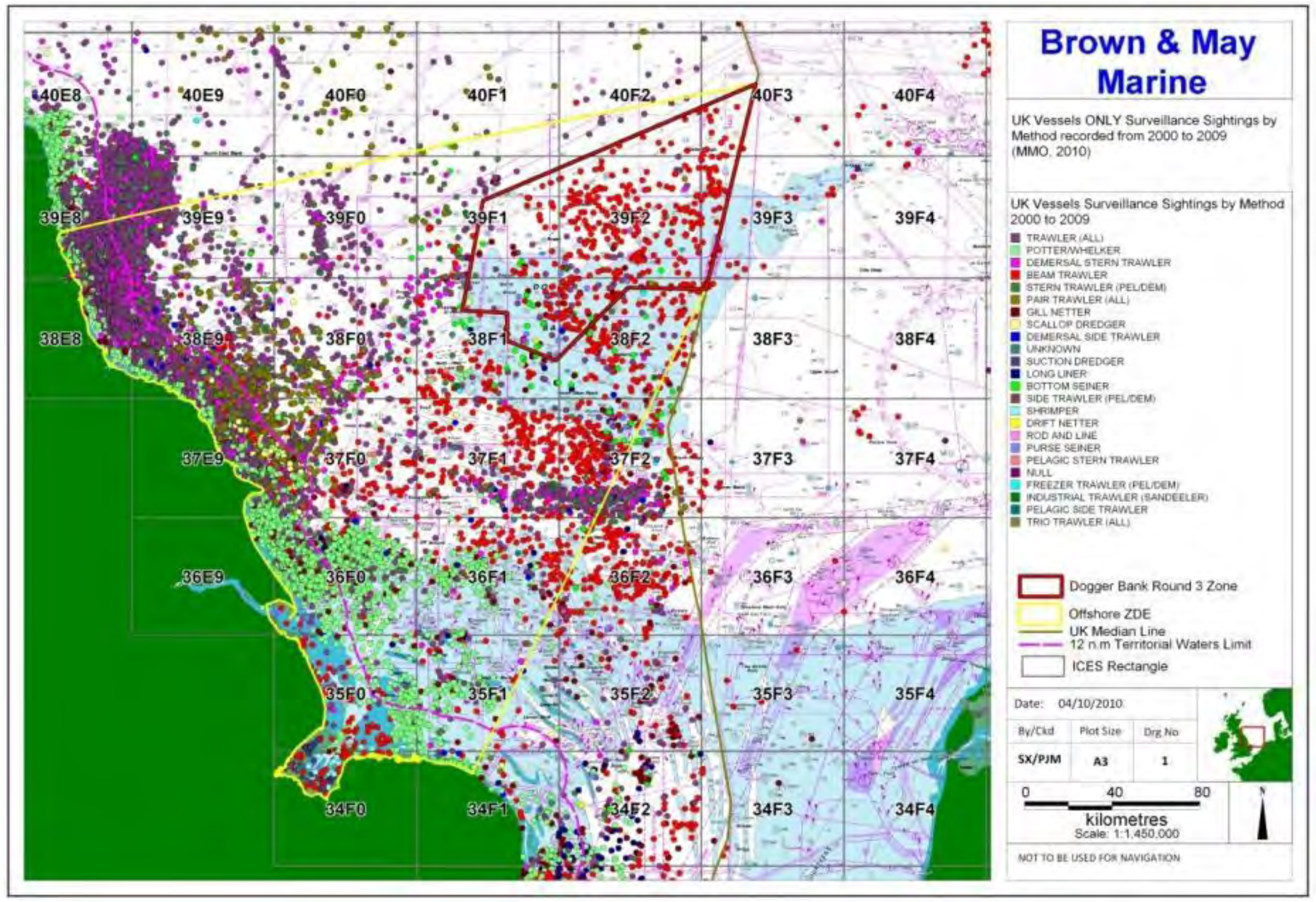

Figure 10.8 UK Vessels surveillance sightings by method (2000-2009) (MMO, 2010).

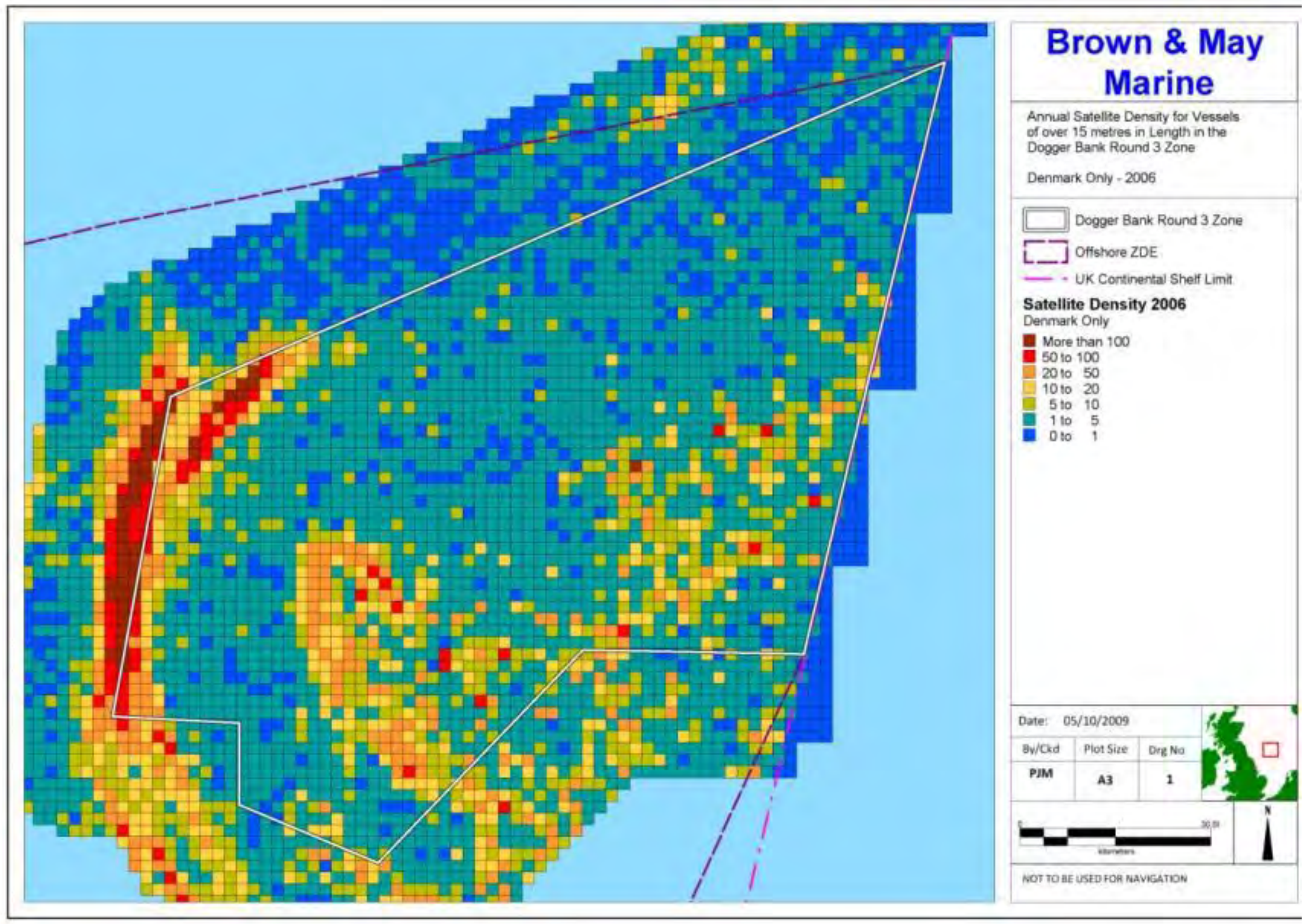

Figure 10.9: 2006 Annual satellite density for Danish Vessels of over 15m in length (MMO, 2006).

10.3.3 Danish Activity

An indication of the levels of Danish fishing activity is given in Figure 10.9 and Figure 10.10. 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 site. 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 10.11).

Other methods of relative importance within the Dogger Bank 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.

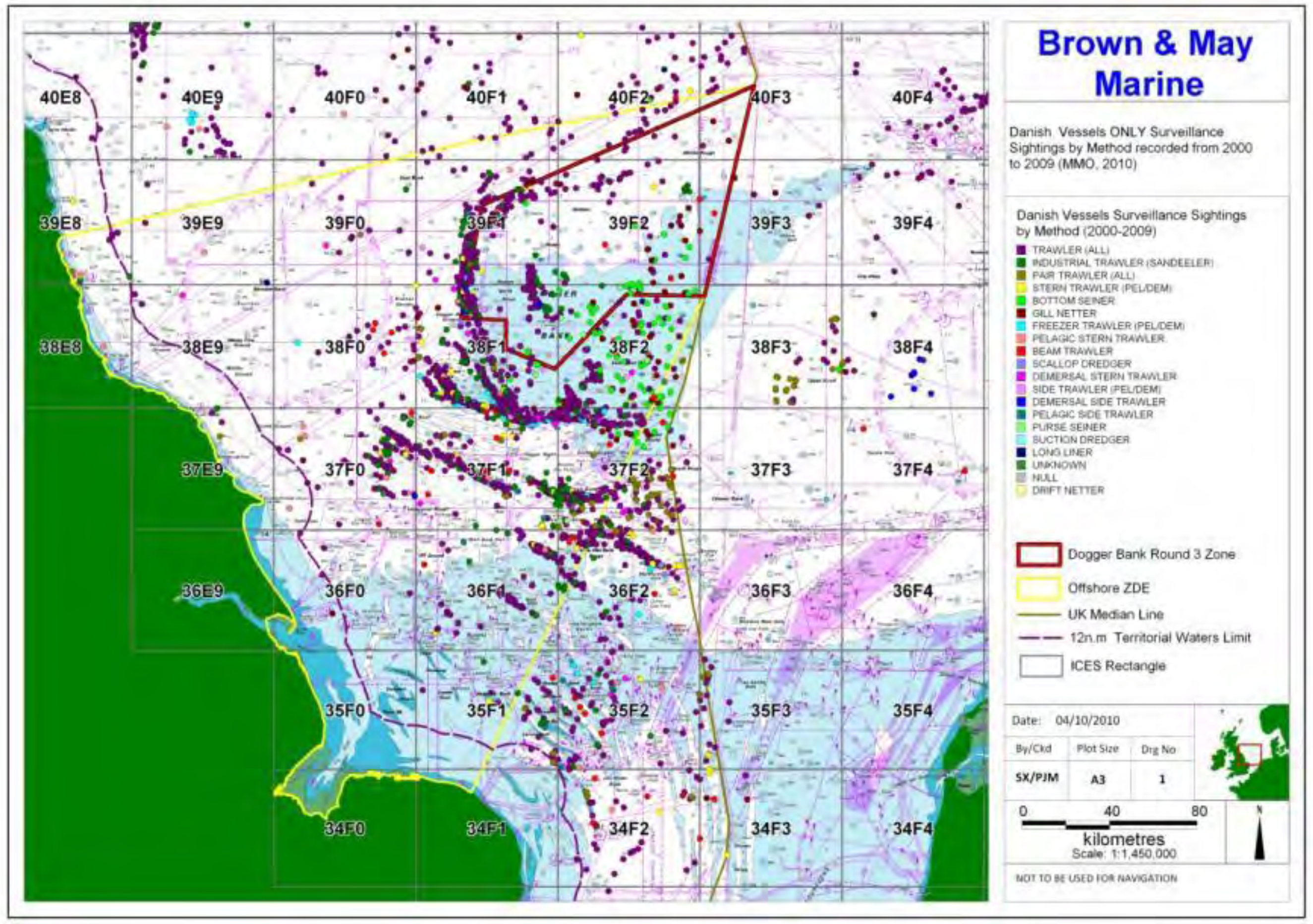

Figure 10.10 Danish vessels surveillance sightings by method (2000-2009) (MMO, 2010).

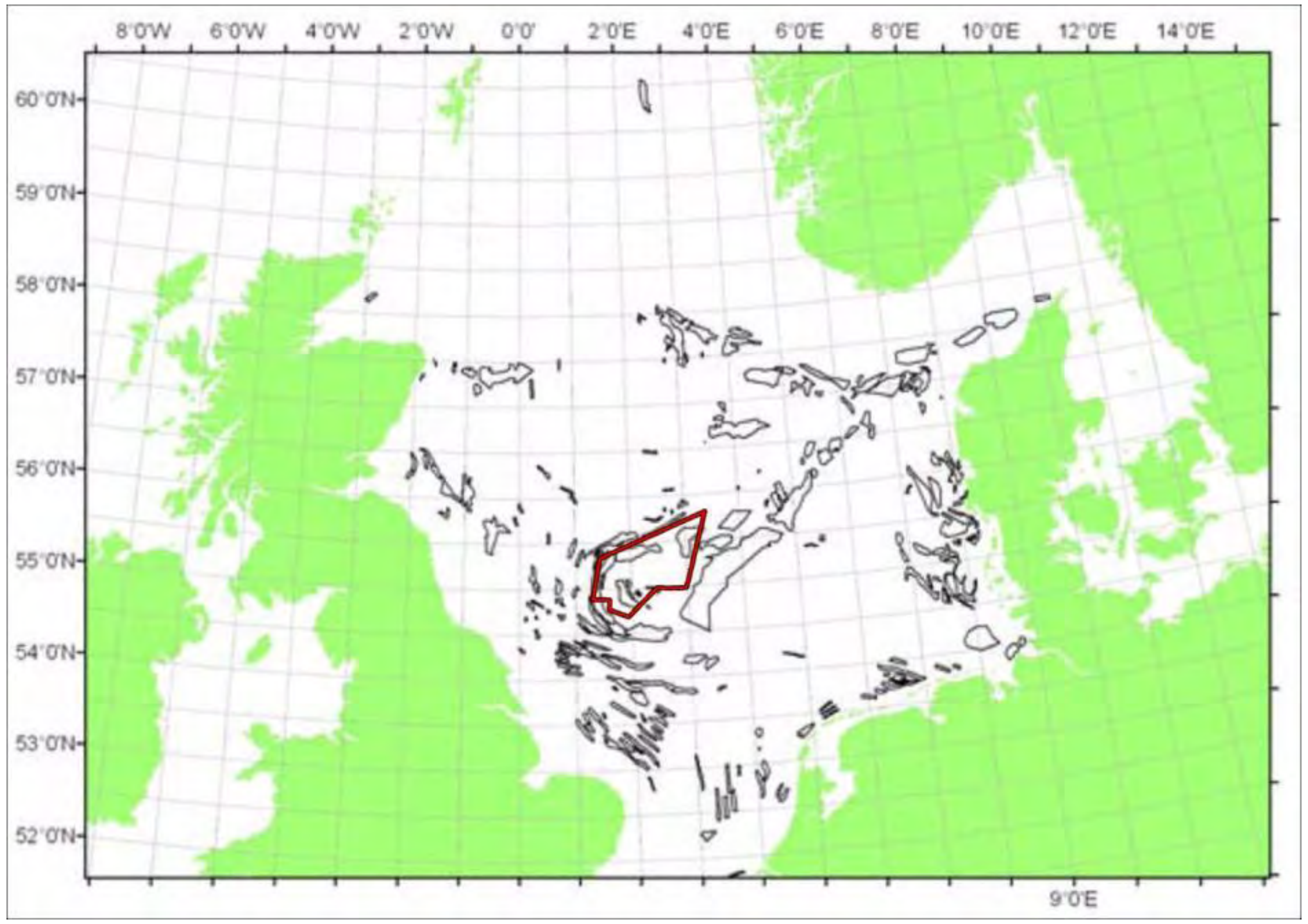

Figure 10.11 Sandeel fishing grounds in the North Sea (ICES, 2007).

10.3.4 Swedish Activity

Fishing activity by Swedish registered vessels appears to be low within the boundaries of the Dogger Bank Zone (Figure 10.12 and Figure 10.13). 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.

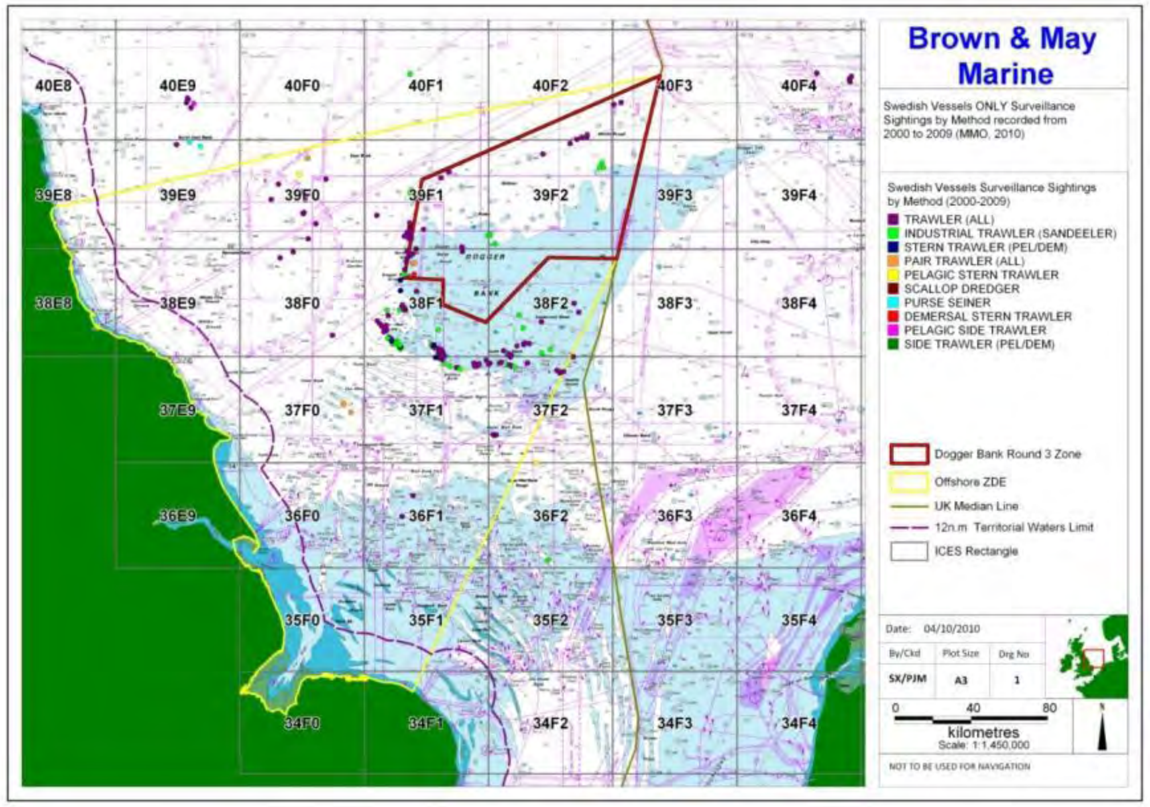

Figure 10.12 Annual satellite density for Swedish Vessels of over 15m in length (MMO, 2006).

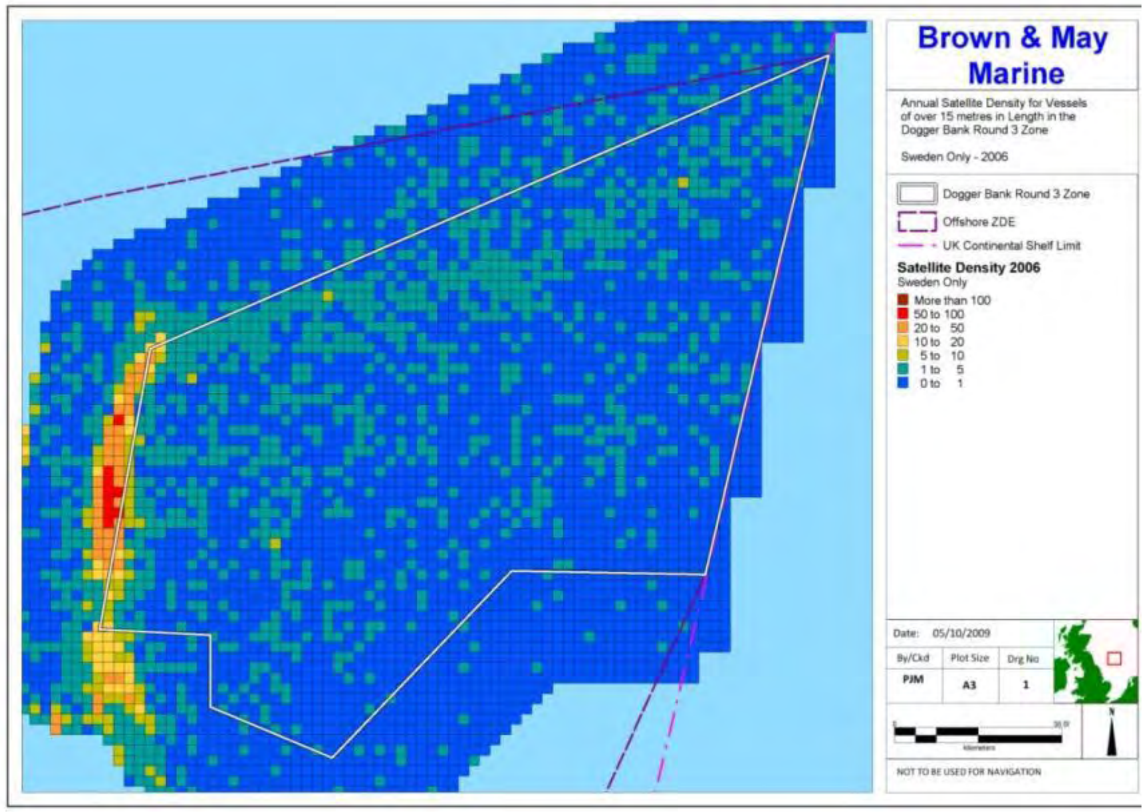

Figure 10.13 Swedish vessels surveillance sightings by method (2000-2009) (MMO, 2010).

10.3.5 Dutch Activity

The available MMO VMS data (Figure 10.14) indicates 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 10.15) show that the limited activity which does occur is mainly concentrated along the southern and eastern boarders of the Dogger Bank Zone. The MMO surveillance sightings (Figure 10.16) identify Dutch activity within the Zone to be almost entirely by beam trawlers.

Figure 10.15 and Figure 10.16 indicate that the proportion of activity by Dutch registered vessels within the Zone is minimal in comparison to the Southern and central North Sea.

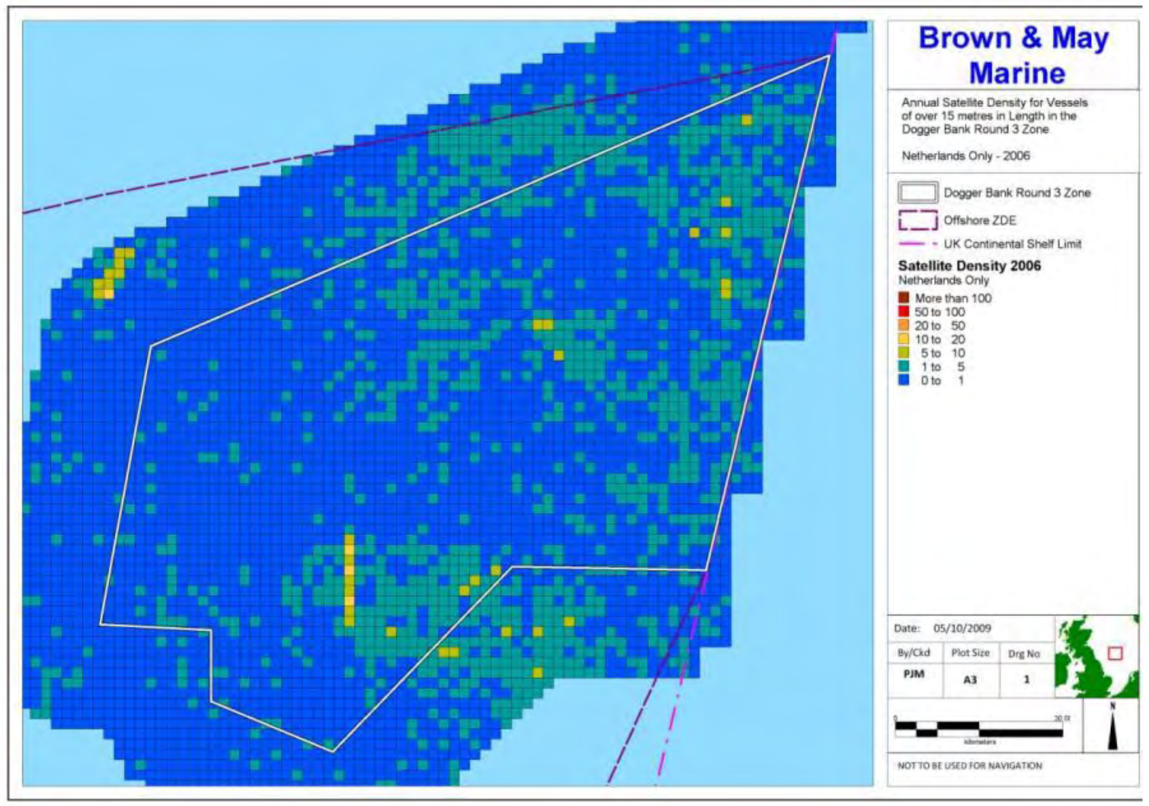

Figure 10.14: Annual Satellite Density for Dutch Vessels of over 15m in Length (MMO, 2006).

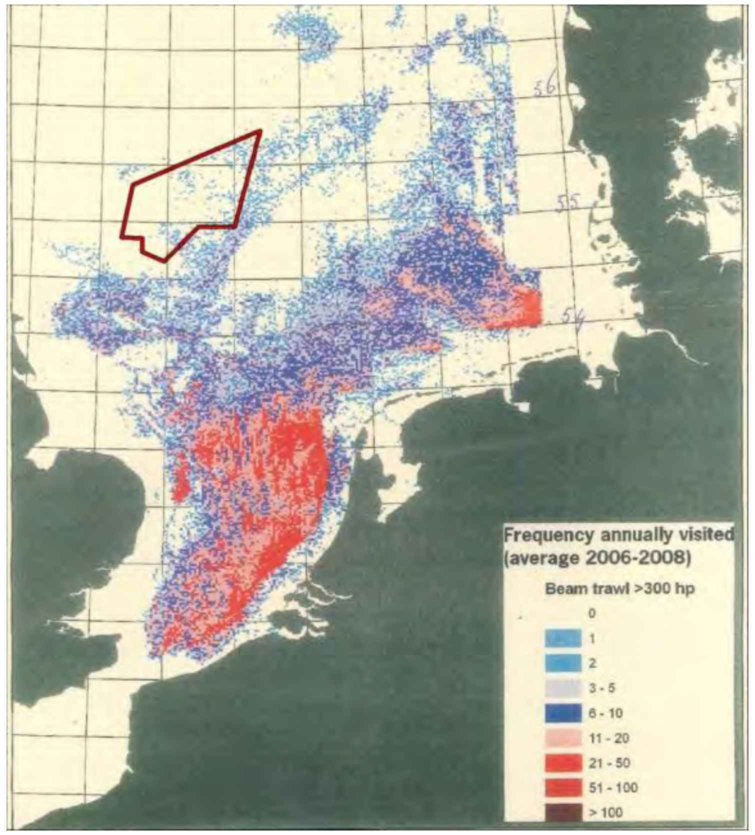

Figure 10.15: Dutch beam trawlers effort based on VMS Data (2006-2008) (VisNed, 2010).

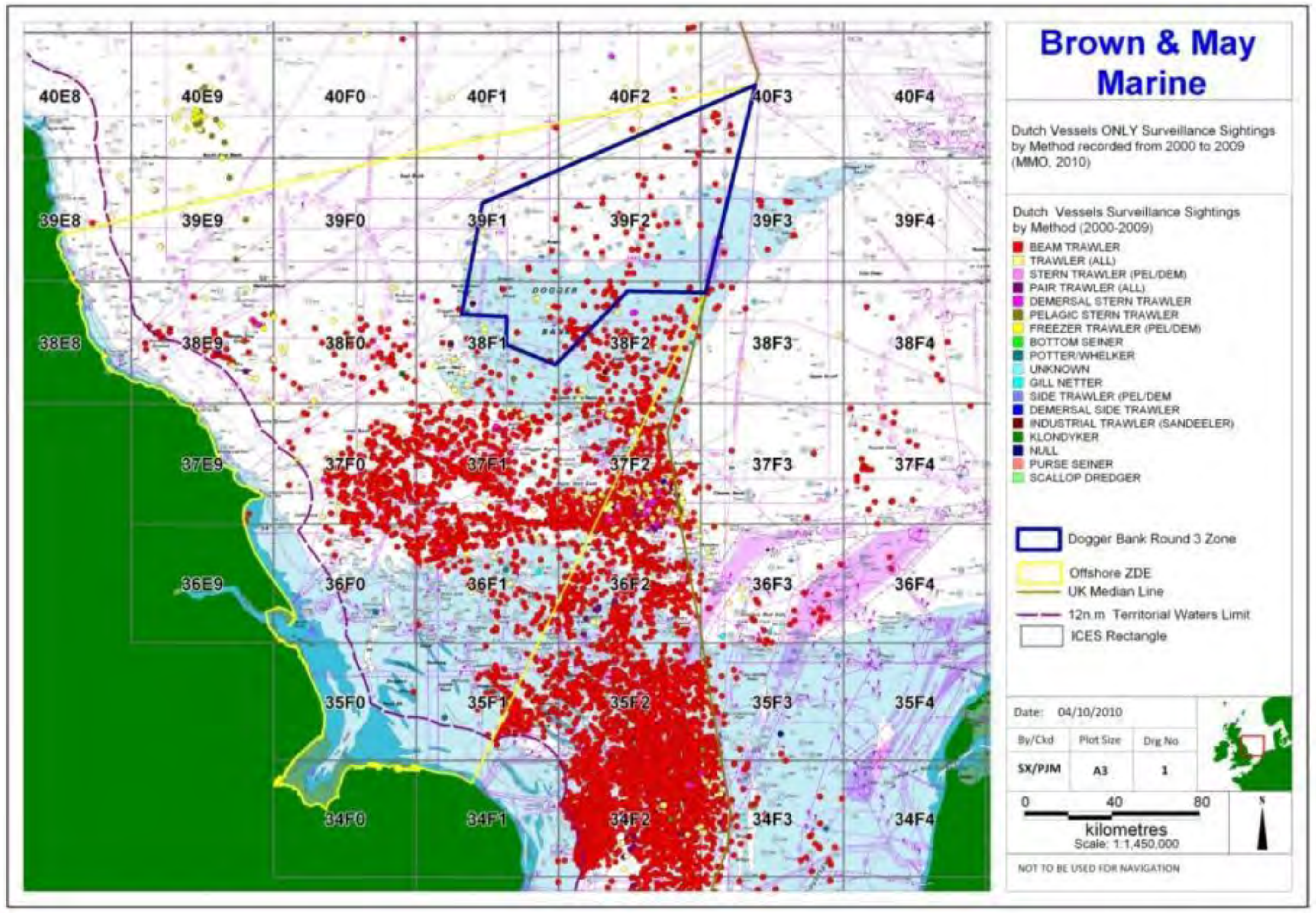

Figure 10.16: Dutch vessels surveillance sightings by method (2000-2009) (MMO, 2010).

10.3.6 Other Nationalities

As suggested by Figure 10.17, Figure 10.18 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 10.18) activity by Belgian beam trawlers has also been recorded within the Dogger Bank 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.

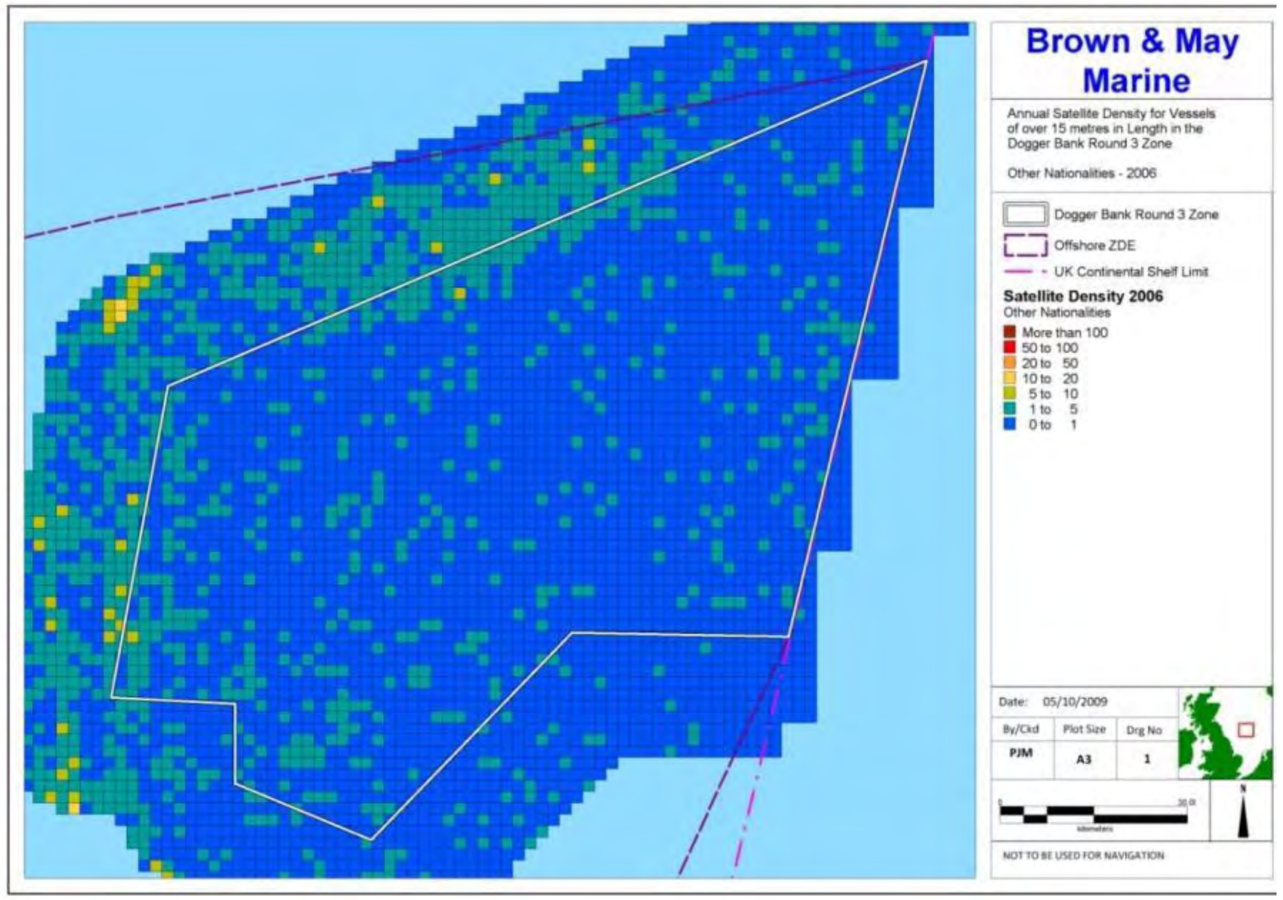

Figure 10.17: Annual satellite density for vessels of over 15m in length of other nationalities in (MMO, 2006).

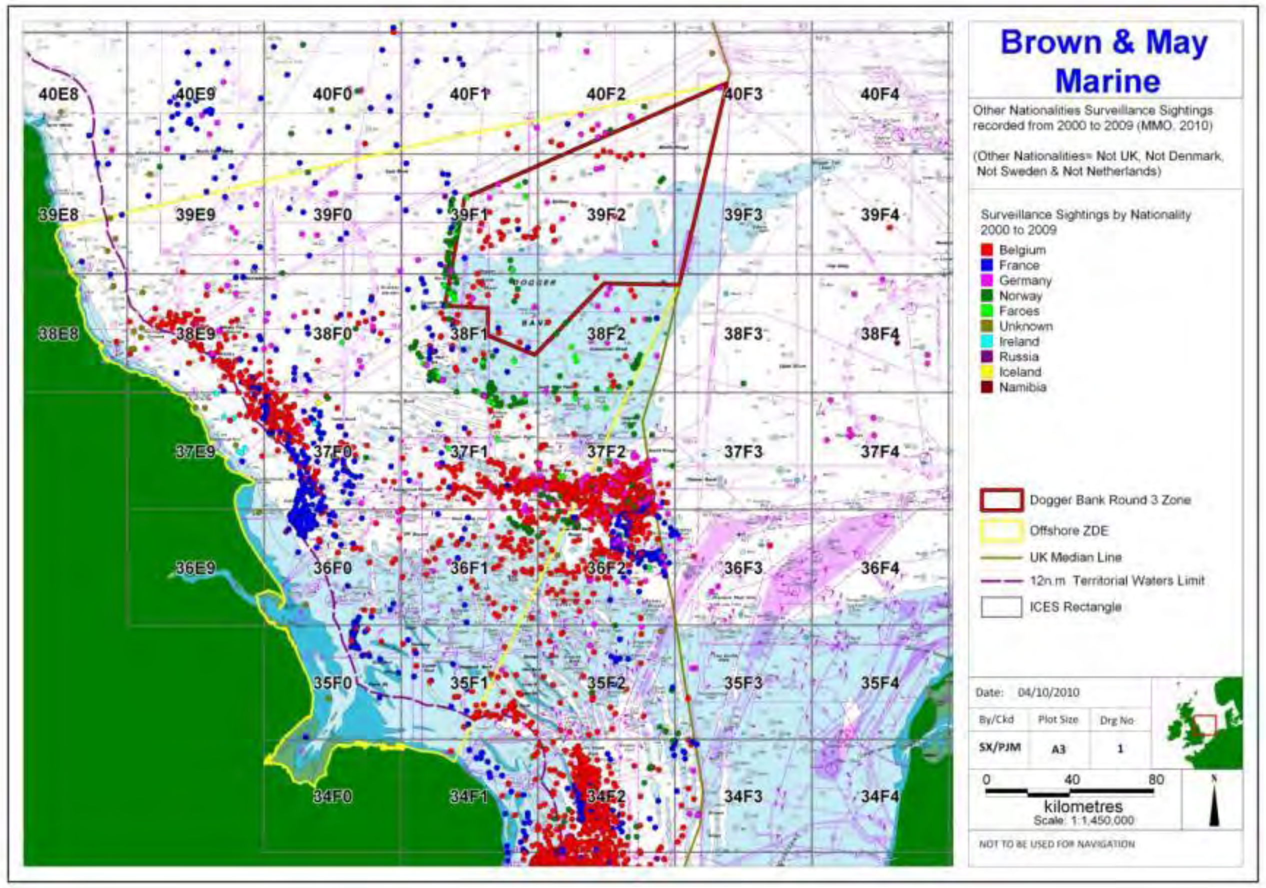

Figure 10.18: Other nationalities surveillance sightings by nationality (2000-2009) (MMO, 2010).

10.4 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 Dogger Bank Zone, as well as occasional activity by long liners, pelagic vessels and potters.

The VMS and surveillance data indicates that fishing activity is not uniformly distributed across the 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 2010, the Danish allocation of the EU sandeel quota for ICES areas IIa,IIIa and IVa of 177,500 tonnes was 167,436 tonnes, i.e 94% (Europa, 2010). As shown by Figure 10.11 there are extensive sandeel fishing grounds within the North Sea and those adjacent to the western boundary of the Zone represent only a small proportion of the total North Sea sandeel fishing areas.

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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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 Dogger Bank Zone and the Offshore Cable Area.

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 infrastructure exists, safety zones of 500 m radius generally apply, as determined by the United Nations Convention on the Law of the Sea (UNCLOS) and the Geneva Convention on the Continental Shelf 1958 (HSE, 2008).

Typically, extended safety zones, 6 nm in radius, surround oil and gas surface installations to allow for safe helicopter access to these installations (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 Dogger Bank Zone and Offshore Cable Area. The key data and literature that have been interrogated include:

- UK DEAL (July, 2010) and SeaZone (March, 2010) GIS data detailing licence information, fields, surface and subsea infrastructure;
- Web-based databases provided by UK DEAL and the Department of Energy and Climate Change (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 (SEA) Appendix 3h – *Other users and material assets* (DECC, 2009a).

The UK DEAL and SeaZone 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 and SeaZone datasets were published (July 2010 and May 2010 respectively). However, given the continual development in hydrocarbon exploration and production, changes may have occurred since the data were released. UK DEAL data only include details of infrastructure and activities occurring on the UK Continental Shelf (UKCS) and therefore the SeaZone data were used to provide information on surface infrastructure beyond the UK Meridian.

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. DECC issues licences through competitive annual Licensing Rounds under the Petroleum Act 1998 and applications under the 26th Licensing Round were made in April 2010, with decisions expected later in October this year. The licence process is continuous, therefore requiring changes to monitored and incorporated throughout the Zonal Characterisation and ZAP process. Further background to the licence types and procedures can be found in Appendix J.

The licence status of the blocks within the Dogger Bank Zone and the Offshore Cable Area are also listed in Appendix K.

11.4.1 Dogger Bank Zone

UK DEAL data (2010) indicates that four blocks, partially within the Dogger Bank Zone, are currently licensed (Figure 11.1). All licenses currently held are Promote type Production Licences (See Appendix J for summary). Blocks 43/9, 43/10 and 44/6 are licensed to PA Resources UK Limited, while 44/7 is licensed to Volantis Exploration Limited (Table 11.1).

PA Resources is a company whose business consists of the acquisition, extraction and sale of oil and gas reserves, as well as exploration to find new reserves (PA Resources, 2010). According to a press release in August 2009, PA Resources were planning to carry out a seismic survey of the area before transferring licence rights to Venture North Sea Gas Limited on completion of the survey (PA Resources, 2009). Venture North Sea Gas are a subsidiary of MPX Energy Ltd. MPX are an exploration and appraisal focused company who look to develop unrecognised or under-evaluated reservoir rocks that contain producible hydrocarbons.

Volantis Exploration Limited was established in 2007 and has a stated aim of creating value through the exploration and appraisal of gas opportunities in the UK and Dutch sectors of the southern North Sea (Volantis, 2010). In 2008 it 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).

The remainder of the Zone partially or wholly incorporates 51 blocks on offer under the 26th Licensing Round and these are listed in Appendix K.

Table 11.1: Current Production Licences within the Dogger Bank Zone (Source: UK DEAL, 2010; DECC, 2010d).

Licence Block	Licence Number	Licence Type	Licensee	Effective	Expiry
43/9	P1529	Promote	PA Resources	01/04/2007	01/04/2033
43/10	P1529	Promote	PA Resources	01/04/2007	01/04/2033
44/6	P1529	Promote	PA Resources	01/04/2007	01/04/2033
44/7	P1730	Promote	Volantis	01/05/2010	30/04/2036

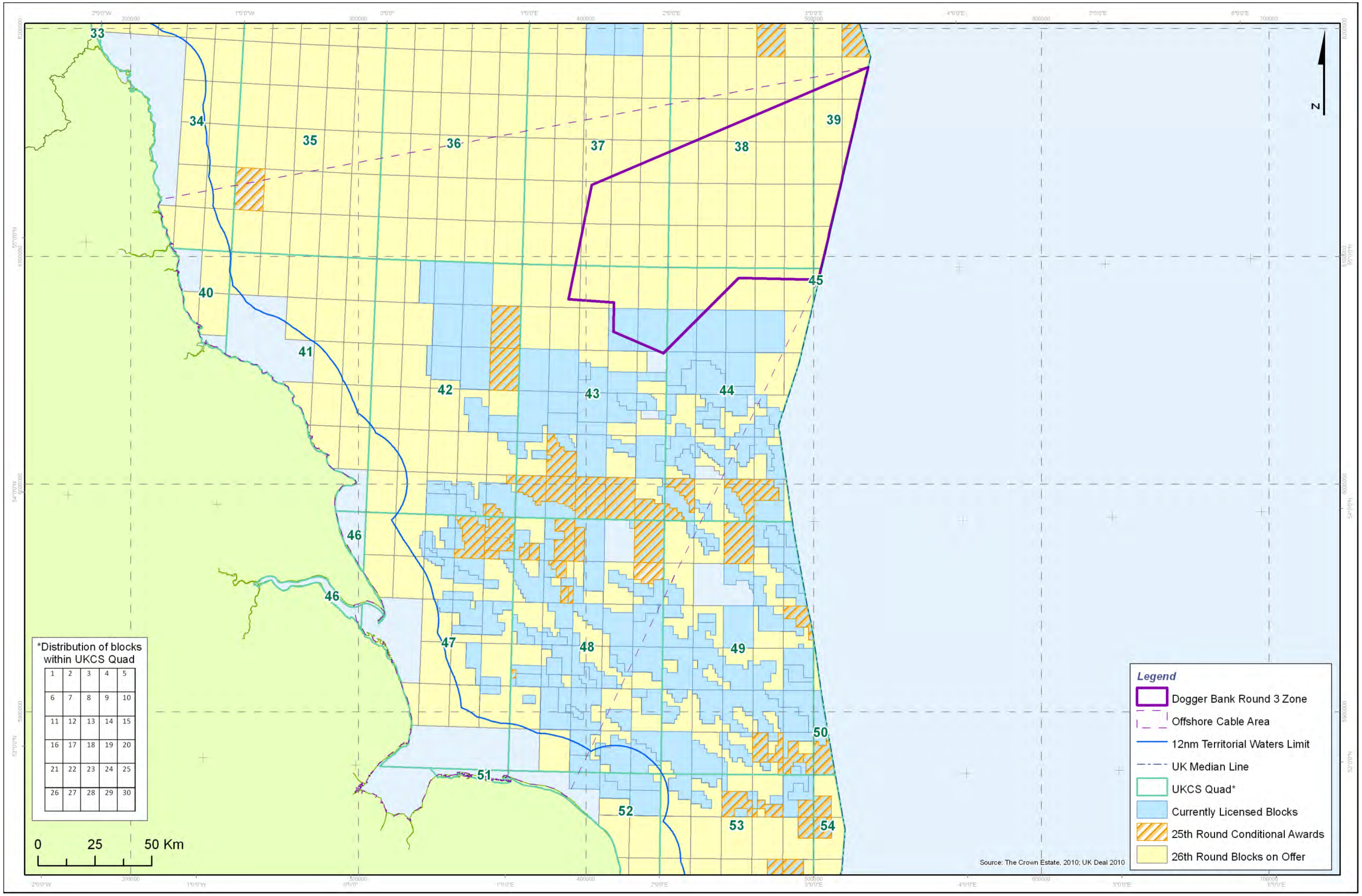

Figure 11.1: Licence status of UKCS Quads and Licence Blocks within and around the Offshore ZDE (UK DEAL, July 2010).

11.4.2 Offshore Cable Area

There are 28 Licence Blocks in the Offshore Cable Area that have been awarded under the 25th Licensing Round (Figure 11.1) and an additional 22 blocks have been applied for but are awaiting further assessment (UK DEAL, 2010). There are a further 171 blocks and block parts within the Offshore Cable Area that are on offer as part of the 26th Licensing Round.

18 Licence Blocks, wholly or partially within the Offshore ZDE, appear on DECC's latest (January 2010) Fallow Blocks and Discoveries list (DECC, 2010d). Further details of Licence Blocks are provided in Appendix K.

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. DECC register details of PON14 applications and consents on their website (DECC, 2010c).

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.
- Potential impacts to data integrity due to the seismic survey sources utilised by the oil and gas industry being much more powerful than those required for offshore wind exploration.

These factors could lead to lead to significant programme delays as the seismic data required by Forewind underpins the geological understanding of the Dogger Bank Zone.

Table 11.2 and Figure 11.2 present UKCS blocks in proximity to the Offshore ZDE (Quads 34 to 49) which have PON 14 applications for seismic surveys (as of 4th August 2010) and which, therefore, have the potential to impact on Forewind's own surveying operations (DECC, 2010c).

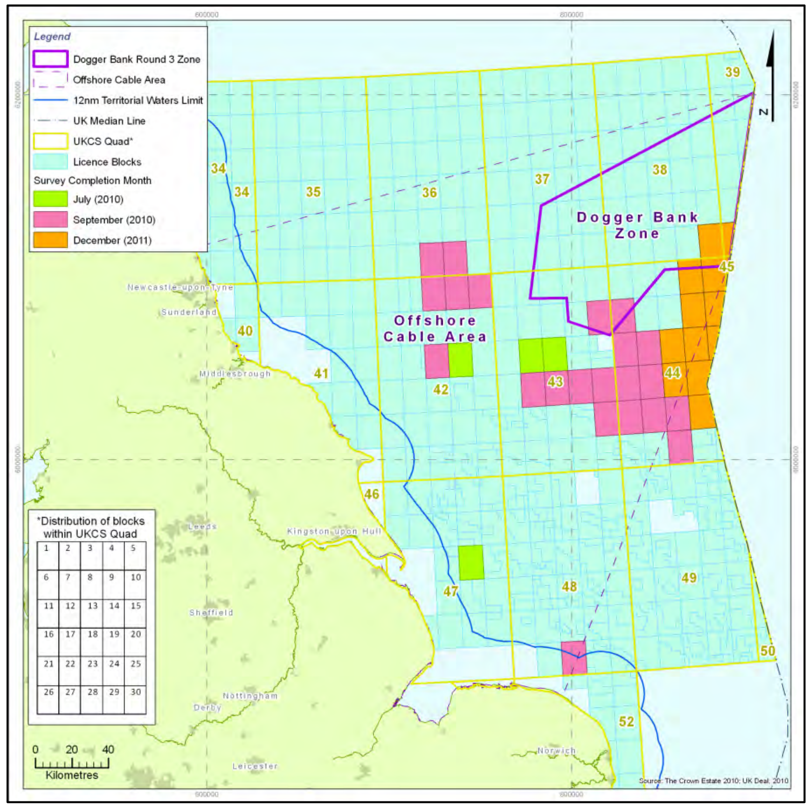

Figure 11.2: Known UKCS blocks subject to oil and gas seismic surveys in proximity to the Offshore ZDE (as of 4th August 2010. DECC, 2010c; UK DEAL, July 2010).

Table 11.2: PON 14 applications for seismic surveys in proximity to the ZDE (as of 4th August 2010. DECC, 2010c).

Quad / Block	DECC Ref.	Operator	Proposed Start	Proposed End	Consented
44/12	2165	GDF Suez E&P UK Ltd	07/05/10	11/07/10	04/03/10
42/14	2233	RWE DEA	30/06/10	20/07/10	20/05/10
47/14	2237	GDF Suez E&P UK Ltd	25/05/10	30/07/10	21/05/10
43/13	2235	Venture	12/05/10	30/07/10	13/05/10
43/12	2223	Venture	14/05/10	31/07/10	12/05/10
36/28	2258	RWE DEA	01/07/10	15/09/10	01/07/10
36/29	2258	RWE DEA	01/07/10	15/09/10	01/07/10
42/03	2258	RWE DEA	01/07/10	15/09/10	01/07/10
42/04	2258	RWE DEA	01/07/10	15/09/10	01/07/10
42/05	2258	RWE DEA	01/07/10	15/09/10	01/07/10
48/28	2246	E-On	15/08/10	30/09/10	21/05/10
43/10	2251	Polarcus / CGG Veritas	21/07/10	30/09/10	27/07/10
43/20	2251	Polarcus / CGG Veritas	21/07/10	30/09/10	27/07/10
43/25	2251	Polarcus / CGG Veritas	21/07/10	30/09/10	27/07/10
44/06	2251	Polarcus / CGG Veritas	21/07/10	30/09/10	27/07/10
44/11	2251	Polarcus / CGG Veritas	21/07/10	30/09/10	27/07/10
44/12	2251	Polarcus / CGG Veritas	21/07/10	30/09/10	27/07/10
44/13	2251	Polarcus / CGG Veritas	21/07/10	30/09/10	27/07/10
44/16	2251	Polarcus / CGG Veritas	21/07/10	30/09/10	27/07/10
44/17	2251	Polarcus / CGG Veritas	21/07/10	30/09/10	27/07/10
44/18	2251	Polarcus / CGG Veritas	21/07/10	30/09/10	27/07/10
44/21	2251	Polarcus / CGG Veritas	21/07/10	30/09/10	27/07/10
44/22	2251	Polarcus / CGG Veritas	21/07/10	30/09/10	27/07/10
44/23	2251	Polarcus / CGG Veritas	21/07/10	30/09/10	27/07/10
44/28	2318	Venture	30/07/10	30/09/10	28/07/10
42/13	2319	RWE DEA	10/08/10	30/09/10	
43/17	2321	RWE DEA	10/08/10	30/09/10	
43/18	2321	RWE DEA	10/08/10	30/09/10	
43/19	2321	RWE DEA	10/08/10	30/09/10	
43/20	2321	RWE DEA	10/08/10	30/09/10	
38/30	2270	Fugro	01/09/10	31/12/11	
39/26	2270	Fugro	01/09/10	31/12/11	
44/04	2270	Fugro	01/09/10	31/12/11	
44/05	2270	Fugro	01/09/10	31/12/11	
44/09	2270	Fugro	01/09/10	31/12/11	
44/10	2270	Fugro	01/09/10	31/12/11	
44/13	2270	Fugro	01/09/10	31/12/11	
44/14	2270	Fugro	01/09/10	31/12/11	
44/15	2270	Fugro	01/09/10	31/12/11	
44/18	2270	Fugro	01/09/10	31/12/11	
44/19	2270	Fugro	01/09/10	31/12/11	
44/24	2270	Fugro	01/09/10	31/12/11	
45/01	2270	Fugro	01/09/10	31/12/11	

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 (DECC, 2010a). The Dogger Bank Zone and the Offshore Cable Area lie in the southern North Sea and almost all the hydrocarbon fields are gas fields. The locations of fields in the Offshore ZDE are shown in Figure 11.3. Fields are defined by UK DEAL (2010) as Producing, Not Producing, Under Development and Discovery.

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. 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 J. Surface structures are automatically protected by a 500 m safety zone measured from the perimeter of each structure (HSE, 2008) and a further 6 nm safety zone surrounds surface installations to allow for helicopters access (CAA, 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, 2010) and these are shown in Figure 11.4 and described in Appendix K. The majority of these are found to the south and south-west of the Offshore ZDE, although Booster Platform 37/4A is situated to the north of the Offshore ZDE and Booster Platform 36/22A to the west of the Dogger Bank Zone.

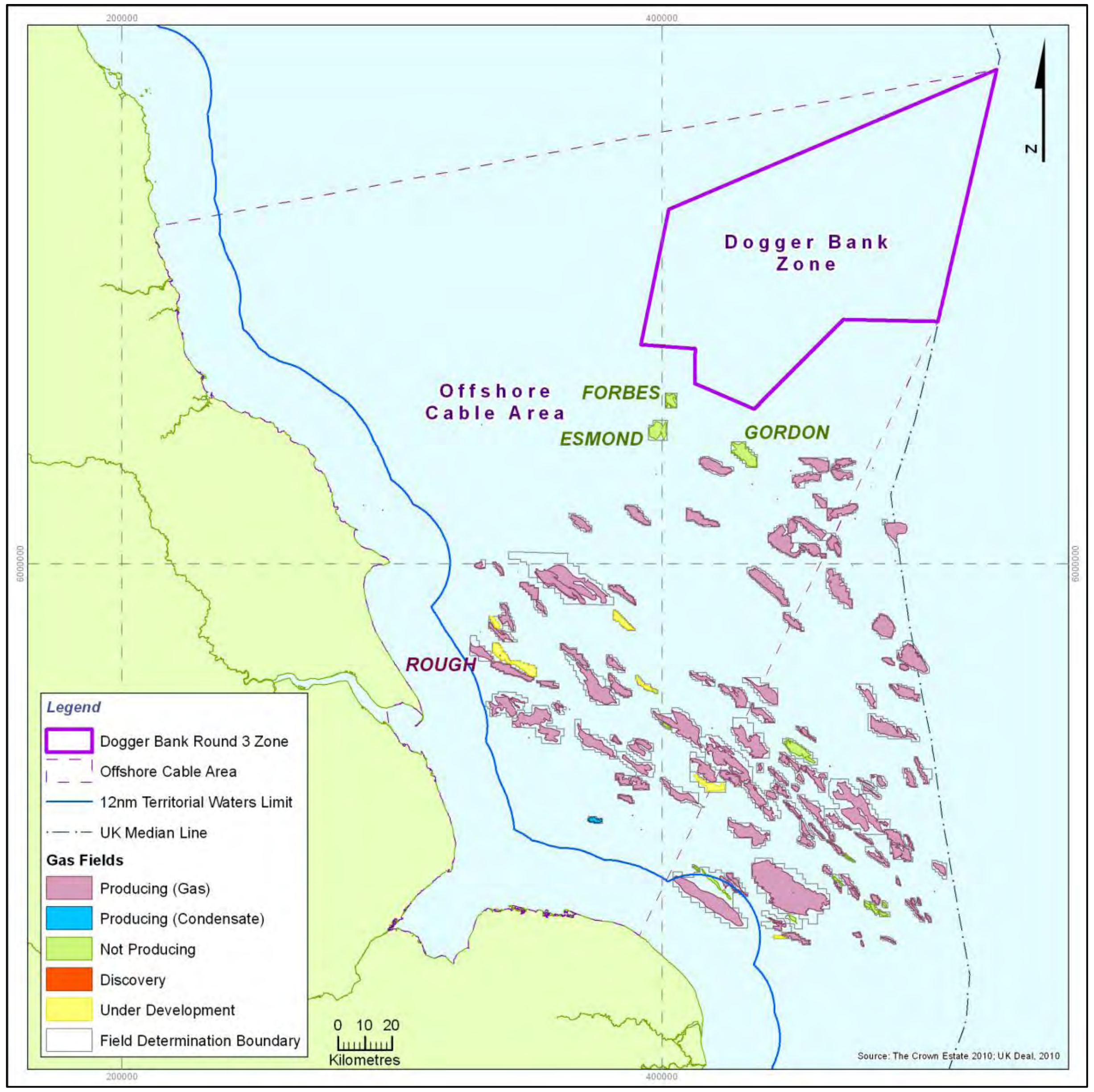

Figure 11.3: Location of oil and gas fields within the Offshore ZDE (UK DEAL, July 2010). The Field Determination Boundary is the boundary for legal and tax purposes and is determined by DECC based on the consented Field Development Plan.

Both booster platforms are located on the Ekofisk 2/4J to Teesside pipeline (the 'Norpipe'), which is discussed in Chapter 14 – *Cables and Pipelines*. UK DEAL (2010) 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 July 2010 data release.

The SeaZone data, as at March 2010, indicates that surface infrastructure is also present to the east of the Offshore ZDE, on the Dutch, German and Danish Continental Shelves, the nearest being approximately 30 km from the Dogger Bank Zone.

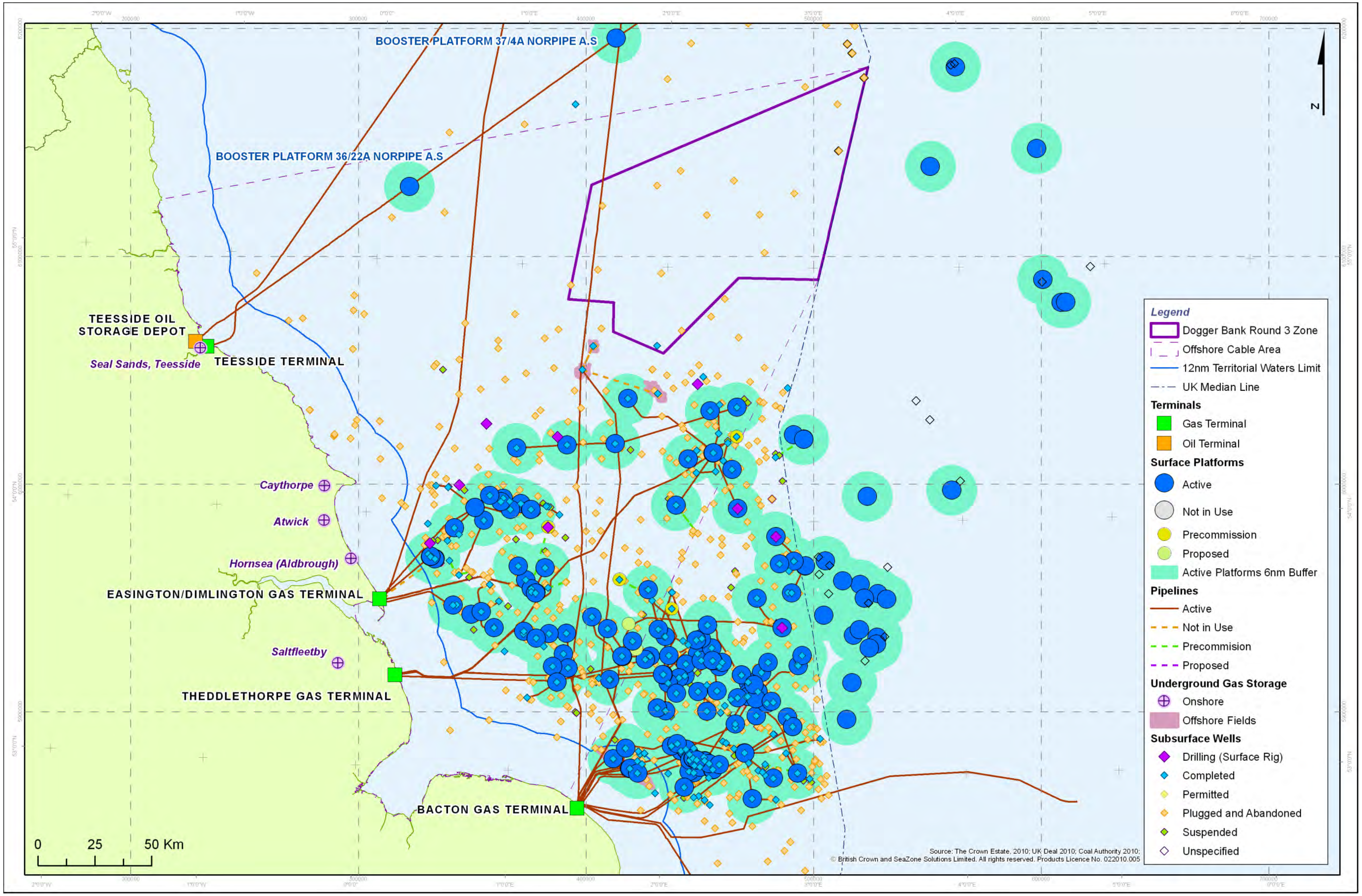

Figure 11.4 Oil and gas surface and subsea infrastructure within the Offshore ZDE and surrounding waters (UK DEAL, July 1010; SeaZone Solutions Ltd, March 2010).

11.8 Subsea Infrastructure

The main types of subsea infrastructure include:

- Production Wells;
- Competed Wells;
- Suspended Wells;
- Plugged and Abandoned Wells;
- Subsea Tress;
- Subsea Templates; and
- Subsea Manifolds.

The structures are defined in Appendix J. Manifolds and production wells associated with surface infrastructure may have a 500 m safety zone surrounding them. It is also possible for operators to apply for a safety zone around subsea infrastructure, even if there is no associated infrastructure. 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 K 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 11.3). These are plugged and abandoned with the exception of well 43/10-1 which is reported to be complete by UK DEAL, but released as a 'dry hole' (UK DEAL, 2010). 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, 2010). 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 (2010) lists all of the plugged and abandoned 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 11.3: Wellheads in the Dogger Bank Zone (UK DEAL, 2010).

Well	Completion Date	Status	Operator	Released Date	Depth (m)
38/16- 1	21/10/1967	P & A	BP	09/01/1976	40.5
38/18- 1	29/07/1967	P & A	BP	09/06/1976	39.9
38/22- 1	07/11/1967	P & A	CHEVRON	09/06/1976	35.4
38/29- 1	31/03/1965	P & A	CHEVRON	09/06/1976	26.8
43/03- 1	25/07/1966	P & A	BHP	09/06/1976	26.8
38/25- 1	21/06/1969	P & A	BP	08/08/1977	30.5
37/23- 1	29/07/1970	P & A	CHEVRON	08/08/1977	38.1
39/7- 1	31/07/1971	P & A	ENI	22/01/1979	51.2
39/11- 1	13/06/1971	P & A	ENI	22/01/1979	44.2
38/24- 1	04/10/1983	P & A	BP	03/07/1989	32.0
43/02- 1	17/02/1989	P & A	BP	05/12/1994	28.0
44/06- 1	22/11/1992	P & A	BP	06/08/1998	22.6
43/05- 1	09/06/1994	P & A	BHP	30/05/2000	24.2
43/10- 1	24/03/1997	Completed	BP	21/10/2002	28.7
39/16- 1	17/07/1997	P & A	HESS	22/04/2003	33.8
37/25- 1	13/03/2009	P & A	EXXONMOBIL	25/01/2010	40.0

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 summarized in Appendix J. There are in excess of 900 wells in the Offshore Cable Area and details of these can also be found in Appendix K.

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 and Relinquishments

When offshore facilities become redundant, the owners of the offshore infrastructure are responsible for preparing and carrying out a decommissioning programme (DECC, 2010a). DECC's decommissioning unit works with the operator 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 11.4 summarizes the relinquishment obligations of oil and gas operators required by DECC (DECC, 2010d).

Table 11.4: Relinquishment requirements for Seaward Production Licenses (DECC, 2010).

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 (2010a) indicates that there are no decommissioned installations within the Dogger Bank Zone. Twenty seven blocks within the Dogger Bank Zone have undergone some type of license relinquishment in the period 2002-2009 (DECC, 2010b) and further details are provided in Appendix K.

11.10.2 Offshore Cable Area

DECC's list of decommissioned installations (2010) indicates that four decommissioned installations exist within the Offshore Cable Area. Table 11.5 summarizes these installations.

The locations of these fields are indicated in Figure 11.3 and are to the south-west of the main Dogger Bank Zone. It is not known whether any structures remain on the seabed following the removal of those platforms.

In addition to the decommissioned installations, a further fifty seven blocks in the Offshore Cable Area have undergone some type of relinquishment in the period 2002-2009 (DECC, 2010d) and further details are provided in Appendix K.

Table 11.5: Decommissioned installations within the Offshore ZDE (DECC, 2010).

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

11.11 Terrestrial Facilities

Major land 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 which is 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 2010 Activity Survey reports on the industry's activity on the UK Continental Shelf (UKCS) from the previous year to the next four or five years (Figure 11.5: Actual and Projected UK oil and gas production and demand (DECC, 2010a).). The survey is based on the latest data supplied by all the leading exploration and production companies operating in the UK. Overall, the survey suggests UKCS production is in decline, owing mostly to a lack of investment since 2006 (Oil & Gas UK, 2010b).

A general decline in production does not, however, mean decreased interest in exploration and potential production in this region of the southern North Sea. Indeed, one of the largest gas fields in the southern North Sea – the Cygnus field – was recently discovered to the south of the Dogger Bank Zone. The Cygnus field was first discovered in 1988 while drilling in 44/12 and two appraisal wells were successfully drilled in 2009. Another two appraisal wells were scheduled to be drilled during the first half of 2010 and preliminary estimates indicate that the field may have reserves of two trillion cubic feet of gas (Offshore Technology, 2010). The field is operated by GDF Suez, which also owns a 38.75% stake, Centrica has a 48.75% interest and Endeavour holds the remaining 12.5% interest.

Historically, the Dogger Bank Zone has not been a significant production area as can be inferred from the absence of fields and hydrocarbon yielding well holes, however given the recent discovery of the Cygnus field, it may be that the 26th Round or subsequent Rounds of licensing prompt interest in additional blocks within the boundary of the Dogger Bank Zone. The 26th Round results will only become apparent when the official announcement is released later in 2010.

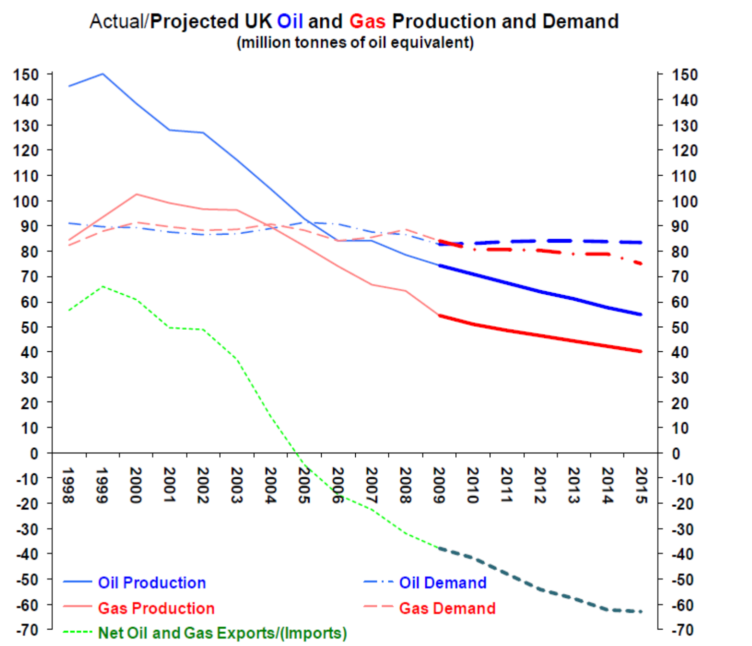

Figure 11.5: Actual and Projected UK oil and gas production and demand (DECC, 2010a).

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.

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 at the south of the Dogger Bank Zone are licensed for oil and gas operations. One block partially within the Zone and two adjacent have received applications in the 25th licensing round. All blocks not currently licensed are available in the 26th Round with a list of offers to be announced imminently. Any licensing, exploration and development activity and infrastructure will need to be considered and ongoing communication with all licence holders will be important.

In the Offshore Cable Area many oil and gas structures exist and should be an ongoing 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 is with potential new infrastructure and installations being constructed. It is therefore important that the ZAP captures these changes. To achieve this, the most up to date data sets must be sourced at each stage of the process 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 require 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) are likely to object to developments which threaten air safety, and similarly, the MoD is likely to 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 (March 2010) detailing military PEXA areas and aeronautical sites;
- 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 (June 2010).
- CAA Helicopter Main Routes (HMRs);
- The CAA and NATS UK Integrated Aeronautical Information Publication (AIP) (CAA and NATS, 2010) 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 (Department of Energy and Climate Change (DECC), 2009); 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 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 south west part 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 is a more complex issue. NERL self assessment data 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. Military long range CNS systems 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 Practice and Exercise Areas (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 areas within the Offshore ZDE include part of the Southern Managed Danger Area (MDA), designated as D323B, an air force PEXA which overlaps the south-western part of the Dogger Bank Zone. D323B, is used 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 south-west corner 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 2 km 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). 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 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 recently 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).

Occurrence	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)

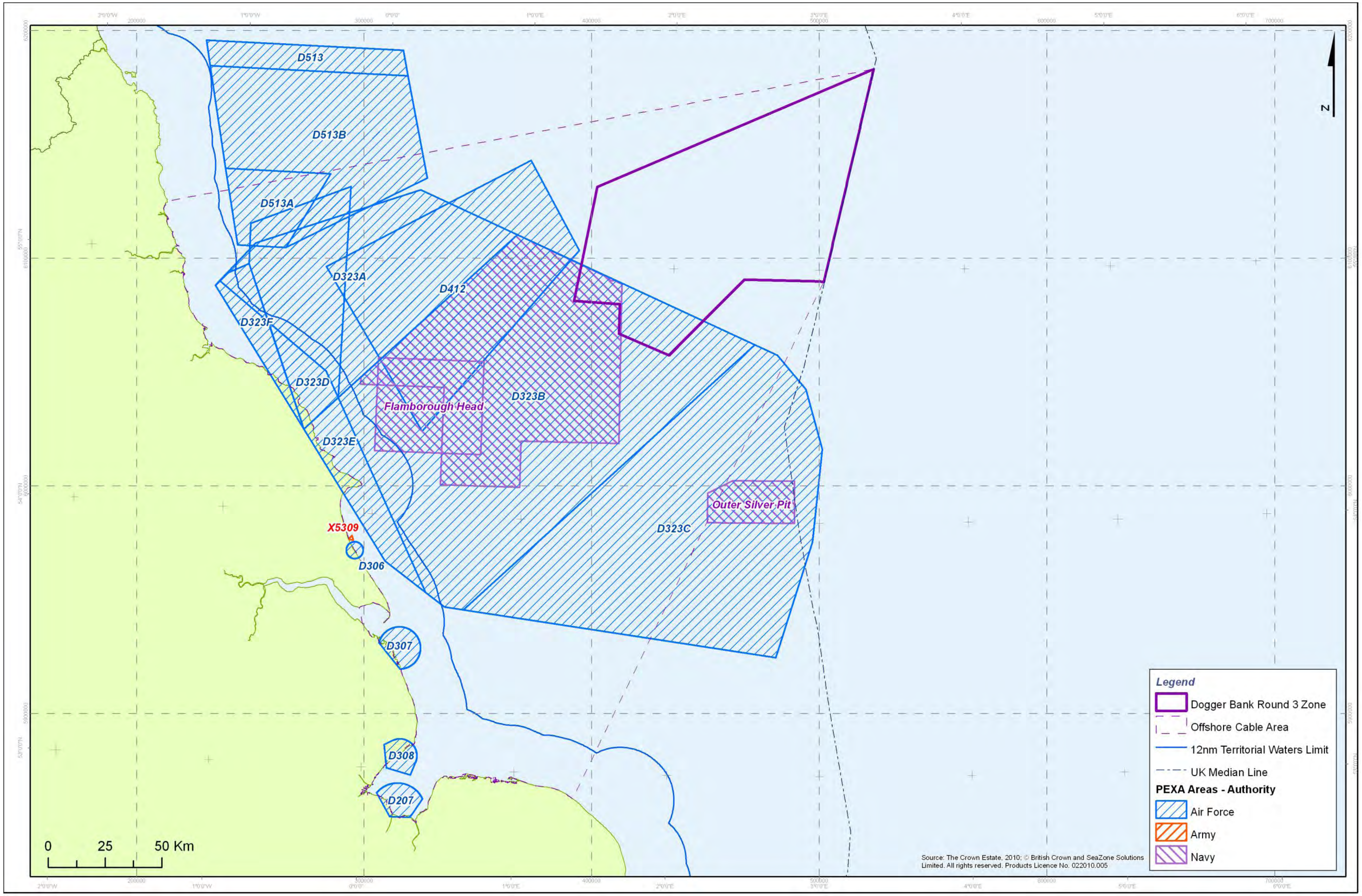

Figure 12.1: Military Practice and Exercise Areas in the Offshore ZDE.

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, 2010) and CAP 764 (CAA Policy and Guidelines on Wind Turbines, 2010) 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, 2008) 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, 2010), 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, 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, 2010).

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, 2010). 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, 2010).

The CAA also indicate the need to maintain a 6 nm radius around offshore surface infrastructure, such as oil and gas platforms, to allow for controlled and missed approaches from all directions (CAP 764, 2010; DECC, 2009). Wind turbines within this 6 nm area would potentially impair the ability to conduct safe operations. The HMRs, corresponding 2 nm safety margins, and 6 nm approach radii are presented in Figure 12.2. Currently, no platforms and 6 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 is only indicative, it suggests 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, 2010).

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.

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, 2010). 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 (2010), 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.

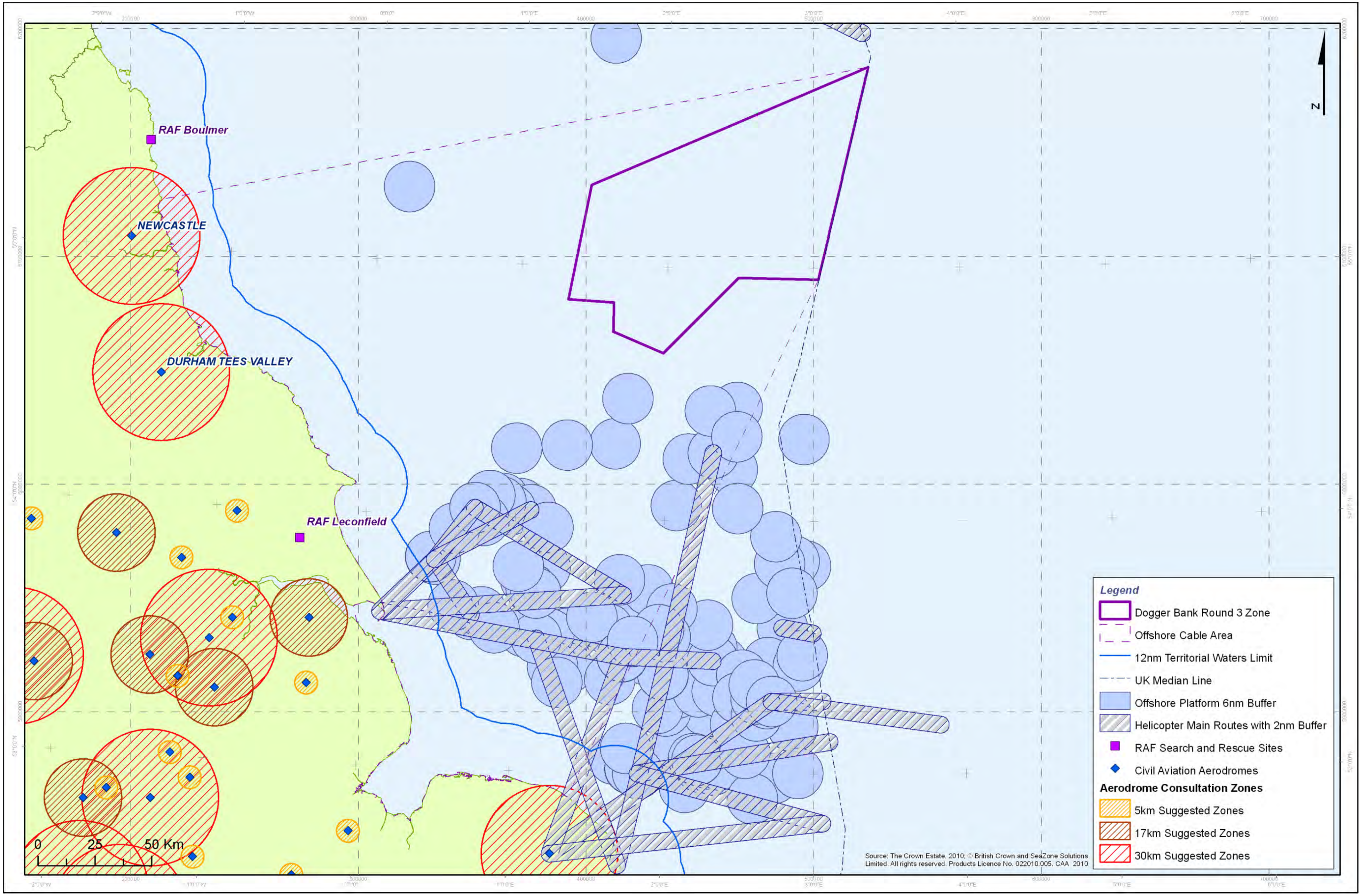

Figure 12.2: Civil aviation aerodromes, air traffic control zones, Helicopter Main Routes and offshore helicopter safety zones around offshore oil and gas installations.

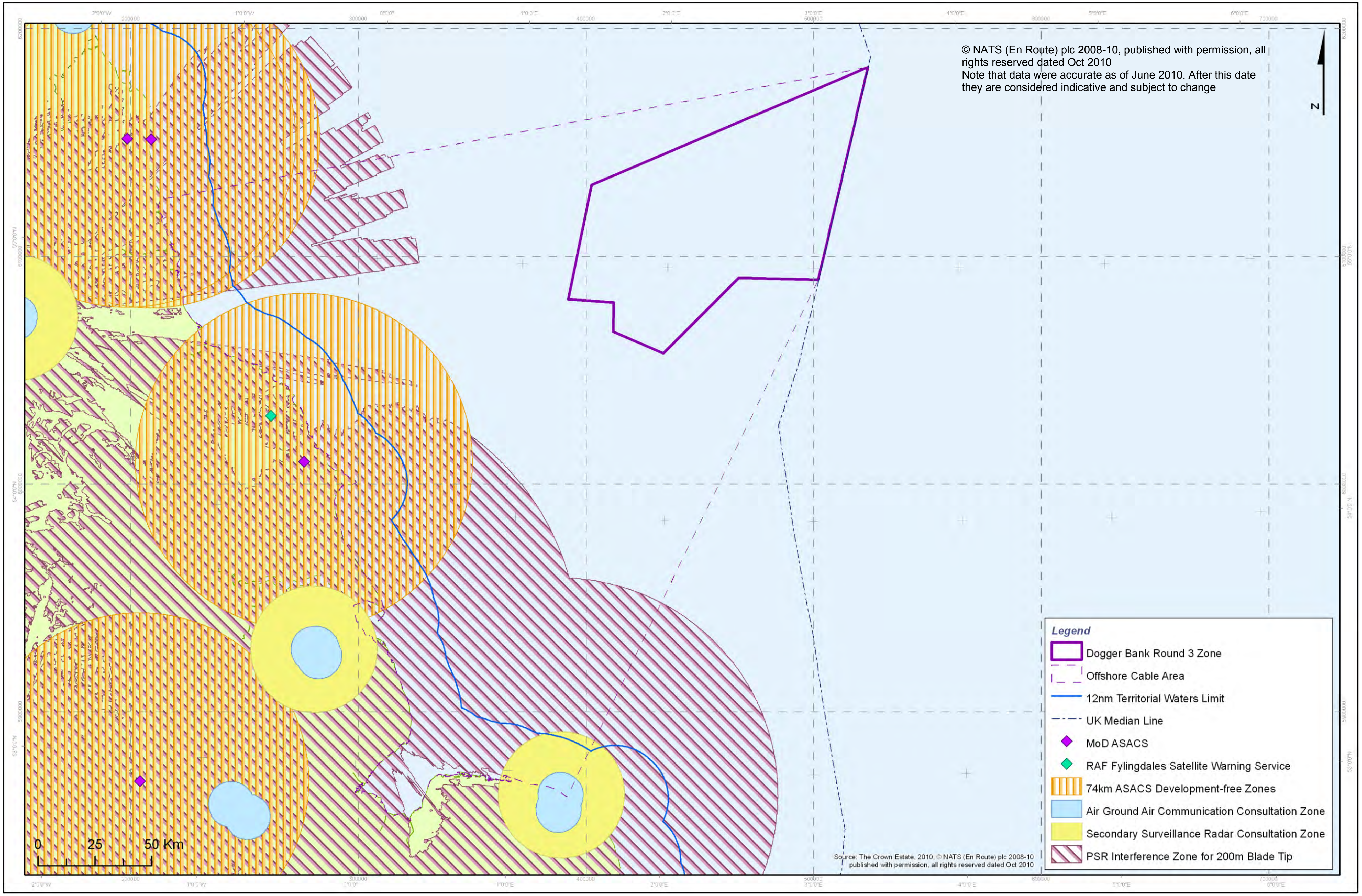

Figure 12.3: Indicative extents of known military and civil Communications, Navigation and Surveillance (CNS) systems across the ZDE.

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, 2010) and so NERL have applied a 10 km consultation zone around such sites, as detailed in CAP 670 (2010). Those occurring within the ZDE are shown in Figure 12.3.

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, falls within NATO Air Policing Area 9. It should be noted that information regarding MoD systems is not readily available. The MoD assess 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 thirty nautical miles 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 yet confirmed if 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). 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.

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.

12.9 Summary

The Offshore ZDE includes areas used for military, aviation and radar purposes. A RAF Danger Area and a Submarine Exercise Area occur in 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, though Helicopter Main Routes (HMRs) transect the southern part of the Offshore Cable Area.

Similarly, interference with military and civil CNS systems is shown to be limited to areas closer to the coast than the Dogger Bank Zone far offshore, 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.

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 south-west 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.

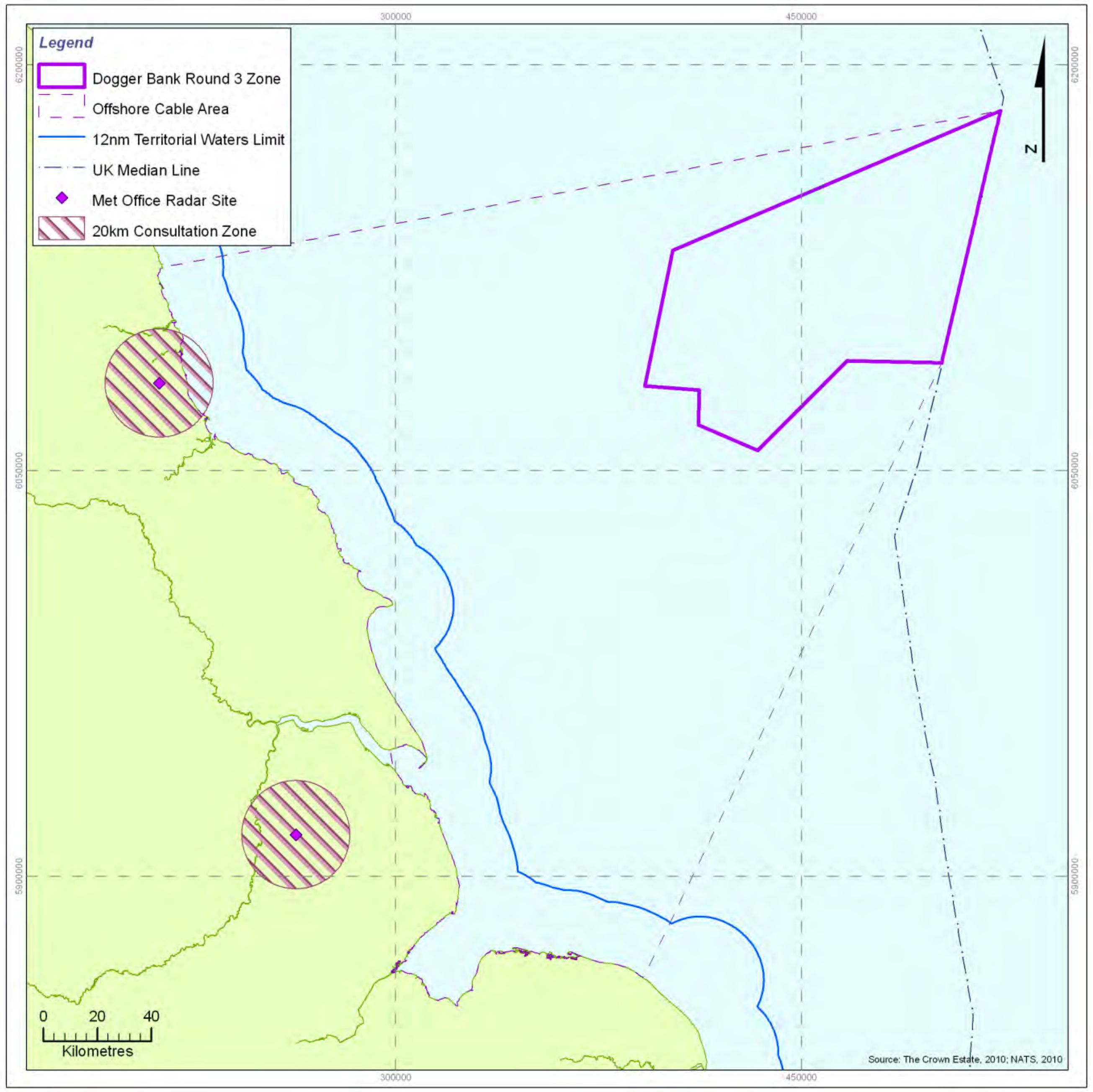

Figure 12.4: Met Office weather radar sites and associated consultation zones at Ingham, Lincolnshire and High Moorsley, Tyne and Wear.

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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 The Crown Estate (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, 2010a, 2010b);
- Marine aggregate dredging 1998-2007: A ten-year review (TCE and BMAPA, 2008);
- The Area Involved: Eleventh Annual Report (TCE and BMAPA, 2009);
- Review of UK Marine Aggregate Extraction Activities: Historic patterns of marine aggregate extraction (tonnes) 2000-2005 (TCE, 2010c); and
- The Marine Aggregate Terminology Glossary (TCE and BMAPA, 2010).
- MMO guidance on the licensing procedure for marine mineral extraction permissions (MMO, 2010a).

Annual waste disposal figures acquired from Cefas 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 provides 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, 2010d). 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 L.

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 drag head moves slowly over the seabed. A single pass of the 2-3 m wide drag head 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 (2010a, 2010b). 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*). These margins of the Dogger Bank are therefore more suitable for aggregate extraction than the Dogger Bank and so more likely to be prospected in the future.

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. 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 Roughs, 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				

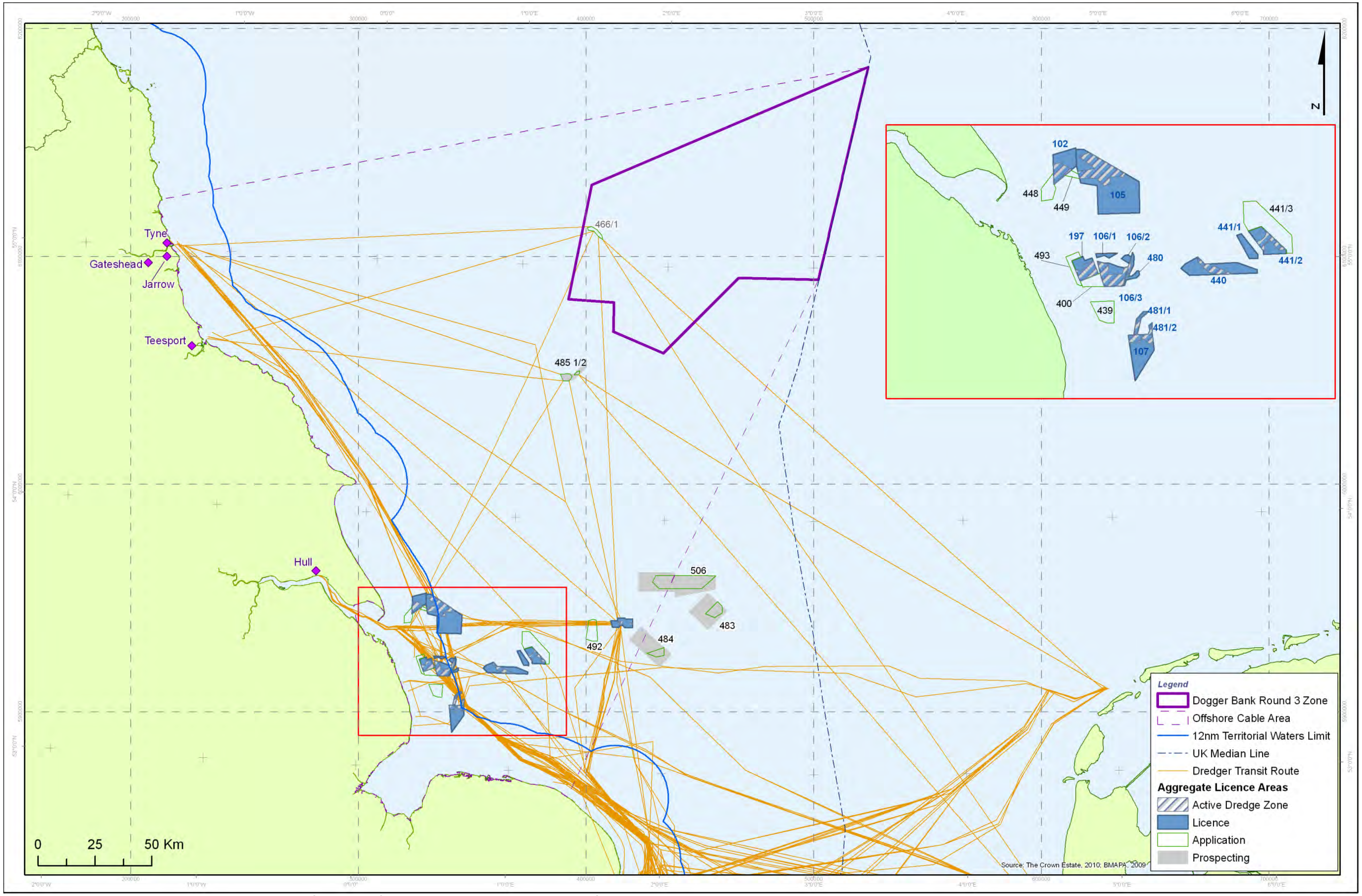


Figure 13.3: Aggregate areas and transit routes. Source: The Crown Estate, 2010a, 2010b, 2010e; Pers. Comm., BMAPA, 2009

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 outside 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 2008, 3.15 million tonnes of aggregate were dredged out of a possible permitted licensed tonnage of 4.40 million. In addition, 0.45 million tonnes were specifically dredged for beach replenishment schemes (TCE and BMAPA, 2009).

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 km² 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 2008 the total licensed area in the Humber Region was 454.62 km². Not all of this 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, and as a result of this zonation the total area actually available to be dredged within the Humber Region during 2008 was 143.91 km² (TCE and BMAPA, 2009). Only a small proportion of this area available is actually dredged in any one year and Figure 13.4 b) shows that only approximately 30 km² of seabed in the Humber Region was actually dredged in 2007 (TCE and BMAPA, 2008).

13.4.4 Dredger Transit Routes and Landing Wharves

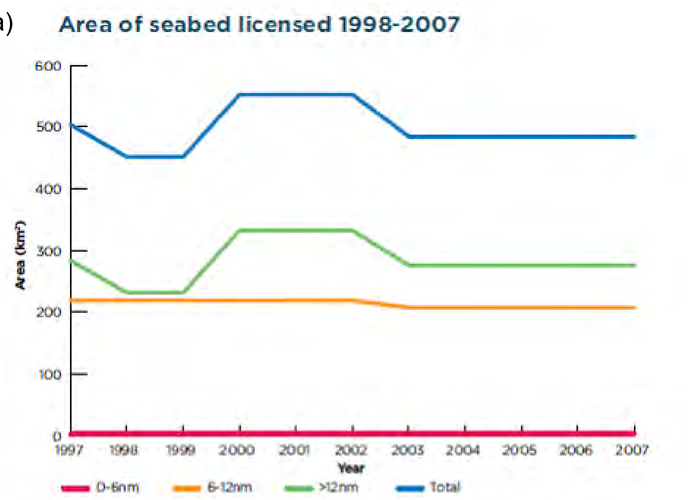
BMAPA has published the transit routes typically used by marine aggregate dredgers from wharves to licensed aggregate extraction areas around the UK coast. Routes to application areas have been designed by marine aggregate companies and are indicative of the routes likely to be used. A review of the transit routes shows that vessels would pass through part of the Dogger Bank Zone to Area 466/1, if it were 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 3.15 million tonnes of aggregate dredged from the Humber Region in 2008, 1.02 million tonnes (33%) were landed at wharves in the North East of England. Some 0.10 million tonnes (3%) were landed elsewhere in England, and 2.03 million tonnes (64%) were landed at wharves in mainland Europe (TCE and BMAPA, 2009).

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).

a)



b)

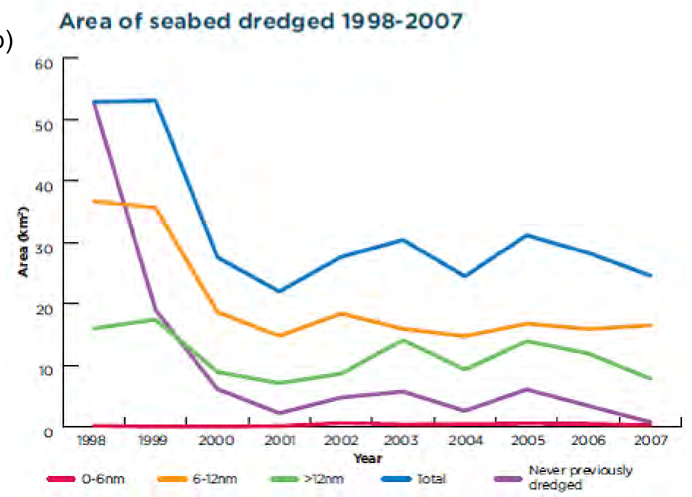


Figure 13.4: a) Area of seabed licensed and (b) area of seabed dredged in the Humber region (1998 – 2007) (TCE and BMAPA, 2008).

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 5 years or more), or 'Closed' (not used within the last 10 years).

Table 13.3: Details of open waste disposal sites in the Offshore ZDE (Source: Cefas, May 2010).

Disposal Site	Site Name	Annual tonnage (dry weight)										
		1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
TY042	Blyth A + B	233,934	242,688	161,204	0	263,315	264,432	237,273	133,883	199,911	133,960	187,650
TY070	North Tynne	162,430	209,870	337,470	54,220	242,775	67,723	125,832	89,119	867,492	160,752	206,586
TY081	Souter Point (Outer)	164,391	247,676	327,110	37,142	167,882	170,615	35,877	321,649	345,919	89,189	141,190
TY085	Tyne Tunnel											
TY090	Sunderland	0	197,328	184,690	0	193,758	0	236,368	0	201,574		0
TY130	Noses Point	23,450	19,142	28,401	17,177	19,238	17,670	9,156	35,858	27,946	19,273	28,910
TY150	Tees Bay C	431,054	1,942,110	0	0	0	0	0	21,384	472	0	0
TY160	Tees Bay A	1,017,187	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
TY180	Whitby	78,520	31,520	41,720	106,270	79,420	54,447	86,089	42,302	31,847	72,151	36,657
TY181	Cleveland Potash Outfall				300	0	0	0	56,432	0	44,558	58,070
TY190	Scarborough Rock	9,950	4,050	15,690	2,380	5,260	4,070	8,409	1,331	47,102	2,922	1,985
TY193	Tyne Burial Site											
HU015	Bridlington A	11,960	6,720	11,040	21,380	13,860	17,120	11,360	2,550	8,000	6,880	4,960
HU020	Humber 4b/Hook	1,576,273	235,314	331,415	252,833	166,580	141,965	264,945	197,235	216,905	156,460	114,390
HU021	Humber 4b/Hook Extension											
HU030	Humber 4	848,355	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
HU040	Whitgift Bight (River Ouse)	43,310	38,180	6,575	5,575	0	1,115	3,345	15,565	10,035	10,105	3,380
HU041	Goole Reach	17,385	42,040	6,690	9,720	10,220	33,451	18,500	21,855	14,565	28,125	8,305
HU046	Hull Marina						44,400	29,600				
HU060	Humber 3a	2,371,148	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
HU080	Humber 1a	7,170,342	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
HU090	Humber 2	676,375	809,118	639,142	713,975	708,221	423,099	681,309	610,857	626,677	928,871	641,382
HU112	Pyewipe Channel									26,800	0	
HU114	Wash Bank											
HU139	Boston 6	77,710	61,179	0								
HU143	West Stones		26,760	56,650	96,065	41,122	69,478	91,210	84,873	67,540	83,480	70,115
HU151	Wells Beneficial Use 1											
HU152	Wells Beneficial Use 2											
HU153	Wells Beneficial Use 3											
HU162	North Killinghome Cargo Haven		24,830	0								
HU170	Boston 7			59,978	54,443	46,403	59,742	52,039	39,506	48,662	14,544	27,517
HU200	West Of Inner Drowsing Bank											
HU201	Conoco Pipeline Trench								25,838	0		
HU203	Babbage											

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 5 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. Where there is no value, this indicates that, while open, the site wasn't licensed for disposal that year. Sites in the Humber Region are identifiable by the 'HU' prefix and sites in the Tyne Region are identifiable by 'TY' prefix.

Sites TY160, HU020, HU030, HU060 and HU080 are evidently the most heavily used – each consistently receiving over 1 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 May 2010, there were no known future disposal sites (in the application process) in the North Sea, though new sites may arise from future applications (Pers. Comm., S. Paccito, Cefas, 25th May 2010).

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.

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.

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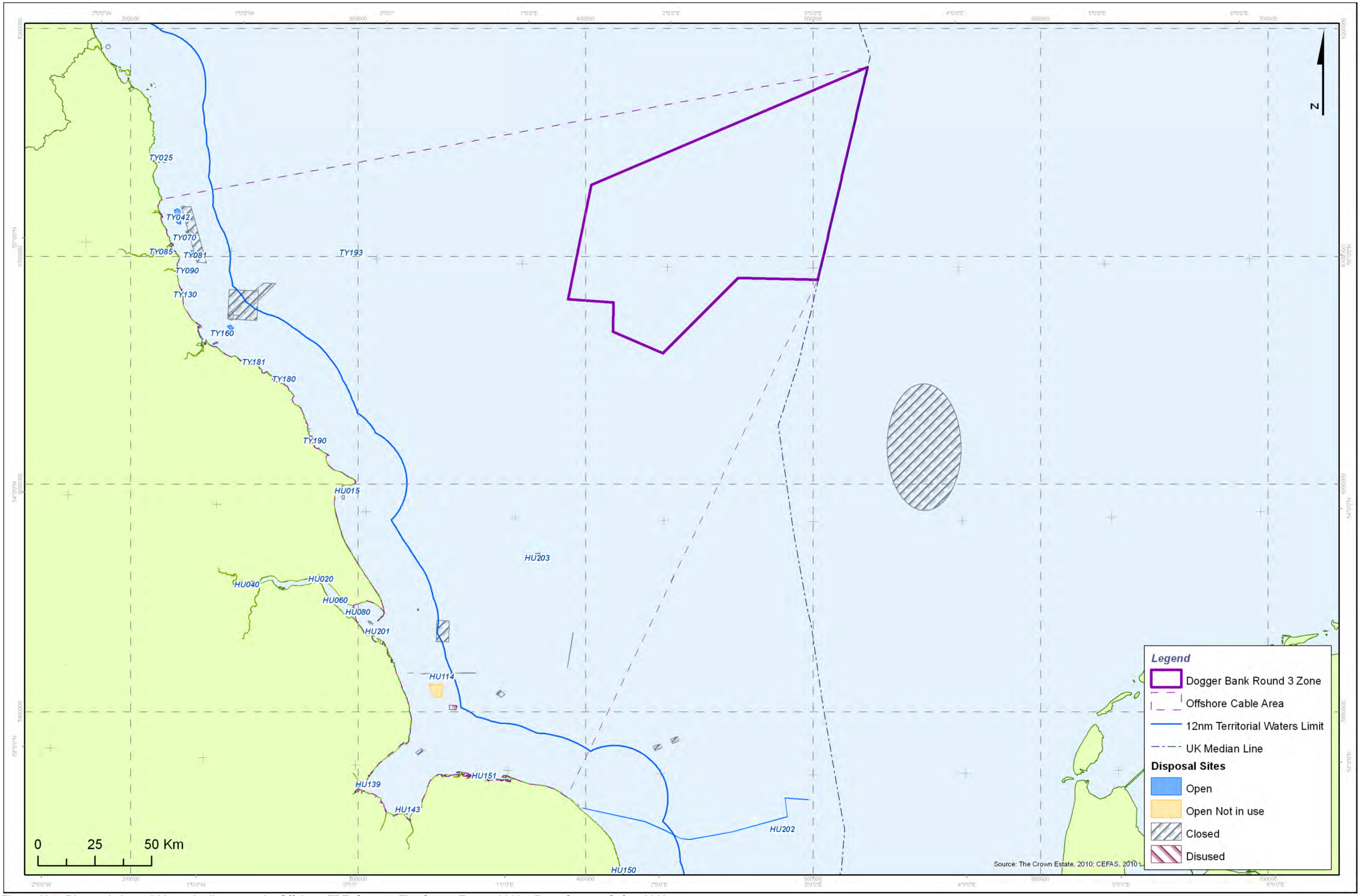

Figure 13.5: Disposal sites within and adjacent to the Offshore ZDE. Source: The Crown Estate, 2010e; Pers. Comm., Cefas, 2010.

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, 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).

Subsea pipeline data were acquired from UK DEAL while SeaZone data provided coastal sewer and outfall pipes.

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.

UK DEAL data include only the infrastructure occurring on the UK Continental Shelf. Where pipelines occur in other nation"s waters, those that are in close proximity to the Offshore 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) (DECC, 2009) and the latest offshore oil and gas infrastructure maps (DECC, 2010).

To provide context on the implications of cables and pipelines on the siting of wind turbines and cables within the Dogger Bank Offshore ZDE, ICPC (ICPC, 2007a, 2007b) and UK Cable Protection Committee (UKCPC, 2006) guidance documents and recommendations have been reviewed.

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: Details of telecommunications cables occurring in the Dogger Bank Zone and Offshore Cable Area, and Offshore Cable Area alone (Source: KIS-CA, 2010; ICPC, 2009). There are currently no known additional cables planned within the Offshore ZoC (ICPC, 2009).

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 south-west to north-east, from Scarborough (Table 14.1: Details of telecommunications cables occurring in the Dogger Bank Zone and Offshore Cable Area, and Offshore Cable Area alone (Source: KIS-CA, 2010; ICPC, 2009).and Figure 14.1).

14.4.2 Offshore Cable Area

North of the Zone, the active CANTAT 3 F4 and Pangea North cables both make landfall at Redcar. 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, and Offshore Cable Area alone (Source: KIS-CA, 2010; ICPC, 2009).

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	Active	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

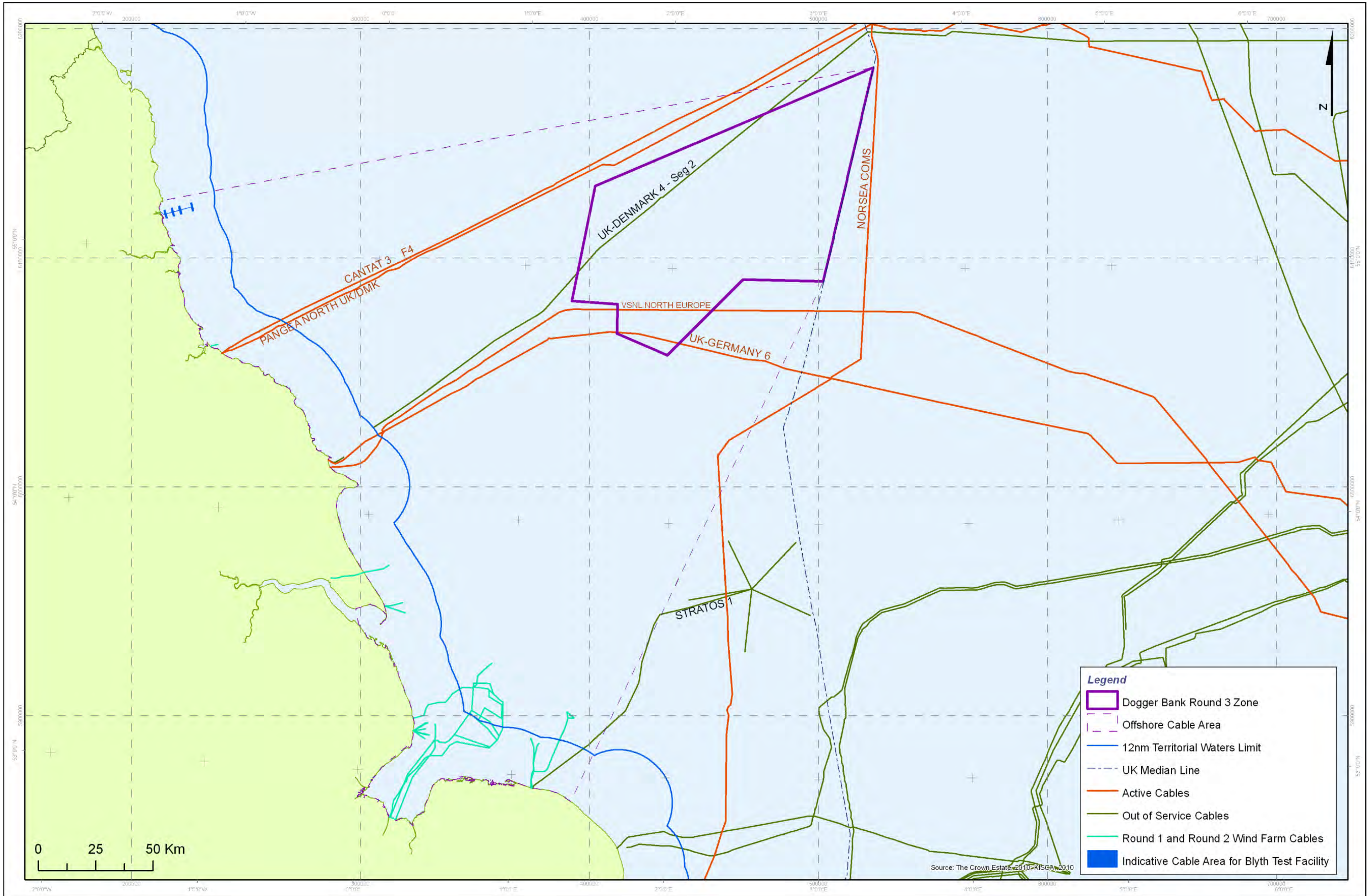

Figure 14.1: Cable Routes across the Dogger Bank Zone and Offshore Cable Area. Source: The Crown Estate, 2010; KIS-CA, 2010.

14.5 Subsea Power Cables

There are 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. A number of 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). 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 in recent years, including:

- Mainstream Renewable Power"s SuperNode configuration for trading power between offshore wind farms, the UK, Norway and Germany (Mainstream Renewable Power, 2010);
- Airtricity"s European Offshore Supergrid linking offshore windfarms with the UK, Netherlands and Germany (Airtricity, 2006); and
- 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).

Consquently, EU member states are moving toward the Supergrid concept with the intention of upgrading existing transmission assets in Europe by 2030 (Friends of the Supergrid, 2010).

In addition, proposals exist for interconnectors between 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).

No formal plans or cable routes have yet been submitted, but progress on the Supergrid and interconnectors should be followed closely as it could result in both development implications and connection opportunities for Forewind.

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 M.

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 14.2). 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).

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 14.2). Bacton, to the south of the ZDE, is also the terminus for a number of pipelines which pass through the Offshore ZoC.

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).

Although not captured in the UK DEAL data presented in Figure 14.2, the Franpipe and Zeepipe lines pass to the east of the Dogger Bank Zone and the UK Median, through Dutch, German, Danish and Norwegian waters (DECC, 2010). The 42 inch diameter Franpipe gas line is operated by Gassco and runs 840 km from the Draupner East riser platform in Norwegian Waters to the receiving terminal at Port Ouest in Dunkerque on the French coast (Gassco, 2008a). 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 is less than 1 km from the Dogger Bank Zone and the Zeepipe approximately 1 km further east (DECC, 2010).

In the south of the Offshore ZoC, the network of pipelines is extensive and complex (Figure 14.2). Each pipeline is detailed in Appendix M. 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 14.2). This information is broadly consistent with the disused pipeline identified by stakeholders in April 2010 (see Section 14.2 and Figure 14.2).

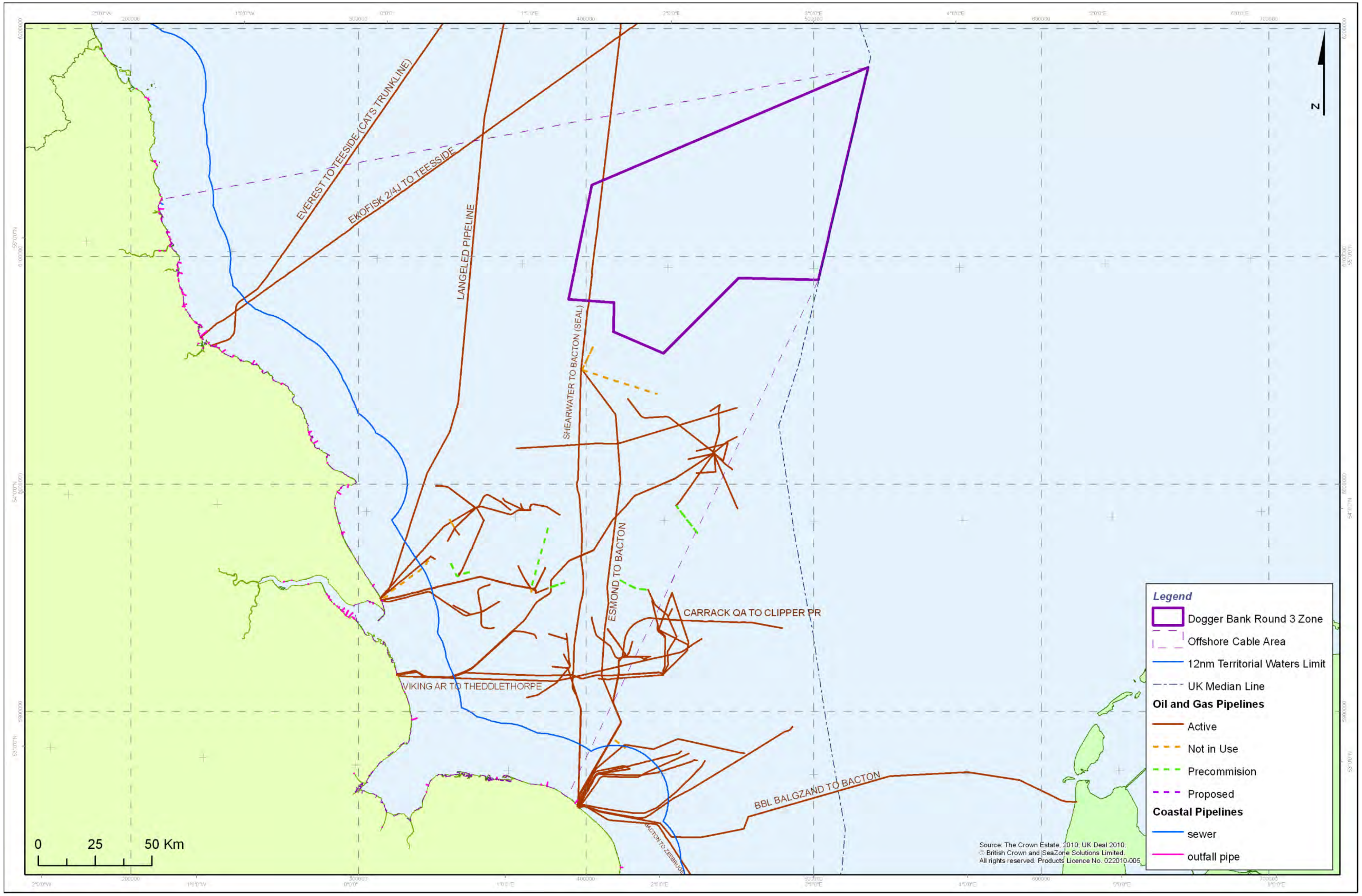

Figure 14.2: Oil and Gas Pipelines and Coastal Pipelines across the Dogger Bank Zone and Offshore Cable Area. Source:The Crown Estate, 2010; UK Deal 2010; British Crown and SeaZone Solutions Limited, All rights reserved. Products Licence No. 022010.005

14.7 Coastal Pipeline Infrastructure

Numerous pipelines occur at the coastline (Figure 14.2). 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 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:

- Renewable energy;
- Underground Coal Gasification (UCG);
- Carbon Capture and Storage (CCS); and
- Recreation and tourism.

15.2 Data and Literature

Data delineating offshore wind farms were provided by The Crown Estate (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 licences and applications 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 The Crown Estate.

Information regarding recreation and tourism was based upon Designated Bathing Water status and recreational boating. Designated 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 Waters Directive, together with information about their water quality status. The 2010 data were downloaded, together with a review of which beaches are awarded the European Blue Flag status, in order to provide an indication of areas that are popular with beach goers. RYA cruising routes, sailing and racing areas, marinas, clubs and training centres were obtained from the Royal Yachting Associations 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 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. sailing, 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 (SKM Enviros, 2010).

15.3 Overview

With the exception of RYA cruising routes, none of the activities discussed in this chapter occur in the Dogger Bank Zone. 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 three licences and two applications in coastal waters, which are subject to planning permission and therefore no infrastructure is currently in place. There is also great potential for CCS in depleted North Sea gas fields and saline aquifers. Both UCG and CCS are likely to use 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 The Crown Estate leasing Rounds 1 and 2 (TCE, 2010a). Development has mostly been focused close to the coast 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 be connected to the UK mainland with export cables and will have a network of inter-array cables within the sites themselves.

Table 15.1: Operational and planned offshore wind projects in the Offshore ZDE (The Crown Estate, 2010; Renewable UK, 2010; New and Renewable Energy Centre (Narec), 2010)

Name	Developer	Capacity	Round	Status
Blyth	E.ON UK	4 MW	Other	Operational
Inner Dowsing	Centrica Energy	97 MW	1	Operational
Lynn	Centrica Energy	97 MW	1	Operational
Teesside	EDF Energy	90 MW	1	Consented, not under construction
Sheringham Shoal	Scira Offshore Energy	315 MW	2	Consented and under construction
Lincs	Centrica Energy	270 MW	2	Consented, not under construction
Humber Gateway	E.ON UK	230 - 300 MW	2	In planning
Dudgeon East	Warwick Energy Ltd	230 - 560 MW	2	In planning
Race Bank	Centrica Energy	375 - 580 MW	2	In planning
Westermost Rough	DONG Energy UK	180 - 240 MW	2	In planning
Docking Shoal	Centrica Energy	375 - 540 MW	2	In planning
Triton Knoll	RWE npower renewables	900 - 1,200 MW	2	Pre-planning
Hornsea Zone	SMart Wind Limited	4 GW	3	Zone Appraisal and Planning
Blyth Demonstration Site	Narec	Variable	Other	Pre-planning

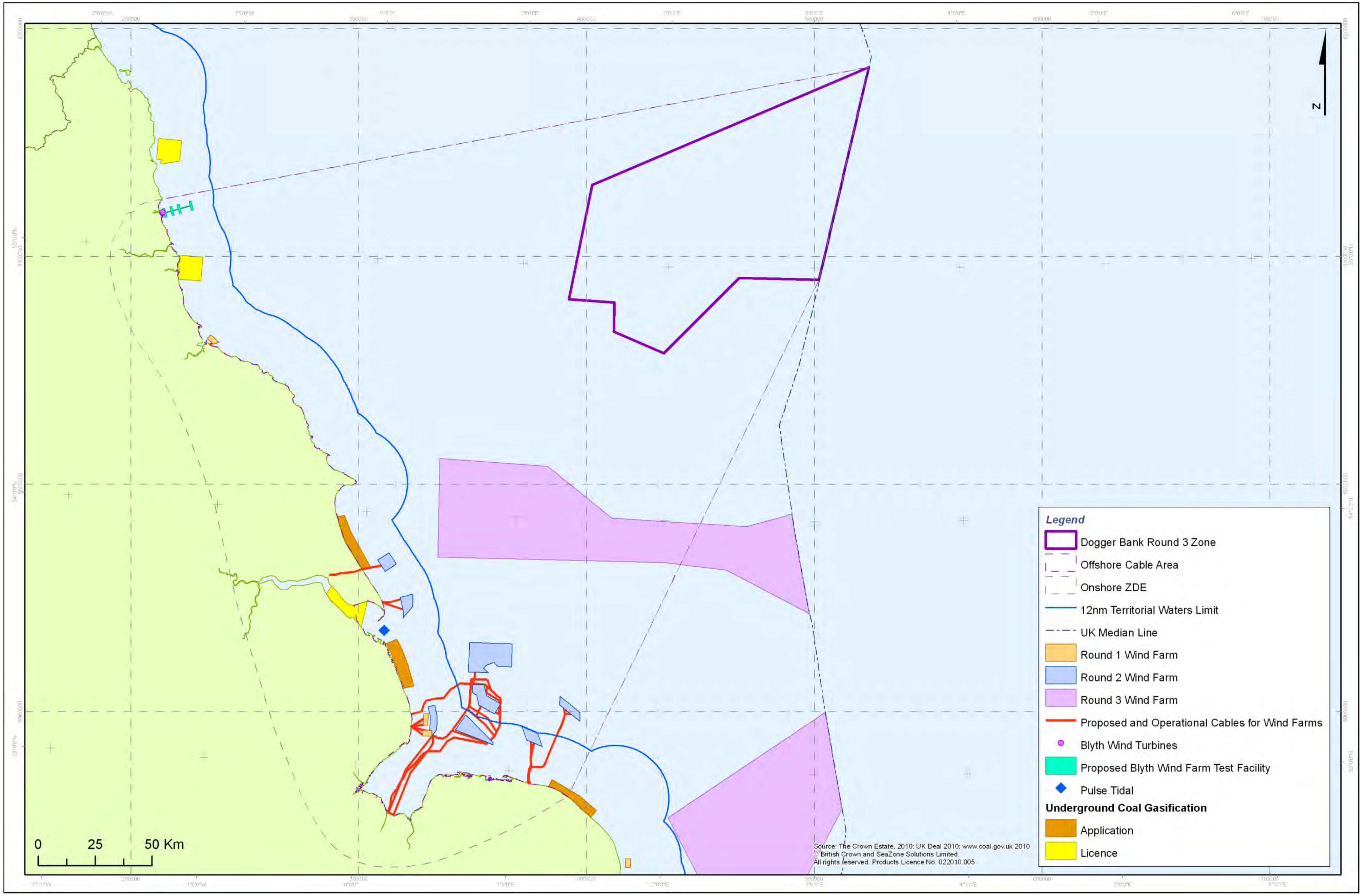

Figure 15.1: Renewable Energy and Underground Coal Gasification Sites in the Offshore ZoC. Source: The Crown Estate, 2010c; UK Deal, 2010; The Coal Authority, 2010b; British Crown and SeaZone Solutions Limited. All rights reserved. Products Licence No. 022010.005

15.4.1 Blyth

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 turbines located offshore were developed by E.ON on behalf of Blyth Offshore Windfarm Ltd and came online in 2000 (New and Renewable Energy Centre (Narec), 2010; Renewable UK, 2010). Both projects are now operated by Sinclair Knight Merz (SKM).

15.4.2 Rounds One and Two

The Crown Estate'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, 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). EDF Energy's 90 MW site at Teesside, 1.5 km north-east of Teesmouth, has been consented for 30 turbines (Figure 15.1)

The Round 2 tender process in 2003 enabled larger scale commercial projects to be identified, some beyond the 12 nm limit for territorial waters. These include the eight Round 2 sites located in the Humber and The Wash region of the Offshore Cable Area (Table 15.1 and Figure 15.1). Sheringham Shoal is being developed by Scira Offshore Energy, a joint venture company shared equally by Statoil and Statkraft, and is currently under construction off the north Norfolk coast. All other Round 2 sites 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.

15.4.3 Round 3

The Round 3 sites, awarded in 2009, were identified by The Crown Estate 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 SMart Wind, 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, 2010). SMart Wind, like Forewind, is presently engaged in the Zone Appraisal and Planning (ZAP) phase of development and specific projects within the Zone have not yet been identified.

15.4.4 Blyth Demonstration Site

Narec has applied to The Crown Estate 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 The Crown Estate, 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 is intended to be developed to increase capacity 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 Partnership, 2010).

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 (The Coal Authority, 2010a).

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 could provide a long term gas supply. Offshore, platform based UCG, if satisfactorily developed, would further extend supply (DTI, 2004).

UCG licensing falls to The Coal Authority. Figure 15.1 shows that within the Offshore ZDE there are three licences and two applications, namely:

- Sunderland Offshore Area – Conditional Licence
- Humberside Coastal Area – Conditional Licence
- East Anglia Offshore Area - Conditional Licence
- Holderness Offshore Area –Application
- South Humber Offshore Area –Application

(The Coal Authority, 2010b).

All licences are conditional and no operations are permitted until all the other rights and permissions are in place with other bodies, including planning permission subject to Environmental Impact Assessment (EIA) (Pers. Comm. S. Cooke, The Coal Authority, 23rd June 2010). In order to implement the appropriate infrastructure, UCG would utilise similar infrastructure as used for oil and gas extraction (see Chapter 11 – *Oil and Gas*). Should wells be drilled offshore, this would create localised structures, around which cable routes may need to be sited.

15.6 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 storage of natural gas (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.

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 CCS demonstration sites. On 8 July 2010 DECC announced the start of a market sounding process for the Demonstration Programme which is intended to help DECC explore workable options (DECC, 2010).

Currently, there are no active sites in the Offshore ZoC or wider UK North Sea for CCS and formal proposals have not yet been submitted. There is potential for future development and this should be followed closely for the purpose of Zonal Characterisation and project specific EIAs. CCS would utilise similar infrastructure and locations as current oil and gas extraction, and so it is unlikely that CCS will result in additional or significant constraints in the ZDE.

15.7 Recreation and Tourism

15.7.1 Bathing Waters and Blue Flag Beaches

Coastal bathing waters are designated under the Bathing Water Directive (76/160/EEC) and assessed against mandatory and guideline standards for water quality. The mandatory water quality standards set by the Bathing Water Directive 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 fulfil the water 'Excellent' quality criterion of the international Blue Flag award scheme (Blue Flag, 2010).

Sixty designated Bathing Waters occur along the coast of the ZDE and indicate the locations of popular beaches. These are depicted in Figure 15.2: Recreation and Tourism Users across the Dogger Bank Zone and Offshore Cable Area. Source: The Crown Estate, 2010c; RYA 2009; Environment Agency, 2010.and Table 15.2. The Bathing Waters identified have consistently maintained a good or excellent level of water quality since 2007 (Environment Agency, 2010).

Blue Flag beaches are also depicted in Figure 15.2 and Table 15.2. Blue Flag status is subject to change on an annual basis.

Table 15.2: Designated Bathing Waters and Blue Flag beaches in the Dogger Bank ZDE.

Bathing Water	Water Quality Status June 2010	Blue Flag 2010	Bathing Water	Water Quality Status June 2010	Blue Flag 2010
Cromer	Excellent	Yes	Robin Hoods Bay	Excellent	
East Runton	Excellent		Whitby	Excellent	Yes
Sheringham	Excellent	Yes	Sandsend	Excellent	
Wells	Excellent		Runswick Bay	Excellent	
Old Hunstanton	Excellent		Staithes	Good	
Hunstanton Main Beach	Excellent	Yes	Saltburn	Excellent	
Heacham	Excellent		Sea at Marske Sands	Excellent	
Skegness	Excellent	Yes	Redcar Stray	Excellent	
Ingoldmells South	Excellent		Redcar Granville	Excellent	
Chapel St Leonard	Excellent		Redcar Lifeboat Station	Excellent	
Anderby	Excellent		Redcar Coatham	Excellent	
Moggs Eye	Excellent		Seaton Carew North Gare	Excellent	
Sutton-on-Sea	Excellent	Yes	Seaton Carew Centre	Excellent	Yes
Mablethorpe Town	Excellent	Yes	Seaton Carew North	Excellent	
Cleethorpes	Excellent	Yes	Crimdon	Excellent	
Withernsea	Excellent		Seaham Hall Beach	Excellent	
Tunstall	Excellent		Seaham Beach	Excellent	
Hornsea	Good		Roker - Sunderland	Excellent	Yes
Skipsea	Excellent		Seaburn - Sunderland	Good	
Fraisthorpe	Excellent		Marsden	Excellent	
Wilsthorpe	Excellent		South Shields	Excellent	Yes
Bridlington South Beach	Excellent		Tynemouth King Edwards Bay	Excellent	Yes
Bridlington North Beach	Excellent	Yes	Tynemouth Long Sands South	Excellent	Yes
Danes Dyke, Flamborough	Excellent		Tynemouth Long Sands North	Excellent	
Flamborough South Landing	Excellent		Tynemouth Cullercoats	Excellent	Yes
Reighton	Excellent		Whitley Bay	Excellent	Yes
Filey	Excellent	Yes	Seaton Sluice	Excellent	
Cayton Bay	Excellent		Blyth South Beach	Excellent	
Scarborough South Bay	Excellent		Newbiggin South	Excellent	
Scarborough North Bay	Good	Yes	Newbiggin North	Excellent	

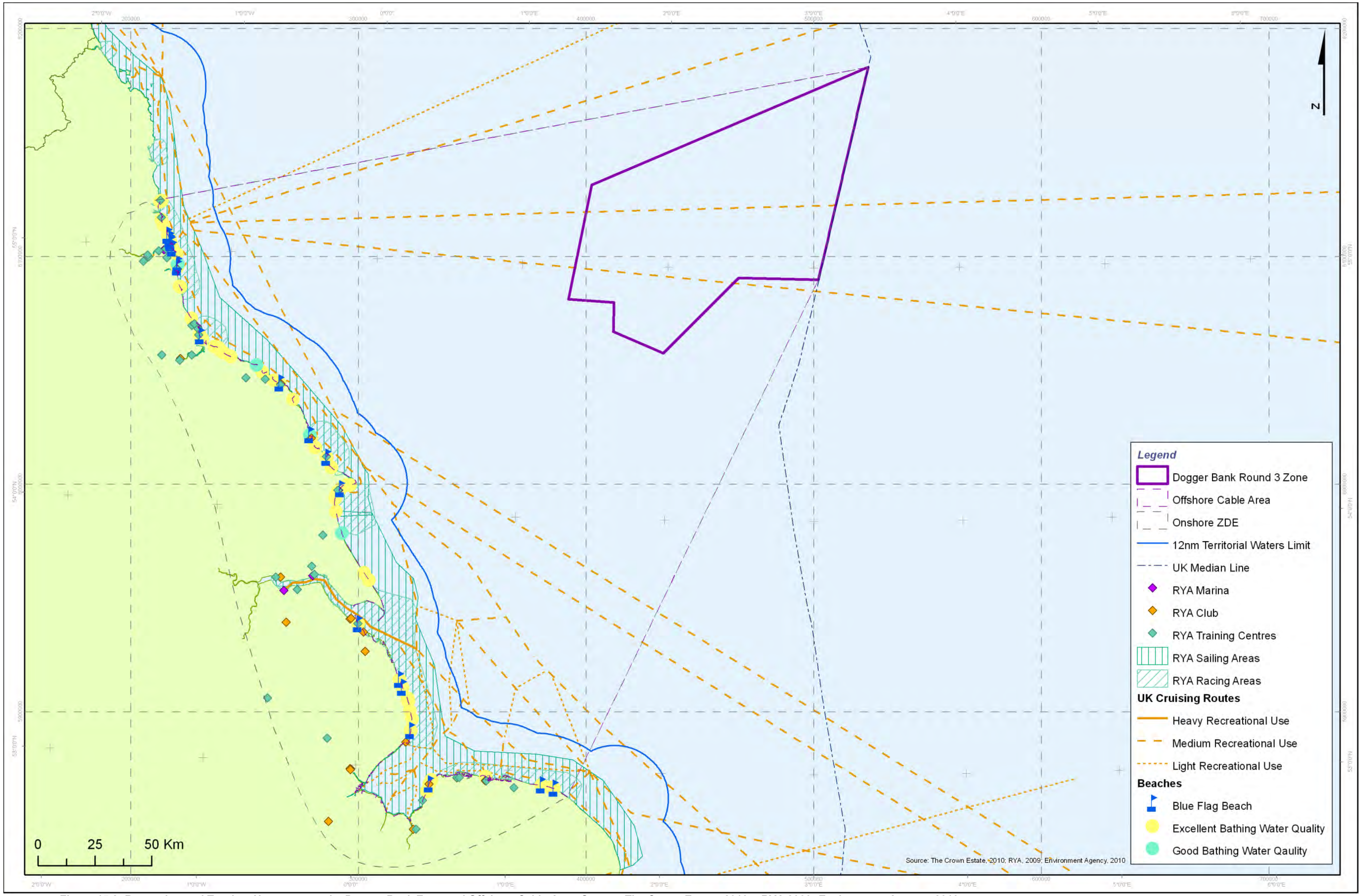

Figure 15.2: Recreation and Tourism Users across the Dogger Bank Zone and Offshore Cable Area. Source: The Crown Estate, 2010c; RYA 2009; Environment Agency, 2010.

15.7.2 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) into Heavy, Medium and Light Use as described below:

- 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.
- 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 between Newcastle-Esbjerg in Denmark which pass through the Dogger Bank Zone (Figure 15.2). 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 is discussed further in Chapter 9 – *Navigation and Shipping*, and in Anatec (2010).

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 Sherringham in Norfolk.

Offshore Cable Area

Boating activity increases towards the coast. Sailing areas front the entire coastline while racing areas are defined around the major estuaries, around Flamborough Head and off the coast of Norfolk. Cruising routes increase in number, 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).

15.8 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 and Carbon Capture and Storage are in the initial development stages and yet to yield any significant development or infrastructure. There are three conditional licenses and two applications for UCG within coastal waters, which are subject to planning permission and therefore no infrastructure is currently in place. These are likely to use existing or similar 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 have been put forward. However the UK Government's target to reduce carbon emissions by 2050 has led the Department of Energy and Climate Change to announce the start of a process to explore workable options, and this should therefore be followed closely for the purpose of ZoC Characterisation and site-specific EIAs.

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 Zonal Characterisation

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 50km 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 4 main themes. The 4 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; and
- Publicly available information from government agencies – official designated sites from Natural England and English Heritage.
- 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 (4 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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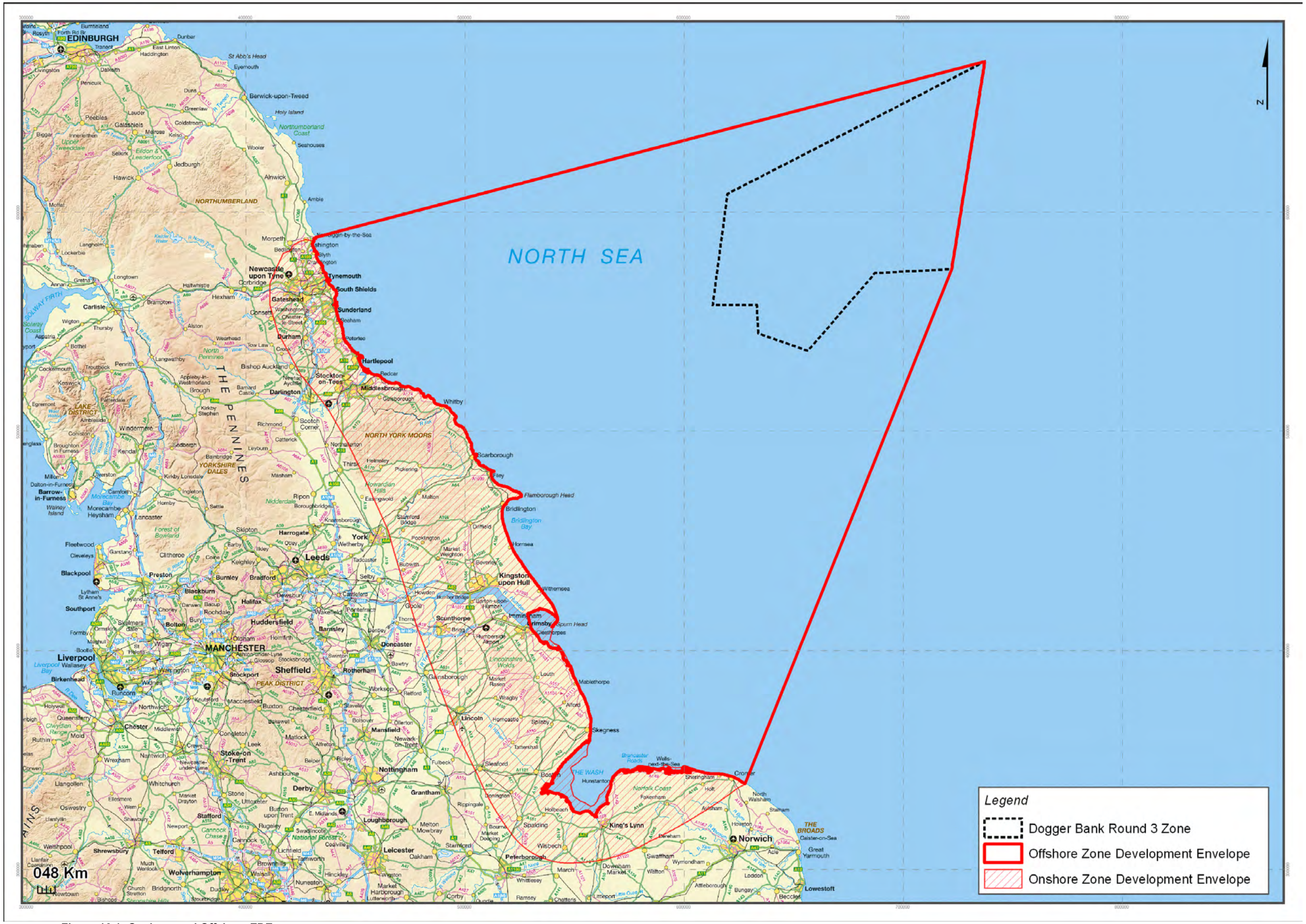
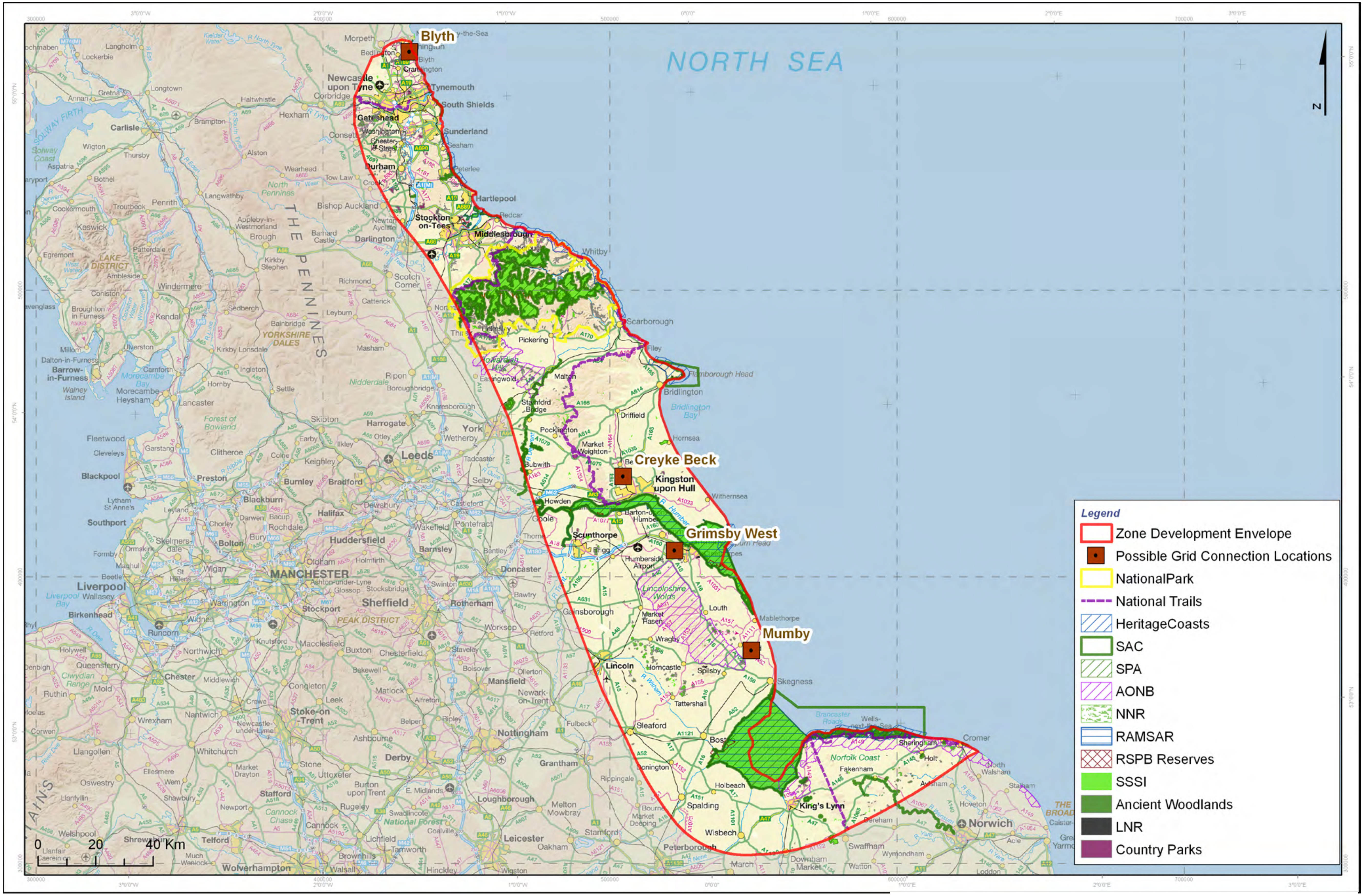


Figure 16.1: Onshore and Offshore ZDE



Ordnance Survey data © Crown copyright and database rights 2010; Natural England, 2010; RSPB, 2010

Figure 16.2: Environmental designations within Onshore ZDE

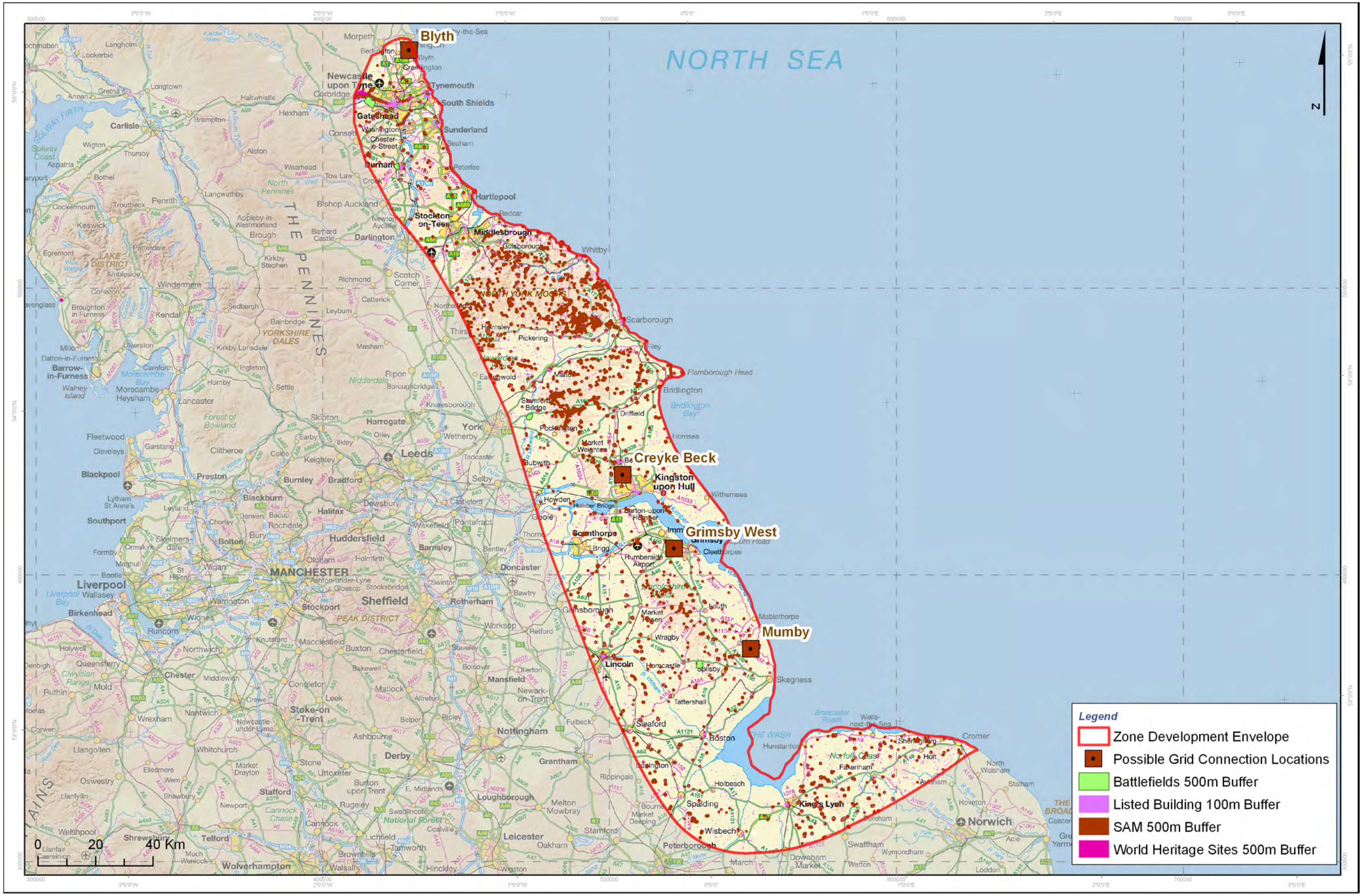


Figure 16.3: Cultural Heritage

Ordnance Survey data © Crown copyright and database rights 2010; English Heritage, 2010

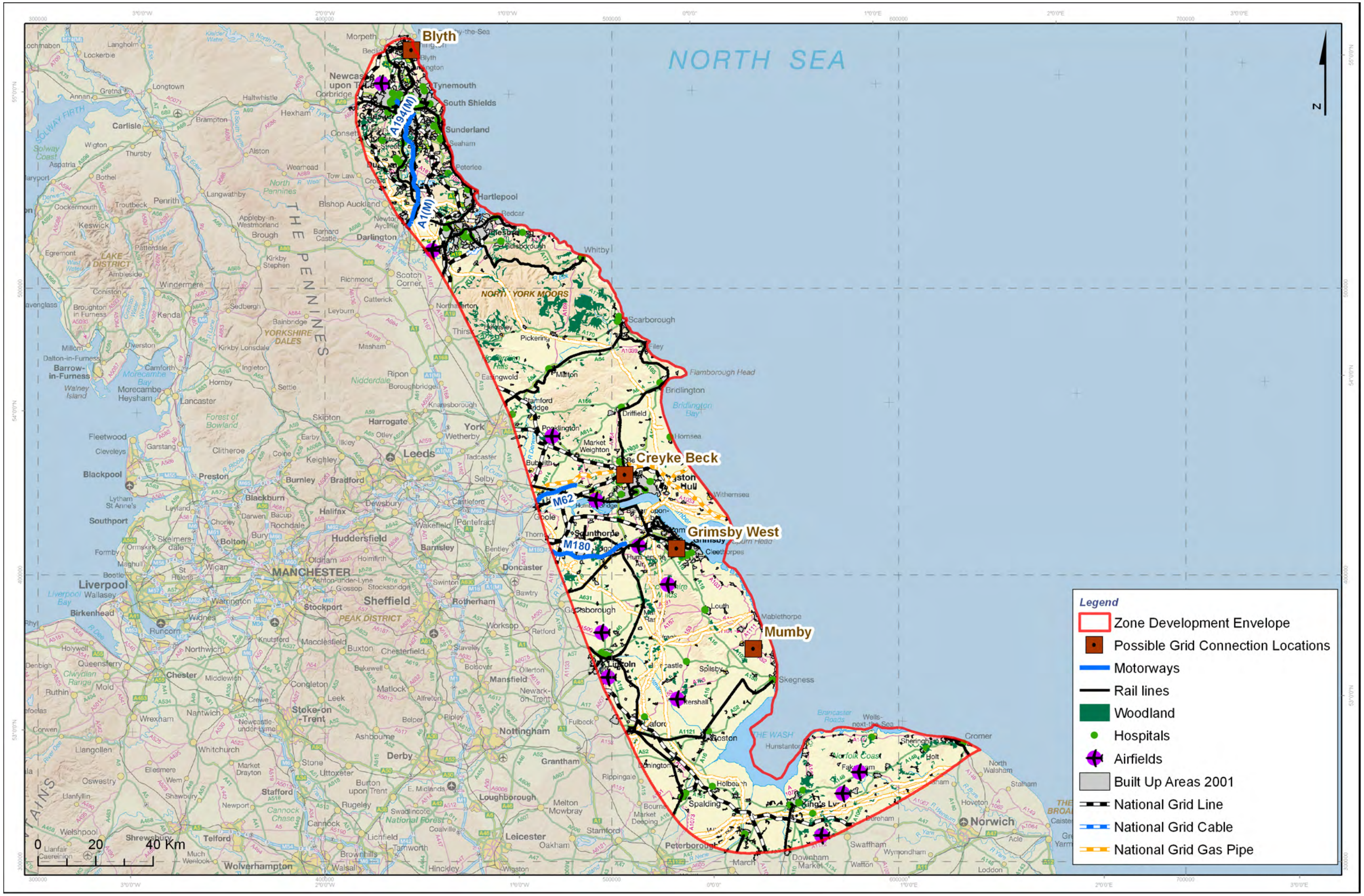


Figure 16.4: Infrastructure within the Onshore ZDE

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 is 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 2 km 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 north west (from the direction of York) to south east (towards Hull). A section of carriageway is duelled approximately 1 mile to the north west of the substation;
- A1174 single carriageway road running north 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 2 km 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 north west 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 1 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, due to the prohibitive cost of purchasing the data. Once a cable corridor is selected this information will need to 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)
  - 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
- 13 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.

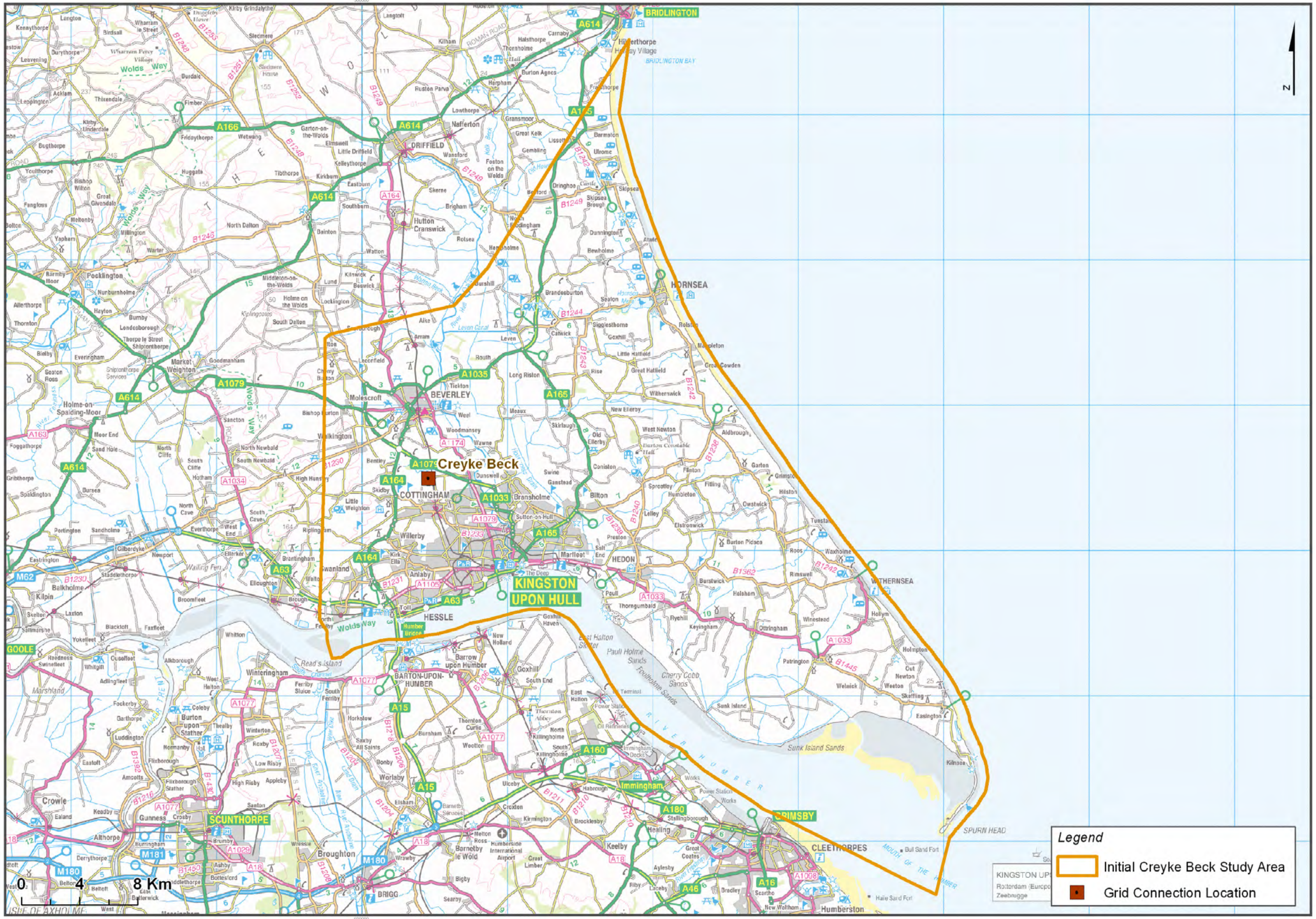


Figure 17.1:Initial Creyke Beck Substation Study Area

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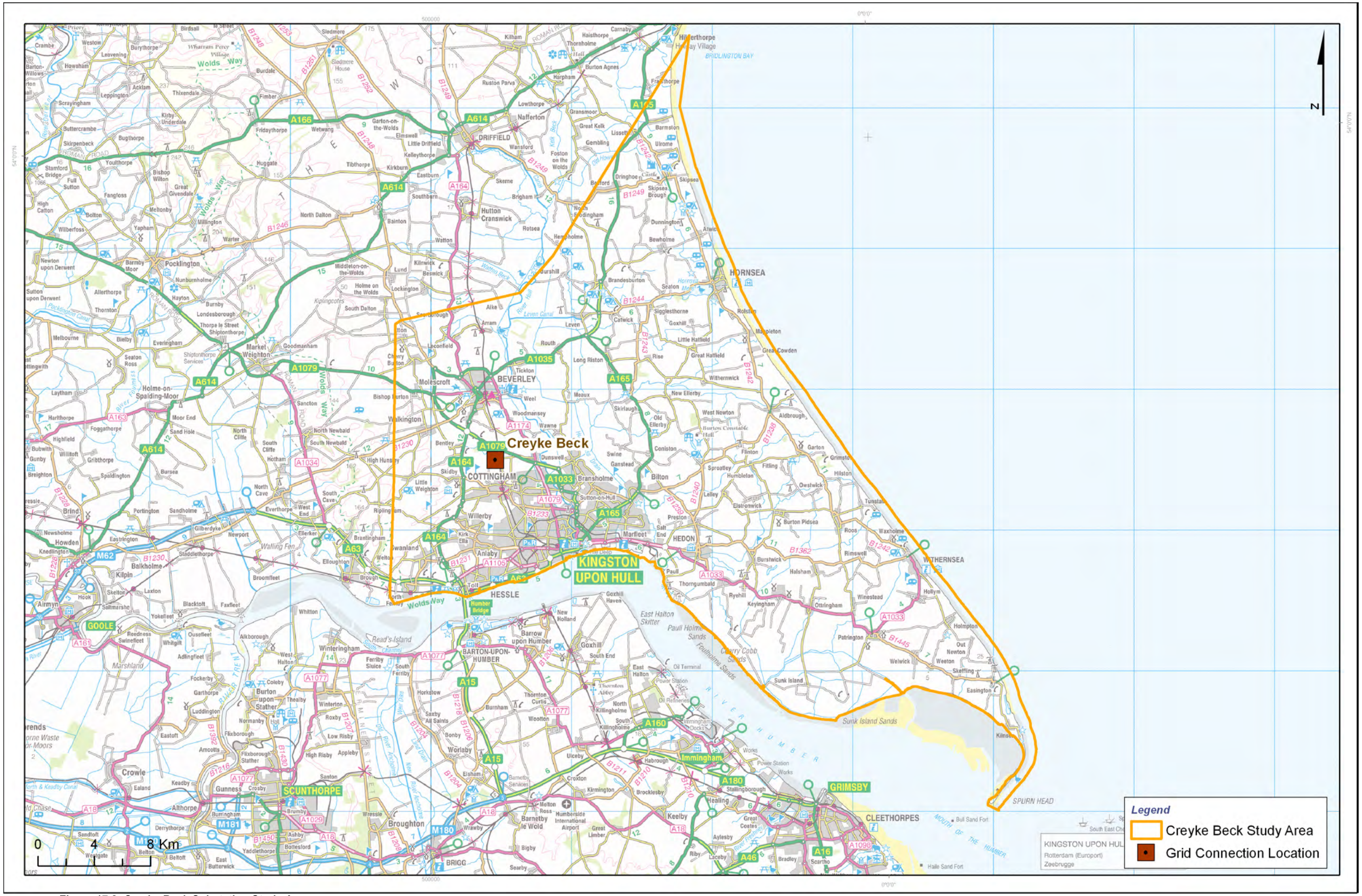

Figure 17.2: Creyke Beck Substation Study Area

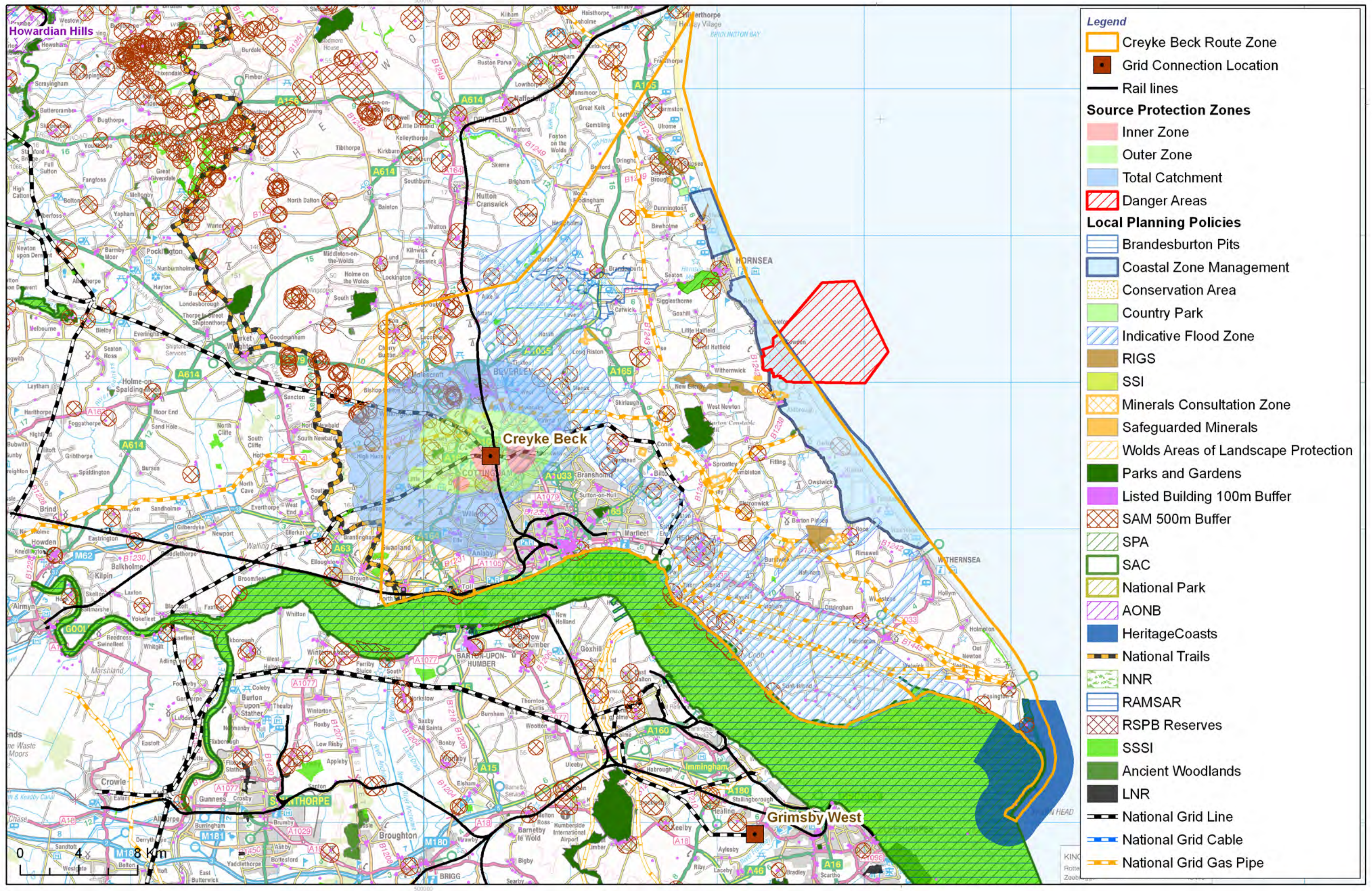

Figure 17.3 Potential Constraints in Creyke Beck Substation Study Area

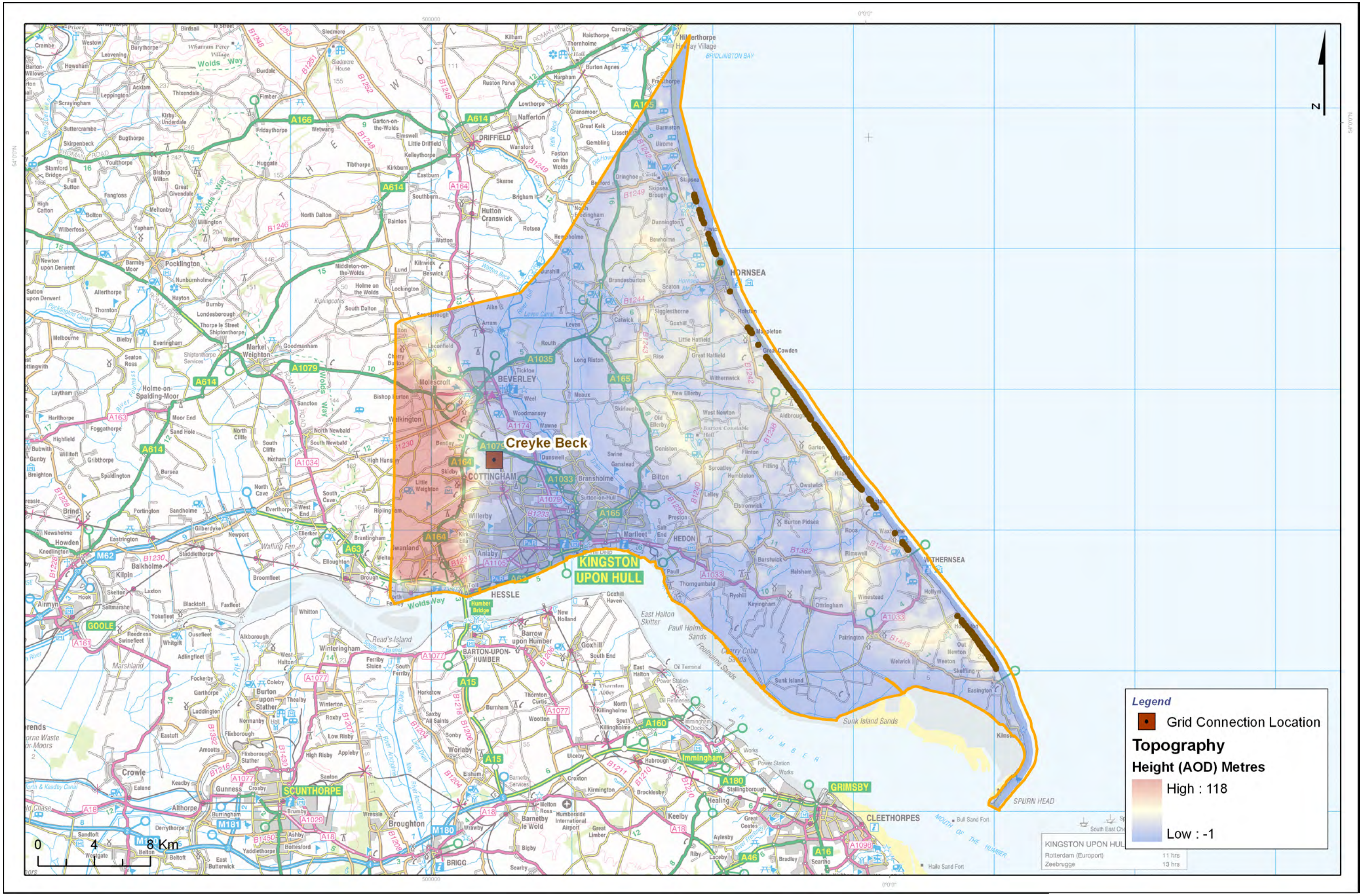

Figure 17.4: Creyke Beck Substation Study Area Topography

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