

Coordinating Marine Survey Data Sources

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Abstract

A pilot study was conducted to demonstrate the challenges involved in assessing and locating existing survey data acquired within English territorial and offshore waters. The study targeted three focus areas around the coast that are geographically distinct and have offered a range of appeal to offshore developers. This study shows that though recent legislation encourages central archiving and data sharing, the majority of ‘the national repository’ remains split across industry, regulators and academia.

Key Words

Marine survey data, seismic, sub-bottom, sediment sampling, industry, offshore development, Environmental Impact Assessment.

Introduction

The North Sea Palaeolandscapes Project (NSPP) has generally relied upon the large Southern North Sea (SNS) 3D seismic MegaSurvey developed by Petroleum GeoServices (PGS). This is a regional merge of surveys at the licence block-scale or smaller, acquired by the petroleum industry – oil and service companies – over the last 20 years (Terrell et al., 2005). It offers an unparalleled source of data for visualising and interpreting buried features of the emergent Holocene/Mesolithic landscape at a regional scale providing a broad spatial framework of the offshore prehistoric landscape following the last glaciation.

As stated by Thomson (this volume), 3D seismic survey data is one of a diverse suite of survey data types that exists within the SNS. Different surveys target different information about the seabed and subsurface. Survey design dictates the range of penetration through the subsurface and the spatial resolution of the features that can be detected. This has implications for the survey scale. Owing to the location of viable hydrocarbon resources and the logistics of development, the SNS MegaSurvey is confined to a region lying at least 11 miles off the English coast. There is a so called “white band” between the coast and the MegaSurvey that is covered only by smaller scale surveys or 2D seismic lines. In order to develop our understanding of how prehistoric man interacted with the evolving postglacial shoreline, sources of data for surveys conducted within the white band must be identified. In addition, we will gain greater insight into Mesolithic human behavioural patterns in the hinterland by augmenting our broad model of the emergent landscape with more focussed interpretations using survey data at a finer scale. This paper seeks to investigate the variety of survey data available to serve these purposes.

Identification of sources – who acquires, owns or holds survey data?

There are three broad groups that require offshore survey data: governmental organisations, industry and academia. Governmental organisations, including conservation and regulatory bodies, survey for monitoring and engineering purposes as dictated by legislation and infrastructural planning. For example, former public service organisations like British Telecom (now BT) are responsible for regularly

surveying seabed cable and pipeline routes to monitor their structural integrity. In relation to this theme, the British Hydrographic Office (BHO) continuously maps the sea floor at a fine spatial resolution to ensure the latest navigation charts are accurate. Conservation and regulatory bodies undertake surveys to monitor environmental change arising from seabed use.

Current government legislation promotes renewal and investment in offshore industrial sectors. This is particularly the case with the growth in renewable energy projects. Offshore 'green' energy generation is seen by the government as a key strategic objective in the battle to mitigate anthropogenic climate change. Funding systems such as the Aggregates Levy Sustainability Fund (ALSF) have involved academia directly in combining research & development with monitoring and evaluation.

Offshore industrial surveys are specifically designed with industrial application in mind. Oil companies carry out large-scale acoustic surveys in order to visualise geological structures and stratigraphy at depth. Smaller-scale, shallow geotechnical surveys are carried out on their behalf for engineering and compliance purposes. Other industries, including marine aggregates producers, specifically target the shallow marine sediments as a resource. They conduct 2D seismic sub-bottom profiling, high resolution, seabed bathymetric mapping using sonar and direct sediment sampling by shallow core or grab. The other growing industrial application within territorial and offshore UK waters is the development of large offshore wind farms. As well as producing survey in order to estimate their environmental impact, wind farm proposals must involve engineering survey to establish the safe installation and anchor of turbines through the sea bed.

The activity of the British Geological Survey (BGS) uniquely occupies parts of all three sectors. The BGS is a public sector organisation that is a component of the National Environment Research Council (NERC), a body reporting to the Department of Trade and Industry (DTI). Yet it is also an academic body undertaking applied research that is part-funded by the government and its own commercial activities. The BGS has undertaken extensive survey of the shallow seabed sediments in UK territorial and offshore waters over many decades.

Key data repositories

Under its remit for strategic research and surveying, the BGS has generated and compiled the national archive of marine shelf seabed sedimentary and geological maps. These are derived from shallow geophysical survey and sediment sampling. Figure 1 illustrates the distribution of acquired shallow geophysical survey lines and shallow sediment samples around the UK according to the BGS data archive web GIS, GeoIndex, as of October 2006. It is clear that geophysical surveying was possible within all waters beyond a certain depth. Direct sediment sampling was achieved closer to shore and is particularly concentrated within slightly enclosed estuaries and embayments.

A variety of geophysical survey techniques have been used along these survey lines. All have been covered by echo sounder and some by more complex sonar techniques used in order to map the shape of the sea floor. The majority have been covered by a potential field instrument: gravimeter or magnetometer. These give an indication of a

variation in bulk density and magnetisation of seabed material laterally. However, the most useful technique for visualising the vertical stratigraphy of seabed sediments is sub-bottom seismic profiling. Most of the BGS geophysical survey lines have been covered by a seismic reflection survey using either a boomer, sparker or pinger acoustic source (reference?). Each of these is an industry name that refers to the method for generating the acoustic pulse that propagates radially outward, through the water column and underlying sediment to be reflected back at interfaces of contrasting density. BGS 2D seismic survey data is particularly suited to our needs because they were acquired using a high resolution single channel receiver (hydrophone) system. The boomer generates a source wavelet that tends to produce the clearest results for interpreting the shallow features of interest.

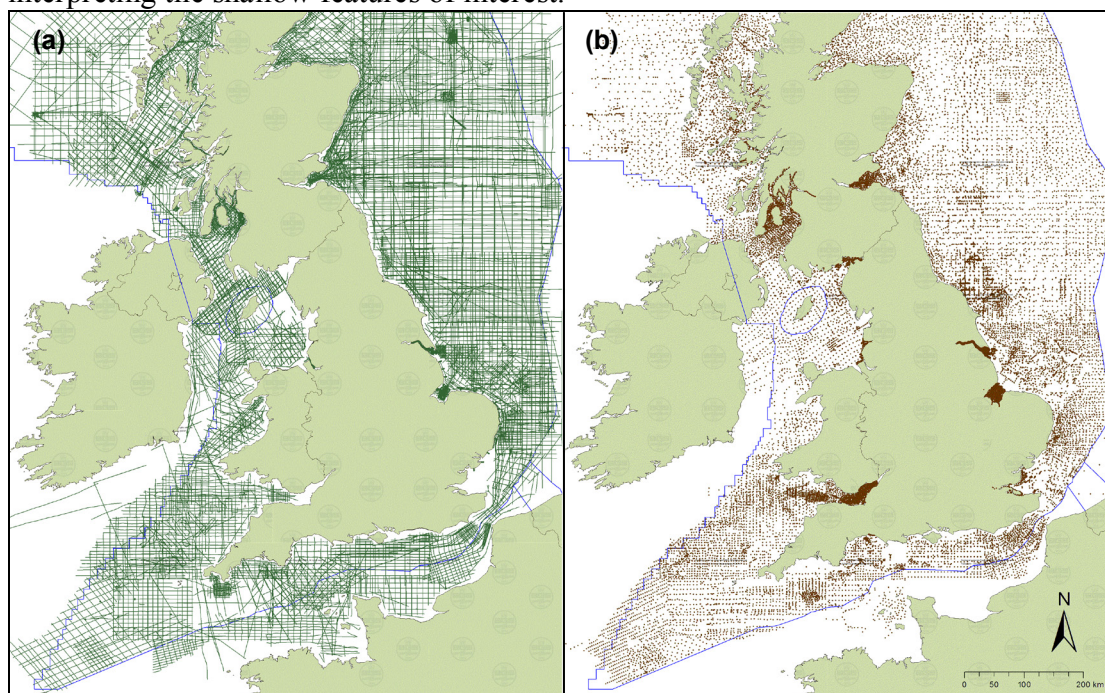


Figure 1: BGS survey coverage on the UK Continental Shelf as displayed by GeoIndex, October 2006. (a) shows geophysical profile lines, (b) shows shallow sediment sample stations.

Sediment samples may be disposed of after cataloguing or may be retained at the BGS collection at Loanhead, Edinburgh. The store forms part of the National Geosciences Data Centre (NGDC), which offers an archiving and curative service for voluntary donations of survey data, samples and field notes by both industry and amateur geoscientists. The NGDC has a section dedicated to conventional prospecting data – seismic surveys and borehole logs – that is divided between onshore and offshore activities. These sections are the UK Onshore Geophysics Library (UKOGL) and the National Hydrocarbons Data Archive (NHDA) respectively. The NHDA can act to relieve UKCS licensee operators of the expensive legal obligation to retain certain survey data in perpetuity for recall by the DTI at any time. However, this obligation does not apply to core samples and cuttings. The decision to donate these rather than dispose of them is made at the discretion of the operator.

The NHDA is a joint venture between the Department for Trade & Industry (DTI) and Common Data Access Limited (CDA), a not-for-profit subsidiary of the UK Offshore Operators Association (UKOOA) that administers data exchange amongst its members. The BGS manages the NHDA and runs the associated UK Digital Energy Atlas and Library (UK DEAL) project, a public web presence to promote data and

information relevant to the exploration and production of hydrocarbons on the UKCS. UK DEAL aims to provide a publicly accessible national catalogue of UKCS geosciences data, their sources and owners, to facilitate data sharing between the public and/or prospective licence applicants and data owners/current licensees. Figure 2 shows the distribution of previously acquired UKOOA seismic survey data, including 3D seismic survey blocks. 3D seismic has been the bulk survey data type used for mapping the broad features of the emergent Mesolithic landscape in the SNS. 3D surveys are ideal for reconnaissance mapping because they are acquired over large areas but can still be manipulated visually to resolve sufficient detail at the current spatial scales of interest. Unfortunately, as figure 2 demonstrates, the distribution of these data is uneven and large areas remain without coverage. The large gap off the northeast coast of England is a prime example, and is in an area of great interest to prehistoric archaeologists.

The *DTI Guidelines for the Release of Proprietary Seismic Data UKCS 2004*, and the *Agreement between the International Association of Geophysical Contractors and the DTI for the release of speculative seismic data 2002*, govern the availability of survey data featured on the UK DEAL web GIS.

Petroleum industry well site surveys are an excellent source of spatially-focussed, high vertical resolution 2D seismic survey data. Unfortunately, these data are not 'tied' to the oil & gas licence block concerned so data owners are not required to retain them in perpetuity. Offshore operators and the DTI continue to debate whether digital site survey data should be submitted by law to the NHDA. Currently perhaps only a 1000 or so site survey reports have reached the NHDA voluntarily. These represent a fraction of all such offshore survey data acquired.

Governance and surveying within territorial waters

The Crown Estate (TCE) owns the seabed within the 12-mile territorial limit and is responsible for issuing leases and licenses for its commercial and infrastructural development. These include leases of easement for seabed cables and pipelines, licenses for the extraction of minerals excluding oil, gas and coal (principally marine aggregates) and leases and licenses for the construction of offshore wind farms. Under the terms of *The Marine Works (Environmental Impact Assessment) Regulations 2007* consultation document released by DEFRA in 2006, the regulator of development and disposal activities within territorial and offshore waters of England and Wales is the body responsible for licensing. These are the Secretary of State for projects within English waters, and the National Assembly for Wales within Welsh waters. The regulator determines the necessity of conducting an environmental impact assessment (EIA). The environmental and cultural heritage of the seabed within territorial waters is of concern to TCE. However, the ODPM awards licenses and acts as the environmental regulator under advice from conservation bodies such as English Heritage (EH).

Marine aggregates comprise up to a quarter of the total sand and gravel used in Britain (Bellamy, 1998). The marine aggregates industry generates almost half TCE's annual marine income and constitutes approximately a third of commercial activities in its marine portfolio (TCE, 2006). Marine aggregates producers generally target shallow glacial sand and gravel banks, usually within the 12-mile territorial limit. Wenban-Smith (2002) suggests it is vital to work with marine aggregates producers to

develop a system for identifying culturally significant deposits in order to carry out study prior to disturbance. In particular, he predicts the likelihood that thin, well-preserved sedimentary layers with high Mesolithic archaeological potential directly overly Marine Aggregates Deposits (MADs) within the English Channel and SNS.

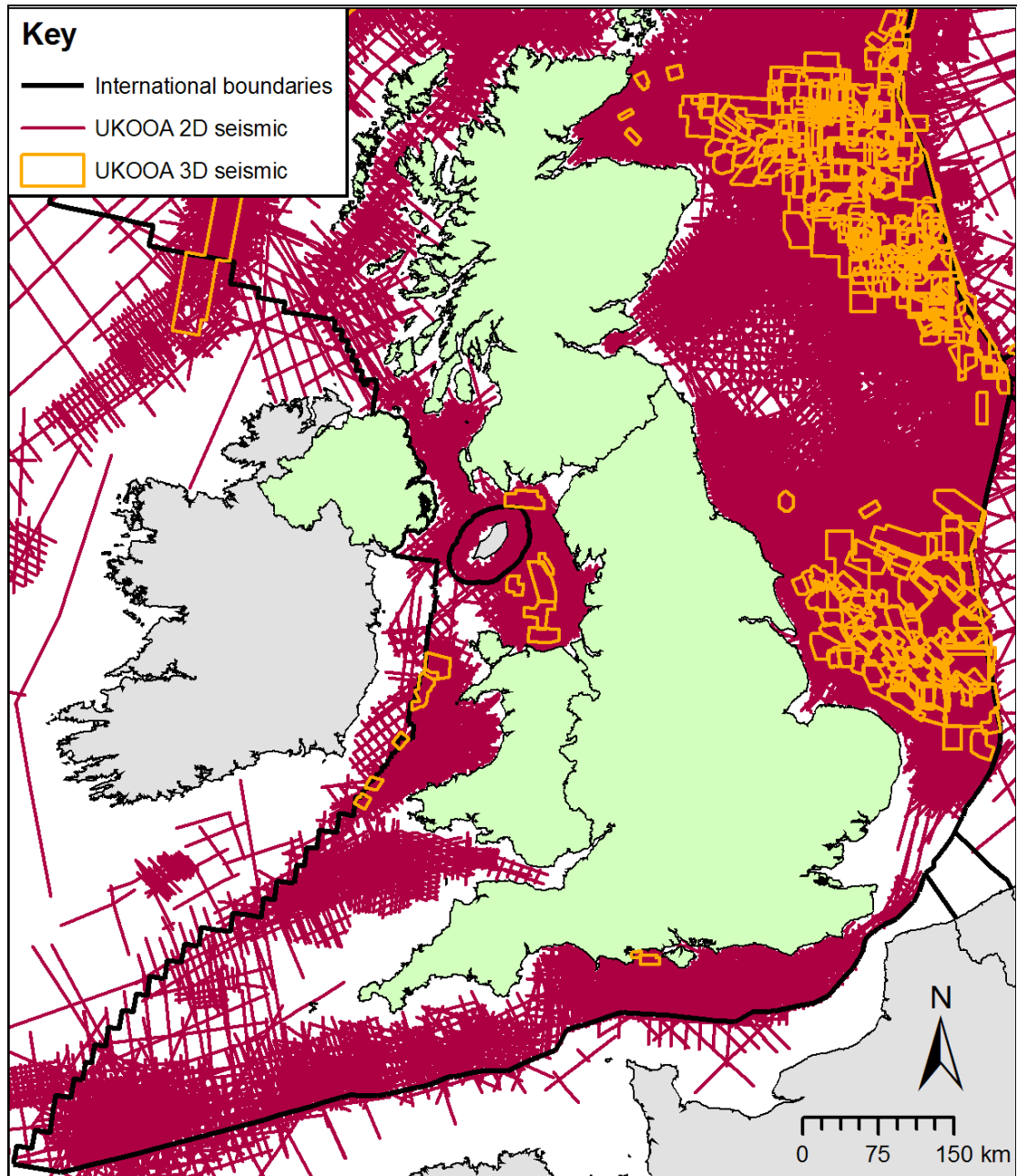


Figure 2: Distribution of 2D and 3D seismic surveys acquired by the UKOOA.

In order to gain a licence for aggregate extraction, marine aggregates producers must complete a two-stage application process to TCE and the ODPM. Consultation on a statutory framework is currently underway. At present, this involves resource assessment and an EIA that must address the potential impacts of removing seabed material on coastal erosion, fishing, archaeology and marine life. Both necessarily require geophysical surveying and direct sediment sampling.

Offshore wind farms currently generate almost 16% of the total electrical power generated by UK wind farms. Most offshore wind farms occur within the 12-mile nautical limit and therefore fall under the jurisdiction of TCE for appraisal and licensing. Licensing for wind farm development begins with a request from the DTI to TCE to announce a competitive tender process for new wind farm developments. After pre-qualification, developers must win statutory consents from two government departments, the Offshore Renewables Consents Unit (ORCU), and the Marine Consents Environment Unit (MCEU). This stage involves submission of an EIA that includes consideration for submerged archaeology. After securing these consents a lease or licence is granted by TCE.

Public metadata resources

There are a number of web-based GISes detailing available survey data across the UKCS. The MAGIC GIS (<http://www.magic.gov.uk>) brings together information on environmental schemes and designations from six UK government organisations: DEFRA; EH; NE; Environment Agency (EA); Forestry Commission (FC); Department for Communities and Local Government. The MAGIC GIS features a Coastal and Marine Resource Atlas theme that presents metadata from offshore regulatory bodies including the DTI and the BGS. These can be queried elsewhere on the project website.

The Mapping European Seabed Habitats (MESH – <http://www.searchmesh.net/default.aspx>) is an international marine habitat mapping programme involving a consortium of 12 partners across the UK, Ireland, the Netherlands, Belgium and France. The aim is to produce standardised seabed habitat maps for north-west Europe. The MESH website hosts a basic GIS. A much larger metadata archive of all forms of marine surveying within particular regional seas can be queried elsewhere on the website.

The British Oceanographic Data Centre (BODC) website (<http://www.bodc.ac.uk>) hosts the European Directory of Marine Environmental Datasets (EDMED). There is information available for bathymetric, seismic and sediment sampling (core, dredge, grab) surveys undertaken in UK offshore waters by a range of research and industry organisations. These fall under the “Geology – Geophysics – Sedimentation” theme. The BODC is part of the NERC MetaData Gateway, which also provides access to catalogues of data held by the other NERC data centres: British Atmospheric Data Centre (BADC); British Geological Survey (BGS); NERC Earth Observation Data Centre (NEODC); Antarctic Environmental Data Centre (AEDC); Environmental Information Centre (EIC). The NERC MetaData Gateway is in the process of being replaced by a service based on the NERC DataGrid, a web-based search facility that aims “*to make the connection between data held in managed archives and data held by individual research groups so that the same tools can compare and manipulate data from both sources*”.

The DTI runs a website dedicated to their regulation of the oil and gas industry, and offshore development in general (<http://www.og.dti.gov.uk>). Users can access a repository of existing development licences and all petroleum industry survey applications (PON14) and decisions since 2001 (*Conservation of Habitats Regulations 2001*). Spreadsheets of metadata associated with these applications

identify the applicant company, and the type, time and location of their proposed surveying.

SeaZone Solutions Limited provides a commercial source of marine environment and coastal zone metadata to the crown, the government, industry and academia. They sell a range of GIS data layers relating to near-coastal land, backshore, shoreline and near-shore environments.

Mesolithic artefacts recovered offshore constitute archaeological ‘ground truthing’ of our palaeolandscape models. There are two sources of such records. Historic Environment Records (HERs) are maintained by local authorities. The National Monuments Record (NMR) is maintained by EH. Only a few coastal HERs incorporate a marine section, however EH hope that all will feature a marine aspect eventually (Roberts and Trow, 2002). The marine HERs and NMR will form an essential tool in the management and protection of the marine archaeological resource (Robert and Trow, 2002). To this end, EH collaborated with ‘legitimate users of the sea’ to draft the *Protocol for reporting finds of archaeological interest* (2005). This protocol should ensure that the location of artefacts dredged or caught up in fishing nets is recorded as part of the cataloguing process.

Case study assessments of survey data

Three areas adjacent to the English coastline were chosen for a pilot study to assess useful survey data that have been acquired within them (Figure 3). These areas are geographically distinct and have offered a range of appeal to offshore developers. Two are adjacent to important coastal sites of Mesolithic archaeology, the other lies just beyond the fringe of the landscape already mapped.

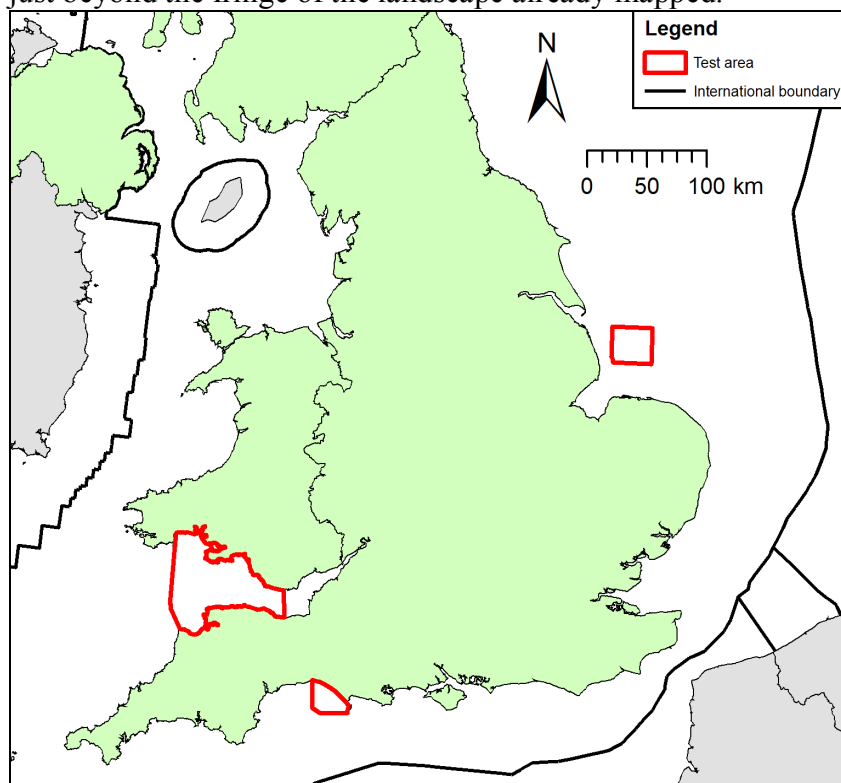


Figure 3: Three study areas around the English coast.

Area 1: the Bristol Channel

The Bristol Channel has the second largest tidal range in the world, 15m during spring tides. This drives a dynamic sediment transport system (Murray, 1987; Newell et al., 1998) capable of filling artificial scour holes within a few tides (Newell et al., 1998). Area 1 is traversed by a number of pipelines and international telecommunications cables that continue west to Europe and beyond the Western Approaches. These must be surveyed annually to assess their structural integrity. Area 1 also supports three licenses to dredge marine aggregates and a single wind farm licence. Figure 4 summarises these known threats to seabed archaeology.

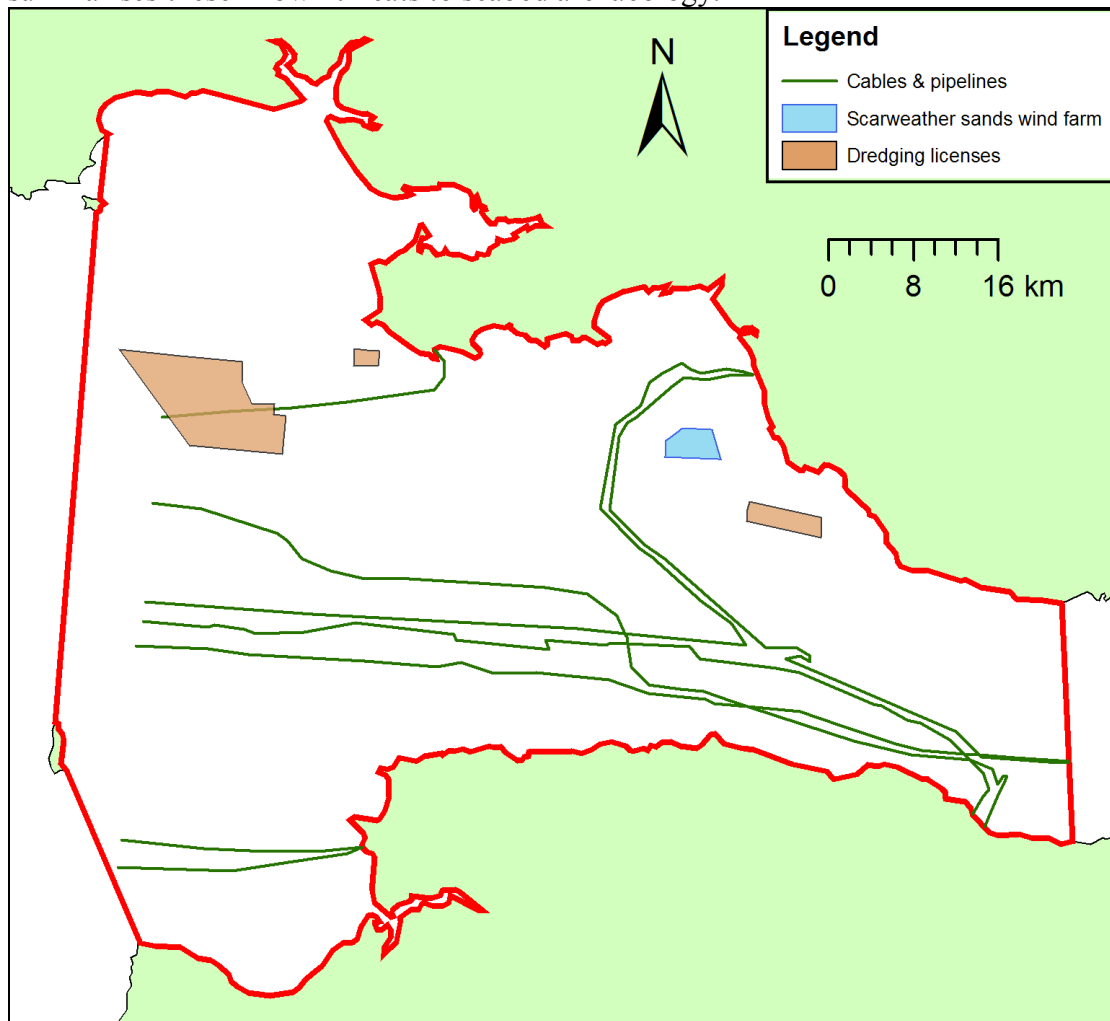


Figure 4: Industrial threats to unknown seabed archaeology within the Bristol Channel.

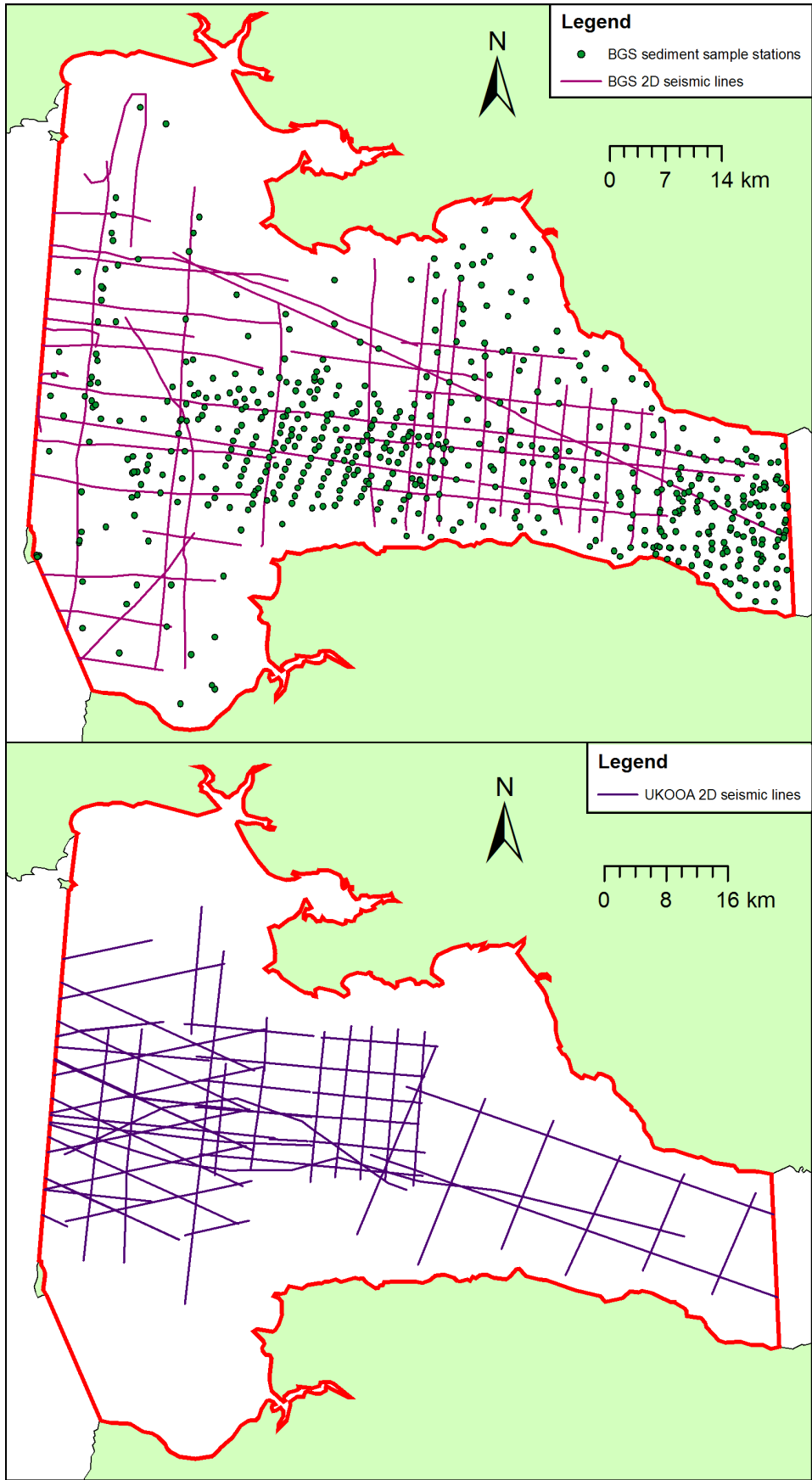


Figure 5: Distribution of BGS and UKOOA surveys within Area 1.

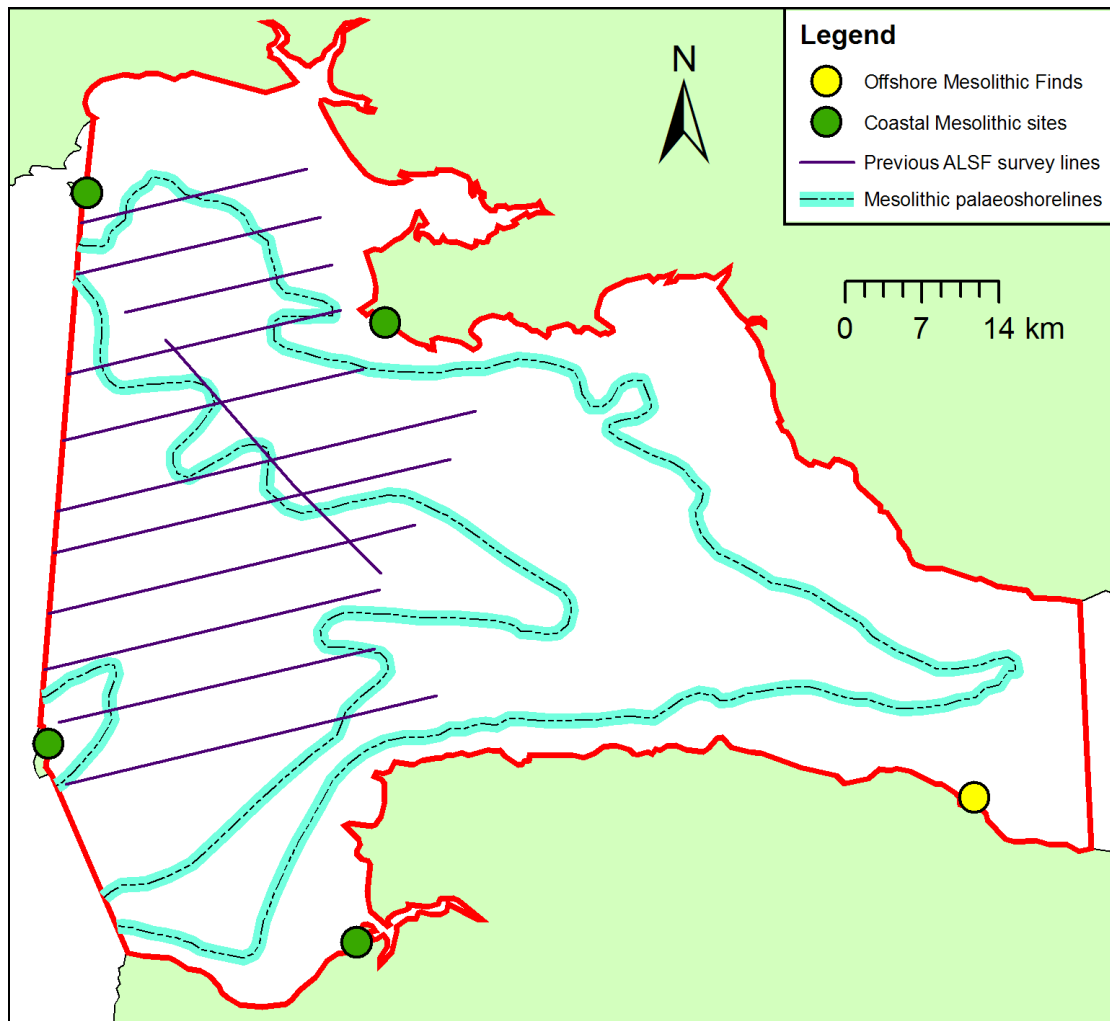


Figure 6: Previous ALSF survey conducted by the BGS within Area 1.

BGS survey here has been dominated by sediment sampling, though the channel is relatively well covered by 2D seismic profiles shot by both the BGS and the petroleum industry (Figure 5). BGS survey data is straightforward to obtain by purchase order at standard rates. Most of the petroleum industry 2D seismic survey data shown belong to BP Exploration. Petroleum companies are often amenable to cooperating with requests for data towards academic studies in the spirit of the *DTI Guidelines for the Release of Proprietary Seismic Data UKCS, 2004*. Individual data release agreements must be drafted, signed and countersigned by both parties. These data are relatively old (early 1970s to early 1980s) and so may be readily available in the absence of active exploration within the Bristol Channel.

The BGS has recently been involved in an Aggregates Levy Sustainability Fund (ALSF) project investigating seabed ecology in the Outer Bristol Channel. Part of the project involved the acquisition of 2D seismic sub-bottom profiles (Figure 6). It is thought that these profile data have not been interpreted in the context of seabed archaeology. They would provide an ideal dataset traversing prehistoric coastlines since the Late Palaeolithic (Figure 6; Bell, unpublished; Tetlow, 2005).

One of the marine aggregates licenses within Area 1 was awarded within the last 12 months. Recent survey data exists there but is still commercially sensitive. Older data exists for the other two licensed areas but is often still pertinent to applications

for licence extension. Access to these depends on the goodwill of the aggregates producers. In the case of the Nash Bank licence, this would involve the agreement of all three operators. The same is true of the environmental and engineering surveys undertaken prior to approval of the Scarweather Sands wind farm.

The University of Wales in Bangor (UWB) jointly owns a survey vessel capable of being used for 2D seismic surveying, sonar mapping and sediment sampling. They have been involved in surveying Carmarthen Bay in the North-western part of Area 1. They hold digital data for all surveys conducted since the mid to late nineties, though in the absence of a dedicated archivist they may not be able to respond to requests for data immediately.

The NMR of England contains a single record of Mesolithic artefacts having been recovered from within Area 1 (Figure 5). Dawkins and Winwood reported a number of Mesolithic blades and flakes, and Neolithic flints and scrapers, just offshore from Minehead on the Northwest Somerset coast in August 1869 (NMR Number SS 94 NE 11, Record 36754).

Area 2: Portland

Area 2 has not proven attractive to the petroleum or marine aggregates industries. In 2001 UNESCO inscribed the coastline alongside Area 2 as part of a World Heritage Site – the British Mesozoic Coast. Area 2 is only traversed by 2D geophysics survey lines acquired by the BGS and the petroleum industry. It also contains a few BGS shallow sediment core/borehole sample stations and a single exploratory well bore. Figure 7 summarises these survey data.

The petroleum industry 2D seismic survey data shot within Area 2 belongs to many different companies and was shot between the early 1970s and the early 1990s. Development did not follow though Maersk Oil North Sea UK Ltd sank well 97/12-1 in late 1995 following extensive surveying including side scan sonar, high resolution 2D sub-bottom seismic profiling, vibrocoreing, carried out by Kerr McGee Oil (UK).

Adjacent to Area 2 are three coastal sites where prehistoric peat and wildlife have been recorded. However, the English NMR and Dorset HER contain no record of Mesolithic finds recovered offshore.

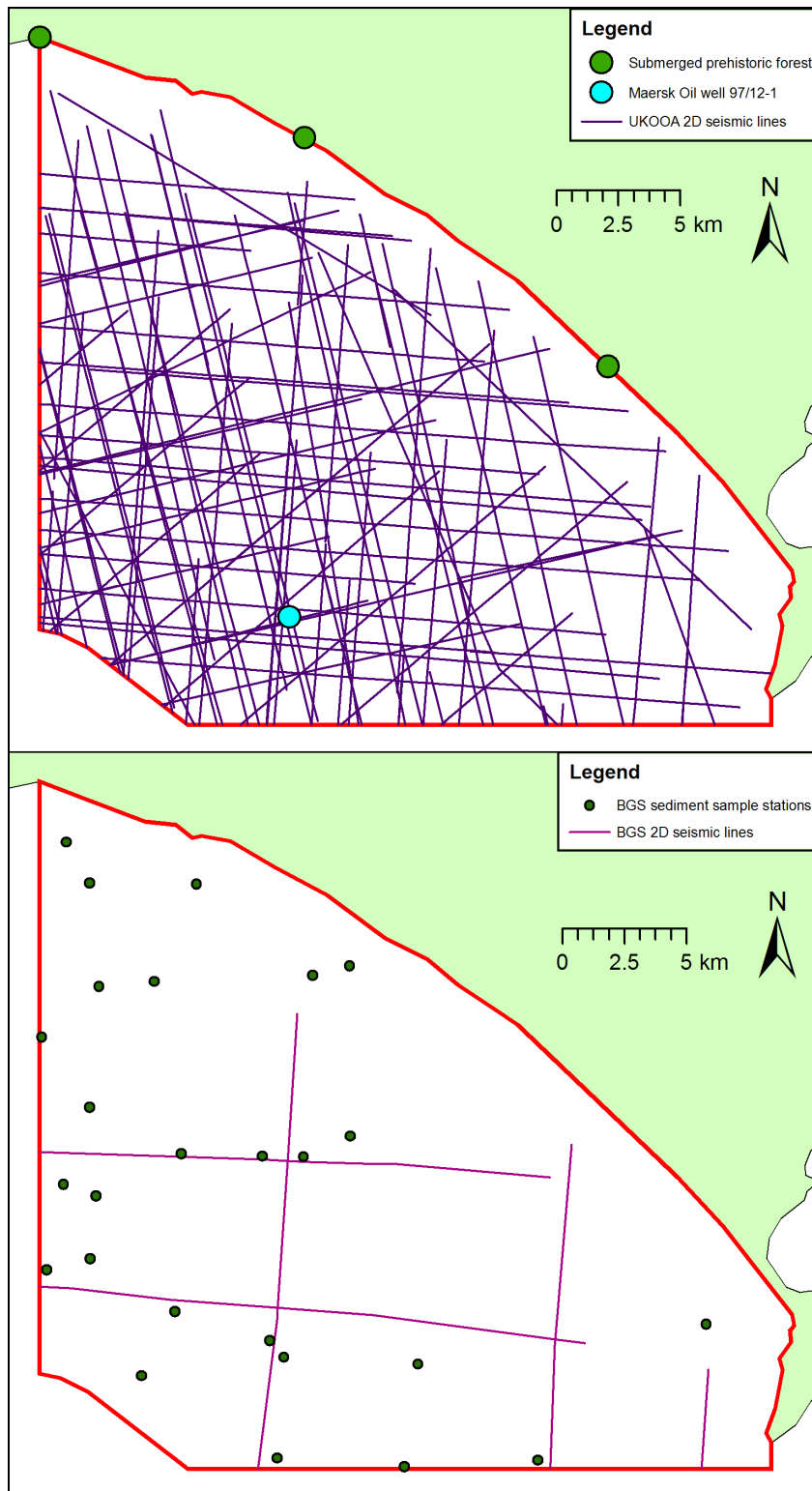


Figure 7: Distribution of UKOOA and BGS surveys within Area 2.

Area 3: The Spurn

Area 3 is situated between The Wash and the study area of the NSPP. It has been an important area for oil and gas exploration, fishing and shipping and is traversed by gas and chemical pipelines. More recently it has become a focal point for marine aggregates production and offshore wind farm development (Figure 8). Area 3 occupies part of the “White band” between the 3D seismic data and the shore

(Terrell et al., 2005). However, it has been intensively investigated by other forms of surveying, aimed at characterising the shallow seabed sediments.

Figure 9 shows the distribution of BGS and UKOOA survey data within Area 3. A quotation for a strategic selection of seismic lines and shallow sediment core records from the BGS was put together based on data availability. The BGS is able to supply these as a selection of scanned image files of scanned paper seismic lines and geological reports. One or two items of the original enquiry are unavailable. Geological and survey reports for the gas pipeline featured in Figure 8 were available from the owner.

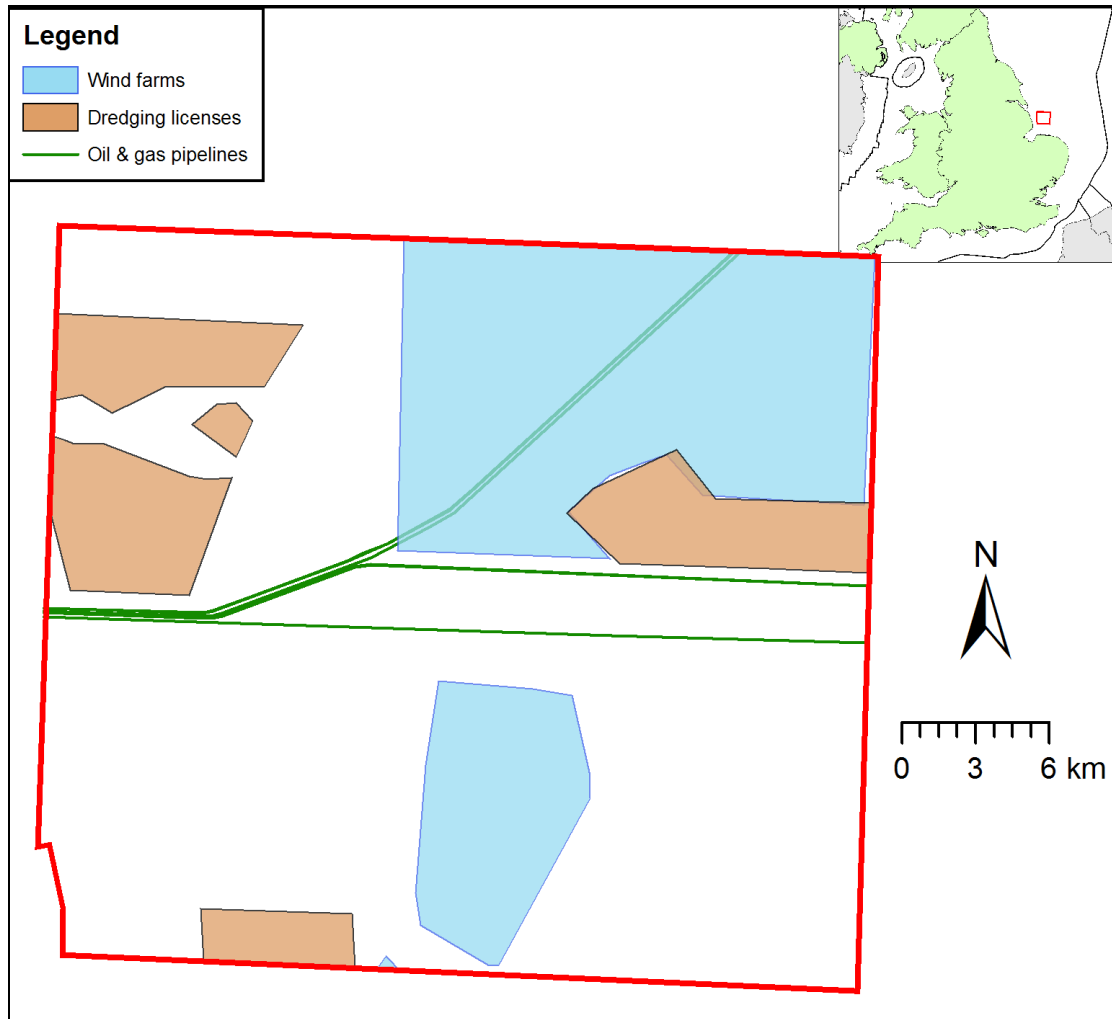


Figure 8: Industrial threats to unknown archaeology within Area 3.

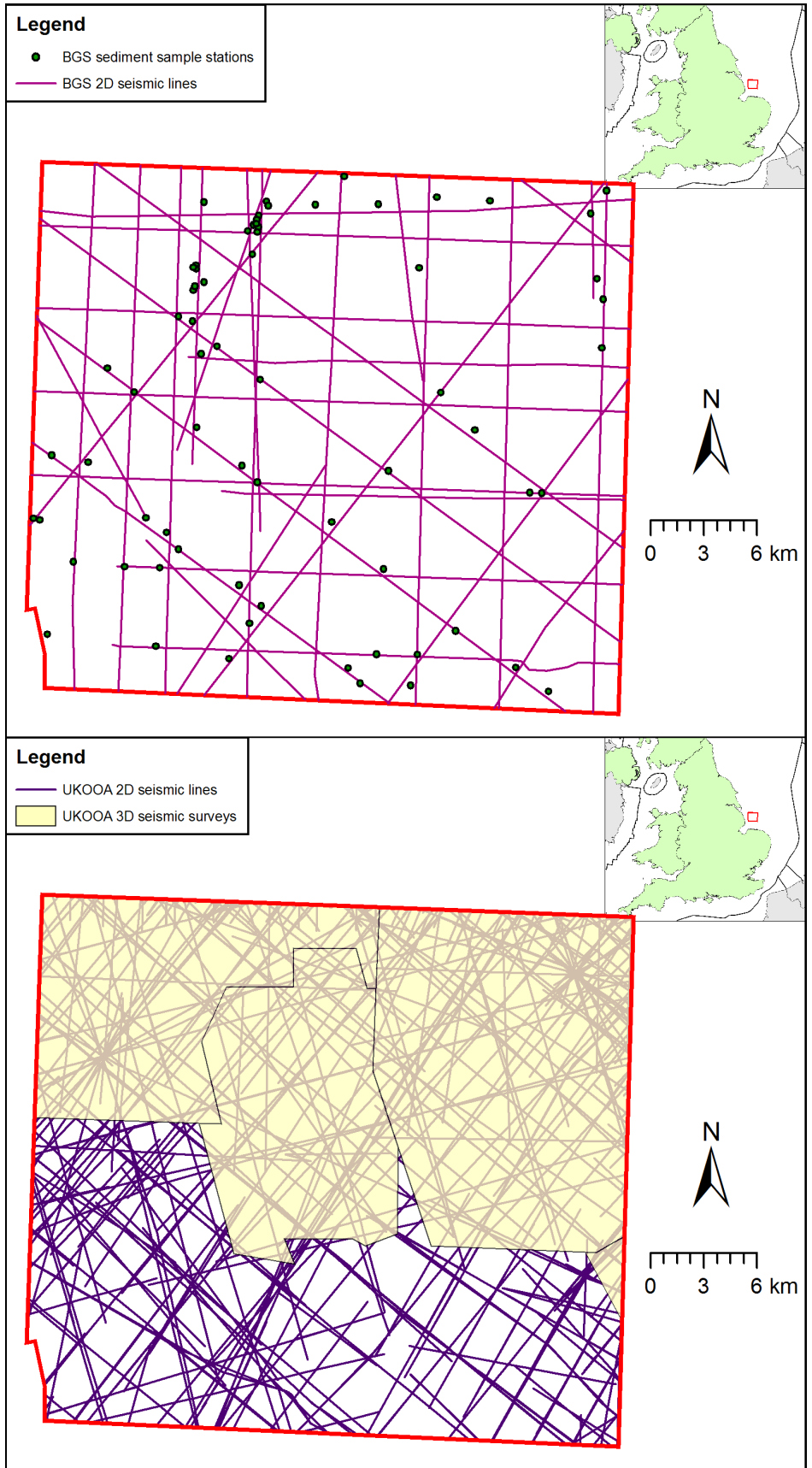


Figure 9: Distribution of BGS and UKOOA survey data within Area 3.

The petroleum industry 2D seismic surveys belong to many different companies. They were shot between the mid 1960s and the early 1990s. Continuing industrial regeneration of this area lends these data greater ongoing commercial value and they may be less easy to obtain.

Half of Area 3 has been covered by petroleum industry 3D seismic surveys (Figure 9). These are part of a group of four surveys fringing the PGS MegaSurvey and belong to WesternGeco. Three are 'unreleased speculative' survey data that would be expensive to obtain. The fourth is a 'released proprietary' survey originally owned by BP Exploration. This should be relatively straightforward to obtain for academic research.

Area 3 contains four zones licensed for shallow marine aggregates dredging, each licensed to a different marine aggregates producer. All underwent the same licence application process in spite of one zone, licence 440, lying beyond the 12-mile territorial limit. Technical environmental statements for these zones are not available in electronic form. Any data that have been retained are likely to be subject to the constraints of commercial sensitivity as they would prove useful in future licence renewal applications.

The Greater Wash area has become a major focus for the second generation of offshore wind farm projects. One of only two large super farms currently under consideration by the DTI and DEFRA, Triton Knoll, falls within Area 3. This and the other smaller project, Race Bank, are currently at a late stage of the DTI consents process. Survey data is likely to remain commercially sensitive until 2010.

A query of the NMR of England, the HERs of Lincolnshire and Norfolk, and the literature revealed there have not been any Mesolithic artefacts recovered and catalogued from within Area 2. However, a more regional view of these combined data suggests that the SNS is a relative hotbed for offshore finds by UK standards. Figure 10 demonstrates a general absence of finds within the region where there is a high concentration of petroleum industry infrastructure. This may be the result of exclusion zones around rigs and well heads having prohibited deep fishing and dredging, the activities often responsible for disrupting Mesolithic Archaeological Deposits (Wenban-Smith, 2002). MADs may have been preserved by the presence of this infrastructure. On the other hand, the importance of a unified database of finds is made apparent where the trajectory of the new Langeled gas pipeline from Norway is seen to pass right through a site where Moorlog – fossilised peat – was recovered (see Figure 10; Kooijmans, 1971).

Conclusions

The requirement for a greater understanding between offshore developers and marine conservationists is becoming more acute as the UK makes greater use of its marine resources in ever more diverse ways. Central to the effective management of the seabed is collaboration between developers and researchers that aims to mitigate our impact on the environment. The archaeological resource contained within the Holocene sediments of the seabed is poorly known. This is due to the practical limitations of carrying out archaeological investigations. However, the NSPP has revealed dramatic insights into the nature of the emergent prehistoric landscape

around our present-day coast. These insights were gained using existing exploration survey data.

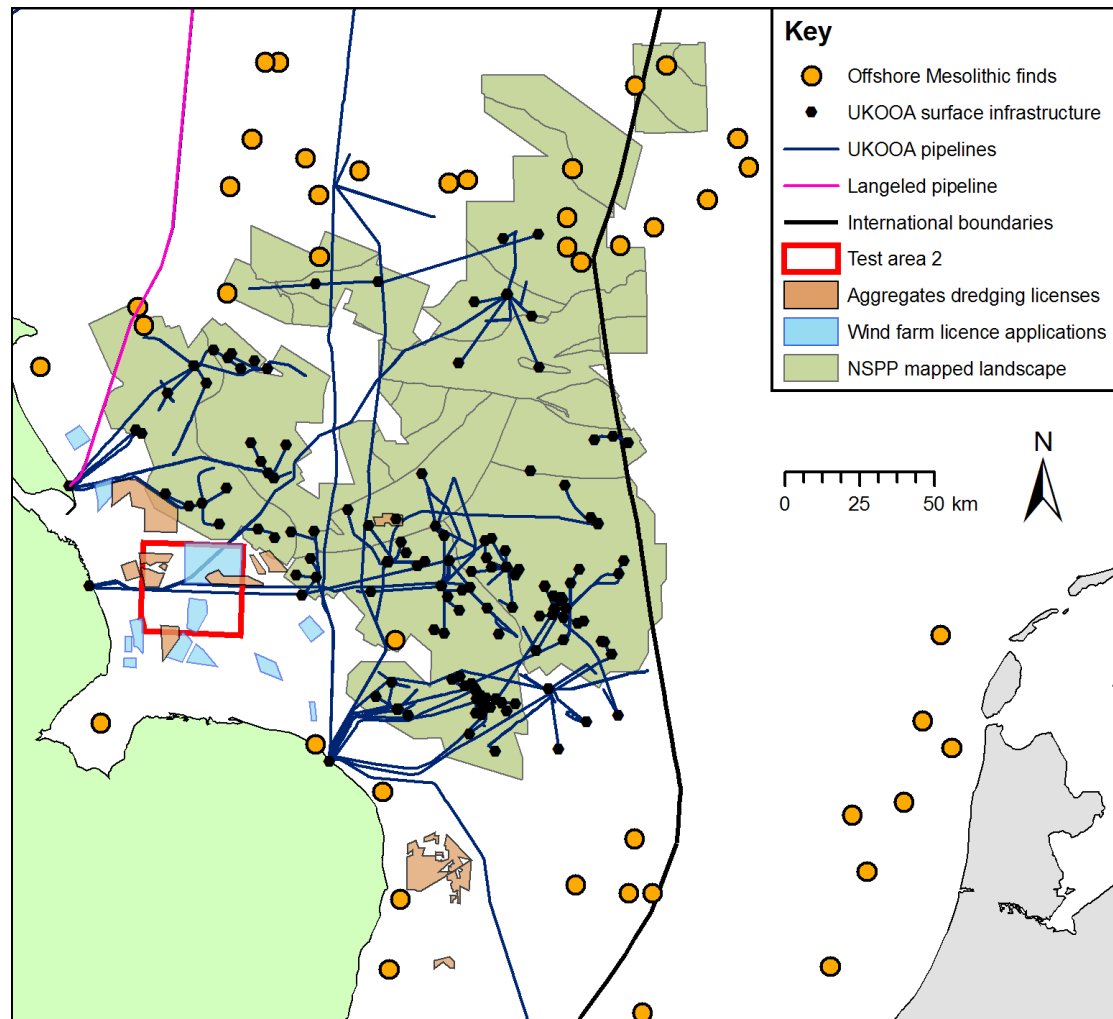


Figure 10: Intense use of space within the Southern North Sea.

The geographic distribution of acquired survey data with time has been led by the location of natural resources and location-specific legislation. Many survey datasets are distributed amongst the archives of the BGS and individual offshore operators. Some data are held within academia but these are often bound by the strictures of specific legal agreements drafted to govern a particular use. Recent government policy is opening up the flow of data between industry and the public. However, this is hindered by a lack of commercial protection. It is up to researchers to prove the usefulness of their work for and with, industry and regulators, in helping define the threat industrial activities pose to the marine environment. In so doing, researchers can help industry meet the demands of an increasingly rigorous regulatory framework.

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