

## In Sight of Doggerland: From speculative survey to landscape exploration

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### Summary



The North Sea has long been known by archaeologists as an area of Mesolithic occupation, and has even been argued as the heartland of the Mesolithic in North Western Europe. Yet this area remains effectively terra incognita to archaeologists, and the nature of its occupation, tantalisingly elusive. The submergence of this landscape has therefore effectively hindered archaeological research into this vitally important region. Yet this region contains one of the most detailed and comprehensive records of the Late Quaternary and Holocene, and its preserved sedimentary successions represent a mine of information that remains untapped by archaeologists. However the lack of direct data pertaining to this region results in all previous maps of the prehistoric landscape being at best hypothetical.

This paper will present results which illustrate that through the utilisation of spatially extensive oil industry data, the recovery information pertaining to the actual Mesolithic landscape of the North Sea is now possible. This information reveals the diversity of this landscape and shows that much greater consideration of submerged Mesolithic landscapes is now required of archaeologists. Whilst the study of such landscapes is in its infancy, the availability of such information offers the possibility of transforming how we interpret traditional terrestrial data and its relationship to the larger European Mesolithic.

### Features

- This article will appeal to: those interested in Doggerland, marine prehistoric archaeology, prehistoric coastlines and those who have an interest in Mesolithic landscape studies.
- Key Features:
- Keywords: Doggerland; Holocene; Palaeolandscape; Palaeogeography; Marine Archaeology; Submerged Prehistory;

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# 1. Introduction



Figure 1: Location of the >22,000km<sup>2</sup> of English [3D Seismic](#) Surveys within the Southern North Sea (data courtesy of <http://www.ukdeal.co.uk> and CDA Ltd.)

Archaeologists have long recognised the potential of the Southern North Sea as an area of Mesolithic occupation, and some have even considered the area as the heartland of Mesolithic North Western Europe (e.g. Clark [1936](#)). Despite this little archaeological prospection has been conducted within the area, and it remains effectively terra incognita to mainstream archaeology. The elusive nature of the landscape has permitted few substantive commentaries on the region (e.g. Jacobi [1976](#)), before Coles' ([1998](#)) formative paper on [Doggerland](#). Yet whilst this speculative survey served to rally interest in marine prehistory in reality it presented little new evidence with respect to the prehistoric landscape of the region. Consequently, published maps, which largely reflect a lack of physical survey, have served to reinforce an archaeological perspective that this region was irrelevant (Coles [1999](#): 51). Attempts to rectify this absence of information have mainly been through the utilisation of isostatic rebound models. Whilst they provide outline representations of the former landscape (e.g. Lambeck [1995](#), Shennan [2000](#)), the scales at which these coarse models operate make them unsuitable for the purposes of archaeological interpretation. Even when considering higher resolution local models, the utilised cell size (1.2km x 1.2km, Shennan [2002](#): 513) is still reasonably large for archaeological purposes. This factor combined with the lack of inclusion of important oceanographic and geological factors, such as burial and erosion, make these models still far from ideal (Bell et al [2006](#), Box 1, 14). Given the issues associated with [isostatic modelling](#) and its use in archaeology, other methods therefore need to be found if we are to survey the marine prehistory of this region adequately .

It is also true that marine prehistory often suffers from being "out of sight" and therefore the mind of terrestrial archaeologists in research terms. To a certain extent this situation reflects the prohibitive cost of performing survey within an offshore

marine environment in comparison to land based archaeology. The consequence of this lack of research is such that our understanding of the Mesolithic landscape constituting "Doggerland" has advanced little from studies of the 1930's (Coles [1998](#), 50). Despite having made these pessimistic observations it remains true that this region probably contains one of the most detailed and comprehensive records of the Late [Quaternary](#) and [Holocene](#) (Fitch et al. [2005](#), 187), and represents a mine of information for the Late Palaeolithic and Early Mesolithic studies as yet untapped by archaeologists. Consequently, if Mesolithic archaeology is to move into a position of understanding, the need for more detailed survey of this core area is pressing. Indeed Caroline Wickham-Jones ([2005](#), 33) recognised this situation when she suggested that "archaeologists of the Mesolithic should now investigate the potential of the under-sea world".

The academic imperative for further work in the North Sea is matched by considerable heritage concerns. Commercial development is occurring at an increasing pace in the region and there is a pressing need for archaeological information on a spatially extensive scale to aid both research and heritage management. However, whilst the commercial development of this region represents a risk to the archaeology it may also be perceived as an opportunity. The vast [3D Seismic](#) datasets acquired on the United Kingdom continental shelf for exploring deep geology, if utilised correctly, can be seen to represent an invaluable archaeo-geophysical data mine for the investigation of the Mesolithic landscape. These surveys cover more than >22,000km<sup>2</sup> in the Southern North sea alone ([Figure 1](#)) and although the potential of this data to inform submerged archaeological prospection has been observed this opportunity has never been realised (Kraft et. al. [1983](#)). Most archaeological work has been focused on specialist [3D Seismic](#) datasets utilising very high resolution systems (Bull et al [2005](#)), and on small sites (e.g. Mueller et al [2006](#)). Unfortunately the small areas involved and the high cost of deployment suggest that it is unviable to deploy these methods at a regional scale. The opposite is true for petroleum [3D Seismic](#) data. Although it is inappropriate for use for small scale or site survey, its extensive nature makes it ideal for landscape studies. With a spatial resolution of petroleum industry datasets approaching 12.5m, an opportunity exists to map the Mesolithic landscape at a regional scale with unprecedented detail. This paper presents some of the results from PhD. research undertaken by Simon Fitch at Birmingham University, and the larger North Sea Palaeolandscapes Project, which demonstrates that recovery of archaeological landscape information through extensive [3D Seismic](#) data is both possible and desirable. The information derived provides a unique opportunity to explore human activities within a spatially extensive prehistoric landscape and, more fundamentally, when considered within the framework of the larger Birmingham North Sea Palaeolandscape Project suggests that the landscape would have contained a significant Mesolithic population. An appreciation of the nature of Mesolithic occupation of this region will remove the constraints currently imposed by a limiting terrestrial perspective and allow Mesolithic archaeologists to ask fundamental and pertinent research questions about the region and its archaeology.

## 2. Background

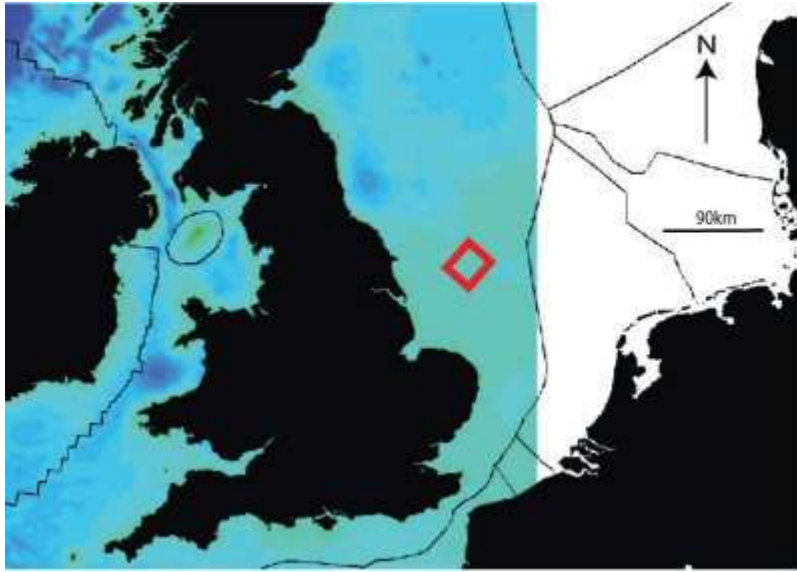


Figure 2: Image of the Bathymetry (topography) of the North Sea area. The 6250 km<sup>2</sup> covered in this paper is marked by the position of the red box. (ETOPO2 v.2 bathymetric dataset provided, courtesy of NOAA [National Geophysical Data Centre].)

In order to appreciate the scale and significance of research within the North Sea it is important to understand something about its geomorphology. The Southern North Sea is a marine basin that occupies a position between the European countries of Norway, Denmark, Germany, The Netherlands, Belgium, France and the United Kingdom, and is confined in latitude between 55 degrees north and 51 degrees north. The North Sea region covers some 574,980 sq km, although the results presented here relate to an area located in the Southern Sector covering 6250 km<sup>2</sup> or approximately 1% of the area ([Figure 2](#)). Water depths within the North Sea range from 15m at the Dogger Bank to 600m in the north. Within the area under discussion the water depths range from 20m in the northern part to 80m in the parts of the southern region.

This landscape of this region owes its appearance in part to Late Pleistocene glacial erosion and deposition. Considerable areas are underlain by a series of Late [Weichselian](#) formations that are broadly contemporaneous and reflect the different depositional environments experienced during that period of glaciation (Cameron et al. [1992](#)). Overlying these older deposits, the Botley Cut [Formation](#) is of Late [Weichselian](#) age to Earliest [Holocene](#) age ([Figure 3](#)). This deposit represents the infill of a series of subglacial valleys. The valleys incise [Weichselian](#) and older deposits and are filled by deposits from glaciolacustrine and glaciomarine environments.



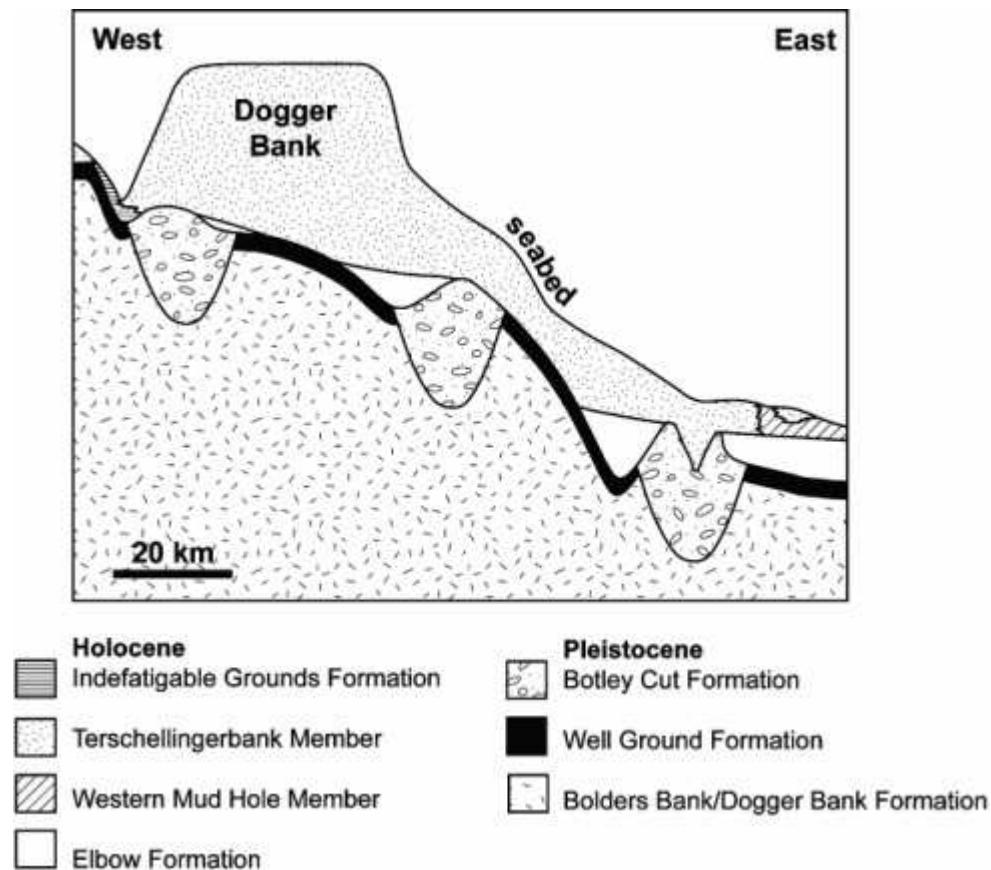


Figure 3: Simplified cross-section (not to scale) of the stratigraphy of the Pleistocene and Holocene of the Dogger Bank area. Adapted from Laraminie ([1989a](#), [1989b](#)).

Whilst the terminal glacial deposits form the backbone of the geology within this region, later [Holocene](#) erosion and deposition has been significant. [Holocene](#) sediments generally attaining a thickness of 1 to 5 m within this region, although locally significant deposits can reach thicknesses of up to 30m (Laraminie 1989). These [Holocene](#) deposits record the marine transgression of the emergent landscape of the Southern North Sea. A number of peat samples have been recovered from the North Sea (see Ward et al. 2006 for a review), most of which suggest that the Dogger Bank region was emergent at 9500BP (Behre and Menke [1979](#)), but was experiencing fully marine conditions by approximately 7500BP (Jelgersma [1979](#)). The early Holocene Elbow [Formation](#) ([Figure 3](#)) is of primary significance to archaeology and consists of a basal clay layer and locally a basal peat. Palynological dates from these deposits are in the range of 9,900BP to 9,000BP (Behre and Menke [1979](#)). These deposits therefore are of prime importance as they are likely to contain records of the human occupation within this region. The start of the marine transgression of the landscape is also recorded with the presence of brackish-marine and tidal flat deposits (Oele, 1969) which also offer the potential of recording the human utilisation of such environments. The overlying Terschellingerbank [member](#) and the Indefatigable Grounds [Formation](#) ([Figure 3](#)) represent the products of more recent marine processes and form a thin veneer over the area (Laraminie, [1989a](#)).

Whilst the Elbow [Formation](#) deposits offer the potential to contain sites of archaeological interest, we actually have little in situ archaeology from the area. Human artefacts and mammal remains have been dredged from the Dogger Bank and it is assumed that the finds have been retrieved from the seabed (Flemming, [2002](#), 33). However, as many of these stray finds lack both dates and provenance they add relatively little to our understanding of the Mesolithic beyond that of chance finds. Those that possess such information provide an invaluable landscape record demonstrating the presence of humans, wild boar and red deer from 9,870 +/-70 BP till at least 8350 +/- 50 BP (Glimmerveen et al. 2004). Flemming ([2002](#): 33) has suggested that suitable environments for the preservation of archaeological materials might include the Holocene fluvial valleys and vast lagoon which must have existed to the south of Dogger Bank at 8,000BP. This is supported by Kooijmans ([1971](#)) who observes the extensive peat deposits that occur at these locations. Further evidence of the importance of this area can be provided by finds of tree stumps near to a filled in river valley located to the east of Dogger Bank (Hansen [1981](#)).

The c. 2,300 Marine prehistoric sites located around Denmark (Fischer 2004, 25, Figure 3.3) also provide valuable evidence, although most of these sites are less than 5km from the shoreline and are a significant distance from the study area. As a consequence, whilst it can be demonstrated that areas containing palaeoenvironmental evidence do survive within the North Sea these, like so much of the marine environment, remain to be explored archaeologically. Many of these areas are however, associated with extensive commercial geophysical datasets which offer a valuable opportunity to explore the region and enhance our knowledge of the area and its archaeology. Indeed, the use of such data is the only viable option to provide data for archaeological research or environmental and heritage management at a regional scale (Flemming [2002](#), 43; 2006, 45).



### 3.. Methodology

In this paper, a focus area of 20 x 35 km has been chosen to illustrate the work currently being undertaken within this region. The study covers both flanks of the main depression within this region: the Outer Silver Pit, some 120 km from the nearest landmass. The main source of data for this paper is a 3D MegaSurvey seismic dataset which has been kindly provided for the purposes of this research by PGS UK Ltd. ([www.pgs.com](http://www.pgs.com)).

The initial visualisation of this data was achieved by time slicing a [3D Seismic](#) data cube at 4ms intervals from 60ms, the first seabed multiple image, through to 200ms where clearly resolvable glacial features appeared. Where the sea bed was poorly resolved multiples were used in the time slicing to gain a full understanding of the features at or near the seabed (see Fitch et al. [2005](#) for more detailed information on the seismic analysis).

In addition to time slicing the data archaeologically relevant horizons were identified within the data and these surfaces exported into a GIS to facilitate the building of a terrain model associated with the Mesolithic land surface. The integration of seismic data in the form of [GeoTIFF](#) slices into a GIS permitted further opportunities for analysis and interpretation of the data. In conjunction with the terrain model it becomes possible to accurately position landscape features within the GIS. Additional benefits include correlation with other non-seismic data sets (e.g. core location databases or geological mapping). Cross correlation with these supported the interpretation of otherwise problematic features. This analysis permitted a range of [Holocene](#) landscape features to be identified and a sample is shown in [Figure 4](#) where a time slice at 0.076s and its interpretation provides evidence for the contemporary coastline, estuaries and fluvial features including major river systems that were active during the Mesolithic period. The considerable detail provided by seismic studies is very significant and this provides the opportunity for detailed modelling of past communities and the potential to plan further fieldwork within the North Sea to support archaeological research and to aid management strategies for what must, at the very least, be one of the most extensive and best preserved prehistoric landscapes in Europe.

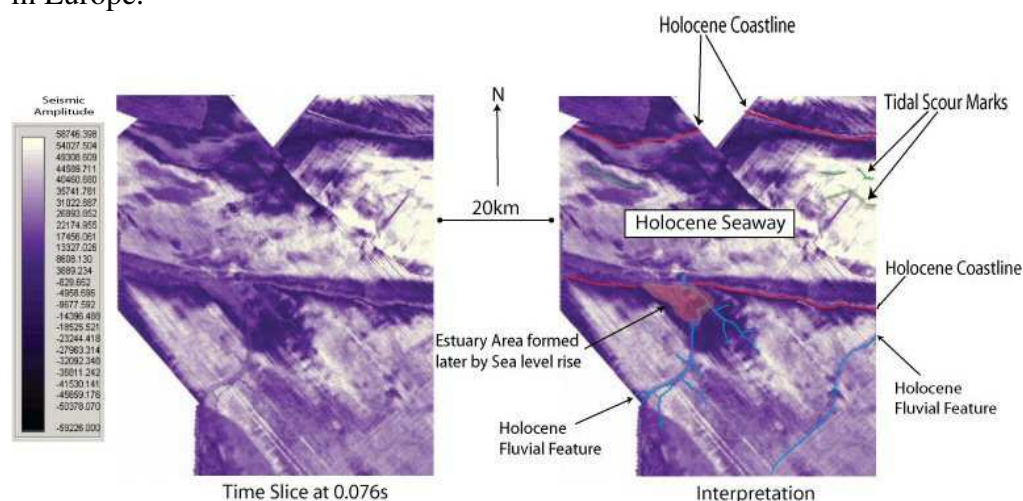


Figure 4: The structure of the Holocene landscape can clearly be seen in this Seismic timeslice taken at 0.076s. The quality of the seismic data allows the image to be interpreted in a manner similar to satellite imagery. Coastlines, Estuaries and large fluvial features in this image can all be seen to be integral parts of the Mesolithic landscape of this region.

## 4. Discussion

In considering the significance of the work currently being carried out at Birmingham it is worth emphasising the scale of land lost during the last 12,000 years (see [Figure 5](#)). At this level the data provided from the southern North Sea is not unique. The availability of industrial seismic data for research, however, provides a unique opportunity to gain an understanding of the prehistoric heritage of this area. Certainly, the sample interpretation provided above represents a very small area of the data either currently being interpreted by the team at Birmingham or potentially available for research. The benefits of such an approach should be obvious. The application of seismic data techniques permits us to explore the geomorphology and archaeology of the area from a substantive and practical base thus avoiding the necessity of speculative summaries required by earlier studies (e.g. Coles [1998](#)).

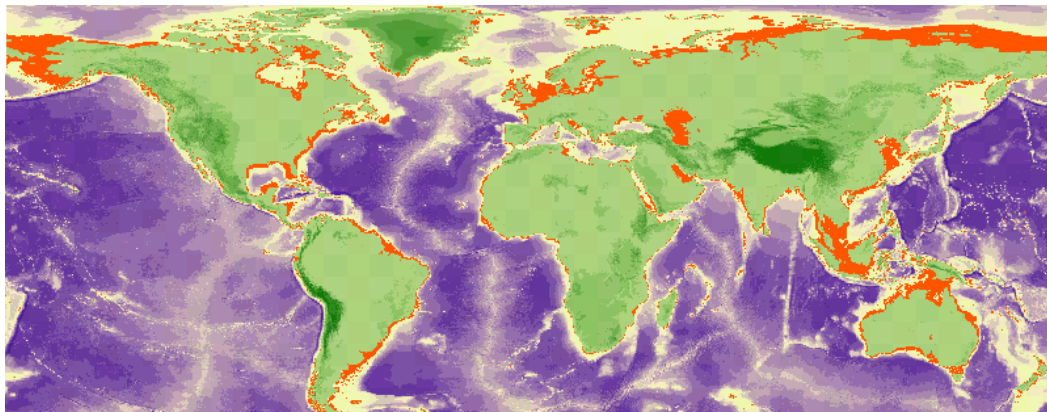


Figure 5: Map illustrating the emergent parts of the continental shelves worldwide during the last glacial maximum. The figure assumes a glacial eustatic lowstand of 120m below present sea level (Fairbanks, [1989](#)) and does not take into account glacially induced flexural uplift in high-latitude regions adjacent to large ice sheets or neotectonic (Holocene) uplift or subsidence. (ETOPO2 v.2 bathymetric dataset provided, courtesy of NOAA [National Geophysical Data Centre].)

An example of potential errors resulting from the lack of evidence for the North Sea is the frequency that the area has been referred to as a "landbridge" (Jacobi [1976](#), 73, Morrison [1980](#), 102) and the underlying assumption that the intervening area was unsuitable for habitation and even "very wet and marshy" (Wymer [1994](#): 13). Such a position is hardly tenable in the light of the seismic study which, in fact supports the earlier position of Coles ([1998](#), 75) who considered the area a diverse and interesting place to live in, providing a variety of valuable biological and mineral resources (Clarke [1978](#), 23).

This fundamental shift in viewpoint has important implications for the archaeology of the Early Mesolithic, especially as this area is so often absent from "terrestrial" interpretations (Bailey [2004](#), 5). Implications that may derive from this include a reconsideration of the significance of early Mesolithic coastlines (Mellars [1974](#), 80, Wickham-Jones [2005](#): 33). Those who have speculated on this subject have long regarded the coastline as a prime area for Mesolithic occupation (Morrison [1980](#), 118, Coles [1998](#), 74). It has been argued that these locales would have supported higher

population densities (Coles [1998](#), 74) but there are questions as to why we do not see more evidence for the utilisation of coastal resources within the early Mesolithic isotopic record (e.g. Barton and Roberts [2004](#), 353).

From the seismic evidence it is apparent that early Mesolithic coastlines, for England at least, would have been situated some distance from the majority of the present coastline (see [Figure 6](#)). This lack of evidence is not perhaps surprising given the extent that current conditions significantly reduce accessibility and material recovery. The isotopic evidence from a human cranium trawled from the North Hinder Bank has also prompted some dispute over the value of marine resources in the North Sea region (Barton and Roberts [2004](#), 348). However, given the date of the sample, 9,640 $\pm$ 400BP, it may be more significant to note that the find is as far from the original coast as Mesolithic sites situated on dry land today (UtC-10063; Erbrink and Tacoma [1997](#)). The terrestrial isotopic signature of this find is therefore not anomalous. In contrast, in those few areas where the early Mesolithic coastline is extant the utilisation of marine resources during this period is apparent (e.g. Nordqvist [1995](#)).



Figure 6: Schematic illustration of the main topographic features of the [Holocene](#) Landscape of the area. The area in this paper is contained within the red box. Other fluvial features (light blue) and intertidal currents (green) represent schematically preliminary results of the North Sea Palaeolandscapes Project. Discoveries made during the course of the thesis study are in dark blue. The approximate location of the coastlines observed within the seismic data are marked on in black lines. (ETOPO2 v.2 bathymetric dataset provided, courtesy of NOAA [National Geophysical Data Centre].)

It is possible to take this argument further. The evidence may be better interpreted to suggest that the marine potential of the coast encouraged hunter gathers to congregate along the coastline (Nordqvist [1995](#)), rather than to engage in seasonal movements inland (e.g. Rowley-Conwy [1987](#), 76). Information from the Scandinavian coastline suggests that resource utilisation within a maritime zone was favoured (Indrelid [1978](#),

169-70, Nygaard [1990](#), 232), and it is possible that the contemporary occupants of the "[Doggerland](#)" coastline followed a similar lifestyle. Indeed it is entirely possible that the occupants of the North Sea coastline perceived inland areas as marginal (Morrison [1980](#), 118) and that the potential of the interior for settlement was limited and intermittent. This mode of occupation might even have denied interior groups access to coastal resources: although the possibility of some form of trade seems likely. If correct, we should not expect significant evidence for utilisation of marine resources during the early Mesolithic in the present terrestrial record. Instead, we would have to look beyond the current shoreline and to the submerged coastal landscapes of the southern North Sea, to resolve such questions.

If this is the case, future research agendas must identify appropriate methodologies that allow us to integrate substantive data from those areas which have been inundated. This critical change will allow the development our understanding of the terrestrial archaeological record. Current methodologies for locating/predicting sites that may be investigated using existing technologies tend to be restricted in scope and without the potential for operating at the regional level (Fischer 1995). Only models based on remote sensing at various scales are likely to produce information that can be used across the whole of the region.

## 5. Conclusions

### 5.1 What has the study shown?

The North Sea contains an exceptionally well preserved landscape with considerable research potential. Whilst the impacts of mineral exploitation, infrastructural developments, fishing and, more recently, the construction of wind farms have been considerable, data presented here suggests a large part of the Southern North Sea contains an in-situ prehistoric landscape which never suffered the effects of later agricultural and anthropogenic practices. Given that such conditions could not occur within the terrestrial sphere, the potential of petroleum geophysics to inform our understanding of the submerged landscapes and to guide research at a regional scale is unique.

The potential of [3D Seismic](#) data to provide new data for this period is such that it will no longer be appropriate to regard the marine archaeology in this area as peripheral or "lacking" (Conneller & Warren [2006](#), 7). However, more important is the fact that the availability of such information will transform how we interpret traditional terrestrial data by studying how and to what extent these communities interacted. The study of marine prehistoric landscapes is still in its infancy but the data currently available is sufficient to demand that our interpretations of the early British Mesolithic must include and consider the archaeology of this region.

### 5.2 What next

Having demonstrated the significance of the submerged landscapes around the British Isles and the potential of [3D Seismic](#) for mapping the region, it should be clear that the next step is to enlarge the scale of research from the mere six thousand square kilometres of the study area discussed here. This has, in fact, already begun. The North Sea Palaeolandscapes Project, staffed in part by the authors and others<sup>1</sup>, is a large scale marine landscape project funded by the Aggregates Levy Sustainability Fund and managed by English Heritage. It is currently seeking to explore the Holocene landscape of the Southern North Sea through the utilisation of some c.23,000km<sup>2</sup> of [3D Seismic](#) data provided for research at Birmingham by PGS UK ([www.pgs.com](http://www.pgs.com)). This area approximates an area the size of Wales and represents the largest continuous geophysical survey ever utilised for archaeological purposes. Following 18 months work the first phase of the project is now drawing to a close and the results of mapping this large area will be published shortly as an atlas of the region. It is hoped that further funding will be found to extend this work into other areas.

Another logical step is the utilisation of the extensive landscape information to facilitate archaeological predictive modelling. Given the expense of working in the marine environment almost all site scale work must be targeted. Whilst models, including the "Danish Fishing Model", do exist for prospection and are reported to be very successful; (Fischer 1995, 375), these have used localised bathymetry as a topographic proxy. This inevitably has led to them performing less successfully in



waters deeper than 10m or in areas where burial of the landscape has occurred (Fisher 1995, 377). The utilisation of information from seismic data should help improve such modelling strategies by providing data which is not affected by these limitations.

The areas of coastline observed within the seismic data so far suggest that on landscape requirements alone the area may be amenable to the utilisation of this model. Further, the presence of large rivers that directly connect to a marine coastline fit admirably to the landscape characteristics required by the model (Fischer 1995, 374, fig 5.). However, caution must be considered with the utilisation of this model, especially in the North Sea, since the area represents a slightly earlier archaeological period and a slightly different marine environment. It is therefore possible that the settlement patterns in the North Sea may have been different to that predicted by this model, posing a potential risk. However this must be tempered by the fact that we have no knowledge of the utilisation of coastal resources from this area during the early Mesolithic due to sea level rise (Coles 1998, 74). Any attempt to test this model in a different area will not only provide valuable information about the validity and cross transference of this model in other environments, which is sorely required, but also provide new information upon the Mesolithic in this area which can be utilised to produce new more refined models (Kamermans & Wansleben 1999). The generation of further predictive models using the North Sea seismic data for this area has formed a part of the postgraduate research to be carried out at Birmingham and now is beginning to generate interesting results (see [Figure 7](#)).

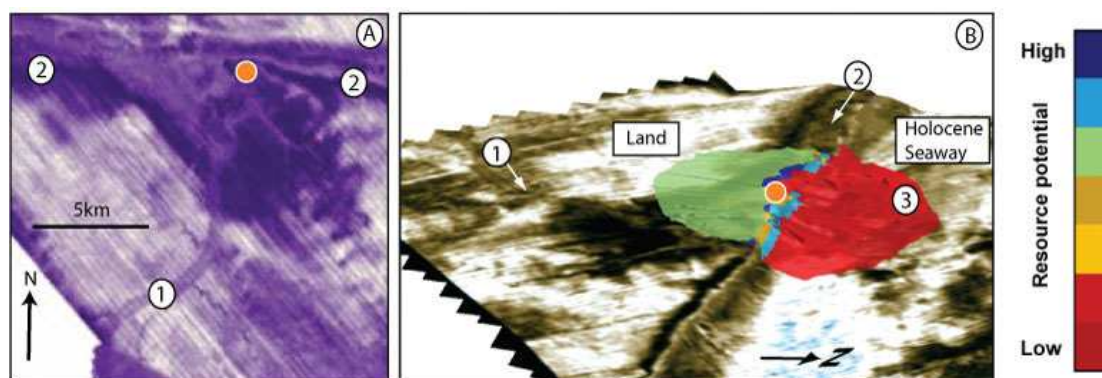


Figure 7: An illustration of some of the early results of site prediction. Figure 7 (A) shows a predicted site (orange dot) in relation to the seismic data within the study area. It can be observed to fall close to the shoreline and both the estuarine and fluvial environments. In 3D View of Figure 7 (B) the predicted resource distribution for this site is shown (scale bar is relative), which suggests that resource utilisation of the coastline may have been favoured by the inhabitants of the region.

The final area of research involves the development of novel technologies to examine and represent the challenging data from the North Sea (Fitch et al. 2005, Cameron et al. 1992). Given the inaccessibility of the region few archaeologist and fewer members of the public will ever be able to experience the actual marine environment or, given the scale of the data, even the results of analysis. It seems likely that the only way we will be able to perceive or, perhaps, "visit" this landscape will be through Virtual Reality technologies. ([Figure 8 - Movie](#)) These will be vital not only to inform our academic studies, they will also provide the wider public with a sense of ownership of what must be one of the most alien of our cultural heritages. This level



of public accessibility will be vital given the emerging threats to what is probably Europe's best preserved in-situ prehistoric landscape.

Looking beyond that there are many marine areas with comparable histories and which have also been subject to mineral exploration. These could also benefit from similar research programmes and it is the desire of the authors to expand our interests into some of these other areas. In doing so we would hope to develop the methodologies presented here but also to encourage other archaeologists to consider the significance of submerged prehistoric landscapes to wider interpretative schemes.

<sup>1</sup> Individuals involved in the projects aside from the authors are Kate Briggs, Simon Holford, Mark Bunch, Andy Howard, David Smith, Ben Gearey, Eugene Ch'ng, Bob Stone.

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## Glossary of Terms

**3D Seismic** - This term is given to a geophysical seismic survey that comprises of a suite of numerous closely-spaced seismic lines that provide a highly sampled measure of subsurface reflectivity, and which after processing results in a cube of geophysical data. (Schlumberger, 2007)

**Doggerland** - The term given by B.J Coles (1998) to the former Late Palaeolithic/Mesolithic landscape of the North Sea in recognition of C. Reid's (1913) appreciation of this landscape . It derives its name from a prominent topographic high in the region, the Doggerbank.

**Formation** - A geologic unit - A Formation is the primary unit of lithostratigraphy, and is delineated at the scale of geologic mapping

**GeoTIFF** - A version of the digital Tagged image format which contains geospatial information pertaining to the location of the image.

**GIS** - Geographical Information System.

**Holocene** - A geologic time division, running from ~10,000BP to present

**Isostatic Modelling** - The use of topographic (or Bathymetric) data, commonly from satellite sources, in conjunction with information on ice sheet coverage, land rebound and sea level rise information to produce a palaeogeographic reconstruction

**Member** - A geologic unit - This is the next rank below formation, and commonly is represented as having distinctive lithological properties that distinguish it from other parts of the formation.

**Quaternary** - A subdivision of geologic time, that covers roughly the last two million years.

**Weichselian** - A period of geologic time covering used in both European and the North Sea that is broadly equivalent to the British Devensian period. This covers the time from ~70,000 to 10,000BP

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