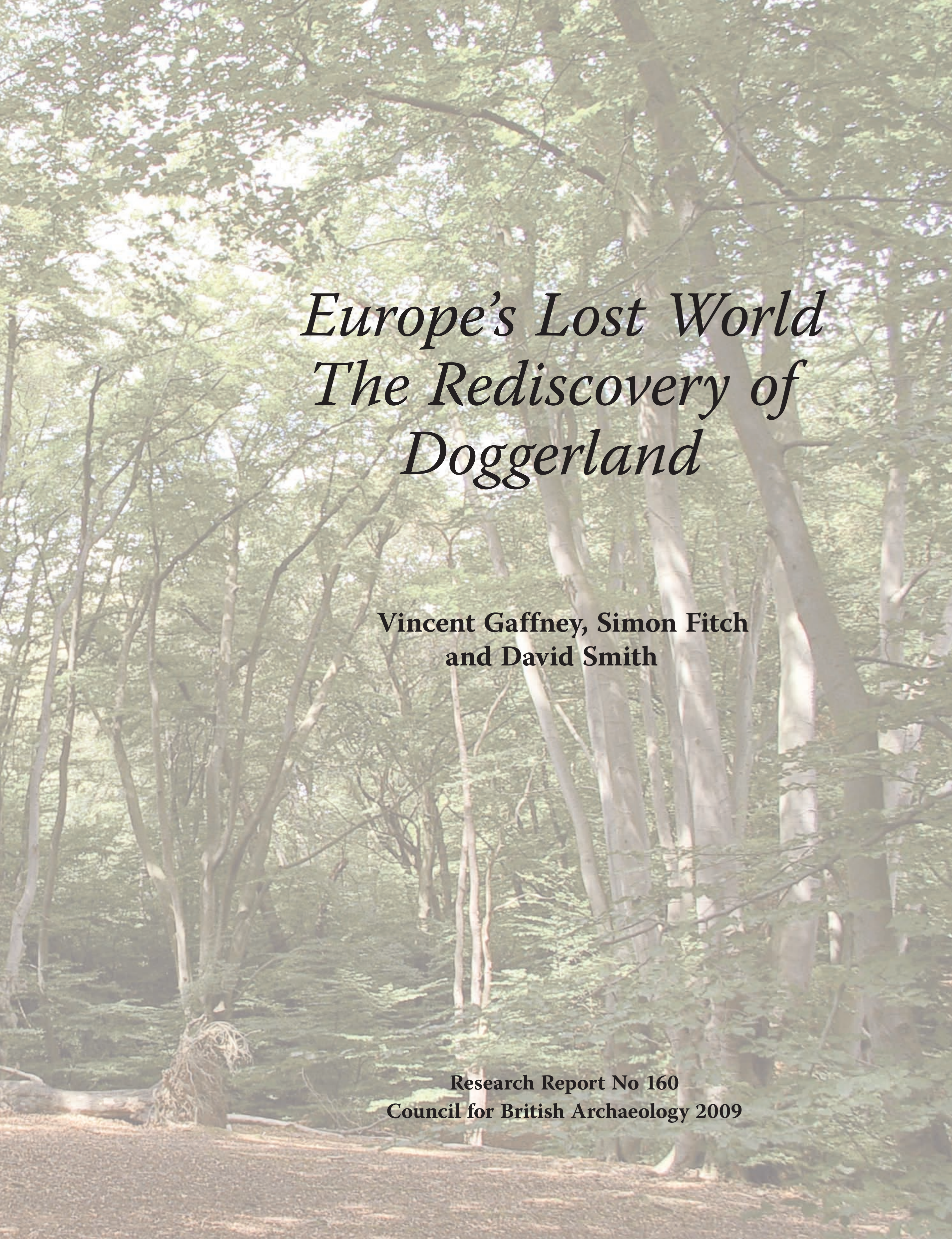
EUROPE'S LOST WORLD
THE REDISCOVERY OF DOGGERLAND



Europe's Lost World The Rediscovery of Doggerland

Vincent Gaffney, Simon Fitch and David Smith

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Dr Kenneth Thomson
(1966–2007)
Explorer of the North Sea

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Front:
Back:

Contents

List of figures

List of tables

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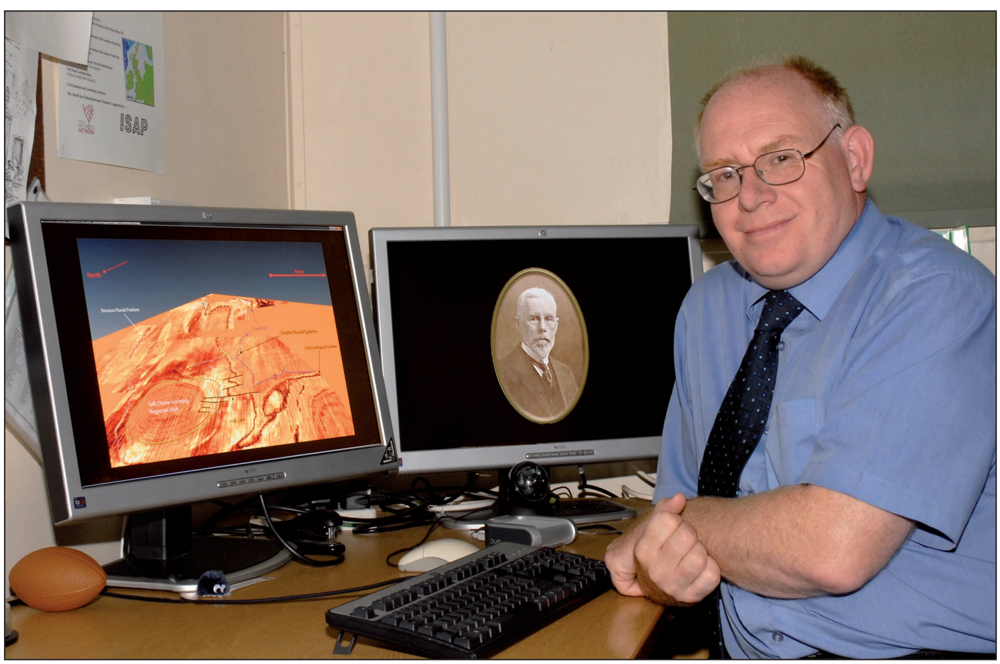

Simon Fitch took his undergraduate degree in Geology at Durham and his postgraduate degree in Landscape Archaeology at Birmingham. He now works for VISTA, the Visual and Spatial Technology centre (www.vista.bham.ac.uk) at the University of Birmingham. Simon maintains an active interest in the use of visual and immersive technologies in the investigation of marine geophysical data, and has been an external advisor to geophysical software companies. During his archaeological career he has worked on projects from as far as Oman in the Middle East to Fort Hood (Texas) where he worked as an Intern for the United States Military Archaeology Service. His current research interests are now focused upon marine prehistory across the globe, and this has seen a continuation of research into his favourite area of prehistory, Mesolithic Europe.

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1 http://www.hp.com/

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July 2008
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Institute for Archaeology and Antiquity (www.iaa.bham.ac.uk)

Introduction

> *Eventually, all things merge into one, and a river runs through it. The river was cut by the world's great flood and runs over rocks from the basement of time. On some of the rocks are timeless raindrops. Under the rocks are the words, and some of the words are theirs. I am haunted by waters.*
>
> Norman Maclean (1902–90), *A River Runs Through It*

As we proceed through the 21st century very few people will ever again have the opportunity, or good fortune, to be explorers in a truly foreign land. This book, however, sprang from an archaeological project that allowed its participants to do just that: to explore a lost world, to see valleys and hills that had been hidden from human society for millennia and even to name the rivers that ran through those lands. However, this lost territory, known as Doggerland, was a country that none of the explorers could ever actually visit. Doggerland, a vast plain that originally stretched across much of the area that now forms the North Sea, disappeared after the end of the last Ice Age when temperatures increased, the great ice sheets melted and sea levels began to rise. Over time it was buried deep in marine sediments and covered by tens of metres of murky grey water. What is most important, however, is that this was not an uninhabited plain; it was a traditional heartland for generations of European hunter-gatherers. The ancestors of the people of Doggerland had lived there for thousands of years yet by *c* 6000 BC the entire country had been lost to European history.

Eight thousand years after these dramatic events a team of geologists, archaeologists and palaeoenvironmentalists was assembled at the University of Birmingham, in Britain, to see if they could map this lost land using seismic reflection data collected by the oil and gas industry. Perhaps to their own surprise they found they could and, over a period of only eighteen months, the team mapped nearly 23,000km^2 of the lost European country of Doggerland and opened a new frontier for archaeological exploration that will eventually include the lost lands of Beringia, between Alaska and Siberia, and the immense inundated area of south-east Asia known as Sundaland. The exploration of these countries may well take decades and that will only be the beginning. The next challenge will be to use this information to seek out the archaeological and palaeoenvironmental evidence that remains hidden within the valleys, rivers, fens and lakes of these lost countries, to learn more about the shadowy peoples that lived on the plains, to rediscover their lives, traditions and heritage. All of this is in the future; the goal of this book is more modest. It seeks to tell how

Doggerland was lost to Europe and then rediscovered. This is a tale that spans a century and includes the work of famous archaeologists and scientists as well as researchers whose books are rarely read today but who deserve to be better known. There may be lessons to be learnt from the fate of Doggerland. This was, after all, the last period during which mankind experienced climate and landscape change on such a massive scale. However, some caution is required. The allure of lost worlds and the myths and media hype that surround them may confuse any message. Moreover, unlike Atlantis or Tír na nóg, Doggerland was a real country and its loss a truly tragic story. We have a duty to the people who lived on the north European plain to tell their tale in an appropriate manner and to ensure that any conclusions drawn are substantive and relevant.

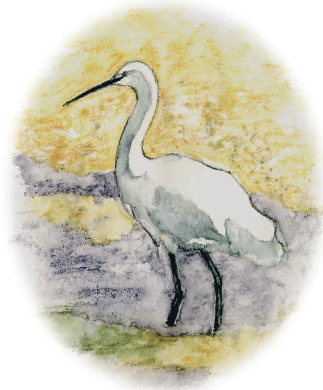
Having made this point, there is little doubt that the North Sea project will change how we view the histories of continental shelves and that the results represent a major achievement for all who worked on it. The project directors, Professor Vince Gaffney and Dr Kenneth Thomson, and the senior researcher, Simon Fitch, worked alongside Kate Briggs, Dr Mark Bunch and Dr Simon Holford as the team assiduously mapped the landscape. A palaeoenvironmental group comprising Dr David Smith, Dr Andy Howard, Dr Ben Gearey, Dr Tom Hill and Christina Jolliffe worked on the core data to support the mapping programme. This book represents their endeavours as well as those of the authors. All the team, however, would like to record their debt to Dr Kenneth Thomson. Ken was the lecturer in Basin Dynamics at Birmingham and an acknowledged expert on the interpretation and visualisation of seismic data. Tragically, he died on 18 April 2007, just as the project concluded. To the project staff Ken was a pioneer and an inspiration. To those who knew him beyond the project he remains, in our memories, a great friend and irreplaceable colleague. This book is humbly dedicated to his memory.

Preface

KNOWLEDGE cannot be divided into compartments, each given a definite name and allotted to a different student. There are, and always must be, branches of knowledge in which several sciences meet or have an interest, and these are somewhat liable to be neglected. If the following pages arouse an interest in one of the by-ways of science their purpose has been fulfilled.

Clement Reid, preface to *Submerged Forests*, 17 February 1913

CHAPTER ONE



Noah's Woods and island Britain

The grasp of the sea

Like ashes the low cliffs crumble,
The banks drop down into dust,
The heights of the hills are made humble
As a reed's is the strength of their trust;
As a city's that armies environ,
The strength of their stay is of sand:
But the grasp of the sea is as iron,
Laid hard on the land.

By the North Sea, Algernon C Swinburne

For most people in Europe the North Sea is a stretch of water crossed, perhaps, when going on holiday or as part of a business trip. Few travellers are aware, however, that these grey waters cover a prehistoric landscape that once stretched without break from England to the Danish coast. Yet, between 18,000 and 5500 BC, global warming raised sea levels to the extent that water engulfed a plain larger than the United Kingdom, and lands that had been home to mankind for millennia gradually sank. Essentially, an entire European country disappeared beneath the North Sea, its physical remains preserved forever but gradually being lost to memory. Presented in such a manner, the loss of this country may appear little more than a historic curiosity or a scientific novelty. Yet a real human tragedy lies behind the disappearance of this immense landscape. The coastlines, rivers, fens and hills of this lost country were for thousands of years a familiar landscape to the peoples of Europe. Rivers would have been named and estuaries and hills linked with ancestral memories that were precious to these peoples. Their loss may have been insidious and slow overall but terrifyingly fast at times, and whole territories may well have disappeared within the memory of generations. This must have been devastating for those communities that lived on the North Sea Plain and the distress caused by the loss of lands that supported families and tribes is now almost impossible for us to appreciate. However, as sea levels rose and the land retreated the memory of these events disappeared along with the landscape itself. Long forgotten, the loss of this land is beginning to gain a contemporary relevance. Although it is more than 6000 years since climate change transformed the shape of Europe in such a dramatic manner, global warming and sea-level rise are again emerging as amongst the greatest threats to our lifestyles. The fate of the lands and peoples of the North Sea may yet be interpreted not as an academic curiosity but a serious warning for our future. Yet, if lessons are to be learnt from these events, how can we proceed? The past is sometimes said to be a foreign country separated from us by time. However, the landscapes of the North Sea are not parts of a country that anyone can visit. Whilst preserved by the sea, the murky waters and overlying marine sediments have largely placed this country far beyond the reach of modern prospection or exploration. Consequently, our knowledge of the dramatic changes to the map of Europe is recent and still relatively vague. Despite this, archaeologists are beginning to explore the lands that Europe lost, and forgot, and the story of their rediscovery begins with a small book by a retired Victorian geologist and a mysterious object caught, by chance, in the nets of a fishing boat nearly 80 years ago.

A 'delightful little book' – Clement Reid and the submerged forests

There are many odd sights around the coast of Britain but none, perhaps, stranger than those remnants of trees preserved as stumps below sea level, and which can be traced to the line of the lowest spring tide and even beyond (see Figure 1.1). Set within a black peat soil the curious can find hazel, alder, and even the remains of mighty oaks standing individually or sometimes so dense that they form small forests. The remains of extinct animals such as bears, wolves and beavers can be found within these mysterious woods. They testify not only to the past presence of these animals in Britain but also to the antiquity of the trees and the sticky black earth that surrounds them. Previously, locals were sensitive to the peculiarity of these finds and, at the turn of the century, some people knew these as 'Noah's Woods'. Their inexplicable position, apparently rooted in soil beneath the marine sand, admitted no explanation other than that the rooted trees were clear evidence for the biblical deluge that had swept the world clean at the time of Noah.[1] There were, of course, more prosaic suggestions for their origin that were mooted at the time. Landslips and compression of the local sediments were

Figure 1.1 Buried forest in Cheshire illustrated in Clement Reid's book *Submerged Forests*

also suggested as explanations for these enigmatic landscapes. However, as the woods had always escaped serious study no one could be sure.

Many people had recorded the existence of these woods over the years. Samuel Pepys had observed and noted the presence of ancient hazel preserved in the mud when visiting the Thames dockyards. However, the woods were hardly the most welcoming of subjects for study. Always wet and regularly submerged, researchers faced the prospect of wallowing in filth, the inclemency of the British weather and the danger of the incoming tide, with an uncertain return in terms of knowledge. Unloved, no one took responsibility for 'Noah's Woods' and, as one man noted, 'the archaeologist is inclined to say that they belong to the province of geology, and the geologist remarks that they are too modern to be worth his attention; and both pass on'.[2] That man was Clement Reid, a geologist who, when nearing retirement, began a study of these unloved landscapes and in 1913 published a small book on the subject entitled *Submerged Forests*. Today this book is rarely read or consulted but this is where the rediscovery of Europe's lost lands can be said to begin.

Clement Reid (see Figure 1.2) was one of those great Victorians: self-made men who rose from the ranks to the tops of their professions.[3] Reid was born in 1853, the son of a goldsmith and a great-nephew of the famous scientist, Michael Faraday (1791–1867). He had clearly been an inquisitive child and he attended public lectures at the Royal Institution of Great Britain where Faraday was Fullerian Professor of Chemistry. From a large family, Reid had to find work when he was older but he was clearly not inclined towards business. After a short time working for a publisher, Reid threw himself into study in order to achieve a post at Her Majesty's Geological Survey. This was rewarded in 1874 when he joined the survey, eventually staying for nearly 40 years until his retirement in 1913. Reid was not necessarily an easy man to get to know. He was tenacious in his work and vociferous in his views. However, he was also a diligent fieldworker and his deep knowledge of both geology and biology lent itself to an expertise in Pliocene and Pleistocene plants and a degree of eminence within his chosen profession. He served on the councils of the Linnean and Geology Societies and also received the Murchison Fund and Bigsby medal for his work, which culminated in his publication in 1899 of a paper on *The Origin of British Flora*. The years spent studying and quantifying fossil plant remains, along with associated geological strata, gave Reid a real interest in chronological and climatic change. He appreciated that you could use fossil remains to trace past change according to the variation in plant types. Moreover, where similar plants existed, the evidence could also be used to infer comparable climates or even to suggest that different strata could be of the same age on the basis of the plant record.

Reid's work hardly appears dramatic today but we tend to forget that our knowledge of the antiquity of the world is really quite recent. Fifty years before Reid was born the primary sources for understanding the history of the world in Europe were the writings of Greek and Roman historians and, for earlier periods, the Bible. In 1650 the Archbishop of Armagh, James Ussher, famously calculated the antiquity of the world on the basis of biblical genealogies. This suggested that the world was created in 4004 BC. This apparent fact was printed in the margins of the authorised version of the Bible and, for many, was indisputable. Contentious now, most of these historical sources were, of course, always largely irrelevant for Britain and north-western Europe. These areas were rarely mentioned in early historic texts or, in the case of the Bible, were completely ignored. The consequences of Europe's reliance upon the Bible for an absolute chronology were intellectually profound. Mankind's entire history was required to fit into a mere 6000 years. Having filled most of this short span with the history of Egypt and the peoples of the Bible, there was little room for more remote periods of human history. Moreover, the certainty that God had created the world in its present form also denied the possibility of substantial change to its inhabitants including man. To a large extent, the world was seen as immutable. In what became known as the 'Mosaic Theory' mankind was believed to have been created perfectly by God and, although falling from grace, fitted inexorably into a single and unchangeable world order alongside the plant and animal kingdom as perceived by modern man.

The Victorians, of course, were not insensitive to some degree of coastal change at least. The history of the lost town of Dunwich is probably familiar to generations of British schoolchildren forced to study British political history. This medieval town in Suffolk had been one of the largest ports in eastern England, but it became a victim of coastal erosion from the 13th century when successive dramatic storms swept houses away. Finally, the majority of the medieval settlement eroded into the sea and Dunwich ceased to exist, except as a small village on the new coastline. Despite this, the electorate of the town, a grand total of 32 people during the early 19th century, enjoyed full municipal rights and even returned two Members of Parliament. The absurdity of a town lost to the sea retaining political representation remained a scandal until the Great Reform Act of 1832 when this and other 'rotten boroughs' were removed from the rolls. However, the cadence of the loss of the town was such that it is still said that on foggy days you can hear the bells of the lost town's churches chime through the North Sea frets!

Knowing that the coast could change on a small scale did not, however, prepare the Victorian mind for the implications of a history extending for millions of years and landscape change on a potentially continental scale. The occasional discoveries of hominid fossils together with extinct animals, many of which could never have existed in Britain's current climate, were therefore problematic. These could, on occasion, be treated as historical curiosities. In 1715 the remains of an 'elephant' were found in association with a hand-axe in London. The bones, presumably part of a mammoth, were immediately associated with the elephants brought by the Roman Emperor Claudius to subdue the ancient Britons in AD 43 and the axe identified as a crude weapon used by the barbaric natives. However, other examples of stone tools found with extinct animals included the hand-axes from Hoxne in Suffolk. These were found some 3.6m (12ft) below ground level and clearly required specific explanation. John Frere's perceptive comment on the Hoxne discoveries in 1797 was that 'the situation in which these weapons were found may tempt us to refer them to a very remote period indeed, even beyond that of the present world'.[4] However, whilst perceptive, the contemporary interpretative context was still able to place such material within a biblical chronology. It was well known that God had destroyed the world at least once. This was recorded in the Bible as the Great Flood – Noah's Flood – and Archbishop Ussher dated this event to 2348 BC. It was therefore possible that these finds could be explained as evidence for a strange and unfamiliar antediluvian world destroyed by the wrath of the Lord. This was a convenient and, for many, an entirely satisfactory explanation. Today the Hoxne deposits are more credibly dated to about 400,000 years ago.[5]

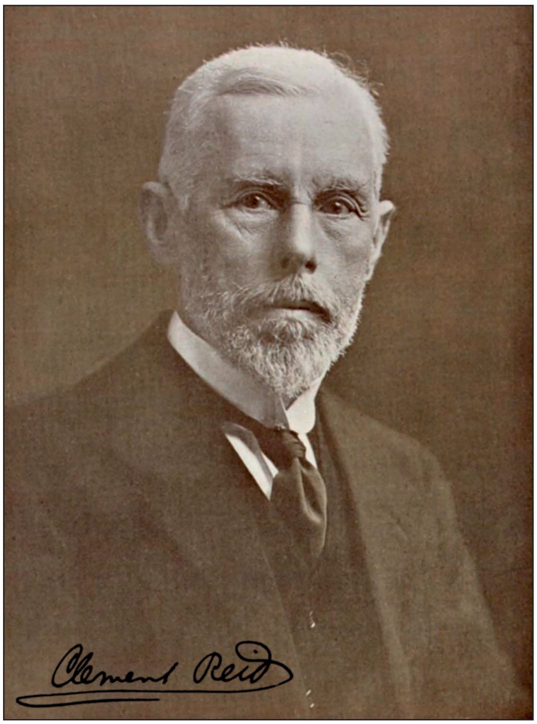


Figure 1.2 Clement Reid (1853–1916)

We should be cautious about being too flippant about those 19th-century academics and antiquaries who professed a literal interpretation of the Bible as the basis for geological and historical knowledge. Those who accepted the testament of Genesis, a group eventually dubbed the 'Catastrophists', were not necessarily uncritical. Some did seek primary evidence to support their interpretation of the evidence. The most famous of the Catastrophists, the first Professor of Geology at Cambridge, the Reverend William Buckland, brought a notable degree of rigour to the young discipline. He even purchased a live hyena, named Billy, to help in his comparative studies of evidence for scavenging in the fossil bone record.[6] Despite this, the weight of evidence against a biblical explanation for major geological and anthropological change increased during the early 19th century. Numerous and rigorous observations encouraged an appreciation of the significance of fossil remains as independent criteria for classification and comparative analysis within and between geological deposits. In Britain a milestone was reached when Charles Lyell, a student of Buckland, published the *Principles of Geology* in 1830. Lyell espoused the principles of 'uniformitarianism', asserting that geological strata could be interpreted if it was assumed that the processes that governed their formation were constant. Superimposition of modern deposits, that is the order in which sediments were observed to have been laid down, therefore gave a clue to when and how past deposits were created. Put simply this meant that fossil bones and artefacts recovered from deep deposits, as at Hoxne, should be interpreted as being of a very great age and not restricted to the short chronology suggested by biblical tradition.

These principles were, in outline, relatively straightforward and elegant but once established they represented an important step forward. With the gradual acceptance of Lyell's work there was a rapid movement towards a more sophisticated geological chronology incorporating landscape and climatic change. For instance, acceptance of the evidence for the repeated incursions of ice across temperate zones and its role in creating landscapes began to emerge during the mid-19th century. However, the identification of four phases of glaciations, termed Würm, Riss, Mindel and Gunz, did not actually occur until 1909 and the sequence has been refined and expanded significantly since then.[7] Acceptance of the implications of Lyell's work was therefore gradual and, it should be stated, did not actually end the debate. Not only was chronology still a contentious issue when Reid was born in 1853, the dispute still continues in a recognisable form through the arguments of contemporary Creationists.

Having made this point, the depth of historic time made available to mankind by the existence of a relative chronology, based on stratigraphy, was also profound in cultural terms. In particular, an extended chronology provided an invaluable opportunity to explore the development of fossil man. In 1859, the increasingly clear association of early hominids and extinct and exotic animals (including elephants, rhinoceroses and hippopotamuses) from deposits in the Somme and Hoxne encouraged John Evans to state that 'this much appears to be established beyond reasonable doubt, that in a period of antiquity remote beyond any of which we have hitherto found traces, this portion of the globe was peopled by man'.[8] Later that year Charles Darwin published *On the Origin of Species* which, despite his public reticence on its published implications, fundamentally asserted that all species were linked by common descent. Refinement and emphasis followed, notably in Lyell's 1864 publication *The Geological Evidence of the Antiquity of Man* and Huxley's *Man's Place in Nature* published in 1863.[9] By this time any consensus regarding the immutable nature of creation had foundered.

The dramatic events surrounding the debate on the antiquity and ascent of man make it easy to miss equally important and, in some senses, comparative developments in broader historical and cultural chronologies. Christian Thomsen and J J A Worsaae, working in the National Museum in Copenhagen, established a primary relative chronology for later prehistory during the early 19th century.[10] The reorganisation of the collections, and the publication of the catalogue in 1836, reflected a basic chronological interpretation of the primary technologies available to man and progressed from the use of stone, to bronze and ultimately to iron. The scheme became known as the 'Three-Age system'. This was a revolutionary step towards understanding cultural evolutionary development. Although the scheme represented little more than a relative ordering of the available data, the underlying premise remains a fundamental concept for archaeologists and historians today. This is demonstrated through the persistent use of the terms Stone Age, Bronze Age and Iron Age. In 1865, Sir John Lubbock published *Prehistoric Times*, expanding Thomsen's scheme by dividing the Stone Age into the Old Stone Age, or Palaeolithic, and the New Stone Age, or Neolithic.

Unfortunately, without access to more sophisticated dating techniques, the refinement of archaeological chronologies was only likely to proceed through detailed study of the typologies of excavated artefacts and the meticulous cross-referencing of this data to identify chronological trends from region to region. In the absence of historic texts, archaeologists sought to date pre- and proto-historic societies in Europe through their occasional association with dateable finds from the great historic societies in Egypt and the Near East. Where this was not possible, archaeologists simply assumed that innovation flowed from these advanced societies and a complex mesh of presumed stylistic links and technological borrowings emerged linking Europe and the East. This was a dubious and frequently misleading exercise and a consequence of shackling the prehistory of Europe to known histories of the Near East was not so dissimilar to the earlier practice of using biblical chronologies. With no real appreciation of the full antiquity of their own data, northern archaeologists were unwittingly forced to compress their chronologies alongside those of the historic south. Consequently, a 'short' chronology emerged for northern archaeology and an intellectual crisis was inevitable. This, however, would not be realised until after the 'radiocarbon revolution' of the late 1960s.[11] At that point, new dating technologies would sweep away these artificial links, extend the timescale of European prehistory dramatically, and in the process begin to write an independent history of Europe.

All of this, however, was far in the future. Clement Reid was born into exciting intellectual times and, given his youthful interest in the public lectures at the Royal Institute, he may well have been aware of the debate regarding evolution and geology from an early age. What must be certain is that his natural interest in geology and plant classification qualified him to make a genuine contribution to the refinement of chronologies as well as to the debate regarding climatic change. Unsurprisingly, and although archaeology was not Reid's prime concern, he did publish papers on Palaeolithic material and his obituary notice emphasised the importance of his work on the Hoxne deposits, Palaeolithic man, and 'the

Great Ice Age'. What is more surprising, in the light of recent research, is the relatively condescending manner in which Reid's work on submerged forests was treated by his peers. This is glossed over in his obituary by a short paragraph noting that Reid 'paid little attention to the popularisation of his subject, though eminently capable of the work, as witnessed by his delightful little book on "Submerged Forests" written for the Cambridge Series of Manuals of Literature and Science.'[12]

For our purposes, Reid's work is of great significance. His 'delightful little book' provides the first survey of these forests in a wider archaeological context.[13] Initially, Reid rapidly discounted a number of competing explanations for the existence of these woods. Neither catastrophic landslips, compression of soft deposits nor breaches of protecting dunes seemed reasonable to account for the evidence. Instead Reid asserted that 'the submerged forest that we have already examined stretched far below the level of mean tide. In fact we followed it down to the level of the lowest spring tides. Nothing but a change of sea level will account for its present position.'[14]

Reid was fully conscious that the primary problems associated with the forests were their date and their extent. As he reviewed the evidence he recognised that there was not a single horizon to which these forests or comparable organic peat deposits might be assigned, but Reid recognised this as an advantage. 'Anyone who has collected antiquities on fields knows what a curious jumble of Palaeolithic, Neolithic, bronze age, Roman, mediaeval and recent things may be found mixed in these few inches of soil … The great advantage of studying the deeply submerged forests is that in them the successive stages are separated and isolated instead of being mingled in such a confused fashion.'[15] Whilst acknowledging the existence of relatively older, and deeper, deposits, Reid realised that these earlier woods were only infrequently available for study in comparison with more accessible later layers. As a consequence he determined that it was the later forests that would command his attention. Having made the decision, Reid also became aware that the processes that led to the burial of the ancient forests were not consistent everywhere. In Scotland, for instance, the period appeared to be represented by raised beaches rather than submerged deposits. There was clearly a significant change in geological process as one journeyed north. He determined that this occurred round Flamborough Head in Yorkshire: at this point depression gave way to elevation in geological terms. On that basis Reid restricted his research to England and Wales south of this position.

Where well-preserved soils could be identified, and differentiated from earlier deposits, Reid soon began to recognise a pattern to the occurrences of these later woods. He noted, in the case of the Humber and Thames valleys, that the postglacial phases of these rivers appeared to be cut to a depth of approximately 18m (60ft) below the present ground level and that this organic horizon was a recurrent feature across much of England and Wales. In the east coast of England this suggested that the rivers must have been flanked by a plain lying some 12–18m (40–60ft) below the current land surface. Identifying the extent of this associated plain was clearly of the utmost importance to him and, in contemplating the coastline and seascapes west of the Humber, Reid noted 'a most surprising piece of evidence, which adds enormously to the importance of this plain.'[16]

The Dogger Bank

Throughout much of the 19th century, oyster dredgers working the shallow coastal waters off the east coast of England recorded frequent finds of bones of extinct animals caught up in their nets. These singular discoveries became a regular occurrence as fishing technology improved and trawlers began to scour the deeper waters of the North Sea. Although the location of such finds was only rarely recorded with accuracy, this material appeared to come from a number of areas within the North Sea. One in particular caught Reid's attention – the Dogger Bank.

The shoal known as the Dogger Bank lies 90–110km (60–70 miles) from the nearest point on the British coast. The bank rises about 45m (150ft) above the seabed, except in the north where it plunges into deeper water, and forms a submarine plateau covering approximately 17,600 km^2 (6800 square miles), with maximum dimensions being about 260km (160 miles) from north to south and 95km (60 miles) from east to west. During Reid's time, the geological origins of the bank were uncertain. However, early trawling of the region suggested that the area had been strewn with the bones of terrestrial animals and peat, known to the sailors as 'moorlog'. All of these finds were clearly regarded as a nuisance to the fishermen as they could damage their nets and bruise fish. Little of this debris was ever considered worthy of note. The occasional pieces returned to the land as curiosities were usually without any accurate record of where they were recovered and, in any case, the remarkable density of these finds seems to have dropped off over time. Presumably the trawlers scraped the surface clean over the period. When Reid was writing, the numbers of recorded finds had declined significantly. He was, however, able to provide a list of species represented by surviving finds and these included bear, wolf, hyena, bison, horse, woolly rhino, mammoth, beaver, walrus, elk and various species of deer.

Reid was also able to suggest, following study of shellfish growing on the peat associated with this material, that the more recent finds were coming from deposits that were newly exposed and then broken by repeated trawls. In contrast to earlier finds, which appeared to have been simply scraped off the seabed, Reid's work suggested that intensive fishing was causing damage to pristine deposits and that these were becoming the principal source for the intriguing fossil material from the Dogger Bank. The number of finds and the wide area over which they were dispersed suggested to Reid that the core of the Dogger Bank might well contain a submerged forest, but he could only guess at the depth at which such a deposit might occur. From the accounts of trawlermen, the finds from the Dogger Bank tended to occur on the edges of the shoal between approximately 10 and 20 fathoms (60–120ft or 18–36m). This variation in depth indicated that the finds might come from deposits of dramatically different date. The range of animals recorded from the area supported such observations. Some finds, including woolly rhino, were likely to be of considerable antiquity. Others, including reindeer, beaver and walrus, might be assumed to relate to a later period. Whether the deposits containing such contrasting bone assemblages were superimposed or whether they came from older deposits emerging as geological islands through more recent stratigraphy could only be guessed at.

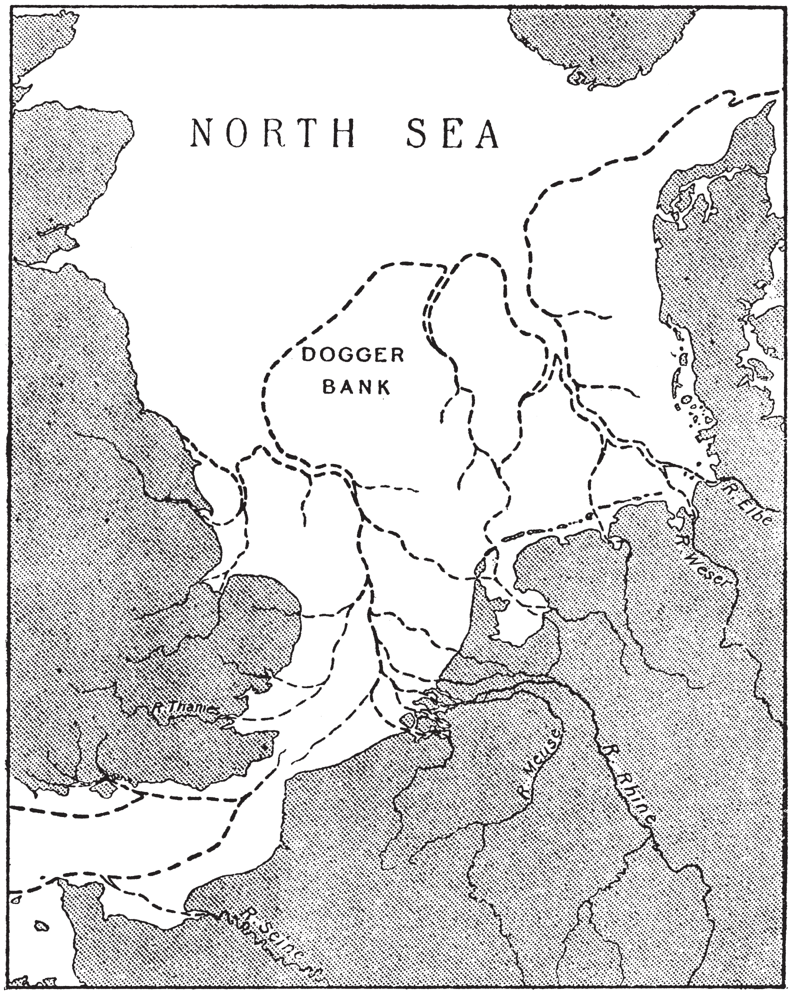


Figure 1.3 Reid's reconstruction of 'the approximate coast-line at the period of the lowest submerged forest'

Reid then took an imaginative and exciting leap forward. He suggested that the discoveries of preserved land surfaces and submerged forests on land could reasonably be extrapolated across the entire area of the North Sea. Reid proposed a recreation of the submerged plain on the basis of bathymetry – the depth of the seabed below sea level. In a simple but elegant manoeuvre Reid interpreted the seabed above about 36m (120ft) depth as dry land during the period of the submerged forests. He then suggested, again using the available bathymetric data, the possible routes of major rivers within this landscape and their relationship to the courses of contemporary rivers including the Thames and the Rhine (Figure 1.3).

Dramatically, Reid also attempted to reconstruct the environment of the plain. In 1909, he and his wife, Eleanor Reid, carried out a scientific analysis of peat samples from the Dogger Bank in order to find out what type of vegetation was present when this mysterious plain was dry land. This is a remarkably early date for such a study although the simple and robust methodology used would probably not find favour with environmental scientists today! Reid notes that because the peat was so exceptionally tough the 'moorlog' had to be broken up and boiled in a strong soda solution for three to four days to extract identifiable plant remains. However, at the end of this procedure the organic remains could then be extracted for study. The peat was dominated by bog-bean, with fern and occasional willow leaves; white birch, sallow and hazel were also present. The climate, Reid suggested, was 'northern', by which he meant cool and temperate.

Nothing suggested brackish water so the sea was presumed to lie some distance away, although several insects, whose hard carapaces are tough enough to be preserved almost indefinitely in these conditions, suggested that there were also sand dunes in the vicinity. From this, Reid argued that the Dogger Bank formed the northern edge of a massive alluvial plain covering the whole of the southern North Sea. In some areas, at least, this plain would have contained vast fens which may have been protected seaward by belts of sand dunes.

Under Reid's keen gaze, the vague outlines of a new land, then without a name, began to emerge tentatively from the North Sea.

Reid's appreciation of the significance of this new land exceeded the comprehension of most contemporary geologists, archaeologists or biologists and his work was set apart by its understanding of its wider natural and cultural context. Reid pithily noted the process of identifying a stratigraphic sequence of rich organic deposits meant that

> the geologist should be able to study ancient changes of sea-level, under such favourable conditions as to leave no doubt as to the reality and exact amount of these changes. The antiquary should find the remains of ancient races of man, sealed up with his weapons and tools. Here he will be troubled by no complications from rifled tombs, burials in older graves, false inscriptions, or accidental mixture. He ought to here find also implements of wood, basketwork, or objects in leather, such as are so rarely preserved in deposits above the water-level.
>
> To the zoologist and biologist the study of each successive layer should yield evidence of the gradual changes and fluctuations in our fauna and flora, during early periods when man, except as a hunter, had little influence on the face of nature. If I can persuade observers to pay more attention to these modern deposits my object is secured, and we shall soon know more about some very obscure branches of geology and archaeology.[17]

Clement Reid's work was certainly groundbreaking and, as described above, might initially appear comprehensive and conclusive. However, there were also problems surrounding his interpretation, if not his observations. Essentially Reid was hamstrung by the lack of a real chronology in which to fit his interpretation. In the absence of scientific dating Reid was left to guess or estimate the age of deposits affected by sea-level rise on the basis of their relative position, depth, thickness and composition. Of course, in the tradition of Charles Lyell, he had some general principles to guide this interpretation. Reid knew that the class of submerged forests he was really interested in was temperate but perhaps cooler than today. These woods were associated with extinct animals such as beaver and wolf but not more exotic animals that might have been associated with radically different climates. Reid could confidently exclude those deposits that must have been far earlier than the woods he was interested in. This occurred, for instance, in the case of the Cromer Forest Beds on the East Anglian coast that were known to contain elephant and rhinoceros. These same deposits, at Pakefield in Suffolk, have recently provided evidence for the earliest presence of mankind in northern Europe and are dated to about 700,000 BC.[18]

From his many observations around the coast of England and Wales, Reid also concluded that there was a clear and consistent horizon associated with submerged woodland at around 18m (60ft) below sea level. Submerged or waterlogged deposits above this horizon would therefore be likely to postdate the intriguing forests. Reid used a number of observations to refine the latest dates of the period he was studying. Several archaeological sites in the west of England were key to this process. These included the 'Glastonbury Lake Villages'. These remarkably well-preserved Iron Age settlements were discovered in the Somerset Levels in the west of England and excavated at the beginning of the last century. Work by Arthur Bulleid and H St George Gray demonstrated, dramatically, the importance of waterlogging for archaeological preservation.[19] Wooden structures and fencing, along with many rare organic artefacts, are preserved on the site and were recorded during excavations that started in 1909, about the time Reid was carrying out his work on submerged forests. These settlements are currently dated to the later Iron Age, around 125 BC, and are situated at the peak of ordinary high tides. Effectively these sites could not have survived intact had sea levels changed significantly since their construction. However, at Westward Ho!, a relatively short distance from Glastonbury and on the north coast of Devon, a scatter of stone tools presumed to be Neolithic was associated with the remains of trees several feet below the high water mark. On the basis of this evidence sea-level rise was active during the Neolithic but had stopped by the end of the Iron Age. Reid further noted that metals, either bronze or iron, were essentially absent from any of the submerged forests but polished stone tools, frequently associated with the Neolithic or New Stone Age, were present. Thus the rise in sea level must have stopped at the boundary between these two archaeological periods and the best available date for the change from stone to metal, and therefore the pause in sea-level rise, was, according to the chronologies available to Reid, approximately 1600 BC.

The onset of sea-level rise, associated with the loss of the great North Sea plain, was much more problematic. In some areas the change in sea level, suggested by Reid's temperate woodland horizon, might be as much as 25m (80ft) but represented by a complex sequence of deposits and preserved organic layers. Reid resolved this by a generalised calculation that produced an estimated period of inundation based on an assumed rate of sedimentation. Reid's conclusion was that sea-level rise had started at around 3000 BC and that this might approximate to the very latest periods of the Palaeolithic or earliest Neolithic. Reid recognised this date as provisional and that it could well be changed if better evidence were available, but he still stressed that we would not be dealing with a long period or one of great geological antiquity. Like many others, Reid was not really very optimistic about refining the dates using evidence from north-western Europe. In particular, Reid was concerned that the chronological evidence he required was actually masked or destroyed by the sea-level rise he was studying. As he noted, 'the relations of Palaeolithic to Neolithic are still very obscure in this country, and the reason is perhaps to be sought in a submergence which has tended to carry many of the transition deposits beneath sea level, or has caused them to be silted up under more modern alluvium'.[20] Like so many of his peers, Reid looked for assistance outside the region. Northern Europe may well have been in a state of barbarism during this period, but the great civilisations of Egypt and the Near East were in full swing further to the south and east. Help might be sought here and Reid even suggested that 'any day one of our submerged forests may yield some article of Egyptian manufacture of known date, such as a scarab, which has passed from hand to hand along the ancient trade routes, till it reached a country still living in the Stone Age, where its only use would be in magic. But it might now serve to give us a definite date for one of these submerged forests'.[21]

The ultimate problem for Clement Reid should now be clear. Although he had correctly identified the scale of land loss associated with recent sea-level rise, he could not date the forests and this undermined his attempts to interpret the evidence culturally. However, the standard chronology for later prehistoric Europe was, in any case, tenuous at best and based on a questionable mesh of associations tied to the historic societies of the Near East. His attempts at interpretation were therefore flawed and the links he presumed were not to survive the introduction of absolute dating technologies some 50 years in the future. Clement Reid should not, of course, be blamed for not anticipating such developments. However, his own methodology to estimate the time required for the accumulation of deposits associated with rising sea levels was also a best guess and would prove equally wrong. Culturally, the period he associated with the onset of inundation, the episode between the demise of the Palaeolithic hunters and the introduction of Neolithic farming, was also essentially ill defined in material or chronological terms. Without some concept of the age and nature of the societies involved, Reid's musings were never likely to achieve further substance. Further evidence, and a major change in archaeological understanding of prehistoric societies, was required. Without this the shadowy peoples associated with Reid's inaccessible land were likely to remain elusive.

After such a promising start, Clement Reid's adventure in the new lands seemed doomed to failure. Despite this, the final paragraph of Reid's 'delightful little book' returned to the Dogger Bank with a note of optimism. Of all the places Reid had visited or studied around the coastline of England and Wales the Dogger Bank, he concluded, might well be the best place to seek new evidence. Here, specifically, Reid felt that future researchers might find implements made by man that could provide real dating evidence and insights into the mysterious world he had begun to explore. Clement Reid died in 1916, shortly after retirement and only three years after publishing *Submerged Forests*. Eighteen years later a chance discovery in the southern North Sea not only supported Reid's ideas about the extent of the drowned lands but also set in motion a sequence of events that ultimately provided the evidence that had eluded Reid almost totally. This was not an empty land but a living and lived-in landscape. The North Sea truly hid a lost country.

A chance discovery – the Colinda 'harpoon'

> We were halfway between the two North buoys in mid-channel between the Leman and Ower … I heard the shovel strike something. I thought it was steel. I bent down and took it below. It lay in the middle of the block which was about 4 feet square and 3 feet deep. I wiped it clean and saw an object quite black.
>
> Skipper Pilgrim E Lockwood interviewed by Dr H Muir Evans, 14 March 1932[22]

In September 1931, the trawler Colinda, sailing from Lowestoft in the United Kingdom, was fishing at night some 40km (25 miles) off the Norfolk coast, near the Leman and Ower Banks in the southern North Sea. When the Colinda's nets were hauled in, aside from the catch of fish, they must have contained the usual haul of debris caught up as the ship trawled the sea bottom. The Dogger Bank was well known for such flotsam, which could include wood, shells, odd bones and lumps of peat, often called 'moorlog'. These objects were usually regarded as little more than a nuisance although, to the annoyance of all the crews, they could sometimes damage the nets. All the unwanted debris was usually 'heaved' over the side of the boat without much consideration but this occasion was different. One large piece of peat was hit by a shovel and gave a strange noise. The master of the ship, Skipper Pilgrim E Lockwood, decided to investigate and broke open the block. Out dropped a prehistoric antler 'harpoon'.

Skipper Lockwood was intrigued enough to take the find back to land and he gave it to the ship's owner, Mr Hall. The find was eventually offered to the British Museum. Having two similar harpoons, they declined the gift. Eventually it came into the possession of the Cambridge biologist, Dr Muir Evans, who interviewed Lockwood about the find and where it came from and then gave it to the Castle Museum in Norwich.[23] The harpoon was exhibited at a meeting of the Prehistoric Society of East Anglia on 29 February 1932 and attracted considerable attention and excitement. Visually the find is a rather elegant artefact measuring 21.6cm in length (8.5in) and with a row of barbs running along much of its length, as shown in Figure 1.4. A series of incised lines along one side presumably helped bind the point to a shaft. What it was used for is slightly problematic. All the early literature refers to it as a harpoon but today it would more likely be called a bone 'point'. Ethnographic parallels suggest that these bone objects are unlikely to have been used as harpoons; it is more likely that they would have been used singly, or tied together for use as a leister, eel or fish spear.

Archaeologically, as the British Museum noted, the point was not unique. Indeed, it was soon identified as one of a small number of 'harpoons' already known from England and north-west Europe. Even with the rudimentary chronology available it was rapidly dated to the archaeological period known as the Mesolithic and more specifically to a culture known as the Maglemose (Danish for 'big bog'). The Mesolithic, or Middle Stone Age, was a part of the chronological story of the North Sea that had essentially been missing when Clement Reid was studying the area twenty years earlier. In Britain, the Mesolithic is conventionally dated to about 10,000 BC to 4000 BC and is generally recognised as the period immediately before the introduction of agriculture. This was a time

Figure 1.4 The Leman and Ower point and its find-spot. Original photograph and drawing by H Muir Evans

when Europe was still populated by hunter-gatherers, small communities whose mobile lifestyles allowed them to make use of the wide range of seasonal game and plants available in north-western Europe.

The Dogger harpoon was eventually dated by radiocarbon to 11,740 ± 150 BC but this level of precision was obviously not available when it was found and, indeed, there have been suggestions that this date may not be entirely reliable.[24] In fact, the study of early prehistoric societies in Britain, including the Mesolithic, was not well served by universities at the beginning of the 20th century. When prehistory was taught at all, the lack of substantive knowledge concerning this distant past confined lectures and publications to little more than long and detailed descriptions of antler, bone or stone tools. There was only the vaguest idea of the age of the artefacts studied, whilst the societies that produced these tools left no histories to testify to their original use or significance. Moreover, the artefacts that had survived the predation of time said little about the majority of everyday items, weapons, tools or clothing that were made of leather, wood or other organic materials. These must have existed but had simply rotted without trace over time. The prospect of reconstructing societies using such frugal information was never attractive. Yet, a century ago our knowledge of the Mesolithic was even worse than this. Virtually nothing was known about the period at all and it was, essentially, only defined on the basis of what it was not! The preceding period, the late Palaeolithic, was characterised by the rich cave and rock shelters of the Dordogne in France. The finely crafted stone, antler or bone tools of this period were widely admired and regarded as the epitome of prehistoric craftsmanship and accomplishment. The later period, the Neolithic, attracted attention because of its association with the introduction of agriculture, pottery and finely polished stone tools. What lay in-between was a problem for archaeologists. Some suggested that there was actually a hiatus in the settlement record. It was argued that as the climate warmed, the big game herds, particularly reindeer, moved north followed by the last Palaeolithic hunters. This left a gap, however, in the settlement record before Neolithic farmers colonised the empty land. Other archaeologists were dimly aware that there was evidence for societies that lived in the shadow of the brilliant craftsmen of the late Palaeolithic and who preceded the 'agricultural revolutionaries' of the Neolithic. Shell middens excavated in Denmark appeared to date to this period as well as several undistinguished stone tool traditions from sites in France. Unfortunately, no one really understood the significance of these finds. Were the people of the period some sort of degenerate Palaeolithic derivative; did the evidence indicate substantial change or were these mysterious cultures something entirely different? The status of the period was so tenuous that, although the name 'Mesolithic' had been termed during the late 19th century, academics were still debating what to call the period during the early 1930s. Names on offer included Epipalaeolithic, Transitional or early Neolithic and choice depended on whether the academic felt these strange artefact groups were derived from the Palaeolithic, were linked more closely to the Neolithic or were just something in-between!

Given this unpromising situation the treatment of the Leman and Ower harpoon was initially no different or worse than that meted out to so many finds of the period. It was made of antler, which is a relatively durable substance. Its shape suggested that its function could be surmised as some sort of harpoon or spear. In other words, it told us little more than the thousands of other mute stone, bone and antler finds from across Britain and Europe. However, what was different about the Leman and Ower point was where it was found – 40km (25 miles) from the coast of modern Britain. How had the harpoon arrived so far from land? Did hunters on a deep-sea fishing expedition or a longer journey drop it from a boat? Its discovery, encased in a lump of peaty clay, apparently provided so few clues about the history of the object that the mystery of the harpoon must have appeared unsolvable to the majority of scholars or antiquaries who collected or studied artefacts from the period. Perhaps more pertinently it was equally likely that few academics regarded such a task as even worthy of consideration.

Muir Evans' opinion in 1933 was that 'the men who made these weapons are known as the Maglemose people; the western coast of Zealand was one of their homes. In Neolithic times the Dogger Bank was the northern limit of the land surface which united England to the Continent and a journey from Denmark round what was the North Sea gulf would give these people access to northern England'.[25] These comments are interesting in their own right. The quote emphasises that although the existence of a lost land mass was accepted, its significance was largely unappreciated. The large plain was already being interpreted as a route between Britain and Europe rather than a place of importance in its own right. The harpoon, carried by and dropped by Danish travellers, *en route*, was considered an intrusive object and not, *per se*, something intimately connected with the landscape itself. The lost lands of the North Sea appear only to have been passed by or through rather than lived in.

In part this may well have stemmed from Reid's original interpretation of the area as nothing more than a vast fen, which, at face value, seemed rather unattractive as an area in which to live. However, if this was the case Reid's initial interpretation was about to be challenged. At the heart of the change were the activities of a small group of young academics from Cambridge. Grahame Clark, a youthful archaeologist who later became Britain's foremost expert on the Mesolithic, and Harry and Margaret Godwin, dynamic botanists at the University, led this group.

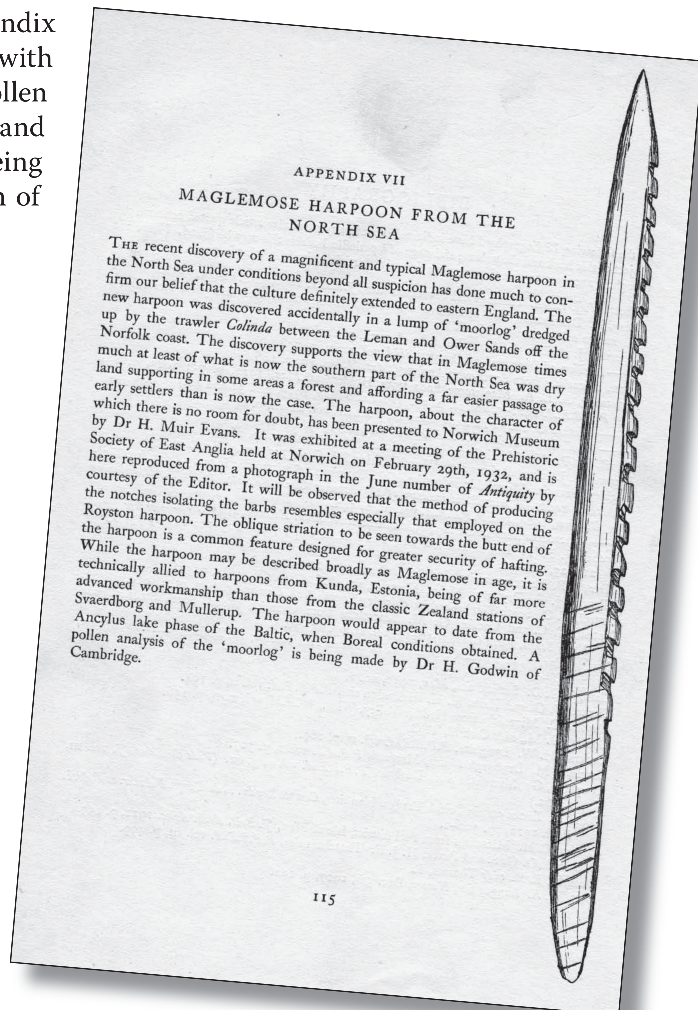
Miserable but not at all despicable – Grahame Clark and the Mesolithic

Grahame Clark registered for a doctorate in archaeology at Cambridge in 1926 and was encouraged to study the vague period known as the Mesolithic by the first lecturer in prehistory at Cambridge, Miles Burkitt. Burkitt's published views on the Mesolithic were not particularly inspiring. In his classic work on *The Old Stone Age* he described the period as 'monotonous' and 'inferior' in comparison with 'the wonderful late Palaeolithic cultures'.[26] Despite this he had enough interest to task the young Clark with classifying the numerous finds that were thought to date to this cultural backwater and Clark threw himself into the work with zeal. He journeyed to Europe to study comparative material and then, using his many contacts in British archaeology, began to identify British material of the period from across the country. This research was presented in 1932 in a book titled *The Mesolithic Age in Britain*. One has to be honest, if a publication were to be judged simply on its preface this volume might well have disappeared without trace. Written by Miles Burkitt it describes the period as 'a dustbin into which any awkward industry which does not seem to belong to any period could be cast'. This was, perhaps, an accurate statement at the time but Burkitt followed this with an unfortunate turn of words and suggested that the period's 'cultures – and therefore the industries too – were not so brilliant as those of the Upper Palaeolithic date which had disappeared at the end of Quaternary times. But at the same time though perhaps more miserable they are not at all despicable'. Happily, Burkitt retrieved the situation by noting both the quality and value of the research to students of prehistory more generally![27]

Clark's first major book deserves comment largely because of what happened after its publication. The book itself is, in many senses, a child of its time and, like so many publications from the period, it is essentially a detailed study of stone, bone and antler artefacts. Whilst there is no doubt that Clark's work was a major contribution to the development of Mesolithic studies it is dry stuff for most people. However, he did define the period as a distinct entity, culturally and chronologically separate from the Palaeolithic or Neolithic. Clark was assisted in this task by refinements in chronology during the early 20th century which appeared to extend the time available for a Mesolithic culture to develop by perhaps as much as 4000 years. His substantial appreciation of the extent of climate change at the end of the last Ice Age also encouraged him to suggest an explicit link between environmental and social change.[28] This he associated directly with the development of Mesolithic cultures, which he interpreted as an adaptation to environmental change, although like many of his contemporaries, Clark remained surprisingly dismissive of the period. Indeed he actually compared the Mesolithic culture groups to the great apes in evolutionary terms and declared them as being 'off the main line of human evolutionary progress', and that 'we regard the Mesolithic folk as the laggard survivors of a more primitive civilisation in a backward region'.[29]

Figure 1.5 Sir Grahame Clark, photographed in 1950

It is clear from reading Clark's first book that he subscribes to the general position of Clement Reid in relation to the evidence for submerged forests. Although Reid is not actually cited in the publication, Clark dates a collection of stone tools from Swanlake Bay in Pembrokeshire as pre-Neolithic because they were below a submerged forest. However, for our purposes the most significant section in the work is Appendix VII, provided here as Figure 1.6. This concerns the Leman and Ower point. Although this was found too late for full inclusion into Clark's work, he provides a description and minimal interpretation of the find in this appendix. Clark states that the find is of undoubted Mesolithic date and suggests that its cultural affiliations were with Estonia rather than with Denmark. Its presence in the North Sea demonstrated, he felt, that parts of the southern North Sea were available for passage during this period. One might question what Clark considered passage to mean in this context and whether this involved settling in the inundated area or merely passing through to colonise mainland Britain. However, Clark's work after this publication suggests that the recovery of the bone point from these deep waters began to crystallise his thoughts about the region and the environmental and settlement history of north-western Europe more generally. Indeed, Clark's biographer, Brian Fagan, later made it quite clear that he believed that the Leman and Ower find was a major turning point in Clark's career (Fagan 2001). The harpoon appendix, which he expanded in his 1934 doctoral thesis, may well have sparked a shift in Clark's future intellectual development. After his first book he shifts radically away from the primacy of detailed find catalogues to the exploration of major landscape and climatic change through collaborative research with botanists and geologists. The final line of the original appendix hints at this change with the statement that 'pollen analysis of the [Leman and Ower] 'moorlog' is being made by Dr H. Godwin of Cambridge.'[30]



APPENDIX VII

MAGLEMOSE HARPOON FROM THE NORTH SEA

THE recent discovery of a magnificent and typical Maglemose harpoon in the North Sea under conditions beyond all suspicion has done much to confirm our belief that the culture definitely extended to eastern England. The new harpoon was discovered accidentally in a lump of 'moorlog' dredged up by the trawler *Colinda* between the Leman and Ower Sands off the Norfolk coast. The discovery supports the view that in Maglemose times much at least of what is now the southern part of the North Sea was dry land supporting in some areas a forest and affording a far easier passage to early settlers than is now the case. The harpoon, about the character of which there is no room for doubt, has been presented to Norwich Museum by Dr H. Muir Evans. It was exhibited at a meeting of the Prehistoric Society of East Anglia held at Norwich on February 29th, 1932, and is here reproduced from a photograph in the June number of *Antiquity* by courtesy of the Editor. It will be observed that the method of producing the notches isolating the barbs resembles especially that employed on the Royston harpoon. The oblique striation to be seen towards the butt end of the harpoon is a common feature designed for greater security of hafting. While the harpoon may be described broadly as Maglemose in age, it is technically allied to harpoons from Kunda, Estonia, being of far more advanced workmanship than those from the classic Zealand stations of Svaerdborg and Mullerup. The harpoon would appear to date from the Ancylus lake phase of the Baltic, when Boreal conditions obtained. A pollen analysis of the 'moorlog' is being made by Dr H. Godwin of Cambridge.

115

Figure 1.6 Appendix VII from Clark's *The Mesolithic Age in Britain* (1932)

Cambridge and beyond! The Fenland Research Committee and the Mesolithic settlement of northern Europe

The reference to Harry Godwin in Appendix VII of *The Mesolithic Age in Britain* is pivotal. Clark, along with Harry and Margaret Godwin and a small circle of friends and colleagues, had become increasingly dissatisfied with the state of prehistoric archaeology in Britain. They were convinced that they could never understand past societies simply by studying artefacts in isolation. In particular, they believed that new scientific techniques in geology and plant sciences could be used to study the environment of past societies and, using this information, they wanted to explore and explain how societies adapted to or changed with their environment. This was particularly clear as Clark's appreciation of the 'great geological and climatic divide' that appeared to separate the Palaeolithic and Mesolithic increased. The Godwins persuaded Clark that palynology, the study of plant pollen preserved in geological or archaeological deposits, could provide the information they needed.

Most plants produce pollen and by the 1930s plant biologists had begun to appreciate that the masses of pollen produced seasonally fell as a 'pollen rain' across landscapes. In the right circumstances pollen could survive almost indefinitely and microscopic study of carefully chosen samples of soil could provide an overview of the range of plants growing at any specific time. The Godwins, who had travelled extensively in Europe to study with experts using this new technique, argued that judicious selection of samples would allow scientists to reconstruct the nature of past environments and even begin to trace change over time. To achieve this they only had to locate key samples of soils in which these precious grains of pollen might survive. One sample was obvious. The Colinda harpoon was clearly associated with organic deposits; it was encased in a block of peat. If this material could be analysed, the results might demonstrate the enormity of landscape change across the area of the southern North Sea. Archaeological textbooks tell us that the Godwins secured a peat sample and the analysis of this material indicated that the Leman and Ower harpoon sample came from a deposit lying within an area of fresh and not marine water. Clark appreciated the significance of this result and that the evidence from the pollen confirmed that the point was not lost at sea. Instead it was the first real evidence that the North Sea had been part of a great plain inhabited by the last hunter-gathers in Europe. The point was dropped by someone who, presumably, was living in that landscape rather than passing through it.

There is, however, a slight problem in this account. The archaeological literature often gives the impression that Harry Godwin sampled the peat encasing the harpoon but this is not actually true. The peat that surrounded the harpoon was not returned to land but was heaved into the sea with all the other flotsam. What actually happened was that in 1932 the Godwins, through the good offices of Dr Muir Evans, asked Skipper Pilgrim Lockwood for assistance.[31] The Colinda returned to the Leman and Ower banks in 1932 to recover more of the 'moorlog' from the general area that the harpoon had been trawled. Consequently, although the results of the analysis of the Leman and Ower moorlog occupy a near iconic status in archaeology, there is no certainty that the deposit studied actually related to the harpoon. Despite this, if the association of the peat with the harpoon is assumed, and this is probably a reasonable presumption in the light of later research, Godwin's analysis of the Leman and Ower moorlog is justifiably regarded as a turning point in European prehistory – despite the awkward truth concerning the origin of the peat sample itself.

It is difficult now to comprehend just how important the find of the Leman and Ower point actually was. Although the concept of an inundated landscape was already current, this small antler point began to provide a cultural context for that idea and acted as a catalyst for a number of important, related events. Four months after the harpoon was exhibited at the Castle Museum in Norwich, Clark and the Godwins called a meeting in the Upper Parlour at Peterhouse College and founded the Fenland Research Committee.[32] This committee aimed to unravel the complex environmental and cultural development of the fenland in East Anglia and, for the first time, specialists in botany, geography, geology and archaeology combined their efforts in a loose collaboration for that purpose. Aside from Clark, future archaeological 'grandees' associated with the committee included Stuart Piggot, whose work defined the British Neolithic, and Christopher Hawkes, the Iron Age specialist. Although Clark served as committee secretary it is notable that Sir Alfred Seward was elected president of the committee. Seward, an eminent palaeobotanist with a longstanding interest in using fossil plants to study climate change, took a keen interest in the committee's work but this interest was, in part, to keep a paternal eye on the activities of these 'young Turks'!

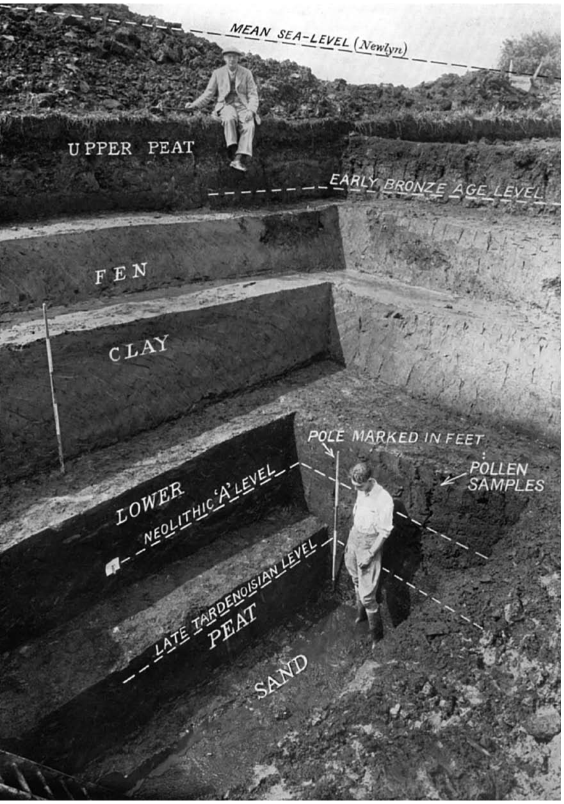
Over the next decade this group began to explore postglacial environmental changes in the fenland region and their effects upon Mesolithic communities and their lifestyle. Excavations by Clark and Godwin, in particular, began to provide dramatic evidence for the extent of landscape change. Their first major collaboration, at Plantation Farm (at Shippea Hill near Ely in East Anglia), was explicitly directed at studying 'postglacial changes of environment in relation to man' and a Mesolithic flint was recovered during coring of the fenland peat at a depth of 5.27m (17ft).[33] A larger excavation at nearby Peacock's Farm followed this. Here, a stepped trench allowed Clark to expose larger areas of deeply buried land surfaces.[34] This site, which lay about 32km (20 miles) from the modern coastline, provided impressive evidence for landscape change. The lowest peat deposits associated with Mesolithic flints, and assumed to be comparable with those in the North Sea, occur at a depth of about 5m (17ft) below sea level. The final, early Bronze Age deposits lay approximately 3m (10ft) above! The pollen and snail samples from this impressive trench supported a reconstruction of the palaeoenvironment from the Mesolithic through to the Bronze Age. The nearby Mesolithic site appeared to have been surrounded by a marsh, with pine and ash located close by. The climate was drier and warmer during the Neolithic and this, in turn, was replaced by a willow carr during the early Bronze Age.

Peacock's Farm also provided an iconic image associated with the study of the inundated landscapes of northern Europe and, perhaps, later prehistory more generally. Reproduced as Figure 1.7, the photograph shows Grahame Clark, in wellington boots, at the base of the massive stepped trench, with Major Gordon Fowler sitting, high above, at the top of the section. Fowler was an amateur archaeologist who worked as a manager in the local beet factory, and was invaluable to the work of the Fenland Research Committee. He not only knew the landscape intimately, he was an ebullient character who knew everyone, labourers in the field and academics at Cambridge. In many ways, this image may be one of the greatest tributes to the work of Clark and the Fenland Research Committee. They had, as a group, sought to explore the impact of environmental and landscape change in the Anglian fens and this photograph portrays change in a truly dramatic manner. Published in 1935, it is hard not to be impressed by the depth of peat and clay overlying the deeply buried Mesolithic land surfaces. The fact that it is such a well-known image suggests that it still resonates today. Despite this, the full significance of the work really only becomes apparent with the publication in 1936 of Clark's second book – *The Mesolithic Settlement of Northern Europe*.

This publication contrasted greatly with Clark's first book which was a conservative, but solid, approach to the material culture of the Mesolithic in Britain touching, briefly, the economic and environmental background of the period. In comparison, and to some extent catalysed by the Leman and Ower find, his second book was a revolutionary break with past research. *The Mesolithic Settlement of Northern Europe* drew on the groundbreaking work in the Fens and extensive travel in Germany and Scandinavia. Clark's increasingly wide network of academics with broad ecological interests informed his interpretation of the evidence but, as importantly, he was also deeply influenced by researchers using ethnographic evidence to interpret past data. Despite this, the book fundamentally provides a deterministic appreciation of the role of the environment in cultural development, alongside a deep appreciation of the extent of environmental and landscape change across much of Europe and north Africa. In the introduction to the book, Clark wrote

> it is less generally recognised that [the] environment has undergone changes in the last few thousand years so profound as to alter its influence on cultural development and so rapid as to afford a natural time-scale for dating. The area of Northern Europe is one in which most has been learnt of the development of the environment in the postglacial period, and, therefore, peculiarly favourable for a study of Mesolithic settlement.[35]

Clark sought to redress this general lack of appreciation of the scale of change in the first chapter of his book. This provides a masterful overview of the current state of geological knowledge relating to the retreat of the ice sheets after the last glacial and the impacts of rising sea levels and a rapidly warming climate. The last point is of central importance in respect of how Clark used the evidence from the North Sea. He recognised the complexity of events following the melting of the north European ice sheets at the end of the Pleistocene and the release of nearly 32 million km^3 of meltwaters. Global sea levels had risen



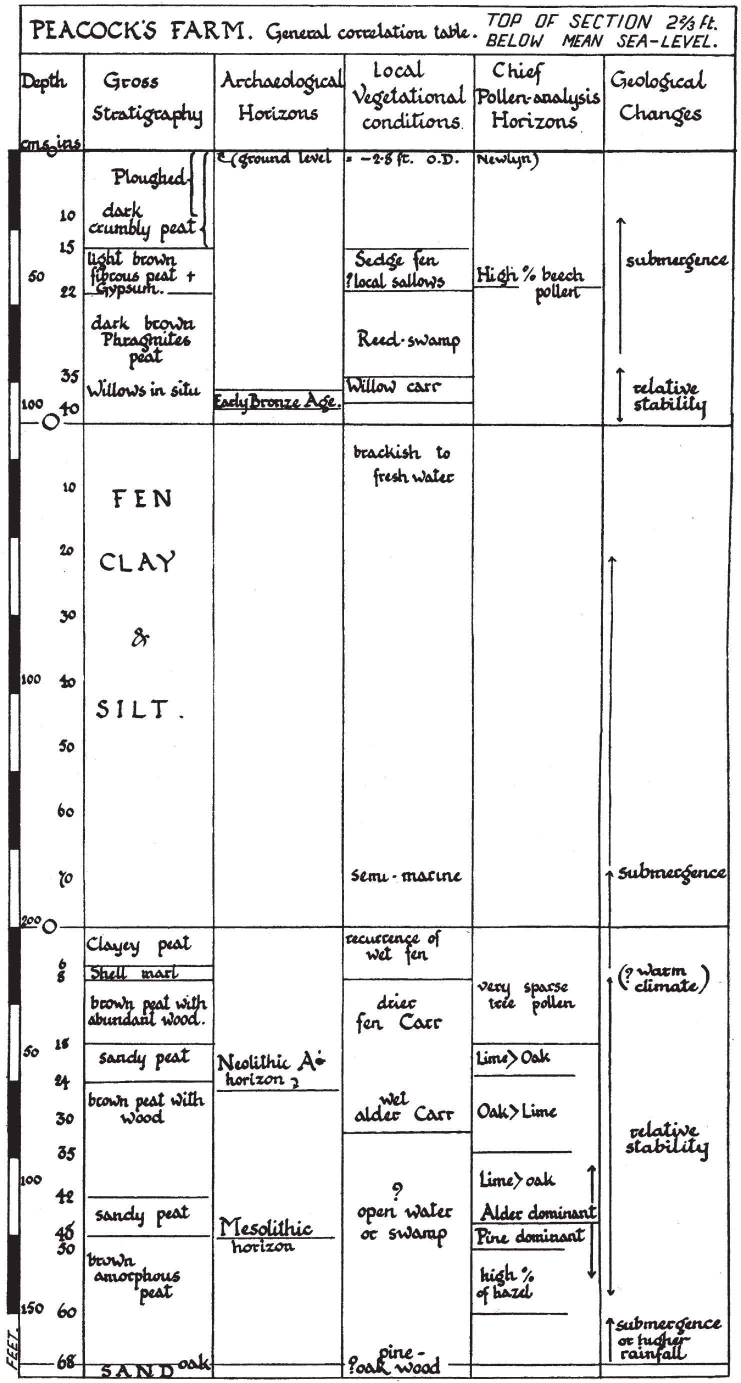


Figure 1.7 The stratigraphy at Peacock's Farm, with Sir Grahame Clark at the base of the trench and Major Gordon Fowler sitting at the top.

by as much as 83m (272ft), according to data then available. At the same time, he also appreciated the role of rising land, occasioned by the removal of millions of tons of ice which had previously compressed the land below. The cumulative effect of rising sea level and land readjustment varied from area to area but was, of course, already recognised by Reid in his comments on raised beaches in Scotland. By then it was also realised that these issues were further complicated in the North Sea because the land in front of the ice sheets was pushed up into a great bulge by the enormous pressures of the advancing ice. Consequently, in these areas rising sea level was paired with land settling as the ice melted. Clark appreciated that the evidence for these changes was particularly well documented in the area of the Baltic Sea, although the scale of change there, impressive as it was in regional terms, was never really comparable to that in the North Sea. Unfortunately, the inaccessibility of comparable deposits in the North Sea meant that the opportunity to date the events, or understand their full significance, was minimal.

The Littorina Sea

When Clark wrote *The Mesolithic Settlement of Northern Europe* the best-documented sequence of sea-level change was actually in the area around the Baltic Sea. At the onset of the Holocene, geological mapping suggested that a great lake blocked by an ice wall up to 25m high covered the area of the Baltic Sea. As this ice melted the water flowed out, perhaps quite dramatically, exposing a wide plain in northern Germany and Sweden. In the lake's place there was now a marine inlet – the Yoldia Sea – named after the marine mollusc *Yoldia arctica*, which then inhabited the salty water. However, the land to the north also began to rise and, perhaps only about 300 years later, blocked the outlet to the North Sea again. The water body then became the Ancylus lake – named after the mollusc *ancylus fluviatilus* – which had then taken residence in the fresh waters (see Figure 1.8). Another 300 years later the lake dramatically forced its way through the Danish Storebaelt, rapidly draining perhaps 10m of water until the sea, to the west, began to flow back into the basin creating the Littorina Sea (again named after a characteristic mollusc). Finally after approximately 7000 BC sea levels began to rise rapidly as a consequence of glacial melt and in little more than 1000 years the waters rose nearly 27m and then a further 2–3m to create the outline of the Baltic today. The relative change of sea level in the Baltic combined with the rebound of the land meant that although the southern shores were flooded, areas to the north, including Sweden and Denmark, were raised significantly. It is difficult to appreciate the relative speed of these events and their impact. On occasion inundation was so rapid that settlements may have suffered catastrophic flooding. In other areas coastal settlements became marooned inland as the land rebounded. By 1936, archaeologists in Denmark had already mapped Mesolithic settlements around the Littorina Sea, now isolated on raised beaches behind the current shore. Clark made great play of his visit to the area and his impressions of standing on the raised beaches of the Littorina Sea were obviously inspirational to his academic development.

Figure 1.8 Shell mounds around the Littorina Sea. After Clark 1936

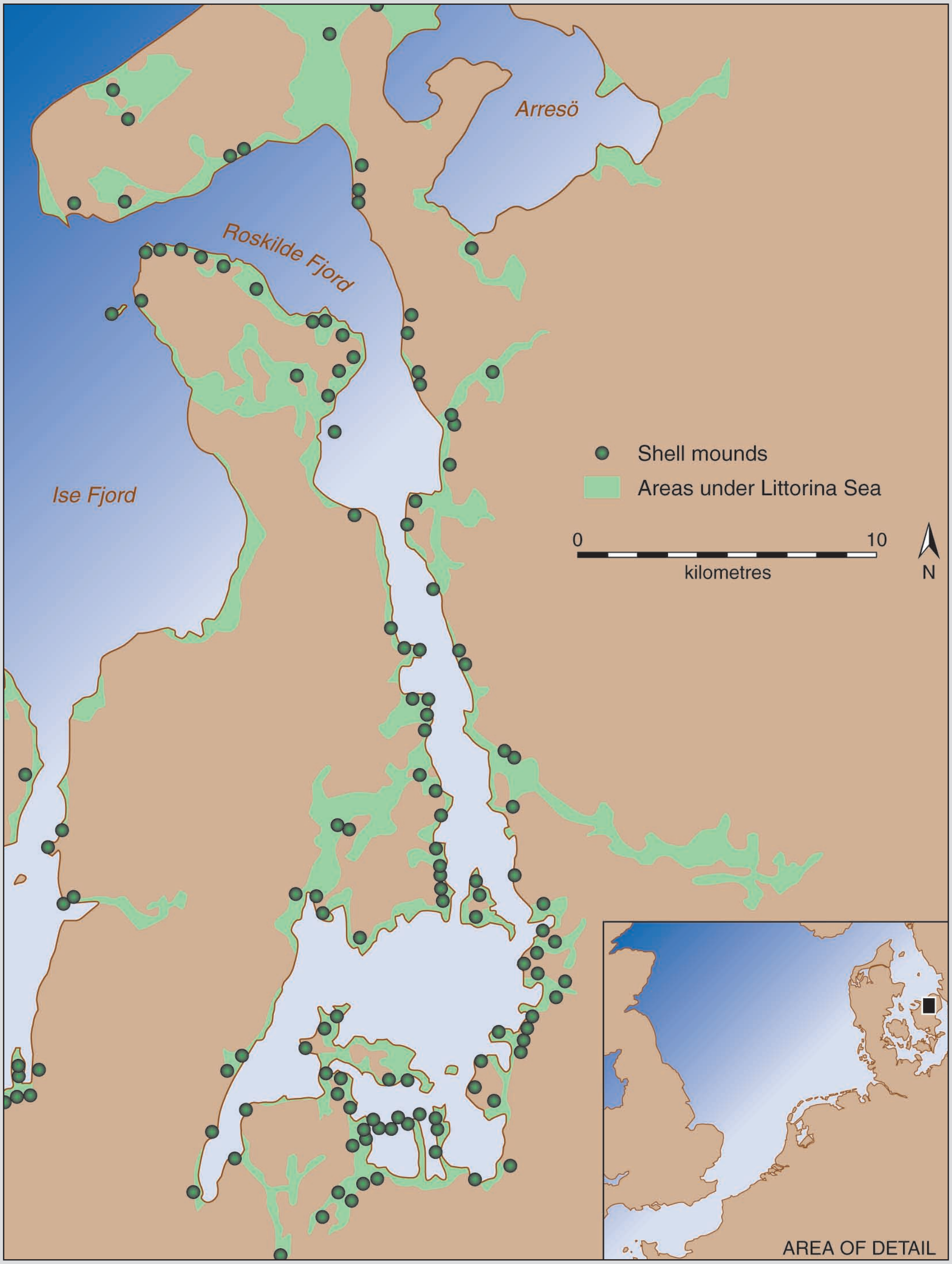


Figure 1.9 Synchronisms of environmental, floral and faunal change from Clark (1936), *The Mesolithic Settlement of Northern Europe*

Clark's interest in pollen and environmental change as an indication of broad date also allowed him to make considerable progress in respect of the chronology of change. Indeed, one of Clark's major contributions to the study of the period was his appreciation of the complex inter-relationship between changing environments and the presence or absence of plants and animals. The tolerance of plants and animals to cold or warmth, damp conditions or dry, suggests that study of the faunal and floral remains should allow archaeologists to recreate past environments with relative confidence. Similar plant groups, for instance, probably indicate comparable environments and, in combination with stratigraphic information, it is possible to conclude that samples may be of similar date. By the beginning of the 20th century botanists had already begun to formalise numerous observations on peats and submerged forests into a climatic and chronological sequence. The north European Mesolithic, for instance, was divided into principal zones which, like the Three Ages system for cultural development, are still broadly used even if considerably refined by later work. For the period of the Mesolithic, Clark identified the following periods:

I. **Pre-Boreal**. Cold. Willow, birch and pine. Early Mesolithic.
II. **Boreal**. Rising temperatures. Mixed oak forest. Pine and hazel. Maglemose and Tardenoisian.
III. **Atlantic**. Climatic optimum with highest temperatures. Mixed oak forest. Late Mesolithic and first farmers.

Clark then brought together a wide range of supporting evidence to demonstrate these environmental synchronisms. Evidence for the changing distribution of hazelnuts and the common tortoise, as well as the presence of regionally extinct animals including aurochs and giant deer, together provided Clark with an outline of environmental change. These he combined within a single scheme so that the data could be also used as a key to regional chronologies, reproduced here as Figure 1.9.

Unfortunately, this elaborate scheme could only be applied in part to the North Sea, which remained resolutely enigmatic because of the inaccessibility of the original land surface. Clark continued to be almost solely dependent upon the pollen record, pioneered by the Godwins on the Leman and Ower point, as his guide to the environment and chronology of the Mesolithic lands of the North Sea. He was fortunate, however, that further samples of 'moorlog' had been examined by 1936 and these provided information not only from the Leman and Ower banks, the Dogger Bank, and areas to the east, but also from sites adjacent to the Dutch coast and on land. Within Clark's scheme the analysis of these samples demonstrated that the southern sections of the North Sea were being submerged, possibly very rapidly, by Period II or the Boreal, whilst the coastal areas were not affected until Period III or the Atlantic (see Figure 1.10).

Clark's work on the Mesolithic of northern Europe was seminal and established the course for research on the period for a generation. He pioneered the primacy of environmental analysis, supported by ethnographic analogy, as a means to interpret the economy of Mesolithic societies and in doing so ensured that the economic base would remain the dominant interpretative paradigm for hunter-

Geochronology	Glacial eras	Land movement: Baltic	Land movement: North Sea	Climate phases	Forest development	Fauna	Archaeology	
BC (2500) 3000	POST-GLACIAL	*Littorina* Sea	Fen clay laid down	SUB-BOREAL			NEOLITHIC	
4000 5000			Transgression of North Sea bed	Warm and moist-oceanic ATLANTIC Warmth maximum Temperature (July) 17°C	Alder and/or oak-mixed-forest (elm, oak, lime) dominant	Dog Forest, lake and sea forms Elk rare Reindeer absent	MESOLITHIC	PERIOD III
6000 (6800)		*Ancylus* Sea		Temperature (July) 16°-17°C BOREAL Warm and dry-continental Temperature (July) 12°-14°C	Birch and/or pine dominant Alder and oak-mixed-forest coming in Hazel becomes important near the end of the period	Dog Forest and lake forms Elk very common Reindeer survived		PERIOD II
7000 8000 (8300)	FINIGLACIAL	*Yoldia* Sea	'Moorlog' forming	PRE-BOREAL Gradual and rapid rise of temperature from 8° to 12°C (July)	Birch, pine and willow the only forest trees	Mixed tundra and forest forms Lemming absent		PERIOD I
9000 10000	GÖTIGLACIAL	Ice-dammed lake		SUB-ARCTIC ARCTIC	*Dryas* flora Dwarf birch and willow	Tundra and steppe forms Lemming	PALAEO-LITHIC	

gatherer studies in Britain for nearly 50 years. His work in the North Sea, however, was different. Clark clearly regarded the evidence for the North Sea as critical to understanding the archaeology of north-west Europe at the very least. This was demonstrated, specifically, in the famous final illustration from *The Mesolithic Settlement of Northern Europe*. This shows the available pollen data for sites from across Europe dated, according to geological or palynological procedures, to Period II (see Figure 1.11). The figure also provides a context for the Leman and Ower find-spot through an outline for the inundated areas of the North Sea. However, whilst he dropped Reid's speculative reconstruction of the river systems of the North Sea he also concedes that the coastline provided was an arbitrary line based on the 50m bathymetric contour. Consequently, Grahame Clark's interpretation of the archaeological potential of the North Sea largely reflected Reid's position of twenty years earlier although, admittedly, supported by a better understanding of the contemporary terrestrial archaeology. Finally, Clark stressed

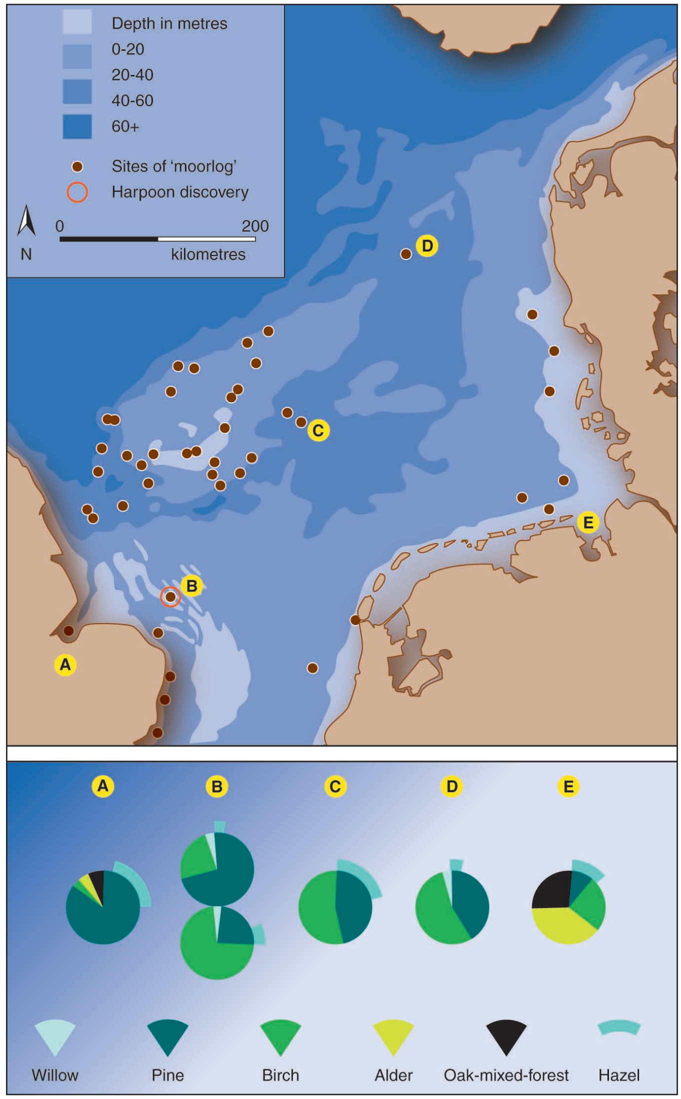


Figure 1.10 Find-spots of moorlog and pollen spectra of samples from the North Sea. Figure 3 in *The Mesolithic Settlement of Northern Europe*

> the important fact, which has been sadly missed in many archaeological speculations, is that the entire coastal culture of periods I and II has been lost for the whole extent of mainland now submerged. It would be possible to take comfort from the fact that such cultures might not have existed were it not eminently probable that they not only existed, but flourished under conditions more favourable than those obtaining inland … wherever old strand-lines exist above modern sea level they are found to have been the foci of human settlements, then it would be unreasonable to suggest that the same was not true of the submerged coast of the old mainland. Moreover, there is good reason for believing that the coast of the old mainland between east Yorkshire and north Jutland must have been especially favourable for settlement.[36]

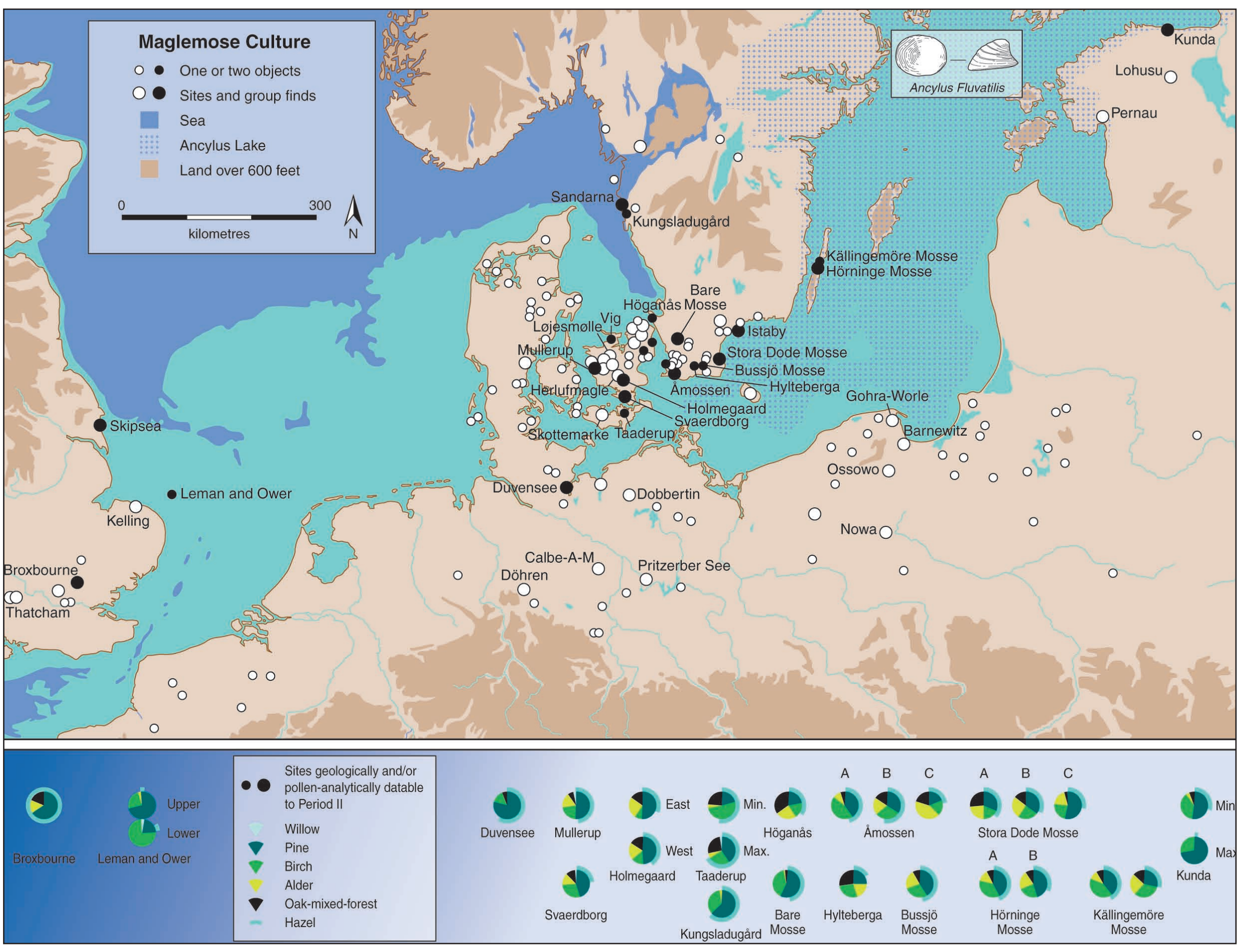
Ultimately, whilst Clark waxed lyrical on the potential of the North Sea for human settlement, the truth was that the area, as mapped by him, remained flat and featureless and only the Leman and Ower find-spot hints at human activity.

Clark had taken a major step forward in defining the environmental context and likely chronology for the loss of the North Sea landscape but after that there was little more that could be inferred on the basis of the insubstantial evidence available.

What's in a name? Bryony Coles and 'Doggerland'

It is, perhaps, not so surprising that there was little new concerning the prehistoric archaeology of the North Sea for nearly 62 years after Grahame Clark's work. At best, specialists acknowledged the potential of the region but, more often than not, the lost lands of the North Sea were simply referred to as a 'land bridge'. Was this important? Probably it was. The concept of a land bridge is very different from that of a settled landscape. Rather than emphasising the intrinsic value of the landscape to the people who lived within the area, designation as a land bridge suggested that this great plain retained little significance other than as a track linking Britain to Europe, and this began to mould archaeological thought and action in an insidious manner. In contrast to Clark, the unspoken assumption

Figure 1.11 Map of the Maglemose Culture including Clark's interpretation of the coastline of Doggerland (Clark 1936, map in end folder)



of most archaeologists was that the inundated area was unimportant in cultural terms. Of course there were archaeologists who always asserted the significance of the area but, in the absence of any practical method to explore such an extreme environment, little could be done to demonstrate this. Consequently, there was a spiral of indifference towards the unexplored archaeology of the region amongst British archaeologists at least.

This began to change because of the actions of a relatively small number of people. In the 1970s, Dutch archaeologist Dr Louwe Kooijmans published bone artefacts trawled from the Brown Bank, an area to the south of the Leman and Ower find.[37] He believed, on the basis of the known geology, that some of these finds indicated a settlement on the edge of an 'inland sea' and the tools, when compared with similar finds on land, suggested a different cultural tradition. This was a radical departure. It suggested that the populations of the inundated lands were different and could be studied in their own right. However, the entire issue of the lost lands came to the fore when Professor Bryony Coles, at the University of Exeter, published a complete synthesis of the available data.[38] The paper gave the lost lands a name, perhaps for the first time in 7000 years. It became 'Doggerland' after the submarine banks identified some 80 years earlier by Clement Reid as the source of so much archaeological material and the area most likely to provide answers to his questions about the North Sea.

Coles' work was seminal partly because she inspired a resurgence of archaeological interest in the North Sea but also because she used the expanding amount of available geological evidence to provide a chronology for the landscape development of the North Sea basin. It is an interesting contrast that whilst the North Sea had become increasingly peripheral to the interests of archaeologists it had become progressively more important to many other people. This included geologists prospecting for oil or aggregates, environmentalists studying marine plants, engineers laying pipelines or building wind farms and a host of other

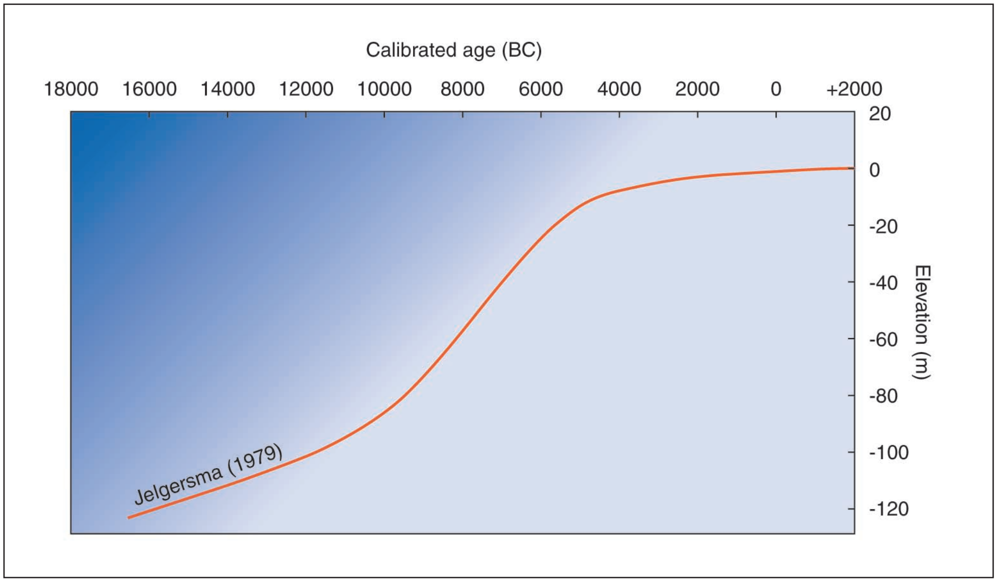


Figure 1.12 Sea-level rise in the North Sea since the last glacial maximum (after Jelgersma 1979)

people who needed detailed information on the sediments and geology of the basin. Separate from the archaeologists, scientists had been studying the region for decades and had begun to provide a detailed understanding of the scale of change in the North Sea. It was clear by the 1990s that sea level had risen a staggering 120m since the end of the last Ice Age (*c* 18,000 BC) and an area of land greater than that of the United Kingdom has been inundated as a consequence (see Figure 1.12). Indeed, on the basis of this information, geologists and geomorphologists had begun to create basic maps of this lost land. These reconstructions ranged from relatively simple approximations of the land mass at specific periods in history based on simple bathymetry through to complex models that attempted to correct the results for isostatic change. Few of these, however, had any significant landscape detail and certainly never provided the information that an archaeologist would require to consider prospecting the area.

Despite this, Coles used all the available evidence to produce a series of maps showing the probable outline of the plain from the end of the Ice Age at about 18,000 BC through to the end of the Mesolithic and the time that the landscape was finally lost to the sea around 5500 BC.[39] Coles' maps (Figure 1.13) are dramatic and, in general terms, must be reasonably correct. Archaeologically, they provided for the first time a visual representation of the loss of Doggerland from its maximum extent during the later Palaeolithic, when the available land stretched in an unbroken plain south from the Shetlands, to the final period of the Holocene when the Dogger Bank may have existed as an island. The paper provides a vivid account of the appearance of this dynamic landscape as flooding changed the shape of estuaries and lakes or the courses of rivers, how different animals and plants colonised the doomed land as the climate changed from icy tundra to temperate forest and also, on the basis of evidence from archaeological sites on land, how contemporary hunters may have used the vast plain.

However, Coles very carefully entitled the paper 'a speculative survey' and when she discusses specific landscape features there is considerable caution. Detail is sparse and information is provided only for the largest rivers and these are, again, highly speculative. Coastlines in particular are problematic and can rarely be fixed with certainty for any of the periods mapped. Once again this lack of firm evidence was filled by an expedient choice of bathymetric contours as an approximate guide to past coastlines. Coles essentially redefined the problem of exploring Doggerland for another generation but, ultimately, conceded that her maps of the lost lands were as hypothetical as earlier attempts and that she had 'little more in the way of firm archaeological evidence than Clark had to hand in 1936'.[40]

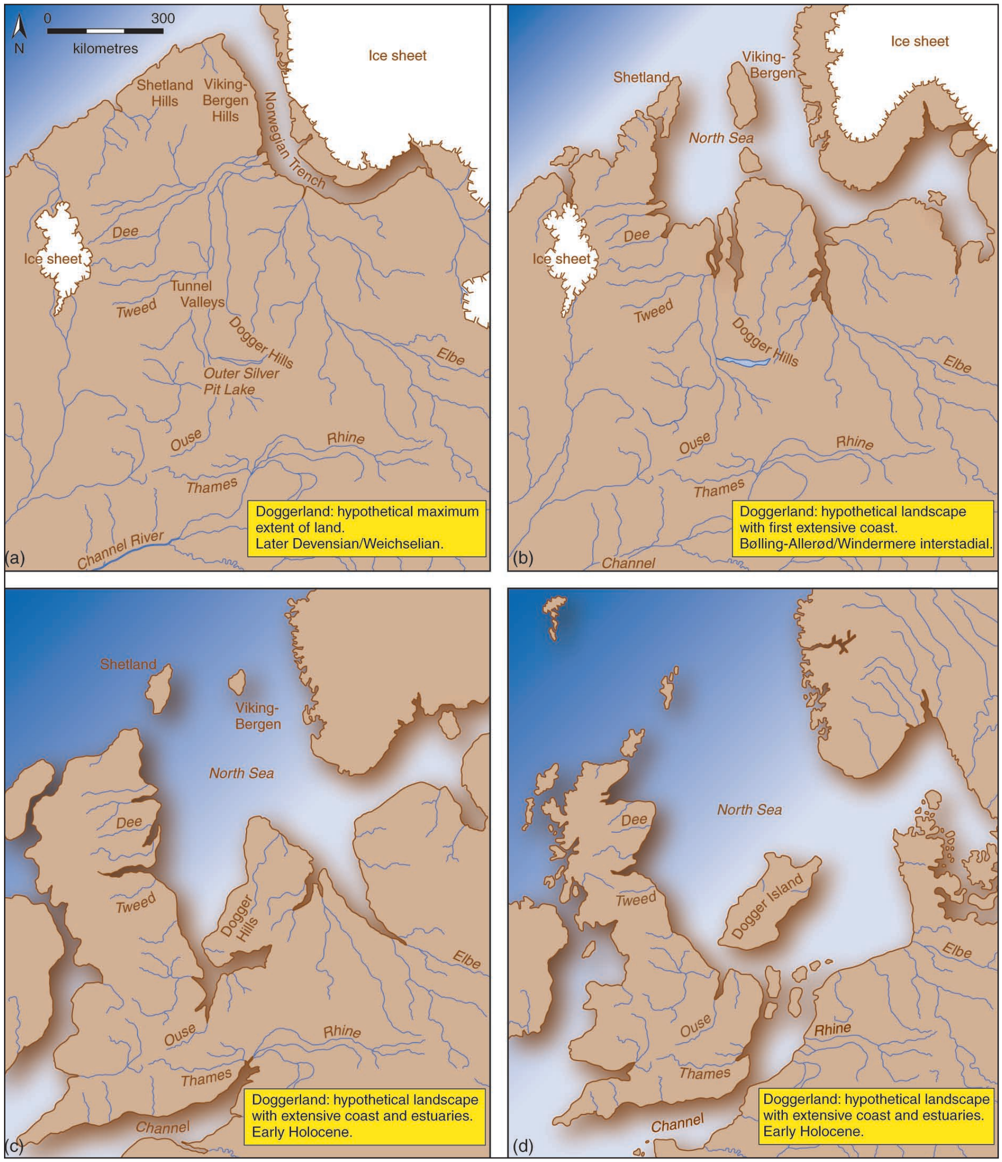
Coles' paper released a flood of archaeological interest.[41] More than 80 years after Clement Reid's first study, archaeologists began to question what was known about the region and whether more could be done to explore the area. Increasing amounts of shallow water exploration, in Europe in particular, began to open the eyes of British archaeologists to the potential of the North Sea. Decades of survey in the relatively accessible shallow waters off the Danish coast had produced more than 2000 archaeological sites including settlements and burials frequently associated with preserved wooden objects rarely found on land. Moreover, by the 21st century the increasingly large number of Mesolithic finds on land were strongly suggestive that there were differences between the character of the Mesolithic archaeology of Europe and Britain. Some things happened on the Continent that simply didn't happen in Britain or, at least, were extremely rare. Formal burials, whilst generally rare across Europe are virtually absent in Britain. Archaeologists began to ask whether such discrepancies were real or if the evidence had been lost with the inundation of Doggerland. The apparent change in the economy between the early and later Mesolithic in Britain was also problematic. In contrast to the evidence for the earlier British Mesolithic, shellfish and marine foods appeared to be consumed in large quantities at the end of the period and large middens of shells are found in some areas. Was this a real change or was the simple explanation that the earlier coastlines were lost and we just can't know what people were doing?

An increasing number of archaeologists began to repeat Clark's earlier suspicions that the hills of Britain were little more than a backdrop to life in Doggerland rather than a cultural heartland of the Mesolithic. Even worse, despite best efforts, it might not actually be possible to explain the evidence on land without more information about what was happening beneath the North Sea. Unfortunately, at the beginning of the 21st century the lands beneath the sea were almost as inaccessible to archaeologists as they were to Clement Reid at the beginning of the previous century. It was not obvious how archaeologists could proceed to fill in the blanks or answer the many questions concerning the North Sea. Yet only seven years into the new century archaeologists had begun to map the lost lands of Doggerland in detail.

The North Sea Palaeolandscapes Project

In 2001, the staff and students on the Landscape Archaeology, GIS and Virtual Environments Masters course at University of Birmingham held an annual seminar on the Mesolithic.[42] This course is dedicated to using advanced technology to study ancient landscapes. Every year the slide of the Leman and Ower bone point was shown as evidence for an ancient landscape that archaeologists could do nothing with. This year was different. As discussion about the enigmatic find progressed, the thought occurred that although Professor Coles had achieved masterful results by collating the traditional archaeological and geological information for the region, there might be a way forward that few had ever considered. Surely the vast amounts of seismic data generated by the oil and gas industry for mapping mineral deposits might also provide some useful information about the archaeology of the region. One of the students, Simon Fitch, declared an interest in starting a PhD on the topic. He and his supervisor, Professor Vincent Gaffney, sought advice from Dr Kenneth Thomson, a basin geomorphologist and expert in the use of seismic data in the School of Geography, Earth and Environmental Sciences at Birmingham. Ken's initial reaction was a

Figure 1.13 The evolution of Doggerland following the last glacial maximum



degree of incredulity. The seismic data, collected by the oil industry, was really intended to look at deep geological strata far below the deposits associated with the Mesolithic. Nobody had really considered using the data for looking at such extensive shallow deposits – possibly only metres below the seabed. The chances were it would not work. Despite this unpromising start, and after considerable discussion, Ken agreed that the academic issues were so intriguing that it was worth trying at least. All that was needed to start was for someone to provide several million dollars worth of seismic data to start the research. Luckily, Ken Thomson knew many people in the industry and he approached Huw Edwards, the Managing Director of PGS (Petroleum Geo-Services) for help.[43] Huw was equally surprised by the request. He was accustomed to geologists wanting access to data for research but the idea that archaeologists in Europe might consider using seismics to study a lost land he had never heard of was unexpected to say the least. Despite this, Huw gave access to 6000km^2 of seismic data from the Dogger Bank to be used in a pilot study. Less than a month later the dim trace of an unknown river running across the Dogger Bank emerged on computer screens at Birmingham (Figure 1.14). Almost as large as the Rhine, this river had remained unseen for some 10,000 years but could be followed across 40km of the bank, beneath the seabed. Almost immediately, the original project team named the first major river after the great Birmingham geologist Professor Fred Shotton. The rediscovery of Doggerland, Europe's lost country, had begun.

The excitement amongst archaeologists following the discovery of this single river channel is possibly difficult to understand for anyone not actually an archaeologist. From the time of Clement Reid, archaeologists had suspected that the North Sea contained one of the largest preserved prehistoric landscapes in the world. At its most extensive the lost land covered an area equivalent to the whole of the United Kingdom, whilst the country inhabited by Mesolithic hunter-gatherers was at least as large as England. The prospect of exploring an entire, preserved, European hunter-gatherer country had fired the imagination of some archaeologists but the difficulties of doing so had discouraged others from even considering the significance of the area for their own work. This single image offered Europe the opportunity to explore a real lost world at a scale never previously attempted. English Heritage recognised the importance of the results and in 2005 provided a grant from the Aggregates Levy Sustainability Fund to support more work.[44] PGS donated 23,000km^2 of seismic data, covering much of the southern North Sea within English territorial waters, for use in the study. Figure 1.15 shows the project study area.

The scale of the archaeological work then being contemplated was unparalleled.

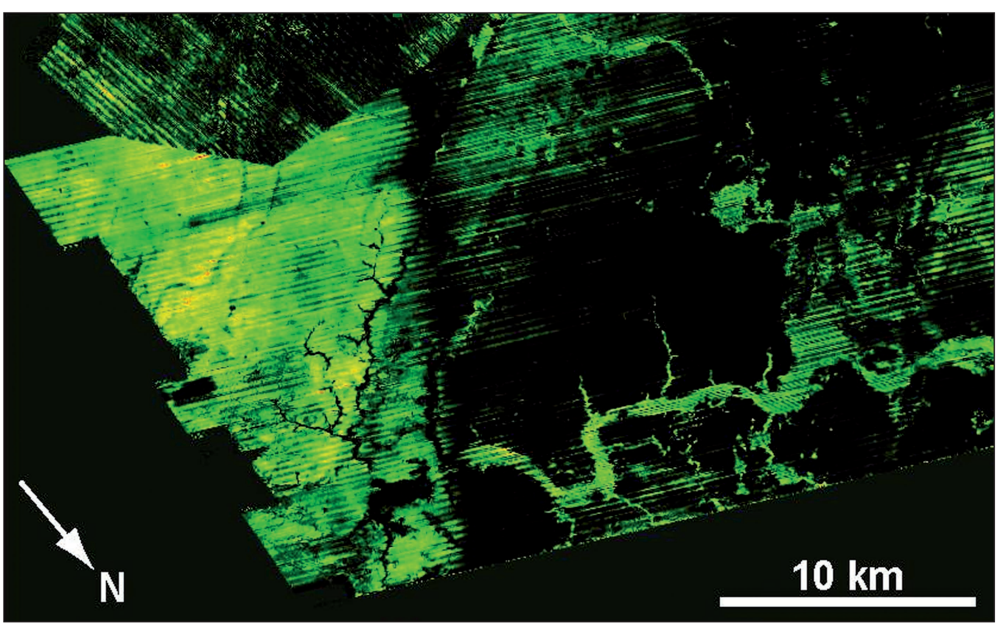
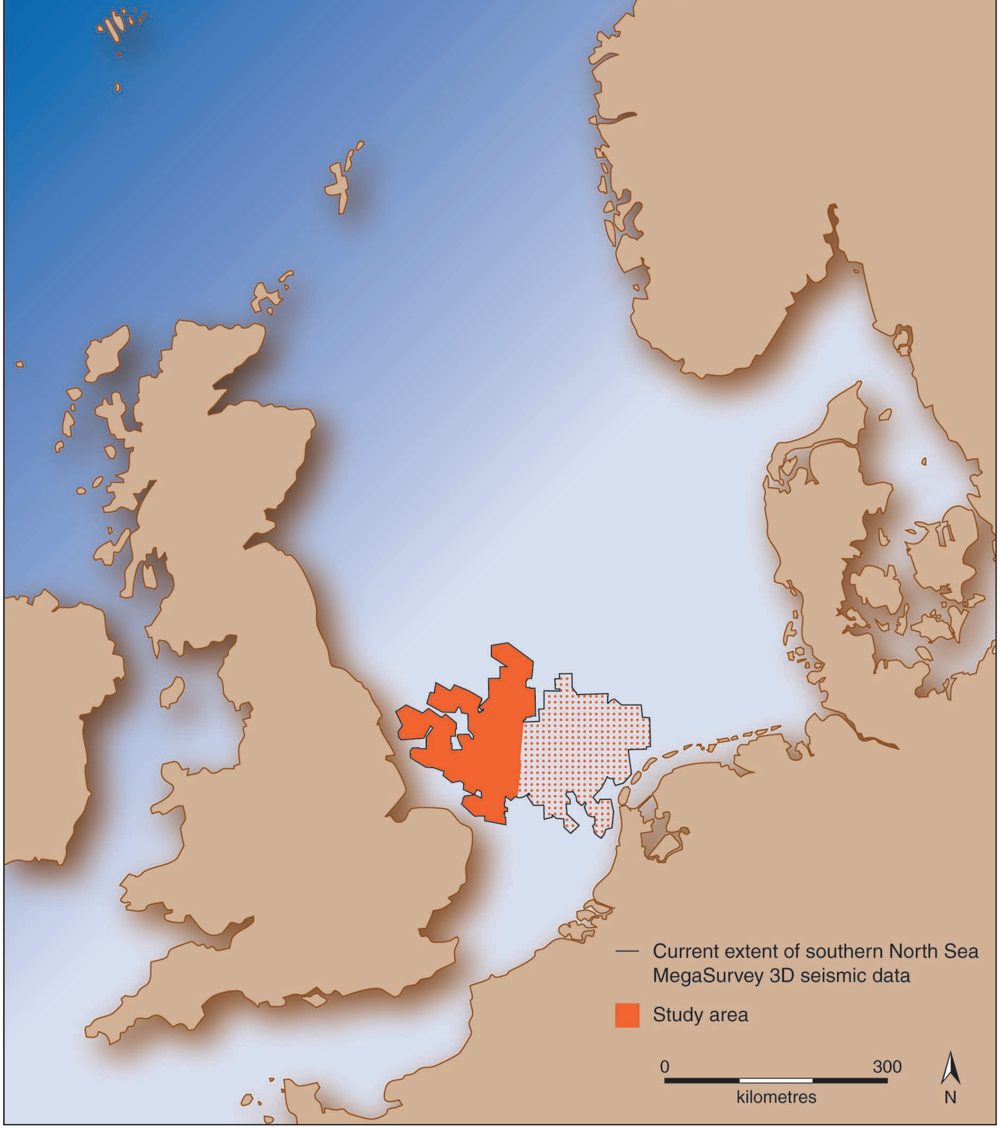


Figure 1.14 The first glimpse of Doggerland. The valley of a large river, later called the Shotton, can be seen snaking across the bottom of the image from left to right. There are small tributaries running into the main river on the left. The abrupt change in colours between left and right is the result of changing geology

Figure 1.15
The North Sea
Palaeolandscapes
Project study area



For example, the survey area is slightly smaller than Belgium and comparable to mapping an unknown prehistoric country the size of Wales. The idea of exploring a new country and mapping, and naming, previously unknown hills, rivers and valleys was particularly appealing. At Birmingham the original PhD research team was reformulated as the North Sea Palaeolandscapes Project (NSPP) and four people, including senior researcher Simon Fitch, Kate Briggs, Mark Bunch and Simon Holford, plus the project directors, Vince Gaffney and Ken Thomson, set out to map the whole of this vast seismic data set in only eighteen months. Alongside these was a team of palaeoenvironmentalists tasked with providing evidence on the environment and vegetation of the new land. These were David Smith, Andy Howard, Ben Gearey, Tom Hill and Christina Jolliffe.

The results of all this work will be presented later in the book. To begin with we need to look in more detail at what constituted our idea of the British Mesolithic prior to work at Birmingham. Following that, we can consider how Doggerland was mapped and the significance of this new information for our understanding of the Mesolithic of Britain and north-west Europe.

Professor Fred Shotton

Fredrick William Shotton was born in Coventry and was inspired in his enthusiasm for natural history, geology, fossils and archaeology by his friend Jack Edwards, a boot repairer (Figure 1.16). A childhood stay in Switzerland inspired a fascination with the Ice Age. Following studies at Cambridge he taught at the universities of Birmingham and Cambridge from 1928 to 1940. During the war Shotton served as a military geologist in north Africa and the Middle East, locating water supplies for the army. He mapped the geology of the beaches of northern France prior to the D-Day landings in order to assess those areas that might present problems for heavy vehicles. Following the war, Shotton was appointed Professor of Geology at the University of Sheffield, and from 1949 until his retirement in 1974 he was Lapworth Professor of Geology at the University of Birmingham.

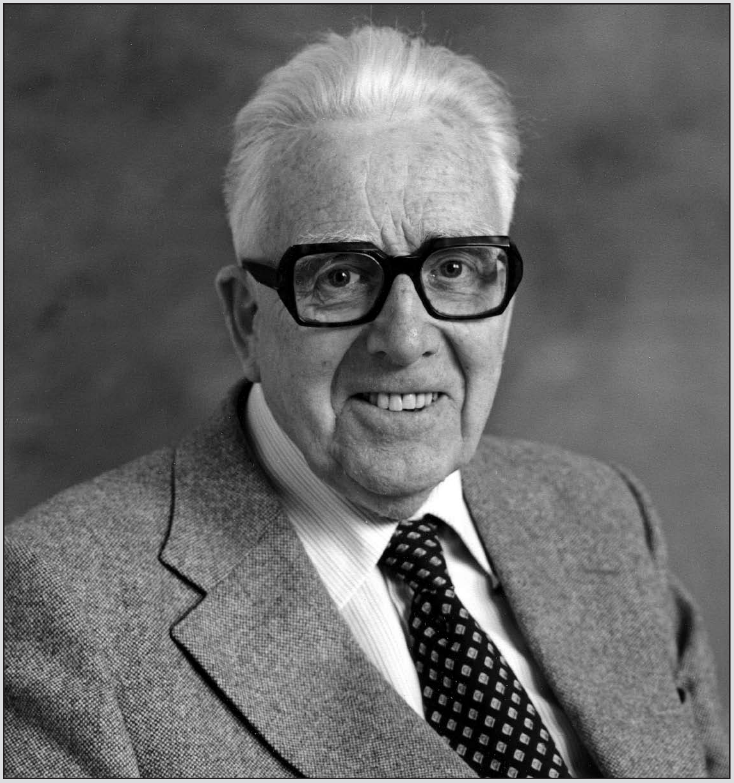


Figure 1.16 Professor Fred Shotton (1906–1990)

Professor Shotton's major contribution was the study and interpretation of the complex Pleistocene sequences of the Midlands. This included studies of deposits associated with the palaeoriver, the Bytham, shown in Figure 1.17. Some 500,000 years ago the Bytham drained from the south-west Midlands and the Pennines through Warwickshire and parts of Leicestershire before turning south through mid-East Anglia and eventually eastwards into what is now the North Sea but was then dry land. The river was probably one of the most important routes of colonisation for Britain's first human inhabitants. One of Shotton's most significant discoveries was made towards the end of his life at Waverley Wood Farm Pit in Warwickshire, near the Bytham.[45] During a field trip to this gravel quarry with the Midlands group of the Geologists' Association in the late 1980s, he observed fossil exposures which are now recognised as a crucial archaeological site relating to the earliest human colonisation of Britain.[46]

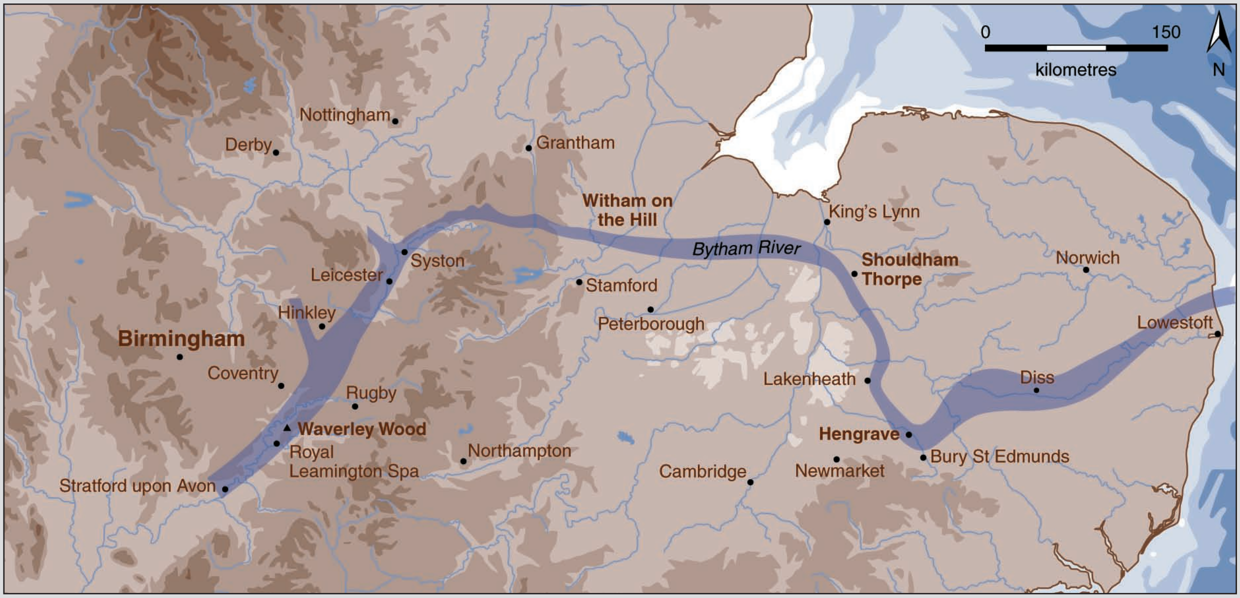


Figure 1.17 The Bytham River and Waverley Wood

Notes

1. The first recorded reference to submerged forests in Britain appears to be in Giraldus Cambrensis's *Itinerarium Cambriae*, dated to 1191 and cited in Bell's excellent book on the Mesolithic of Western Britain (2007, 1). Here Giraldus makes reference to the deluge of Noah as a cause for the loss of the forests. However, he also appears to accept that the inundation of the forests may not simply have been

the consequence of divine intervention but that natural processes might have had a role in their creation.

> We then passed over Niwegal sands [near St Davids, Pembrokeshire], at which place (during the winter that King Henry II spent in Ireland), as well as in almost all the other western ports, a very remarkable circumstance occurred. The sandy shores of South Wales, being laid bare by the extraordinary violence of a storm, the surface of the earth, which had been covered for many ages, re-appeared, and discovered the trunks of trees cut off, standing in the very sea itself, the strokes of the hatchet appearing as if made only yesterday. The soil was very black, and the wood like ebony. By a wonderful revolution, the road for ships became impassable, and looked, not like a shore, but like a grove cut down, perhaps, at the time of the deluge, or not long after, but certainly in very remote ages, being by degrees consumed and swallowed up by the violence and encroachments of the sea.

Giraldus Cambrensis, *Itinerarium Cambriae* (Book 1, chapter XIII, http://historymedren.about.com/library/text/bltxtitineraryi13.htm)
It is, perhaps, interesting that most British folk references tend to link these mysterious trees with the biblical flood rather than any other, indigenous tales of undersea kingdoms. Despite this, it is not true that there are no traditional tales of lost lands in the British Isles. Notable examples of such myths include the sunken island of Lyonesse off the Scillies, and the Irish Tír na nóg or St Brendan's Isle. Charles Kingsley, amongst others, connected these British tales with classical traditions in his wonderful Darwinian children's tale *The Water Babies*, published in 1863:

> on still clear summer evenings, when the sun sinks down into the sea, among golden cloud-capes and cloud-islands, and locks and friths of azure sky, the sailors fancy that they see, away to westward, St. Brandan's fairy isle.
>
> But whether men can see it or not, St. Brandan's Isle once actually stood there; a great land out in the ocean, which has sunk and sunk beneath the waves. Old Plato called it Atlantis, and told strange tales of the wise men who lived therein, and of the wars they fought in the old times. And from off that island came strange flowers, which linger still about this land: the Cornish heath, and Cornish moneywort, and the delicate Venus's hair, and the London-pride which covers the Kerry mountains, and the little pink butterwort of Devon, and the great blue butterwort of Ireland, and the Connemara heath, and the bristle-fern of the Turk waterfall, and many a strange plant more; all fairy tokens left for wise men and good children from off St. Brandan's Isle.

What is most interesting is that these indigenous tales appear to occur only within the western parts of the British Isles. Whilst there is incontrovertible evidence for land loss in the west (the area of Liverpool Bay deserves specific mention), the lack of any comparable tales in the east where we have the best evidence for extensive land loss seems anomalous. Certainly, the situation contrasts with other parts of the world which were similarly affected by flooding following the last Ice Age and which preserve some memory of the events through tales and myths. Stephen Oppenheimer, for instance, has collated flood tales from many parts of the world in *Eden in the East*, his book discussing the inundation of the Sunda Shelf (1998). One explanation for this situation, raised during discussion between the authors and Clive Waddington, is that repeated invasions of the east coast during the late Roman and early medieval periods may well have been significant enough to disrupt regional myth cycles to the extent that these tales were simply lost. In contrast, the continuity of Celtic culture in the west of Britain may well have retained these folk memories. Consequently the tales we do have may once have been a part of a much larger mythic tradition which has now been lost. Archaeologically, the repeated association of 'special deposits' with water during many periods of British prehistory might also indicate a ritual or mythic concern with water but to associate this with an earlier period of inundation would be overly simplistic (Bradley 1990).

2. Reid 1913, 2.
3. J E M and E T N 1917.
4. Frere 1800.
5. Stringer 2006, 84. Chris Stringer's excellent book is one output of the Leverhulme Ancient Human Occupation of Britain (AHOB) project which, over five years, has been studying early colonisation in Britain, and what factors promoted survival or local extinction. Information on this, and the successor project AHOB 2, can be found at http://www.nhm.ac.uk/hosted_sites/ahob/AHOBI/index_2.html.
6. Stringer 2006, 8.
7. MacDougall 2004.
8. Daniel 1978, 61; Stringer 2006, 17–18.
9. Huxley 1863.
10. Daniel 1978, 44–53.
11. Renfrew 1973.
12. J E M and E T N 1917.
13. Reid's interest in submerged forests may well have been spurred by his involvement in the investigation of the geological strata exposed during the construction of Barry Docks in 1895 (Strahan 1896). This sequence included an exposure of a submerged forest and Reid provided a report on the plant macrofossils for the final publication.
14. Reid 1913, 5.
15. Reid 1913, 32.
16. Reid 1913, 38.
17. Reid 1913, 9.
18. Parfitt *et al* 2005; Stringer 2006, 45–51.
19. Coles *et al* 1992.
20. Reid 1913, 113.
21. Reid 1913, 120.
22. Muir Evans 1932, 131.
23. Muir Evans 1932, 131–2.
24. Housley 1991. Ward *et al* (2006, 215) have studied the available dating evidence for the southern North Sea and have concluded that, if the details of the find are

accurate, the date for the Dogger Bank point appears to be an outlier to the general sea-level rise curve. Consequently, they suggest that the artefact may be reworked older bone or that there is an error in the dating.

25. Muir Evans 1932, 131.
26. Burkitt 1933.
27. Burkitt in Clark 1932, xiii–xiv.
28. It should be said that a reviewer in the Proceedings of the Prehistoric Society of East Anglia was not entirely convinced by Clark's thesis: '… it is not an easy matter to envisage Mr Clark's Great Divide, for in the present state of our knowledge it is not easy to see exactly where the Great Divide – if there be one – between the Upper Palaeolithic and the so-called early Neolithic or Mesolithic is to fall' (ASB 1932).
29. Clark 1932, 7.
30. Clark 1932, 115.
31. Godwin and Godwin 1933.
32. Smith 1994, 8; Smith 1997.
33. Clark 1933.
34. Clark *et al* 1935.
35. Clark 1936, xiii.
36. Clark 1936, 23.
37. Louwe Kooijmans 1971.
38. Coles 1998.
39. Ward *et al*'s recent review of the chronology of sea-level rise demonstrates that we only really understand the progress of inundation in the broadest sense. They suggest that fully marine conditions had been reached by *c* 6555 BP and that the Dogger Bank itself must have been fully submerged by 6000 BP but they state that a more comprehensive dating programme will be required in order to understand the dynamic relationship between sea-level rise and plant, animal and human colonisation of the region (Ward *et al* 2006, 214).
40. Coles 1998, 77.
41. Flemming 2004; Waddington and Pedersen 2007.
42. Gaffney *et al* 2007.
43. PGS, or Petroleum Geo-Services (www.pgs.com), is a company principally involved in providing geophysical services worldwide. The company provides a broad range of geophysical and reservoir services, including seismic data acquisition, processing and interpretation plus field evaluation.
44. For general details of the Aggregates Levy Sustainability Fund see http://www.defra.gov.uk/environment/waste/aggregates/index.htm. For details of English Heritage's involvement in the fund see http://www.english-heritage.org.uk/server/show/nav.1315.
45. Stringer 2006, 44.
46. For more information on Shotton and his work in the Midlands see 'The Shotton Project' web site at http://www.arch-ant.bham.ac.uk/shottonproject/profshotton.htm.

CHAPTER TWO

Through a glass, darkly: the idea of the British Mesolithic

Strangers in a strange land

For most people their first, and possibly last, contact with the Mesolithic period may well be through the glass of a museum case. A few pieces of flint or perhaps some worked bone might equally be the sum of such an encounter. A keen visitor may also have read that the period was the last in Europe defined by the universal pursuit of hunting and gathering as a subsistence activity. Lasting between about 10,000 BC and 4000 BC, according to geographical position in Britain, the period drew to a close with the successful and lasting introduction of farming and a largely settled lifestyle. Such displays rarely capture the imagination of the general public. The majority of visitors will undoubtedly be drawn to the more visually stimulating relics of later eras. It is an exceptional person who stands beside these cases and believes they can discern, reflected dimly by the artefacts on display, one of the most exciting eras of human prehistory.

This situation is hardly surprising as until comparatively recently archaeologists have also frequently struggled to define the period adequately. Even today, period experts occasionally represent the Mesolithic as a transitional stage in environmental and cultural terms. In some sense this may be correct. For instance, the period is characterised by rapidly changing climatic and environmental conditions following the last Ice Age. Over time, the landscapes adjacent to the

North Sea morphed from bleak tundra to the temperate forest we are reasonably familiar with today. This period also corresponds to the apparent decline (and some might equate failure) of the hunting and gathering lifestyle that had been pursued by the emergent human race over many hundreds of thousands of years. The same period, as we saw in chapter one, also corresponded to a point in time when the very shape of mainland Europe changed dramatically. There was no island Britain at the start of the Mesolithic but by the end of the period Europe was recognisable as a geographic entity. It is a cliché to say that the past is a foreign country, but, unlike succeeding periods (the Neolithic, Bronze and Iron Ages), for much of the period the Mesolithic was truly foreign. Its climate, its pastimes and pursuits were not familiar to us. Even the shape of the known world was different. The problems generated by a lack of familiarity with the period are, perhaps, exacerbated by the concept of the Mesolithic as a period of transition. Indeed, some of these issues are comparable to those mentioned in connection with Doggerland's previous designation as a land bridge.[1] The difficulty with presenting any cultural period in such terms is that it may suggest that the most important points to define are those where the transition begins and ends. The processes in between are sometimes considered less important or even ignored. Consequently, one occasionally gets the feeling when reading archaeological text books that the Mesolithic was merely something that had to be passed through, possibly until the world became one that the authors felt more familiar and comfortable with.

Figure 2.1 'Cheddar Man': the most complete human skeleton of the Mesolithic period to have been found was originally considered by antiquaries to be of Palaeolithic origin[3]

For certain, this situation is not helped by the nature and extent of the archaeological evidence for the period. In comparison with later periods the Mesolithic is characterised by relatively small numbers of sites either known or explored. Many sites are only represented by individual finds or as unstratified lithic scatters eroding from peat or collected from ploughed fields by enthusiasts. In part this must reflect the relatively mobile lifestyles associated with hunter-gatherer societies but in the past this certainly led antiquaries to dismiss the Mesolithic period simply as unsophisticated. Whilst a number of these preconceptions have been dispelled over time it is slightly ironic that some of the evidence that previously defined the Mesolithic as culturally impoverished now actually hints at the potential wealth of the period. 'Classic' evidence for social complexity during the preceding Upper Palaeolithic formerly included Cheddar Man, found in 1903 in Gough's Cave in Somerset and for some time believed to be Britain's oldest complete burial (see Figure 2.1). Modern dating has undermined this claim and today it is regarded as a rare example of a Mesolithic interment dating to some 9000 years ago![2]

Following this, the period has hardly been helped by the generally utilitarian approach of many archaeologists to the limited evidence for the period.[4] The content of museum cases largely reflects the durable nature of stone and bone rather than life during the early Holocene. One consequence of an apparent dearth of information and a surfeit of tools without any adequate context was that too many Mesolithic scholars have pursued research that solely focused on the study of surviving artefacts and their economic role. The limited and ephemeral evidence for settlement has also frequently been interpreted only in terms of the requirements of a seasonal never-ending, and apparently mindless, round of mobile hunting and gathering. Consequently, Mesolithic research has remained essentially an environmental study and fundamentally determined by those economic and subsistence practices that archaeologists believe they can interpret most easily using the meagre available evidence. In some ways Mesolithic communities have been researched much as we might approach the study of sophisticated animals. The implicit assumption of much work is that only the daily grind of existence had any value or relevance to explaining past actions and, consequently, most people could rarely imagine life as a Mesolithic hunter-gatherer being anything other than 'short, brutish and nasty'.[5] Our concept of life during the Mesolithic has been so limited that one archaeological wag pithily suggested that whilst farmers have social relations, Mesolithic hunter-gatherers appear to have had relations only with hazelnuts!

Of course, life in the early Holocene must have been hard, yet there are good reasons to believe that Mesolithic life was as rich, in social terms, as most pre-modern societies.[6] In particular, ethnographic study of historic or surviving hunter-gatherer groups has helped us to reconsider how we imagine Mesolithic communities may have lived. Although once a global way of life, hunting and gathering has now almost disappeared and surviving communities represent an incredibly small part of the world's population, possibly as little as 0.001% of the total.[7] Pressure on land has forced many of these societies into marginal areas and it is unlikely that any pristine groups actually survive today. Despite this, ethnographic studies demonstrate that modern hunter-gatherer groups are not impoverished, socially or materially, and the evidence suggests that we should not presume otherwise for past societies. Ethnographic research, and exceptional examples of preserved historic finds, clearly indicate that hunter-gatherer societies could possess a sophisticated array of tools and weapons, clothes and containers that were made of organic materials which simply have not survived. These societies also require complex social systems. Hunter-gatherer groups actually spend a considerable amount of time socialising: visiting friends and relations, playing games and even gambling. Gender differentiation is apparent in all of these groups and the complex webs of social relationships that exist within families, or between kinship and tribal groups, are fundamental to understanding present and past hunter-gatherer lifestyles. Equally important is the complex relationship between communities, the landscapes in which they live and the pervasive awareness of the spirituality of the material world that governs and guides their actions. The flints and bone tools studied by archaeologists today are meagre residues of a rich and complex past.

As a consequence of this emerging appreciation of the complexity of past lifestyles, recent studies of the British Mesolithic have begun to investigate the larger social context of the period.[8] There has been an increasing emphasis on understanding how hunter-gatherers lived in their landscape and how their actions shaped the world around them.[9] There has even been a modest growth in the public's interest in hunter-gatherer skills promoted by the media through, for instance, Ray Mears' television programmes on 'bushcraft'.[10] Despite this, Professor Steve Mithen, one of the foremost experts on the period in Britain, suggested recently that of all periods in prehistory, the Mesolithic was least understood and still required the most research.[11] What then do we *think* we understand about the period?

To begin with we should consider a number of empirical issues associated with definitions and chronology. Whilst the Mesolithic can be roughly defined as the final period when hunter-gatherer lifestyles were dominant and which fell between the Palaeolithic (Old Stone Age) and the Neolithic (New Stone Age), the precision in such a statement is more apparent than real. For example, the adoption of agriculture in north-western Europe, which we presume signifies the end of the period, did not occur in a synchronous nature, but rather over a lengthy period of time and it may have been a very regional development. Although archaeologists conventionally suggest that the Neolithic begins around *c* 4000 BC, the adoption of a full Neolithic lifestyle may not have occurred until much later than this in many areas of Britain. Social and economic development may also have been piecemeal and regional rather than the rapid and comprehensive 'revolution' that is implied in old textbooks. The complex picture that we now have of early Neolithic Britain is prompting archaeologists to debate how and why farming was adopted rather than just when it happened. In some areas there may have been a long transition and agricultural skills may have been learnt by indigenous groups or involved the real movement of people, animals and skills. Equally, the adoption of agriculture may not have been simply a question of economics. Recent research suggests that grain may well have been regarded as a special foodstuff rather than a staple well into the Neolithic.[12] However, more recent studies of charred plant remains from Neolithic contexts in Britain suggest that the remains of cereals are as common in this period as they are in later periods such as the Iron Age and that charred plant remains occur regularly in 'domestic' as well as 'ritual' contexts.[13] Given that we have no reason to suggest that hunter-gatherer economies were deficient or incapable of supporting complex social systems, including some degree of sedentism, the reasons for acquisition of grain, and the skill to grow such exotic foodstuffs, may well have been as much social as nutritional.

Other characteristics of a Neolithic lifestyle, including the presence of permanent settlements, may have been emerging independently during the Mesolithic. There was certainly semi-permanent Mesolithic settlement at Mount Sandel in Ireland. Occupation here was based on the exploitation of runs of trout, salmon and eel in the nearby River Bann.[14]

At the other end of the period most archaeologists would utilise a start date for the Mesolithic of about 9600 BC, yet this is in part a palaeoenvironmental

Figure 2.2 Probable maximum extent of land during the late Palaeolithic. After Coles (1998)

construct rather than an absolute cultural divide. There is no obvious reason to suppose that the Mesolithic populations of the region did not develop from those of the later Palaeolithic but, of course, the material evidence does reflect in a fundamental manner the evidence for environmental change and the gradual warming of the northern climate after the last glacial maximum (*c* 18,000 BC). The occupants of Britain and Doggerland would have faced a bleak, glacial environment for much of this earlier period. Considerable amounts of water were locked within the ice sheets around the world and sea levels would have been more than 120m below present levels (see Figure 2.2),[15] creating a plain which stretched as far north as the Norwegian trench during the later Palaeolithic, an area far larger than that occupied by later Mesolithic hunters. These expansive and relatively flat lands would have developed a covering of grassland and scrub which would have supported a variety of animal species hunted by mobile bands of hunters. These would have included reindeer and the icon of the Ice Age, the mammoth.[16]

The barriers to occupation of these lands during the later Palaeolithic were the ice sheets themselves, covering parts of Scandinavia and northern Britain, but also, perhaps, the availability of fuel for fires. In other areas of the northern hemisphere, for instance in Siberia, the lack of kindling and other fuels was a primary factor limiting settlement rather than the low temperatures. The presence of possible late Palaeolithic flints in the far north, for instance on Stronsay,[17] suggests that it is possible that this plain was widely travelled and that even the extremities of this bleak landscape could have been visited at some point. Sites in the lowland areas of Britain, including Creswell Crags, also provide evidence for settlement after the last glacial maximum and the discovery of art engraved onto the cave walls at Creswell indicates that the occupants had time for cultural and ritual pursuits as well as hunting (see Figure 2.3).[18] However, it is important to note that the gradual warming after the late glacial maximum was not a continuous or linear event. There was a major cooling event between about 11,000 and 9600 BC, known as the Loch Lomond Stadial or Younger Dryas, and it is likely that some of the area was uninhabited during this period or that humans were present in such small numbers that settlement may be almost undetectable.[19]

These changes, which are so clear in the environmental record, are also reflected in the evidence for the economy. Although Mesolithic groups still

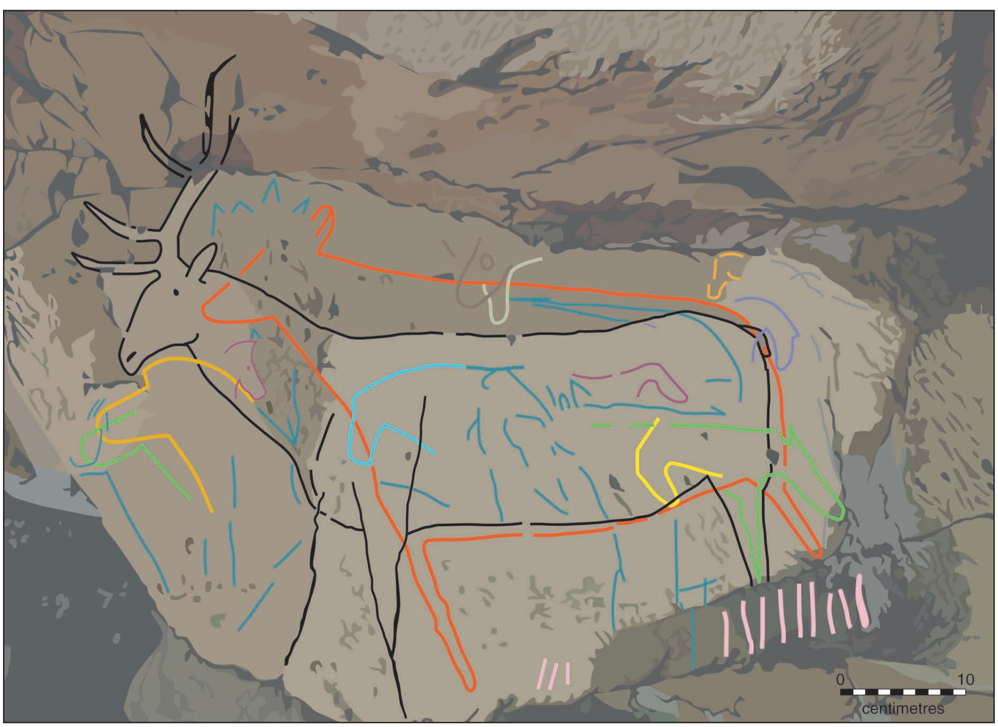


Figure 2.3 Cave engraving in Creswell Crags (Derbyshire) illustrating a stag and dated to 12,800 years ago (etching highlighted for publication)[20]

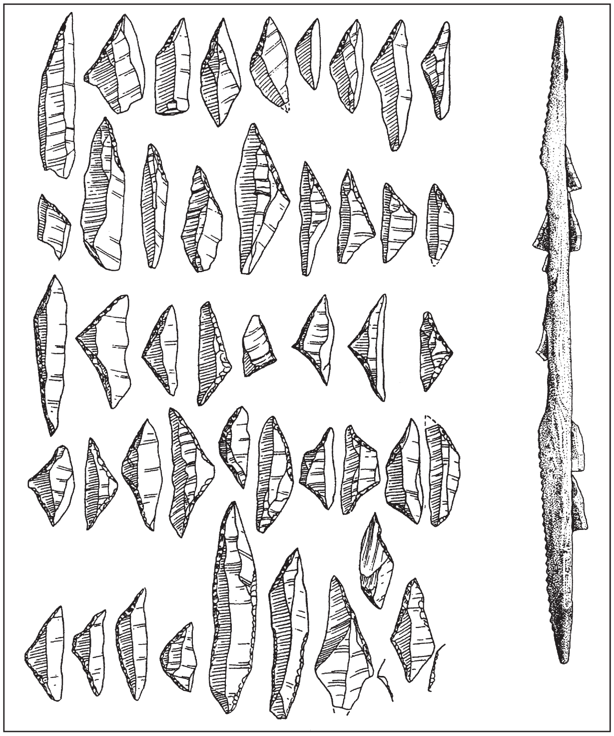


Figure 2.4 Mesolithic microliths. Above from Star Carr plus a Swedish example of microliths inserted into a shaft (after Pryor 2003, fig 14). Below are examples from the 2003 Doel Deurganckdok excavation (Belgium)

remained as dependent on wild food resources as their late Palaeolithic ancestors, the gradual transformation from open grassland to closed woodland, in line with the changed climate, affected people's lives dramatically. In general terms the large herd animals of the late Palaeolithic, such as horse and reindeer, would have disappeared and new forests, beginning with birch and pine and followed by oak, elder and elm, were then colonised by red and roe deer, bear, wolf, fox and hare. There would have been an abundance of wild plant foods to be gathered including the ubiquitous hazelnut! These woodlands eventually became the Mesolithic landscape and, however the period is defined, Mesolithic groups used this landscape successfully across Britain for about 5000 years.

Yet the Mesolithic was not monolithic and although problems associated with the loss of much evidence have been emphasised, the surviving material culture and the changing economic practices of the period permit subdivision. Given the nature of climate and environmental change it is no surprise that the 'early' Mesolithic toolkit shows close affinities to the preceding late Palaeolithic. This suggests a relatively smooth transition that need not require any change in population. However, close typological study of these flint implements has been used to define change within the Mesolithic.[21] Small flints known as microliths are the stone tools characteristic of the period (Figure 2.4). Usually only 2–4cm long, these chips of stone were probably used in 'composite tools'; the small chips could be embedded into wooden hafts singly, perhaps as an arrow point, or in rows to form a serrated or longer cutting edge. Although originally interpreted as a response to the changing hunting strategies associated with the emerging woodland, it is likely that microliths have a wide range of uses. However, they do change in size and shape across the period, becoming smaller and more geometric over time. Consequently, they are often used as a chronological marker and underpin the division of the period into an earlier Mesolithic (9600–7600 BC) and a later Mesolithic (7600–4000 BC). The period occupied by the Mesolithic is large. Indeed it is more than double the time that takes us from the present day to the beginning of the Roman period in Britain. So what was happening in Britain during this lengthy period?

It's the economy, stupid! Star Carr and dining out in Doggerland

To explain this and some of the problems faced when we try to understand the Mesolithic, it may be useful to return to our hypothetical regional museum. There is one other thing that the visitor is likely to see when visiting the Mesolithic gallery and that is an illustration, line drawn or watercolour, showing what appears to be a western nuclear family, dressed in skins set against a hide tent. The man will be heading off to hunt and mum will be at home with the kids scraping hides and preparing a meal. This is, of course, a stereotype but the picture betrays more than simply a formulaic approach to the past. Such stereotypes may often have a basis in truth but they also tend to be most successful when there is a vacuum of knowledge. It is an uncomfortable fact that the Mesolithic, perhaps above all other periods, has essentially been defined by its economic base and yet there are fundamental problems concerning our understanding of the economy of the period.

Traditionally, the available evidence for settlement and land use overall is often interpreted as representing a highly mobile, seasonal round of activities in which groups moved between larger base camps on or near the coast to smaller camps inland to carry out specialist tasks (Figure 2.5).[22] Tasks within this wide landscape varied from local hunting and gathering of plant foods to expeditions to procure raw flint from distant geological outcrops. Presumably the Mesolithic peoples would have possessed an impressive knowledge and intimacy with the landscape and its seasonal changes. Aside from knowing when and where it was best to hunt deer, these peoples would have invested the whole of the landscape with myth and meaning, little of which we can even guess at today.

Such interpretations are attractive because they are quite likely to be correct – to some extent. However, it is still a shock to realise that we actually have very little good evidence supporting past reconstructions of the economy or daily life during the period. The principal problem is that many, perhaps the majority of, sites have no surviving stratified deposits and fewer have any significant palaeoenvironmental potential, in terms of surviving bone or pollen, that can be used to construct accurate models of the economy or other social activities. The consequence of this situation has been for Mesolithic specialists to rely heavily on those rare sites where preservation is good.[23] Unfortunately, this frequently gives the impression that our knowledge is established and not contentious when,

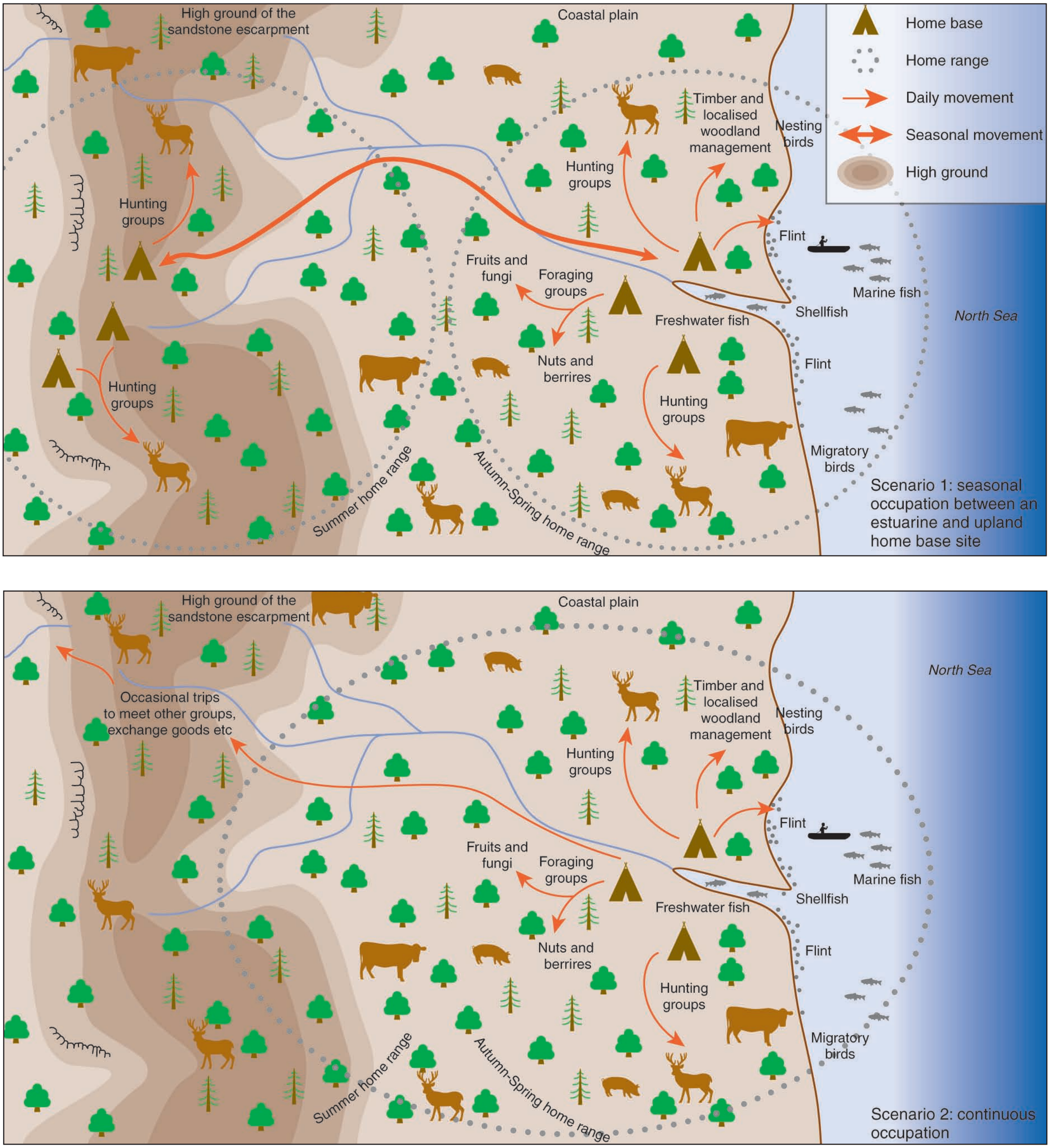


Figure 2.5 The seasonal round

in fact, it is frequently limited and often disputed. Despite this, the archaeological record provides 'hints' that allow us to glimpse something of the nature of the food supply during the Mesolithic and how that may have been exploited not simply in Britain, but also across Doggerland at this time. Surprisingly, this type of evidence also gives us the clearest view of how such a landscape may have been used seasonally.

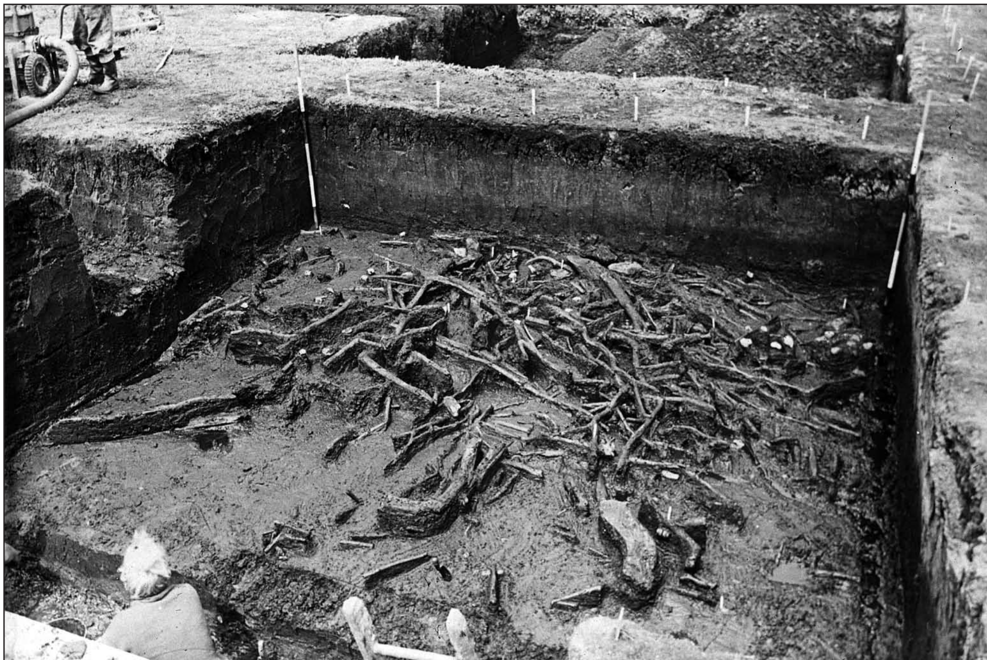


Figure 2.6 The wooden platform from Clark's excavations at Star Carr

Figure 2.7 A red deer frontlet from Star Carr

We can start to explore this evidence by looking at Star Carr, in the Vale of Pickering (Yorkshire, UK), a key site for the early Mesolithic in Britain but actually without equal in northern Europe. The site was excavated between 1949 and 1951 by Grahame Clark and was originally published in 1954. The excavation and publication of the work at Star Carr was very advanced for the time, particularly in relation to the treatment of the animal bones recovered. Unfortunately, Star Carr is probably now best known as a classic example of how the evidence from a site with exceptional preservation can be interpreted in a number of ways.[24]

Star Carr consists of a platform of rather rough branches of birch wood and brushwood used to stabilise the contemporary reed bed and would have jutted over open water (Figure 2.6). The platform, dated to *c* 8700 BC by radiocarbon dating, was associated with a dense scatter of artefacts including more than 14,000 stone tools, over 220 finished antler artefacts (mainly barbed antler points), bone mattocks and the now-famous set of red deer 'frontlets'. These latter objects consisted of the forepart of the deer's skull, with the antlers attached and pierced perhaps to allow the frontlets to be worn as a headdress (see Figure 2.7). These frontlets also were perforated at the front and it has been suggested that these were used as either hunting disguises or ceremonial headdresses.

The animal bone from the site was originally analysed by Frank Fraser and John King of the London Natural History Museum.[25] They found that only five species of large animals were present. The dominant species were red and roe deer, although elk and aurochs also occurred in some numbers, along with smaller amounts of wild boar. They looked at the pattern of how and when the deer antlers were shed and came to the conclusion that this suggested the site was occupied during the winter. This suited Clark's 1954 and 1972 interpretation of the site and how it fitted into a seasonal round. Clark saw small bands of people extending over the upland landscape in the summer as they followed the red deer. They then congregated during the winter months as the red deer retreated to the valley. The platform was therefore part of a small winter base camp.

Later workers in the field, notably Seamus Caulfield and Mike Pitts,[26] suggested that the animal remains could be interpreted in a different way. The main problem, they suggested, was that the large amount of red deer antler present on the site was clouding the issue. Instead, they argued that the site was best seen as a 'factory' for the manufacture of bone points rather than as a settlement or temporary camp. If this is the case, it is entirely possible that antler would have been kept (cached) as a resource for tool making. Equally, antler often needs to be softened before it can be effectively worked. One way of doing this is to put the antler into water for a long period. If so, the true function of this part of the Star Carr site, at least, might be very different from Clark's original supposition. Pitts suggested that the antler could have been brought to the site at any time of year and was, consequently, a very poor seasonal indicator. Equally, if the red deer antler is taken out of the picture it becomes clear that roe deer and auroch are the dominant sources for meat at the site. Pitts then suggested that the presence of unshed roe deer antler indicates that the site was occupied in other seasons rather than just the winter. The effect was twofold. Firstly, Clark's 'seasonal round' began to fail as an idea. Secondly, if the site was, in essence, a 'workshop' area of a larger settlement that was occupied all year round, it is possible that the food waste present may represent little more than 'packed lunches' or snacks rather than an average meal.

In 1988, Tony Legge and Peter Rowley-Conwy[27] published a re-examination of the animal bones from Star Carr. They studied the teeth in the jaws of both red and roe deer from the site and used these to age the individuals present based on the times of loss and replacement of milk teeth and the degree of wear. They then used this data to work out in which month of the year the individual animals were probably killed. This turned out to be primarily limited to the early and late summer. This is, of course, the opposite of Clark's interpretation. Legge and Rowley-Conwy suggested that Star Carr was simply one of a wide range of sites scattered across the moors and the Vale of Pickering in the summer. This raises the possibility that this group used areas of the North Sea plain adjacent to the coast during the winter.

Legge and Rowley-Conwy also came to the conclusion that the idea that Star Carr was a central base camp had to be discarded. The bones left on site at Star Carr were not primarily meat-bearing cuts such as the upper fore and rear limb bones, but the neck bones from beneath the 'saddle' of the deer and the ribs. These are the bones that are traditionally cooked 'on the joint' or are carried away after slaughter and the processing of the carcass. They suggested that the body parts present, head, pelvis, lower limbs etc, are typical of those elements left over after slaughtering and processing a carcass. Hardly what would be expected in a settlement or base camp (think about the bones you might find in your own rubbish bin). This leads to the conclusion that Star Carr, our best Mesolithic site, is little more that a rubbish tip left over from a hunting 'kill site'. This conclusion, however, was questioned by Paul Mellar and Petra Dark in 1998.[28] They noted that the site did actually produce a wealth of worked flint and antler and gave the impression of 'a scene of intense activity' (as Clark originally put it)[29] beyond that expected for a mere rubbish dump. One way around this might be to think about the 'factory' and 'waste dump' as two separate episodes of unrelated activity occurring at the same location.

What this debate demonstrates is the difficulty faced when trying to interpret this kind of evidence. It also flags up just how hard it is for us to gain an impression of the nature of settlement and land use in the Mesolithic even when Star Carr, which is a gem of a site, is a lynchpin in the discussion. One thing is striking though. There are no fish bones and little bird bone from the site (although sediments from the site were not sieved to recover these remains). Fish and birds are suspected to have been prime food resources during the period and, therefore, would be expected in the food waste from a hunting base camp. It is entirely possible, therefore, that we are attempting to generate broad interpretations about how landscapes were used seasonally, based on the results from an atypical site that may have been dedicated to point manufacture or meat processing. The absence of comparable sites for the period and the need to generalise from this single site, sitting as it does in splendid isolation, raises serious issues about whether we are actually misrepresenting the past. Despite this, Star Carr does, at the very least, hint at how early Mesolithic Doggerland may have been exploited and settled before the landscape was inundated.

One final aspect of Star Carr does need comment. This is the extraordinary find of the red deer frontlets. Clark suggested that these were used as hunting disguises. However, if Legge and Rowley-Conwy are right and the sites were occupied during the summer this seems a bit odd. It suggests that hunters were creeping through the undergrowth with unwieldy antlers strapped to their heads at a time when the deer do not actually have them. It may be that these unique artefacts were actually more likely to have been used in ceremonies and ritual and thus may be one of the few glimpses we have into Mesolithic life beyond the much-discussed topics of stone tool manufacture, resource exploitation and hunting.[30]

Shell middens

The 'later' Mesolithic in Britain has often been interpreted as a time of increasingly visible settlement and activity, associated with major economic change and

Figure 2.8 Caisteal nan Gillean I is a Mesolithic shell midden. It is pockmarked with indentations resulting from excavation trenches. However during the Mesolithic the site would have been perhaps 2m higher and more sharply conical

a marked divergence from cultural developments in Europe. Jacobi (1976) for example, concluded that such discrepancies were related to the submergence of parts of the North Sea and the increased difficulty of maintaining connections between Europe and Britain. However, some researchers note that the evidence for change is relatively limited, for instance in the development of stone tools and, specifically, smaller microliths. Another characteristic sometimes associated with the transition from the early to late Mesolithic, and often assumed to be a consequence of the change in sea level, is the assertion that there is an increasing focus upon coastal resources.[31] This shift has been interpreted as a response to higher population levels or movement linked to displacement caused by sea-level rise.[32]

A better indication of the range of resources that might have been exploited at Mesolithic sites can be gathered from a number of shell midden sites from later in the period (after 5500 BC). Shell middens examined in Scotland at Morton, Fife,[33] and on the island of Oronsay (Figure 2.8)[34] have all produced relatively large animal bone assemblages. Red deer, auroch and boar are present at Morton, but the occurrence of red deer in the middens on Oronsay is most unexpected, as it seems unlikely that such a small island could have supported a herd of red deer. This means that boats must have been used to mount hunting expeditions to the mainland and larger islands as well as for the capture of grey seal. The use of deep-water boats is also clearly suggested by the type of fish eaten at both sites. At Oronsay, coalfish accounts for well over 90% of fish bone and this species is only caught away from the coast. Similarly, at Morton most of the fish bone comes from deep-water cod. Indeed, the bone sizes suggest some of these cod were monsters and over a metre in length! These must have been taken from boats far from shore using long lines. The remains of these fish also give us some idea of the seasons during which these sites were used. At Morton this conclusion is based on the season the fish would have been present off shore. At Oronsay the estimate is based on the seasonal growth rings in the ear bones (otoliths) of the fish. At Morton it appears the sites were used mainly in the winter months, presumably with a range of inland resources being exploited during the summer. On Oronsay it seems that the middens formed part of a seasonal round, perhaps to ensure that resources in any one area were not over-exploited.

Of course, as the site types suggest, shellfish were also heavily exploited. Limpets, periwinkles, mussels and other shellfish were all recovered at both sites. At Morton crab also seems to have been frequently consumed. Cliff-nesting sea birds such as guillemot, gannet, cormorant and razorbill were also taken and eaten here. Similar shell middens occur in the late Mesolithic of Denmark and southern Scandinavia where the range of resources present seems to have allowed year-round occupation, with other sites in the landscape being used seasonally and as needed by smaller groups.

There is another aspect of these sites that deserves comment: an association between shell middens and human remains. It has already been noted that human burial, whilst generally rare during the Mesolithic across Europe, is very rare, but not unknown, in Britain.[35] However, some middens, including Ferriter's Cove in County Wicklow[36] and Cnoc Coig on Oronsay, incorporate fragments of human bodies within the middens, if not formal burials. It may be that these sites were regarded as appropriate for human burial and, given the fragmentary nature of the finds, possibly suggests that excarnation may have been practised – a process involving the exposure of bodies to allow the flesh to rot from them followed by the redeposition of the remaining parts of the body elsewhere. This hints at a degree of sophistication in terms of symbolic association with the middens that are, in some manner, one of the few permanent 'built monuments' created in the Mesolithic landscape and apparently linked with both consumption, and life and death. Of course, most of these middens date from the later Mesolithic and not the period of Doggerland but if excarnation had been practised earlier, the loss of the coastline along with any associated mounds may well explain why evidence for early Mesolithic human remains is so rare.

Unfortunately, such suggestions remain speculation because these 'shell midden' sites are from a later period. Information from these sites may not be directly comparable or indicate the way that seasonal food resources may have been used in the hills and valleys of pre-inundation Doggerland. Yet, in the absence of any other evidence, it is possible to draw general comparisons. Our current, partial, knowledge of the terrestrial economy, along with the emerging understanding of the nature and extent of lakes within Doggerland, indicates that seasonal resources including freshwater fish, salmon runs and migrating wild fowl may have shaped settlement and movement around the landscape to a profound degree. Equally, the inland valleys and plains of Doggerland may have had their own seasonal use or times of activities. Similarly, as the rising waters inundated the landscape, salt marsh formation and the appearance of coastal landscapes would have opened up a wealth of coastal resources to be exploited, at least during the short term, until they too were lost to the sea.

Whether the apparent changes in settlement density in adjacent countries around the North Sea is directly linked to the loss of Doggerland remains to be proven as, in reality, this process must have begun much earlier in the period. However, one thing is certain, the later Mesolithic is characterised by an increasing *visibility* of activity in landscapes that had previously been under-represented in the archaeological record, most notably in river estuaries, areas that had previously lain beyond the contemporary coastal margins. These largely unexplored areas would have provided a diverse range of resources that were unlikely to be ignored during any period of human occupation.[37] Once again, we should be cautious about the extent, or significance, of apparent change, as the current picture of the Mesolithic may well be the result of increased visibility of coastal resources and their exploitation rather than substantive economic change.

The use of plants

The discussion above tends to emphasise a meat- or fish-based diet. This is, of course, slightly misleading. Animal bone and shellfish preserve very well in the archaeological record, whereas the remains of plants do not. The principal cause of preservation for plant material is total carbonisation by burning but this is actually a very rare event. Consider, for example, how rarely when cooking, unless a first-year university student, you produce a totally carbonised potato or leek. The rarity of such events means that we really have little idea of the range of plants used routinely in the Mesolithic despite the fact that there are around 250 edible plants in the British Isles today.

Marik Zvelebil[38] and Gordon Hillman[39] recently studied these plants and managed to arrange them in such a way that it is possible to see how these could have been used seasonally. The availability of such an abundant and potentially important food supply was unlikely to be ignored. Not surprisingly there may be some proxy evidence to suggest that these foodstuffs were used. Microliths, the definitive tools of the period, may well have been mounted in wood to form 'graters' so that large amounts of wild plants and tubers could be processed at speed. If this is the case, it might suggest that plant resources were a prominent part of the life of the past.

Controlling the land and tending animals (perhaps)

The previous chapter has emphasised that the Mesolithic has not fared well at the hands of academics in the past. For the majority of time that the Mesolithic was actually recognised as a separate phase, it was a shadowy period for which there was little evidence. When it was recognised it was dismissed as 'savage' and at the bottom of the cultural ladder leading to civilisation. To a large extent

Clark's excavations at Star Carr, and those at the shell midden sites at Morton and Oronsay, have begun to change this perception. Even so, for much of the last 30 years, when the majority of academics now studying the period were educated, the period was regarded as a time where people simply 'used' the landscape as given. These communities were essentially regarded as slaves to the environment. This is a rather unattractive and bald view of the past. It certainly did not, and to some extent still does not, excite students. Yet this attitude has continued despite the fact that Mesolithic communities were innovative in the management and use of their environment and, in some ways, may have set the stage for later developments. It has been known for some time that, for instance, the dog had been domesticated during the early Mesolithic and was present at Star Carr. However, work over the last 20 years, mainly by palynologists, has begun to suggest that Mesolithic peoples may have actually manipulated and changed their landscape from the start of the period rather than just drifting through it like ghosts.

The research leading to this conclusion essentially started with the examination of an eroding peat surface at a range of sites in the North York Moors by Ian Simmonds and John Innes in the 1970s.[40] The site that produced the most spectacular sequence of deposits is Bonfield Gill Head. Figure 2.9 presents the summary diagram produced from the environmental analyses from this site.

Three aspects of the sequence in Figure 2.9 deserve specific comment and all, apparently, occur at the same time in the sequence. Firstly, there appears to be a considerable change in the tree canopy at the site over time. Oak, elm and beech all decline and are replaced by hazel in several periods, presumably in the clearings that were present in the woodland. At the same time, fragments of charcoal are clearly visible in the section and there are peaks in the amount of microscopic charcoal seen on the pollen slides. The latter phenomenon is

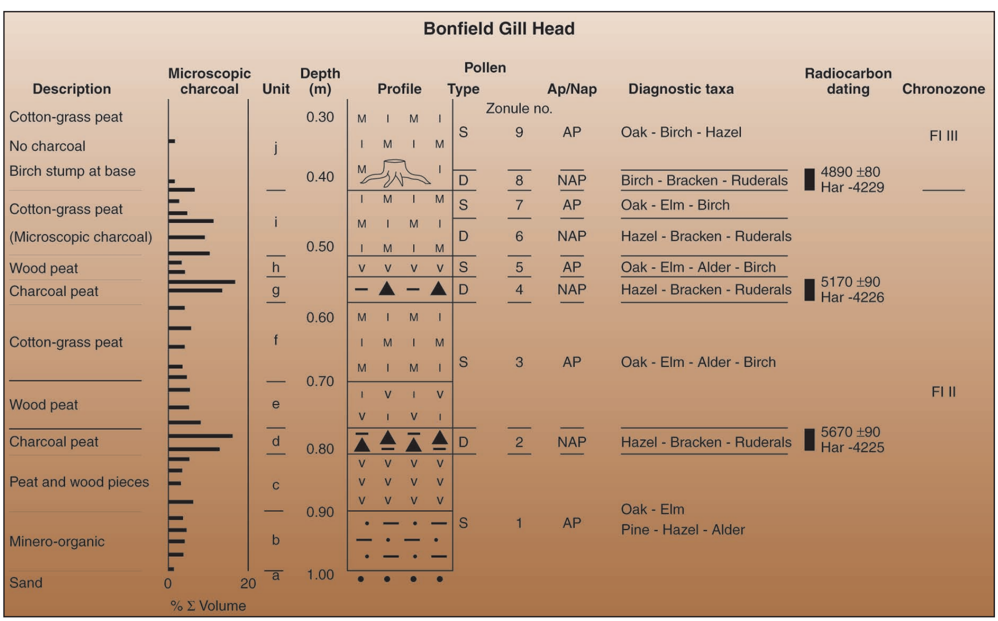


Figure 2.9 The archaeological and palaeoenvironmental summary from Bonfield Gill Head

thought to represent smoke. Innes and Simmonds concluded that the clearings and the fires recorded through the environmental analyses were related. They suggested that Mesolithic groups might have deliberately burnt the forest. Other studies from Dartmoor, Wales and the Weald to the south of London, as well as elsewhere on the North York Moors, saw a repeat of this pattern with clearings in the forest also linked to episodes of burning. Unlike Bonfield Gill Head, some of the sites were also associated with stone tools. At first it was thought that much of this burning and clearance occurred mainly in the later periods of the Mesolithic but recent work around London at Uxbridge and Thatcham in Berkshire has indicated that similar events also occurred at the beginning of the period. Regular burning events were also associated with the early Mesolithic platform site at Star Carr, where reed seems to have been managed through controlled burning. Goldcliff East on the Welsh side of the Severn estuary also has evidence which suggests that both reed and forest were burnt at around the same date.

Why did this occur? Paul Mellars[41] and Ian Simmonds[42] suggest that these fires were deliberate events and may indicate an attempt to manage and increase the herd size of wild animals in the area and to ease the difficulty of hunting. In 1976 Paul Mellars presented a range of ethnographic and historic work that suggested how such a strategy might have worked. When hazel is burnt it responds to fire rather in the manner managed woodland reacts to coppicing by a forester. Old stems are removed and over the next few years the hazel produces long whippy fronds covered in leaf. This would provide any deer, elk and other grazing animals with an increased food supply that potentially could support larger herds of animals. The availability of rich browse and grasses in a newly cleared landscape would, in turn, prove attractive to grazing animals. This would concentrate the wild herd into one area and would make hunting less hit and miss and a more predictable activity. Finally, the firing of forest clears out a lot of the undergrowth. This would make hunting, particularly with a bow, much easier. Water reed may also have been burnt to increase the nutritional value of the rhizomes (the vegetative roots) that are a good stable food source for gathering. Burning backwater reed would also create openings at the shore, providing easier access to the water for large animals and humans. If this interpretation of these burning events were correct it would suggest that Mesolithic communities were deliberately altering and controlling their environment throughout the whole of the period and across a large area of Britain. In the last fifteen years it has become clear that similar burning events occurred in Holland and Germany at the same time. Given that Doggerland lies directly between these two areas, it would seem logical that similar strategies and events probably occurred in the woodlands and marshes of the Doggerland Hills.

This does lead to the rather attractive suggestion that Mesolithic peoples were deliberately altering the woodland they inhabited and effectively started a process of 'nascent herding'. This is often seen as the precursor to the uptake of agriculture in the Neolithic. This exciting idea came to the fore with the work undertaken in the late 1970s and early 1980s in the Weald. Here, in addition to burning events, there is also apparently a rise in ivy pollen in the late Mesolithic. Simmonds and Dimbleby, writing in 1974, suggested that ivy and other vegetation was collected and gathered as fodder for deer herds, an activity that would not only attract animals but might encourage them to over-winter in an area. This, it was suggested, was just one step away from actively maintaining herds of wild animals as a formal strategy and establishing a loose notion of care for the herds. Significantly, this was also said to be comparable to the origin of the relationship between the Sami of Finland and their reindeer herds in the present day. The logical extension of this suggestion is to see these events as precursors to the adoption of agriculture and domestic animals along with the Neolithic agricultural lifestyle. The step from 'herding' deer to managing cattle and pigs in a similar manner would not be that great. In addition, if you are used to altering woodland and marsh vegetation to increase the productivity of natural plant resources, it is merely one more step to do the same with cereals.

Unfortunately, this is most certainly a fiction. There is no other evidence to support the assertion that the rise in ivy pollen indicates that any such process actually occurred. Indeed, the whole idea that 'deliberate burning' in the Mesolithic radically altered the whole landscape has recently been questioned. An alternative interpretation, suggested by Richard Tipping, is that burning events may result from natural forest fires during dry climatic periods. It is notable that these events seem to occur during two specific periods: the very early and very late Mesolithic.[43] Equally, Frank Chambers and colleagues[44] have suggested that the 'burning' could actually result from the repeated use of small fires at regularly used, but seasonal, campsites and living areas over long periods of time. Of course, none of this precludes Mesolithic groups from subsequently taking advantage of any clearance caused by accidental fires but it may be that the actual significance of these events has been overstated.

A home on the range?

Up until recently the majority of archaeologists would have discounted any suggestion that settlement during the earlier Mesolithic might have presented any characteristics of permanence. The assumption of mobility, largely presumed in the above discussion, dominated the models of Mesolithic land use. However, in other areas, in Scandinavia for instance, there is evidence for contrasting lifestyles. Here Nygaard has suggested that the settlements of the coastal regions were occupied year round, utilising only those resources found within the maritime zone.[45] Given the proximity and similarity of the North Sea region, it is possible that the contemporary occupants of the 'Doggerland' coastline might have followed this type of lifestyle and that the idea of highly mobile communities engaged in extensive travel to exploit seasonal resources may be less relevant than we currently believe. Indeed, recent discoveries at one site in particular suggests that we might expect significantly more complexity and diversity in economic and social practice during the Mesolithic than previously imagined.

Figure 2.10 Howick Mesolithic house during excavation

The Mesolithic site at Howick is located on the Northumberland coastline, 10m above the sea and on low sandstone and limestone cliffs.[46] The cliffs are interspersed with small sandy bays and a freshwater stream, the Howick Burn, discharges into the sea nearby. The same insidious process that destroyed Doggerland, sea-level rise, is threatening this site today but the scars caused by erosion recently led to the discovery of one of the most important Mesolithic sites found in Britain in recent years. In January 2000, Jim Hutchinson picked up a number of Mesolithic flints from material eroding from the cliff. These finds led to a trial excavation by Dr Clive Waddington and a small trench located several features of Mesolithic date. Given that the period is notorious for its lack of excavated features or structures these results were significant enough to lead to a focused investigation during the summer of 2002. A larger trench was opened next to the erosion scar on the cliff edge and this revealed, in addition to associated pits, a series of stains and postholes in the soil marking the presence of a circular Mesolithic timber house (Figure 2.10).

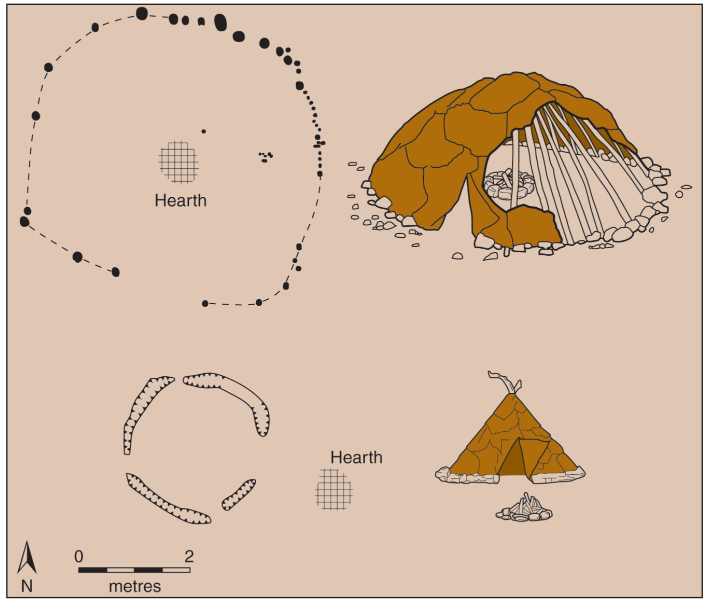
Although Mesolithic structures are known from Britain, they are relatively rare. Most archaeologists assume that this rarity reflects the nature of Mesolithic lifestyles and that settlement, at best, involved impermanent structures, possibly like wigwams or modern 'benders' (Figures 2.11 and 2.12). Such ephemeral buildings are not likely to leave much of a trace other than, perhaps, the odd stakehole or pit and a scatter of artefacts showing where people worked and dropped things. In these situations archaeologists can only infer the presence of buildings or tents from the distribution of excavated artefacts.

A site that illustrates the problems of survival is that at Thatcham in Berkshire.[47] Thatcham, like Star Carr, stood at the edge of a former lake and in a birch wood.

Excavations by Professor John Wymer in 1957 recovered thousands of pieces of worked flint and bone waste (deer and wild pig) associated with a sequence of hearths dated to *c* 8000 BC.[48] However, the presence of a hut is inferred from the distribution of flints at the site and a noticeable void in the scatter of flints may have held a hut measuring perhaps 6.5 ? 5.5m (Figure 2.13). Thatcham is, again, interpreted by archaeologists as a base camp that people visited regularly. However, settlement was not believed to be in any sense permanent and inferred structures were probably ephemeral.

The Howick hut, which was about 6m in diameter, is different. It would have had posts supporting a steeply pitched and presumably thatched roof. Although truncated by erosion, the Howick structure still possessed accumulated floor deposits of approximately 0.5m, making this one of the best preserved Mesolithic dwellings ever found in the United Kingdom. Unfortunately, because of erosion, it was impossible to determine if there was a group of structures present at the site or whether this house stood alone within the Mesolithic landscape. Either possibility is intriguing. The hut at Howick was clearly a much more substantial structure than any previously discovered and, to the excitement of academics, Clive Waddington's detailed excavations and radiocarbon dating of hazelnuts recovered from the site dated the hut at *c* 7800 BC.

All the evidence suggested that the house had been maintained and rebuilt on several occasions by a family group,[50] perhaps six to eight people, and that it served several generations of hunters. Unfortunately, despite Howick's proximity to the sea, the site still suffers from the lack of preservation that



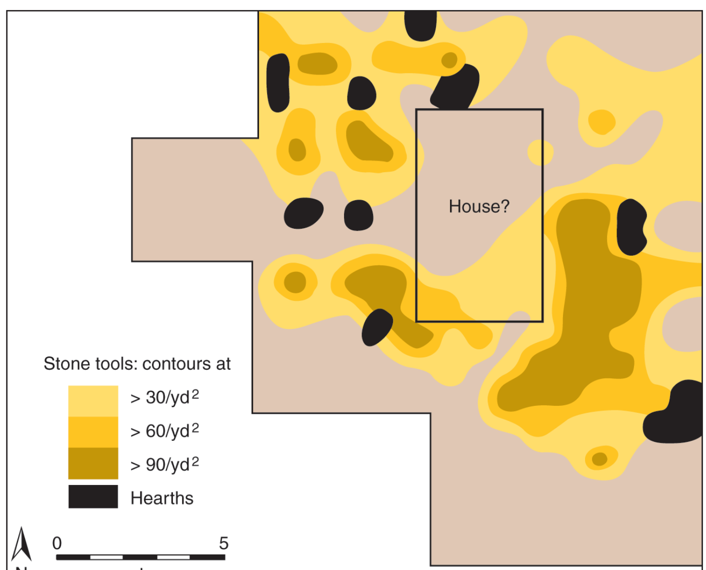


Figure 2.11 Structures at Mount Sandel, County Antrim, Ireland
Figure 2.12 'Bender'-type tent, Seaton Den, near Arbroath, Angus[49]
Figure 2.13 Distribution of artefacts at Thatcham, Berkshire

characterises most terrestrial sites of this period. Finds from the site included more than 18,000 worked flints but materials such as wood, plant fibres and other organic materials have completely disappeared. Even bone is not well preserved on the site although burnt bone fragments included wild pig, fox and, possibly, a domestic dog. Marine shellfish, particularly dog whelks, were also present on the site but not in stratified deposits. Consequently their use, either as a foodstuff or, perhaps, as fishing bait, is uncertain.

Despite these difficulties the discoveries at Howick suggest a degree of sedentism not previously appreciated in Britain. Generations of hunters must have lived here and this has fundamental implications for how we interpret Mesolithic remains from elsewhere and also what we believe may have been happening in Doggerland at the time. Howick is, fortuitously, located at a relative 'zero' position in terms of sea-level rise for the period.[51] Whilst the land to the south has been impacted by rising sea levels and the relative sinking of the land, the removal of the great ice sheets has been followed by readjustment and raising of land in Scotland and the North. Howick, however, sits at a point that was almost in equilibrium. The settlement was always near the sea and, given the proximity and similarity of coastline and environment to the lost lands, the site acts as a useful analogy for contemporary occupation in Doggerland. We can imagine that the coastal location, above a small estuary, would have provided access to many resources, potentially including red deer, roe deer, pig, wild cattle, nuts, berries, fruits and other edible plants. The Howick Burn or other wetlands could provide reeds (for basketry), fish and fowl, while the cliffs, rocky foreshore and coast could provide shellfish, seaweed, seal, sea birds, sea fish and mammals, and access to runs of salmon and sea trout. If ever there were a site whose natural wealth might encourage sedentism, Howick is a potential candidate on all these grounds.

Further discoveries of comparable structures have recently occurred as far north as East Barns on the east coast of Scotland.[52] Here work has revealed a substantial hut, only slightly smaller than that at Howick and associated with dates centring around 8000 BC. At a slightly later date, semi-permanent structures occurred at Broom Hill in Hampshire (7610–7300 BC) and around 7500 BC at Mount Sandel (Figure 12.11), in Ireland.[53] In the latter case an increasing intensity of occupation appears to have been made possible by the rich fish runs in the River Bann. This may have enabled hunter-gatherer communities to stay in the same place for extended periods of time. Several different types of house have been excavated at Mount Sandel; some indicated by little more than circular gullies enclosing hearths. Presumably the gullies were dug to carry water away from the tents which would have surrounded the hearths. Other circular or oval structures were defined by angled stakeholes that suggest bent poles covered with hides. These structures average 5m in width and are not so different in area to the structure at Thatcham but they are still relatively slight constructions and tend to support the idea of transient settlement.

All these sites suggest that the phenomenon of large house structures was not purely a localised innovation but the dating evidence suggests that sites with such structures appeared over a relatively short period of time – the first half of the 8th millennium BC. Why this should be the case is clearly a crucial question. When attempting to answer this we should be cautious about simply suggesting that a superfluity of good things leads directly to sedentism. If this were the case we might expect much more evidence for structures in the later Mesolithic than we actually do. Intriguingly, Clive Waddington has suggested that the creation of these substantial structures, for the first time in the history of Britain, might also be interpreted as a social response to rising sea levels.[54] Their construction may reflect the need to assert a strong relationship with land that was increasingly under pressure from the rising sea. It is not impossible that the requirement to establish a degree of ownership over land, for the first time in history, might have resulted from pressure upon groups forced to migrate because of the effects of sea-level rise. If true, the social implications for the development of human societies in Britain are substantial. The origin of important social concepts such as sedentism and land ownership, which are most usually associated with the introduction of agriculture nearly 4000 years later, may have to be re-evaluated.

Figure 2.14 Situation of the Howick hut

Howick is an intriguing site that raises many questions about settlement in Doggerland but the fundamental problem remains that, despite the frequency of chance finds from the North Sea, no settlements have currently been found in Doggerland to test any of the hypotheses made by archaeologists.[55] However, there is one Mesolithic site within British waters that is beginning to provide some clue as to the potential, and the challenges, provided by underwater sites of this period.

Bouldner Cliff (Figures 2.16–2.18) is located a few hundred metres from land and 11m below sea level in the Solent channel off the west of the Isle of Wight in southern England.[56] The coast at Bouldner has evidence for a

Figure 2.15 Reconstruction of the Howick hut – the symbolism of such a structure within the Mesolithic landscape must have been striking

submerged forest but, in 1998, a routine diving survey by Gary Momber, Director of the Hampshire and Wight Maritime Archaeology Trust, in conjunction with volunteers, recorded flints excavated by a lobster from a burrow in a submerged cliff! During 1999 the site was cored and more flints recovered, many of which were remarkably fresh. In 2003 funding by English Heritage allowed an excavation and the divers exposed an area of flint working associated with a hearth. Organic finds, including the Mesolithic staple, the hazelnut, were also recovered. Further work in 2004, next to a pit containing worked flint, located a timber structure which was later interpreted as a platform. Wooden poles and wooden fragments were also recovered and may have come from a house and canoe. Perhaps the most evocative find from the site was a worked flint found embedded in a wooden post, presumably the remnant of tool breakage during a period of woodwork during the Mesolithic. The diving team also carried out another excavation on a site 275m (300 yards) away, which, though not so well preserved, may have been on the banks of a river. These two sites may well have been linked with the larger site: perhaps one was a settlement and the other related to the occupants' fishing activities.

The excavations at Bouldner Cliff recovered not only archaeological finds but also sediment samples for palaeoenvironmental analysis so that the past landscape could be investigated. This important analysis of plant, pollen and insect remains revealed a changing environment, with pine forests being slowly replaced by oak and hazel. The evidence for sea-level rise can be seen with the formation of brackish environments and tidal flats before a marine environment is finally established.

Bouldner is significant not just for the organic finds it provides. As Britain's first underwater Mesolithic site it provides important information on the challenges that archaeologists will face whilst attempting to explore underwater prehistoric sites. Such work is more advanced in Europe. For example, Tybrind Vig, on the west coast of Zealand, in Denmark and dated between 5600 BC and 4000 BC, was the first submerged prehistoric settlement to be excavated systematically in north-west Europe.[57] The site is located at a water depth of 2–3m and is about 250m from the modern shoreline. At the time of occupation it would have been a multi-seasonal site situated on the coast and submergence has resulted in remarkable preservation, with a rich collection of organic artefacts including the remains of three canoes, fourteen paddles (four of which are decorated), fishhooks, leisters and even a fragment of fishing line. Faunal remains consist of a combination of marine and terrestrial species including both large and small mammals, molluscs and fish. In addition, the remains of a woman and a small child were found buried in a pit.[58]

Figure 2.16 The submerged platform at Bouldner Cliff and wooden pole with flint embedded

Working in such conditions is complex, expensive, uncomfortable, and sometimes even dangerous. However, the return in terms of quality of evidence makes the endeavour worthwhile. The truth is that excavation of waterlogged sites of this sort may well be the only way to resolve some of the problems caused by the passage of time and the loss of most organic materials on terrestrial sites.

Beyond the site: landscape and settlement

It is clear from the discussion above that there are real problems in understanding Mesolithic lifestyles even when we have access to well-excavated sites. There are, moreover, even fewer places in Britain where the archaeological record allows us to see, even dimly, beyond those sites, to understand what happened in the landscape more generally and to understand the story behind the occasional flints of this period picked up from ploughed fields. Yet, Mesolithic communities did not simply live on archaeological sites; the animals recorded in dry lists of excavated faunal remains had territories, burrows and lairs and the plants that were gathered also created the landscape around man and animal.

One of the only places in Britain where we can actually walk through the wildwood with our Mesolithic ancestors is in the Severn estuary, a remarkable landscape which has been studied extensively by Professor Martin Bell at

Reading University.[59] The Severn estuary, which lies between England and Wales, contains about 15m of Holocene sediments (Figure 2.19). However, current rising sea levels are cutting into the extensive deposits and Martin Bell's team have worked furiously to explore and record the estuary's prehistory between 6500 and 3500 BC. The basal sequence of the estuary contains a buried soil associated with a forest of large oak trees dated to *c* 5800 BC and work at Goldcliff East, in Wales, has uncovered a rich sequence of Mesolithic occupation sites, along with areas for the butchery and cooking of hunted animals.

Figure 2.17 Diver investigating the Bouldner Cliff site

Figure 2.18 Archaeological excavation of recovered block of seabed sediment

However, it is the remarkable record of human and animal footprints, preserved in the estuary silts, which provides an entirely new and fascinating insight into life in the Severn salt marshes and the human communities that exploited them (see Figures 2.20 and 2.21). Deer, aurochs and wolves are frequently recorded as well as wild birds including crane (no longer present in Britain). Alongside the animals are the people: men, women and children, walking singly or together, possibly even in family groups. These can be traced through their footprints and the evidence of their journeys has been preserved, at a single instant in time, in the marine silts.[60] These tracks also give us insight into the population structure of the Mesolithic communities: 52% of the tracks found can be attributed to young children (3–6) whilst only 7% are definitively adults.[61] Goldcliff's footprints rapidly make it clear that the stereotypical Mesolithic family which waited at home for the hunter did not exist; indeed it appears everyone came along to 'muck in'. The scale of involvement of young Mesolithic children in the foraging activities of the community may appear astounding yet is not uncommon in ethnographically recorded hunter-gather societies, many of whose populations comprise a very high number of children.[62]

The Severn estuary is also a difficult and often dangerous place in which to work. The estuary has the second largest tidal range in the world (14.8m at Avonmouth);[63] the silts containing footprints may only be exposed for a few hours every day and any excavations are refilled with silt during every tide.[64] However, the unique nature of this record is precious and the emotive nature of the footprints profound. This is the only place where we can actually people a landscape and consider how they moved and reacted. It is clear that in some instances people paused and inspected animal tracks, deciding what to do.[65] The tracks of parents or grandparents, taking their children to the water's edge on an expedition to collect shellfish, provide an emotional link with the Mesolithic that would have surprised, and perhaps even shocked, Clement Reid.

The Severn footprints suggest an intimacy between the landscape and its inhabitants that we cannot provide from any other form of evidence and this is an important point and deserves to be stressed. Given the nature of the Mesolithic economy, and the basic requirements of survival, we can assume a detailed practical knowledge of the inhabited landscape. We must not assume that Mesolithic communities were passive in their relationship with the land. We have already noted that settlements may have had a symbolic function and that shell middens may also have had a social role, a fact emphasised by the presence of human remains within shell middens. These structures, at the very least, involved physically changing the landscape in a manner never seen before and these acts must have held significance for contemporary communities, perhaps reinforcing a claim to the land itself. The act of living also gave meaning to places; cutting wood, extracting stone resources, butchering animals and repetitive journeys to places along well-worn paths must have provided personal and group memories, as well as spiritual and mythical associations.

Figure 2.19 The Severn estuary – an analogue for the Mesolithic landscape prior to inundation?

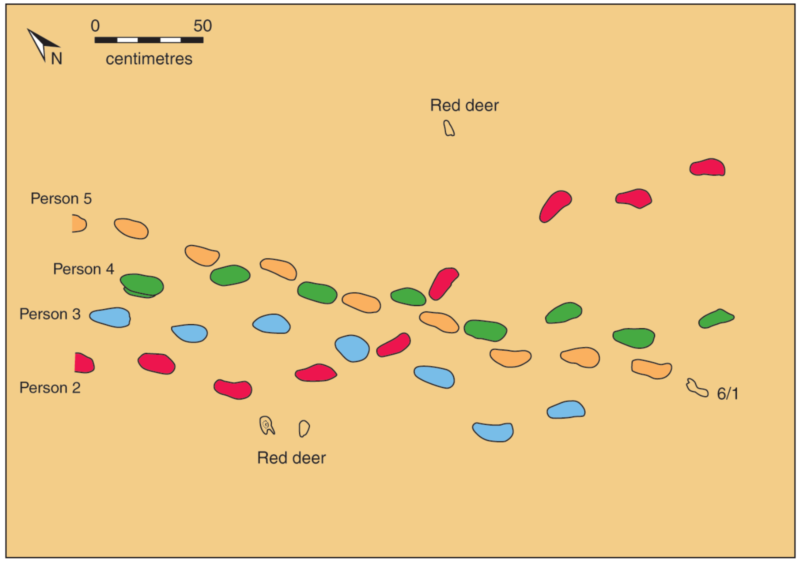


Figure 2.20 Goldcliff East, Site E. Plan of the trails of persons 2–5, shaded to indicate the individual

Figure 2.21 Mesolithic human footprint of a child aged 10–12 exposed at Goldcliff East, Severn estuary, in 2004

Unfortunately, although one suspects that spirituality permeated the life of Mesolithic communities, the evidence is frequently hard to identify, but there are instances where special places appear to have been treated differently. Surprisingly, one of the earliest examples may be Stonehenge. Stonehenge is perhaps the best known and most mysterious of archaeological sites in Britain and visitors from around the world come to see the enigmatic stone arrangements. These, of course, postdate the Mesolithic but as visitors leave their cars they walk over a series of white markers on the tarmac. These mark the position of three large pits hacked into the chalk using antler picks (see Figure 2.22).[66] Set into these pits were large pine posts, nearly 1m in diameter, held in place by wooden wedges. The posts date to the earlier Mesolithic (8820–7730 and 7480–6595 BC) and may have been erected in a clearing in a mixed pine and hazel woodland. They have no obvious practical function but they do form an alignment along with a large tree hole. The suspicion is that these enigmatic posts may well have been the equivalent of North American totem poles and that the link with a tree may indicate that the tree itself may have been venerated. Whether the poles were decorated and if the clearing was the scene of ritual activity or dance we may never know. Whilst we cannot link this directly with the much later development of Stonehenge itself, there is a strong and intriguing possibility that the landscape of Stonehenge had achieved special significance during the early Mesolithic, thousands of years before Stonehenge was erected.

The idea of the Mesolithic in Britain has changed considerably since the days of Clark and, perhaps, provides us with a way to imagine the natural, economic and social landscapes of Doggerland. The crude ideas held by earlier archaeologists are no longer applicable. It seems unreasonable simply to dismiss the British Mesolithic as an age of mechanistic hunters clinging grimly to life. These people, and the communities of the North Sea, certainly lived rich and social lives in an environment that may have teemed with opportunity. They were intimate with the landscape, understanding the seasons and the ways of animals and birds, and the landscape also held meaning at an arcane and spiritual level. The Mesolithic communities of Doggerland sought to influence the land and its wild inhabitants. At a practical level the dog was already a domesticate. Humans may have been manipulating their environment through burning, or using the opportunities of such events, but they also sought to influence nature, perhaps, in shamanistic fashion or through veneration of specific aspects of the landscape – special trees or stones. Their settlements did not simply cling to the bare shelter provided by caves and cliffs. In some cases they built structures that may have served the needs of grandparents, their children and grandchildren. These people walked along the coasts and tracks with children and friends and their actions created a sense of place and ownership. They may also, one must expect, have generated a sense of otherness about those communities which may have appeared separate, different or even threatening as sea levels rose and people moved from the great plains of Doggerland and created island Britain.

Figure 2.22
The position of Mesolithic 'totem poles' marked on the Stonehenge car park

Notes

1. An excellent discussion of this topic can be found in Coles 1998.
2. Gowlett *et al* 1986.
3. Visitors to Cheddar Gorge can find out more about Cheddar Man and his life in the Museum of Prehistory opposite Gough's Cave, where Cheddar Man was discovered.
4. Milner and Woodman 2005, 1–7, provides a useful discussion of this topic.
5. The idea that hunter-gatherer lifestyles are unremittingly grim seems to persist despite the fact that anthropologists have convincingly demonstrated that contemporary groups have often enjoyed considerable leisure time spent in visiting friends, chatting, playing games and gambling. By analogy past communities were likely to enjoy similar pursuits (Lee 1968).
6. See Milner and Woodman 2005, and Conneller and Warren 2006 for more information on this.
7. Lee 1968.
8. Conneller and Warren 2006, 8.
9. Young 2000, 7–8.
10. The book published by Mears and Hillman 2007 is a good example of this trend.
11. Mithen 1999, 55.
12. Thomas 1999; Pollard 2000; Pollard 2004, Richmond 1999.
13. Jones and Rowley-Conwy 2008.
14. See Woodman 1985 for detail on Mount Sandel.
15. Shennan *et al* 2000.
16. Lists of faunal material relating to Ice Age species found in the North Sea can be found in Glimmerveen *et al* 2004, 43–52.
17. These were reported in the popular archaeology magazine, *British Archaeology* **97** (November/December 2007); see http://www.britarch.ac.uk/ba/ba97/news.shtml for more detail.
18. Stringer 2006, 219–20.
19. Smith 1992, 167–8.
20. For further information on this remarkable site visit the Creswell Crags Museum and Education Centre (www.creswell-crags.org.uk).
21. Reynier 2005 is a good example of this.
22. See Clark 1972, Fischer 2004 (fig 3.17) and Darvill 1995 (fig 20) for examples of this.
23. Milner and Woodman 2005, 5.
24. See Clark 1972, Legge and Rowley-Conwy 1988, Mellars and Dark 1998, for example.
25. Fraser and King 1954.
26. Pitts 1979.
27. Legge and Rowley-Conwy 1988.
28. Mellars and Dark 1998.
29. Clark 1954, 21.
30. See Conneller 2004 for more discussion on the nature and meaning of the Star Carr antler frontlets.

31. Rowley-Conwy 1983.
32. Mithen 1999.
33. Coles 1971.
34. Mellars 1987.
35. For burials in Ertobolle shell middens see Albrethsen and Brinch Petersen 1977.
36. Woodman *et al* 1999.
37. Clarke 1978, 25.
38. Zvelebil 1994.
39. Mears and Hillman 2007.
40. Innes and Simmonds 1988.
41. Mellars 1976.
42. Simmonds and Dimbleby 1974.
43. Tipping 2004.
44. Chambers *et al* 1996.
45. Nygaard 1990.
46. A full report on the excavations at Howick has recently been published, see Waddington 2007.
47. See Healy *et al* 1992 for more on Thatcham.
48. Wymer 1962.
49. Saville 2004, fig 1.9.
50. Waddington *et al* 2007a, 190.
51. Boomer *et al* 2007, 89–90.
52. Gooder 2007.
53. Dates are taken from Bayliss and Waddington 2007.
54. Waddington *et al* 2007b, 207.
55. See Kooijmans 1971 or Verhart 2004 for example.
56. Momber 2004.
57. See Malm T for more detail on this work: *Excavating Submerged Stone Age sites in Denmark – the Tybrind Vig example*. Located at http://www.abc.se/~pa/publ/tybrind.htm (visited 03/04/2008).
58. An emotive image of the skull of the young woman can be seen on the front cover of Flemming 2004.
59. Professor Bell has recently published an excellent book on this work – see Bell 2007.
60. Scales 2002, 34.
61. Bell 2007, 234.
62. Scales 2007, 154, provides some of these ethnographic examples.
63. Bell 2007, 30.
64. Bell 2007, 31, notes that the Goldcliff Site B is exposed for only seven days each spring tide for a maximum of *c* 1.7 hours; these figures provide a hint of the frantic pace at which work must have to take place.
65. Bell 2007, 234.
66. See Cleal *et al* 1995, 42–7.

CHAPTER THREE

Mapping Doggerland

What archaeologists don't do in the sea and geologists do!

It may seem strange that the problem of exploring the North Sea has remained with us for nearly a century. Why can't we simply dive to the sites, which we presume exist, and find out what we need? In some areas this may be possible. In Denmark, systematic survey of shallow waters has resulted in more than 2300 marine finds in territorial waters.[1] Here the conditions are such that divers can locate settlements from the distribution of prehistoric flints lying on the seabed along with worked wood and bone. In several cases, Mesolithic graves have been found preserved beneath the waterline. Unfortunately, this type of survey simply isn't possible over much of the southern North Sea where conditions would demand the use of sophisticated compression chambers to allow divers to work on the seabed. Not only would this be extremely expensive but it would not, in any case, solve the problems of overlying sediment and the notorious lack of visibility in the deeper waters of the North Sea.

Traditional underwater archaeological prospection clearly cannot work in many of the areas we need to explore. On land the obvious alternative to locate inaccessible archaeological settlements and other landscape features would be remote sensing. The popularisation of archaeology via television, in particular, means that many people are now familiar with the use of magnetometers and resistance survey to resolve specific questions. Unfortunately, these technologies and instruments are generally only designed to work on land and also to work at very small scales. The largest land-based archaeological remote-sensing surveys may only cover a few square kilometres and these have generally taken many seasons of work to complete. Work at this scale was never likely to be of any significance when the problem involved surveying an area equivalent to a small European country. Luckily, the area of the North Sea was not entirely *terra incognita*; geologists and other scientists had been gathering vast amounts of information on the area using some of the most sophisticated remote-sensing technologies for nearly 30 years and this was available for study as part of this project.

Given the availability of this information one might question why British, and European, archaeologists were not more aware of the emerging potential of available modern geological data for exploration of the North Sea. The vast amount of data available for the area may be part of the problem, as is the difficulty of getting access to all the information.[2] Government agencies, most notably the British Geological Survey or BGS, hold enormous amounts of data. Clement Reid, of course, had worked at the Survey, which was incorporated in 1842 to carry out geological mapping of Great Britain and Ireland. As part of this brief, geologists have mapped shallow sediments in British territorial and offshore waters, including the North Sea, over many decades. However, the BGS are not sole suppliers of marine data. The British Hydrographic Office maps the sea floor to ensure marine charts are accurate whilst former public service organisations, eg British Telecom, are still responsible for surveying cable routes. More recently, oil and aggregates companies have been collecting seismic data and sample sediment cores from the seabed to explore deep and shallow geological deposits. In the last decade the development of marine wind farms has also required intensive survey of considerable areas of the seabed. In fact, the marine waters around Britain are amongst the best mapped in the world and Figure 3.1 gives some idea of the different types of marine activities that affect the North Sea study area and the variety and extent of data sources that have to be consulted. Some of this information is provided digitally and is relatively easy to access but much only exists as a paper record. Large amounts of data are stored in central archives that are relatively easily accessible but significant quantities are held by private companies and can be more difficult to retrieve. The potential quantities of data that were available for the Doggerland mapping project were enormous and, from the start of the project, some decisions had to be made about what information was most useful for our purposes.

Prior to the work at Birmingham almost all archaeological reconstructions of Doggerland were, essentially, based upon bathymetry and general contour maps of the surface of the seabed.[3] These data provide excellent images of the seabed topography and those submarine features that are so large that they can affect the shape of the seabed. Unfortunately, these cannot be used to locate features that may have been buried by sediments during or after submersion. This problem is shown clearly in the case of the very first feature that was identified by the project – the Shotton River (see Figure 3.2). If you overlay the channel of the Shotton on the contemporary bathymetry the river appears to flow uphill! Actually, the Dogger Bank, which most archaeologists mentally assume to be a significant upland, was never much more than a low rise. The current banks largely represent reworked sediments from the large rivers that surround the southern North Sea and were essentially created after the land was lost.

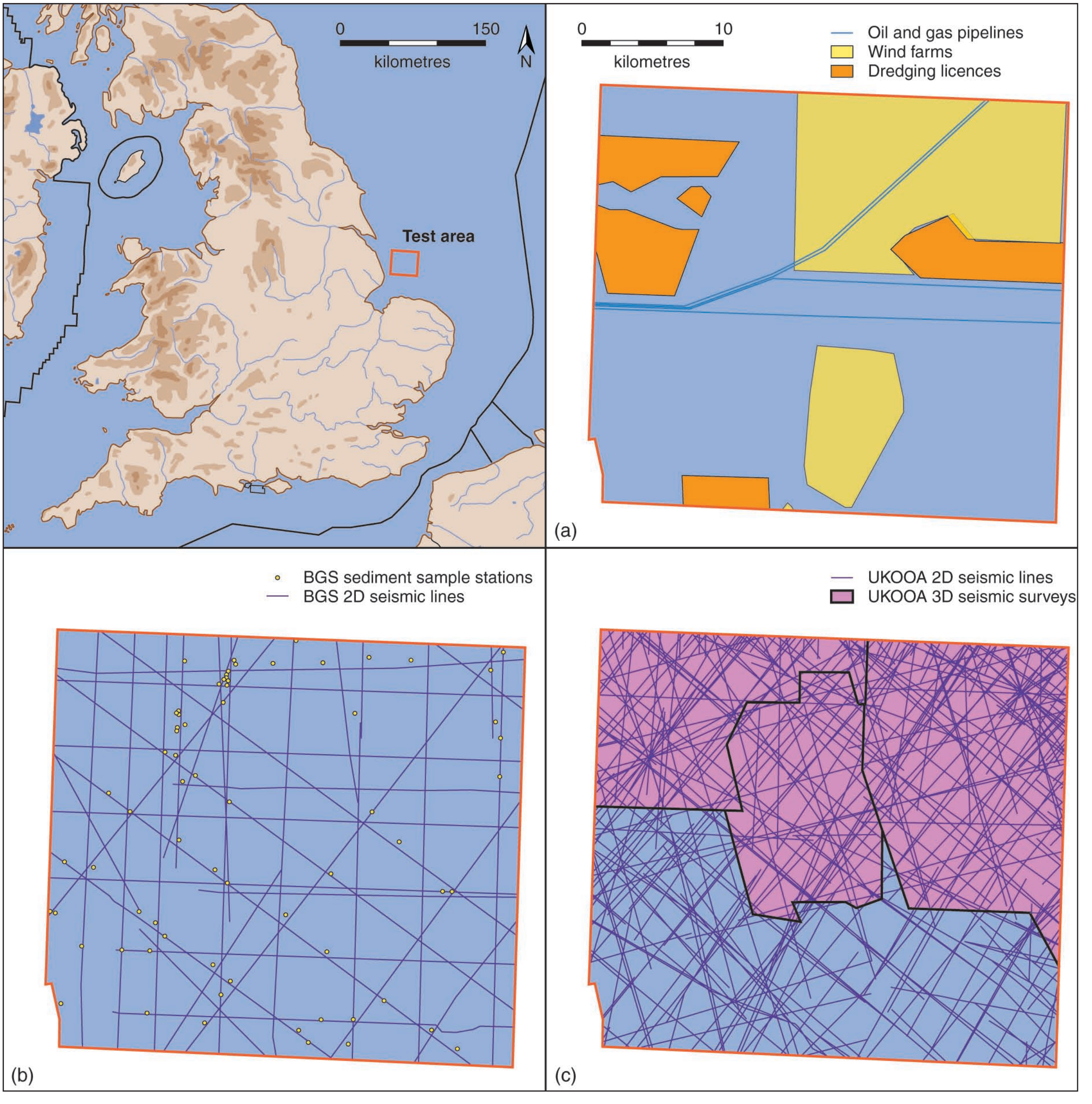


Figure 3.1 Detail of industrial activity in a small sample area west of the NSPP study area, including core positions and 2D and 3D seismic data

The extent of landscape change in the North Sea has other implications regarding the reconstruction of earlier coastlines. When the area was dry land it was a great and relatively flat plain. Any significant deposits on the earlier landscape can therefore have a dramatic effect when attempting to reconstruct coastlines. Indeed, a recent researcher suggested that there might be local changes caused by modern deposition of up to 20m in some areas. Where this occurs, and because the land was originally quite flat, it might lead to inaccurate

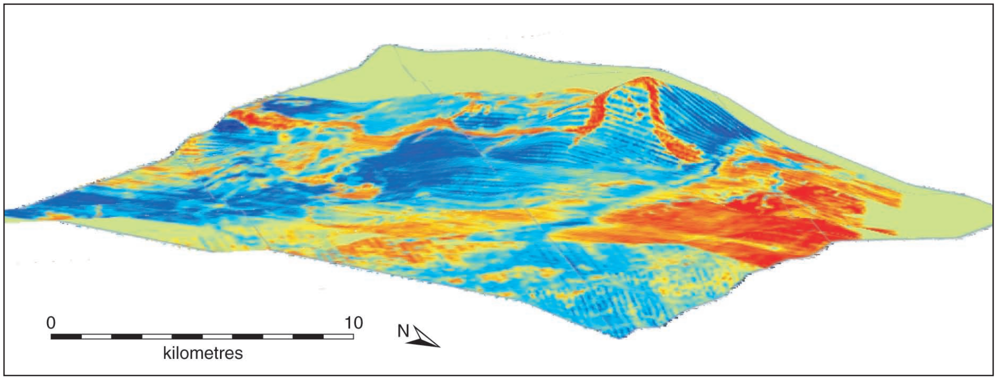


Figure 3.2 The River Shotton overlain on modern bathymetric data. The channel, shown as a red linear feature, appears to flow uphill

representations of shoreline positions with an error of up to 60km! Bathymetry can be used in areas such as the English Channel, where there is either relatively little deposition or where scouring has taken place, but its use for detailed landscape reconstruction in the southern North Sea is probably quite limited.

Seabed sampling and shallow coring may be more useful. Specialist equipment can be used to drive a corer into the seabed to retrieve a column of sediment. These samples provide high-quality chronological, sedimentological and environmental data. However, because samples are actually very small and widely spaced the information is of limited use when trying to assess the larger landscape and its archaeological significance.

The most useful methodology for exploring the North Sea, therefore, had to be able to penetrate overlying deposits and be of a landscape scale. The only data available that actually satisfy these requirements are from seismic reflections surveys.[4] Marine seismic survey is not a single process, however, and different technologies and strategies are adopted according to requirements. Despite this, the basic principles of seismic survey are applicable throughout. Essentially, seismic reflection survey involves passing acoustic energy into the subsurface and then recording the energy that is reflected back by changes in the composition of the sediments. The time that is taken to record a reflection

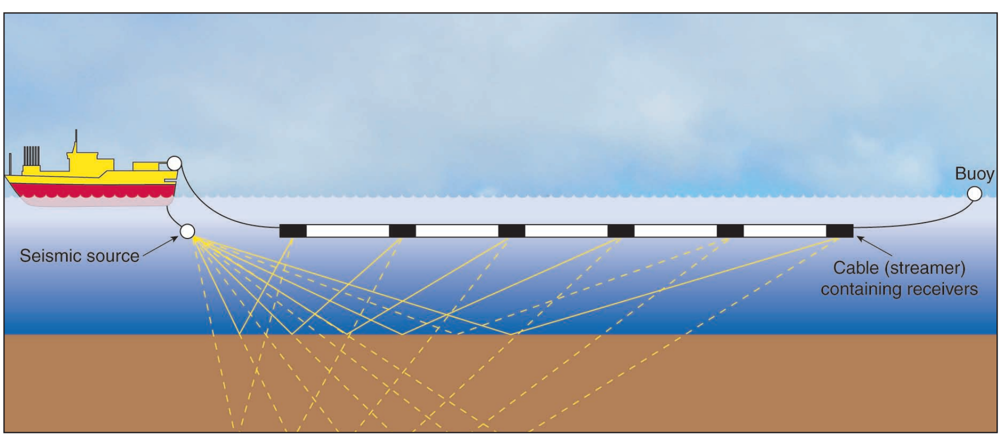
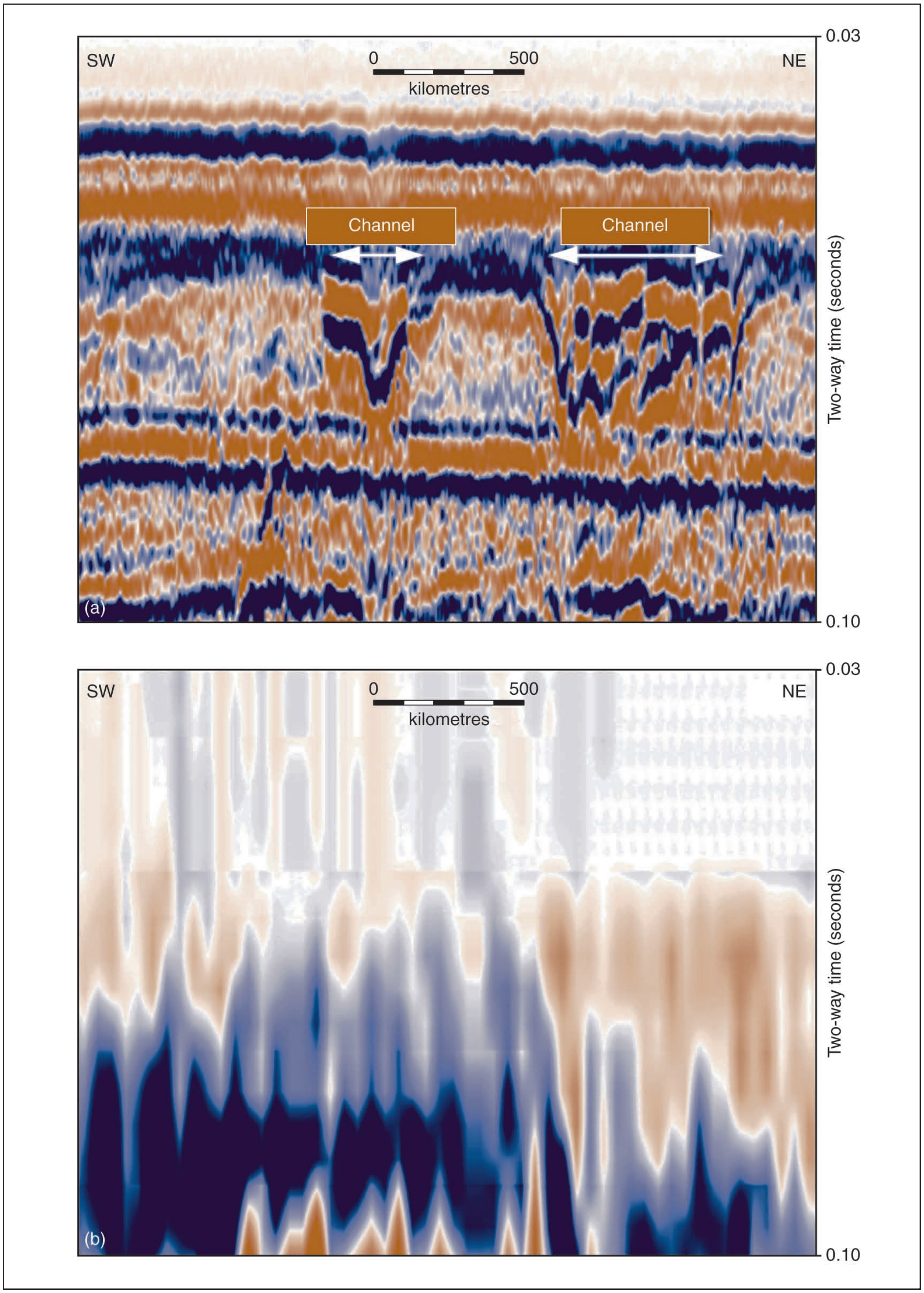
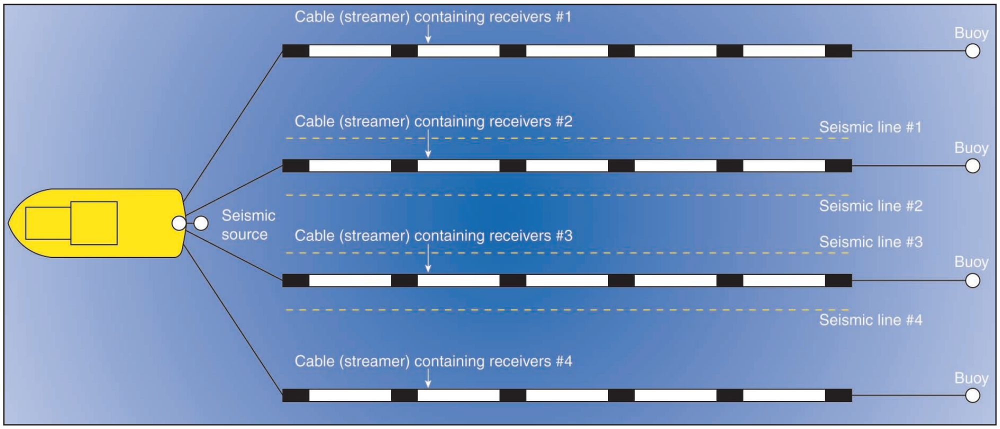


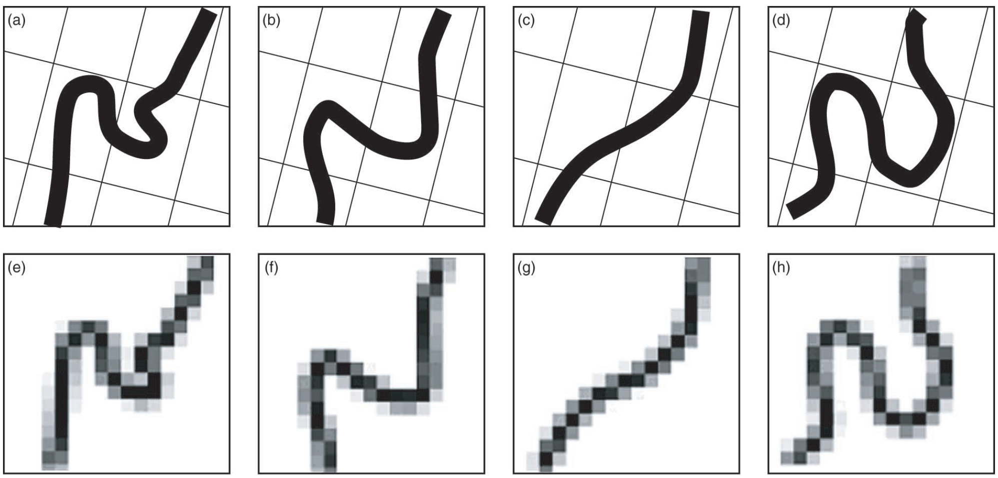
Figure 3.3 Typical marine seismic reflection acquisition

Figure 3.4 A comparison between (a) high-frequency 2D seismic reflection line and (b) low-frequency 3D seismic line from the same location. Note that higher frequencies yield greater vertical detail



can be converted into an approximate depth and the continuous record built up into a profile through the Earth's surface. Typically, a vessel towing an acoustic source collects seismic data through a series of hydrophones designed to record the reflection from the seabed.





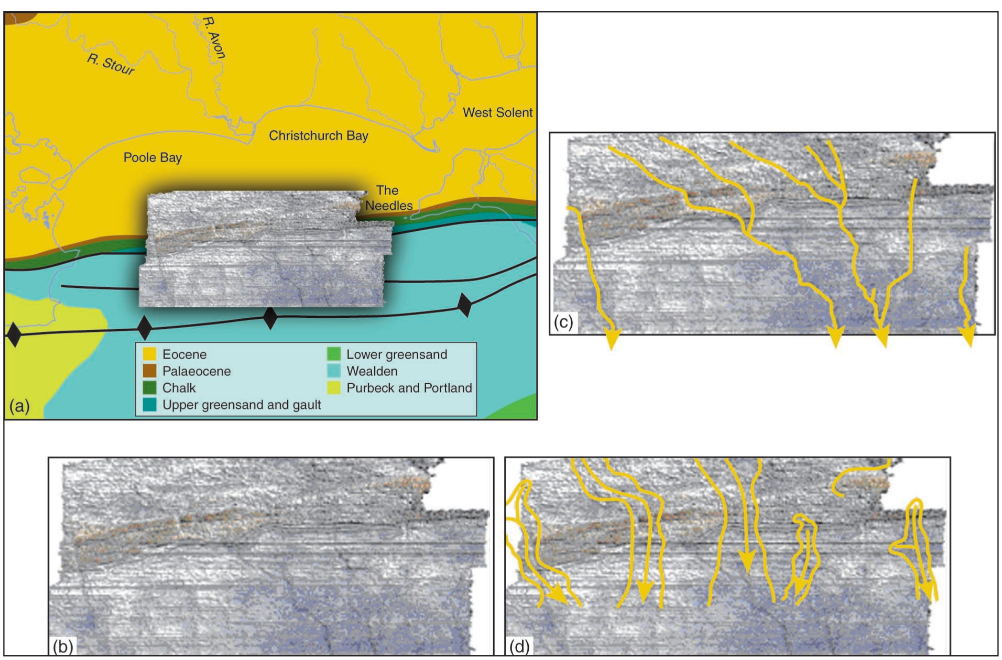


Figure 3.5 Typical 3D marine seismic reflection acquisition

Figure 3.6 (a–d) Four possible interpretations of a channel morphology based on a coarse 2D seismic grid. Each interpretation is equally valid; (e–h) schematic illustrations of how each of the interpretations shown in a–d would appear on a timeslice from a laterally continuous, binned 3D seismic volume. This demonstrates that 3D seismic data has the potential to distinguish between the possible alternatives

Figure 3.7 Poole and Christchurch bays
a) A geological map of the bays with the artificially illuminated plan view of the seabed reflector derived from the 3D seismic data draped over it
b) A close-up view of the plan view of the seabed reflector
c) The location of palaeochannels in the area as mapped using (b) can be seen highlighted here
d) If the earlier interpretation of the location of palaeochannels in this region, as mapped by 2D seismic data, is displayed with the seabed reflector mapped using 3D seismic data, the poor correlation between the 2D interpretation and the actual channel locations becomes very apparent

The resolution and depth of penetration of an acoustic source is generally dictated by its wavelength. High-frequency sources give the best resolution and detail but the signal is weakened as it passes through underlying geology. Consequently, surveyors have to choose between high-frequency sources that give good resolution but relatively shallow penetration, and low-frequency sources which give good penetration but poor resolution. Industry uses instruments with a variety of wavelengths and appropriate names including Chirp, Pinger, Boomer and Sparker. Chirps and Pingers are used to resolve relatively small, shallow features whilst Boomers and Sparkers resolve larger features below the seabed and provide greater penetration.

Traditional seismic reflection data is usually referred to as two-dimensional (2D) because the data is collected via a single cable or streamer and the information displayed as a vertical slice through the earth. Whilst the data has obvious value for remote prospection there are problems with its use. 2D profiles are generally acquired with significant distances between each profile. Consequently, whilst specific features, such as river channels, may be located with a vertical profile, it is almost impossible to build a reliable horizontal plan across a region of interest. These problems can be resolved by using a three-dimensional (3D) array (Figure 3.5). In this instance, large ships tow multiple, closely spaced streamers and the data are collected and interpolated into a cube that can be sliced vertically or horizontally to produce sections or plans as required. The benefits of using 3D data for landscape interpretation should be apparent from Figure 3.6. Wide-spaced 2D profiles may not provide enough information to resolve the path of river channels if they are crossed only occasionally. In contrast, extensive 3D data can provide this important information. The example of comparative data from Christchurch Bay clearly shows that the higher-resolution but infrequently spaced 2D data did not resolve the route of the submerged palaeochannels as successfully as the 3D data (see Figure 3.7).

3D data have other, important qualities. The seismic data does not just have to produce 2D maps. If a feature such as a river channel can be identified, the data can be processed to extract the channel itself as a 3D shape. This is, potentially, very important information. Old river channels, known as palaeochannels to archaeologists, frequently contain deposits that preserve environmental data that can be used to reconstruct past landscapes – pollen, beetles etc. You can assess the likelihood of a channel providing this information if you know its shape and volume.

Using this data you can, for instance, calculate the volume of the channel and use this information to decide whether there is any possibility that the channel may contain deposits with preserved organics or other palaeoenvironmental evidence. Where the data is particularly clear it is also possible to identify the original land surfaces within the 3D cubes and to create 3D maps of the shape of the buried landscape, its valleys and river channels.

The final quality of 3D data is to show the spatial relationship of features in terms of their depth. Figure 3.9 illustrates a 3D model of a glacial valley formed, not by ice gouging out the soft deposits of the plain but by massive amounts of

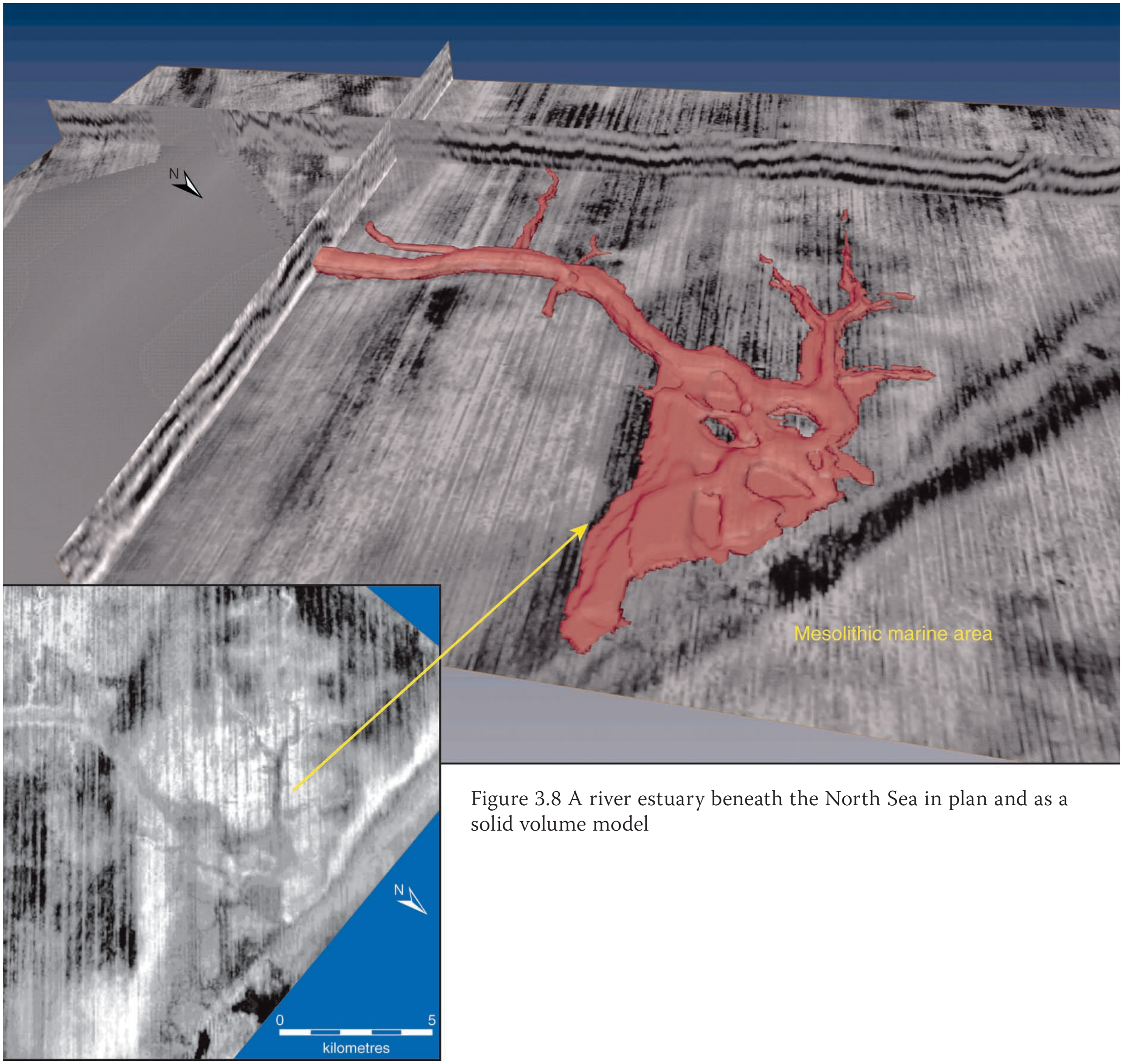


Figure 3.8 A river estuary beneath the North Sea in plan and as a solid volume model

meltwater scouring a deep channel in front of the glacier. Over time this valley was infilled with sediment and at a later date, presumably during the Holocene, a river flowed laterally across the earlier valley cutting another channel into the soft sediments. To illustrate this development the data have been turned into a solid model and the later deposits stripped out to show the shape of the earlier valley. This image also shows horizontal and vertical slices through the data that can be used to confirm the model's accuracy.

In an ideal world the best solution for looking at the relatively shallow deposits of the North Sea would be to use high-resolution 3D data. Unfortunately, although high-resolution 3D seismic systems are available they tend to cover

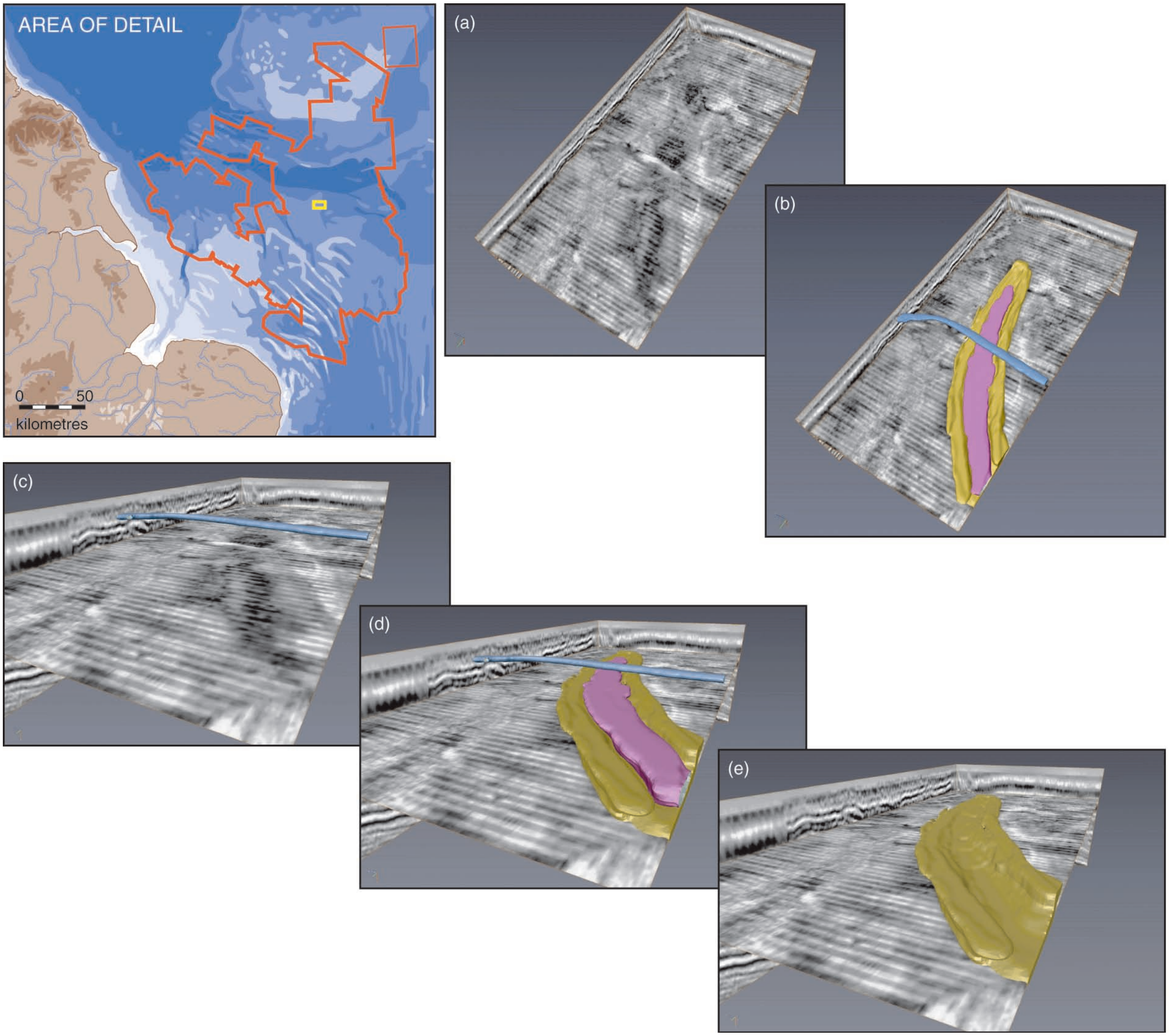


Figure 3.9 A 3D volume model of the relationship between a probable Holocene river channel and an earlier valley showing a) the original 3D seismic data; b) a plan view of a solid (3D) model derived from the seismic data (the Holocene channel is in blue, the earlier valley is yellow and the sediment fill of the valley fill is purple); c) a side view of the solid model (the Holocene river channel with earlier features removed); d) the river channel shown with earlier valley (this image clearly illustrates the spatial and, presumably, temporal relationship between the Holocene and earlier features mapped in the North Sea); e) a view of the interior of the earlier valley with its sediment fill removed

smaller areas in detail due to their low speed and, because they use small vessels, these surveys are often restricted to shallow, coastal waters. In contrast, the large vessels associated with extensive 3D data work best in deeper waters and cover very large areas efficiently but at a much coarser resolution.

In the first chapter we mentioned that the initial port of call for the original research team was PGS, to talk to Huw Edwards about data collected by his

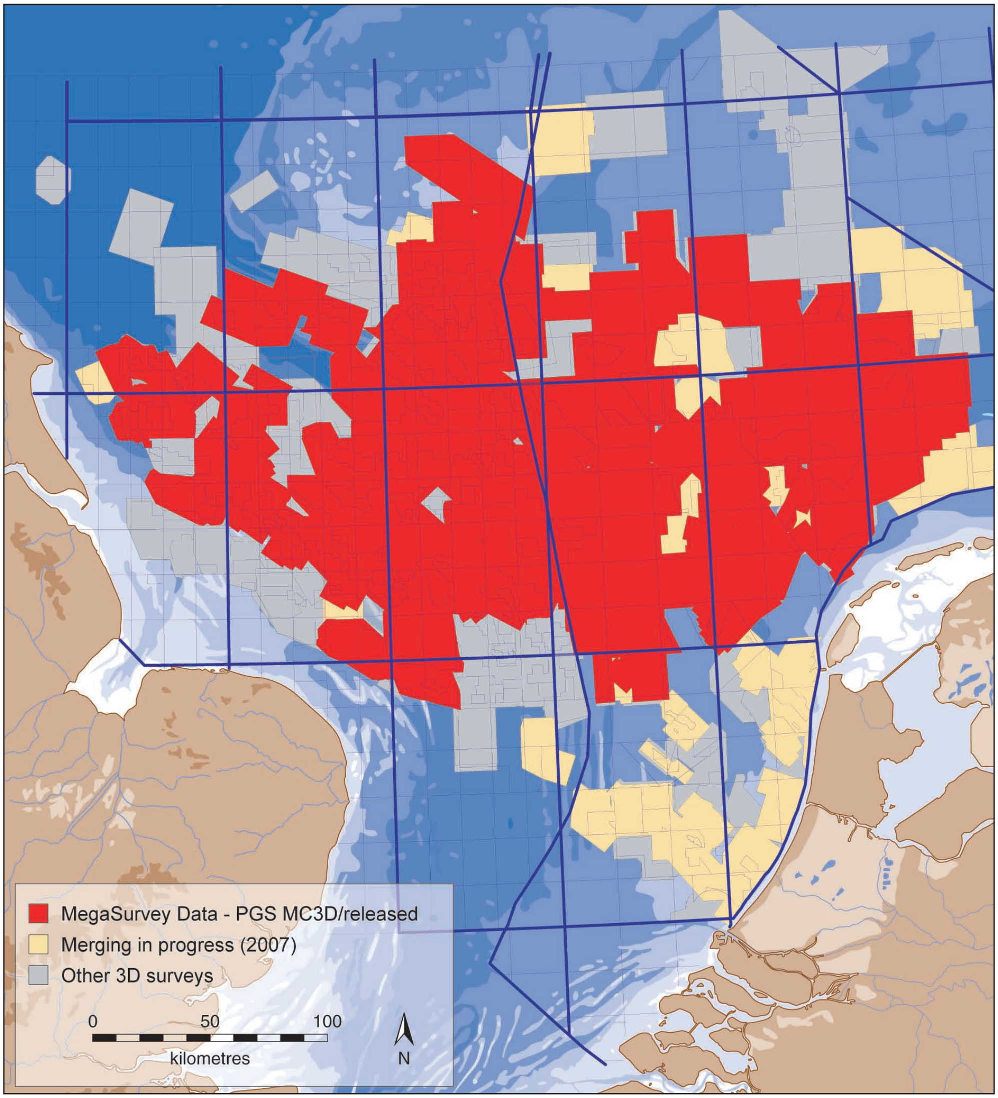


Figure 3.10 The PGS Southern North Sea MegaSurvey

company. PGS is an international group that collects, processes and sells marine geophysics data. Amongst their most important products are the MegaSurvey data sets.[5] These are combinations of multiple surveys, carried out at different times and by various groups, migrated into a single data set. PGS's Southern North Sea MegaSurvey includes more than 60 different surveys and stretches between the UK and the Netherlands (Figures 3.10 and 11). Fortuitously, the PGS data set covers the northern edge of what would have been Mesolithic Doggerland but less fortunately, for technical reasons, the survey does not reach the modern British coast. The resolution of the data is also, perhaps, less than archaeologists might have wished for under ideal circumstances. The line spacing of the data used for this project is about 50m but the vertical resolution of the data may be as little as 10m.[6] Despite this, the scale of the PGS data sets were clearly perfect for the initial exploration of what was, effectively, a completely unknown country and PGS offered 23,000km^2 of seismic data for research.

The area covered by the study could have been larger but was deliberately restricted. In the first instance, the conditions of the Aggregates Levy Sustainability Grant, which funded the project, limited mapping to English territorial waters. The team also constrained the depth of seismic blocks used during the mapping of this massive area. There was clearly no value in processing the complete data sets as the lower sections related to geological and not archaeological strata. The amount of time that might be required to study late Pleistocene surfaces

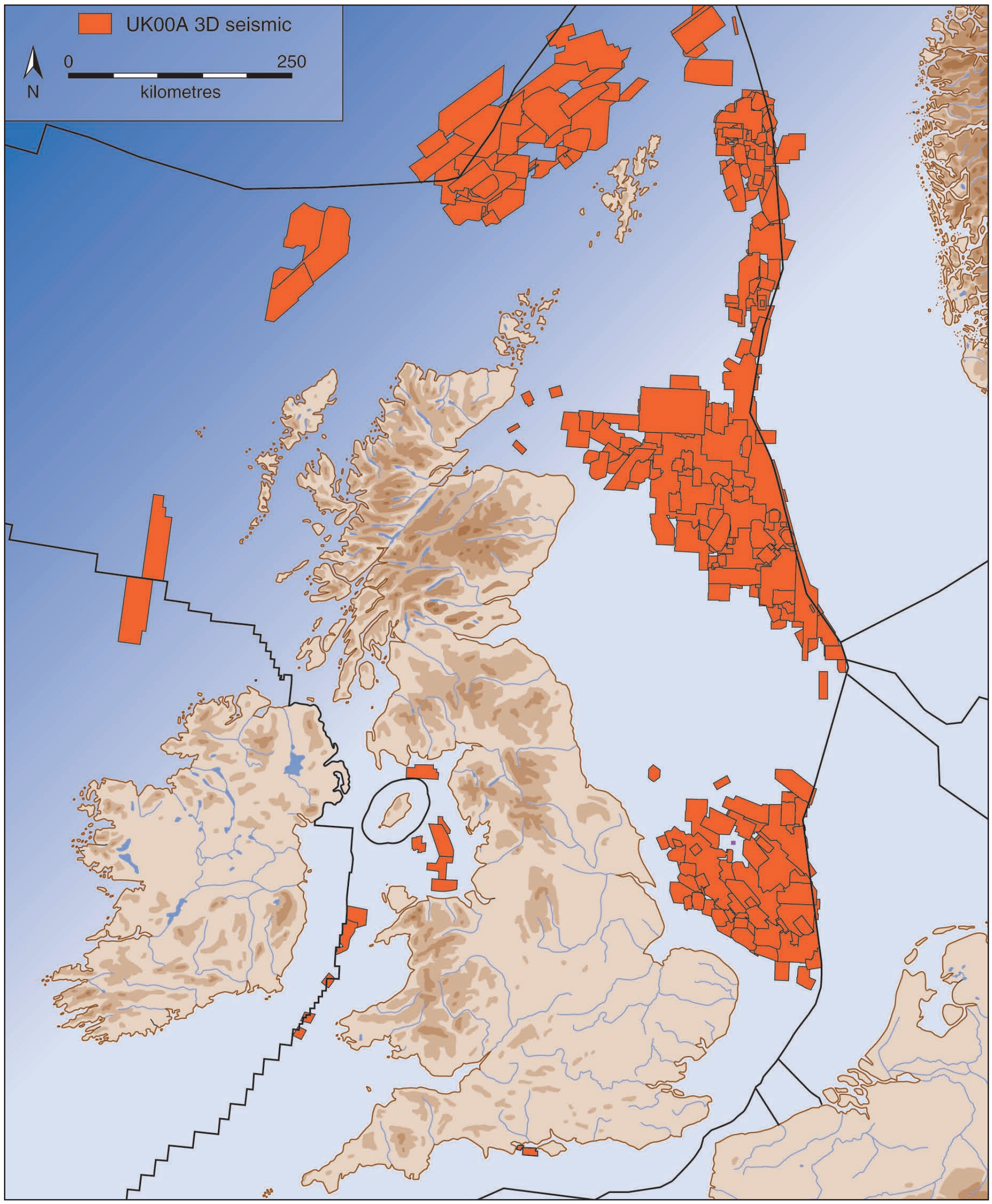


Figure 3.11 3D data sets in British territorial waters

was also a concern. Consequently, the data were also limited to a depth defined by about 200 milliseconds in reflectance terms, as features in this range were most likely to date to the Holocene or Mesolithic. Even so, the base data were enormous in archaeological computing terms and required 1 terabyte of storage (1000 gigabytes) even before any work took place. To put this into context, the complete high-resolution magnetometry survey of the Roman city of Wroxeter was, until quite recently, one of the largest terrestrial archaeogeophysical surveys undertaken in Britain. However, the entire data set for that project, including interpretation, required only about 2 gigabytes of storage.[7]

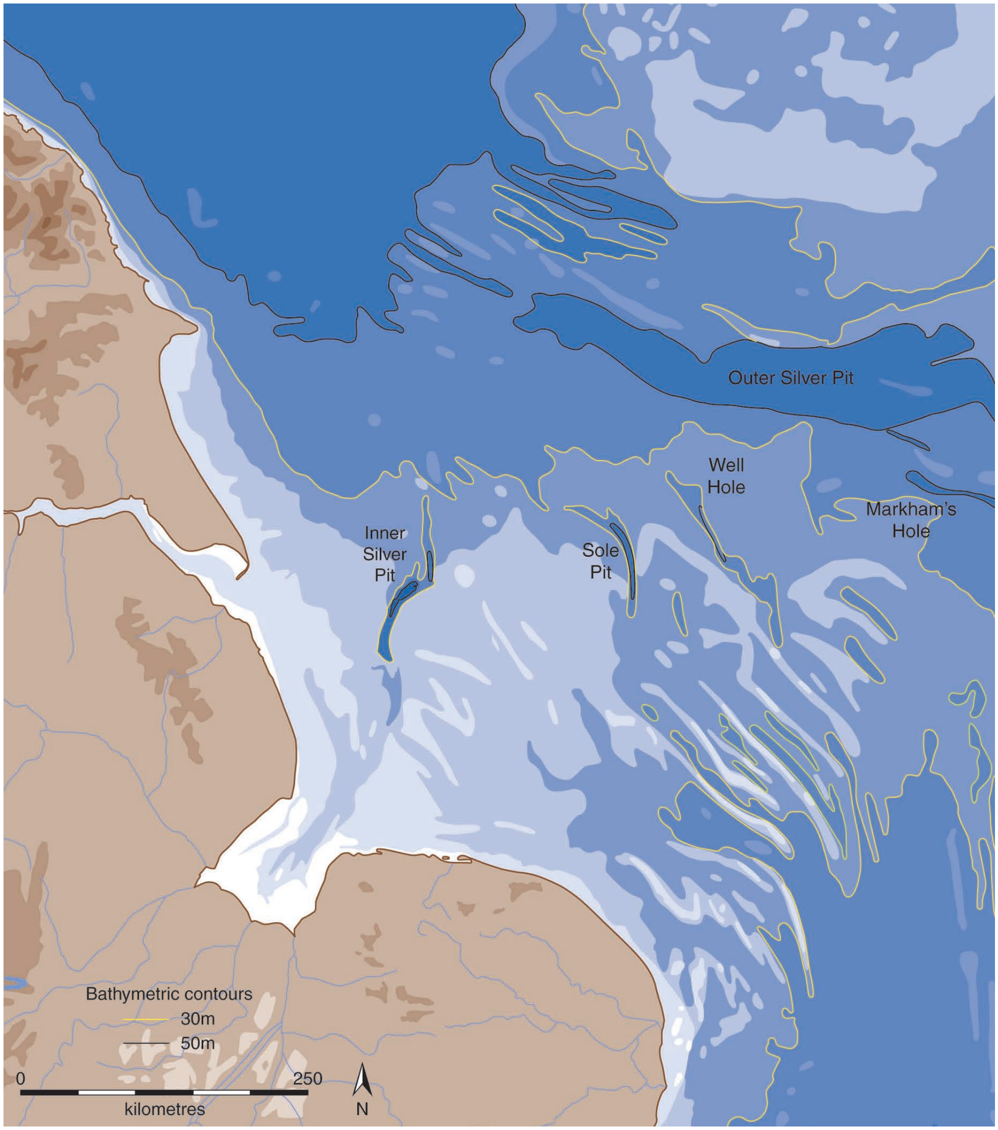
Seeing the past

The North Sea bed within the study area was not featureless. Indeed, as has been stressed, the bathymetry of the seabed has been used to suggest possible outlines for the area of Holocene Doggerland. Whilst there are real problems in accepting the bathymetry as a real reflection of past landscapes, it is still true that the basic shape of the seabed holds valuable information. The Dogger Bank is, of course, a very significant feature; although probably exaggerated by recent sedimentation, it would have existed as a relatively low range of hills or a raised plain in the past. Alongside the bank, however, are a number of major marine 'deeps' or basins that are well known to marine scientists, fishermen and sailors. Some of these are so large that they must have been visible as major landscape features in the past. The most significant of these is the Outer Silver Pit. In size this feature is not dissimilar to the Bristol Channel, the large estuary in the west of England. Both features stretch for approximately 100km and are up to 30km wide and, today, the base of the Pit is more than 80m below sea level. The origins of this feature are, however, uncertain. It may be that the deep formed as a direct result of glacial action, a catastrophic scouring event in advance of the ice or even because of strong sea currents during inundation.

Alongside this are a number of smaller deeps, shown in Figure 3.12, including Markham's Hole, Well Hole, Sole Pit and, nearest to land, the Inner Silver Pit. These features are assumed to be of glacial origin, although the Inner Silver Pit is also clearly linked to outflows from the Wash and a channel can be seen linking the two. At approximately 50m there is a clear break in the bathymetry and the seabed shelves rapidly into deeper waters at this point. In line with previous interpretations this sharp change suggests that a coastline would have been likely to have formed around here as inundation proceeded. Aside from these features the only other objects of note are the great elongate banks radiating from East Anglia into the study area. These, however, are large, modern sand banks and are entirely unrelated to past landscapes. Beyond this the bathymetry gives no real hint of landscape structure nor suggests that the area was anything other than a large desolate plain during the Mesolithic period.

Before processing, the seismic data sets add little to this rather unpromising picture. This is partly a consequence of the scale at which the data are presented but also because the image is a composite of multiple surveys that do not match

Figure 3.12 The bathymetry of the study area and bathymetric features



perfectly. Figure 3.13 shows a horizontal slice of the original data and, for most people, the most obvious features are actually the straight lines and acute angles that mark the edges of individual surveys. A few geological features can be seen, dimly, and these tend to be organic in character, curved and without the hard edges of a survey area. The features that we were interested in only became clearly visible after processing using very powerful computers and specialist visualisation equipment.

Archaeological research centres with the capacity to carry out this sort of work are not common in Britain. Fortunately, the Institute of Archaeology and Antiquity at University of Birmingham houses the Visual and Spatial Technology Centre (VISTA).[8] This is probably one of the best-equipped archaeological

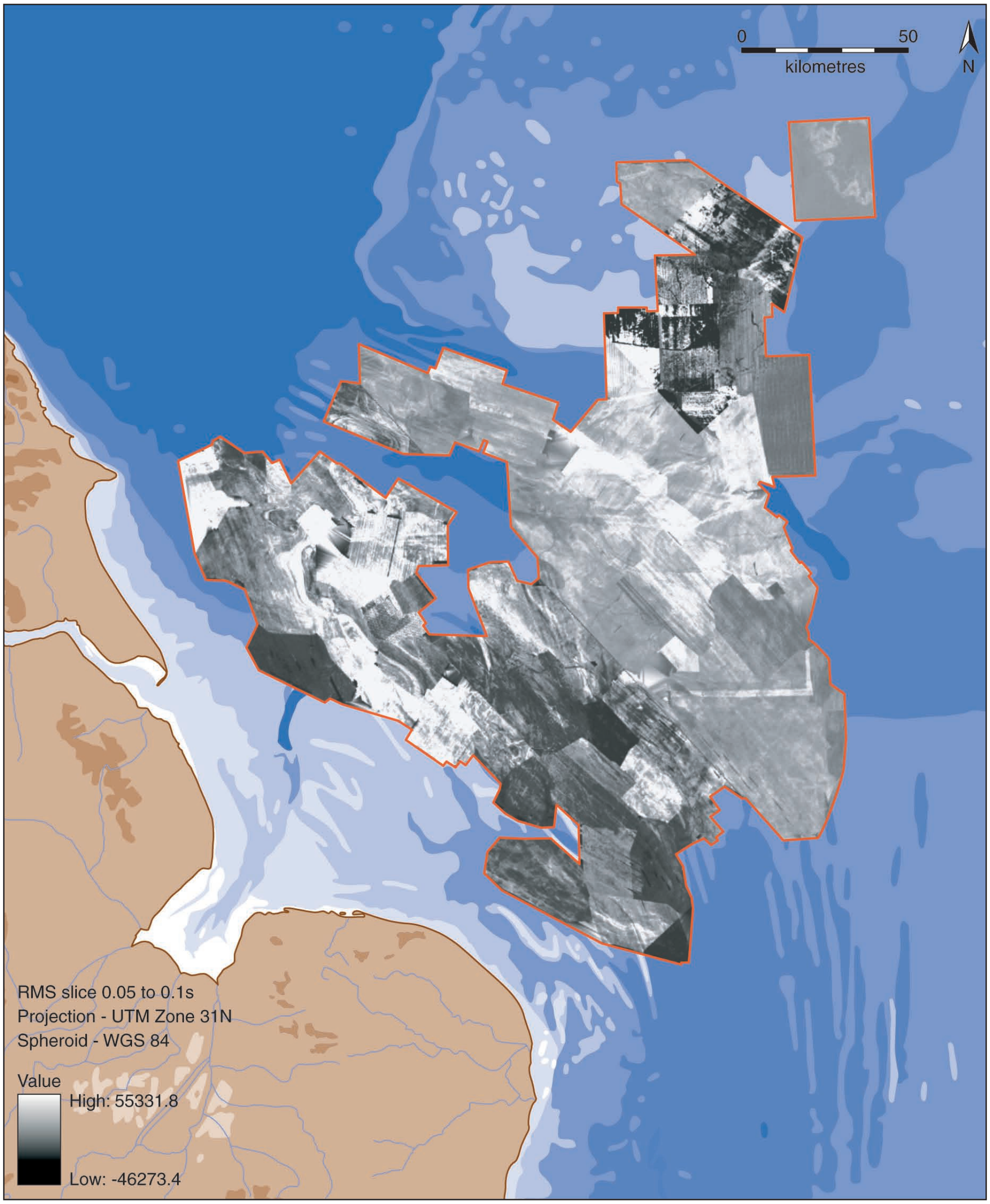
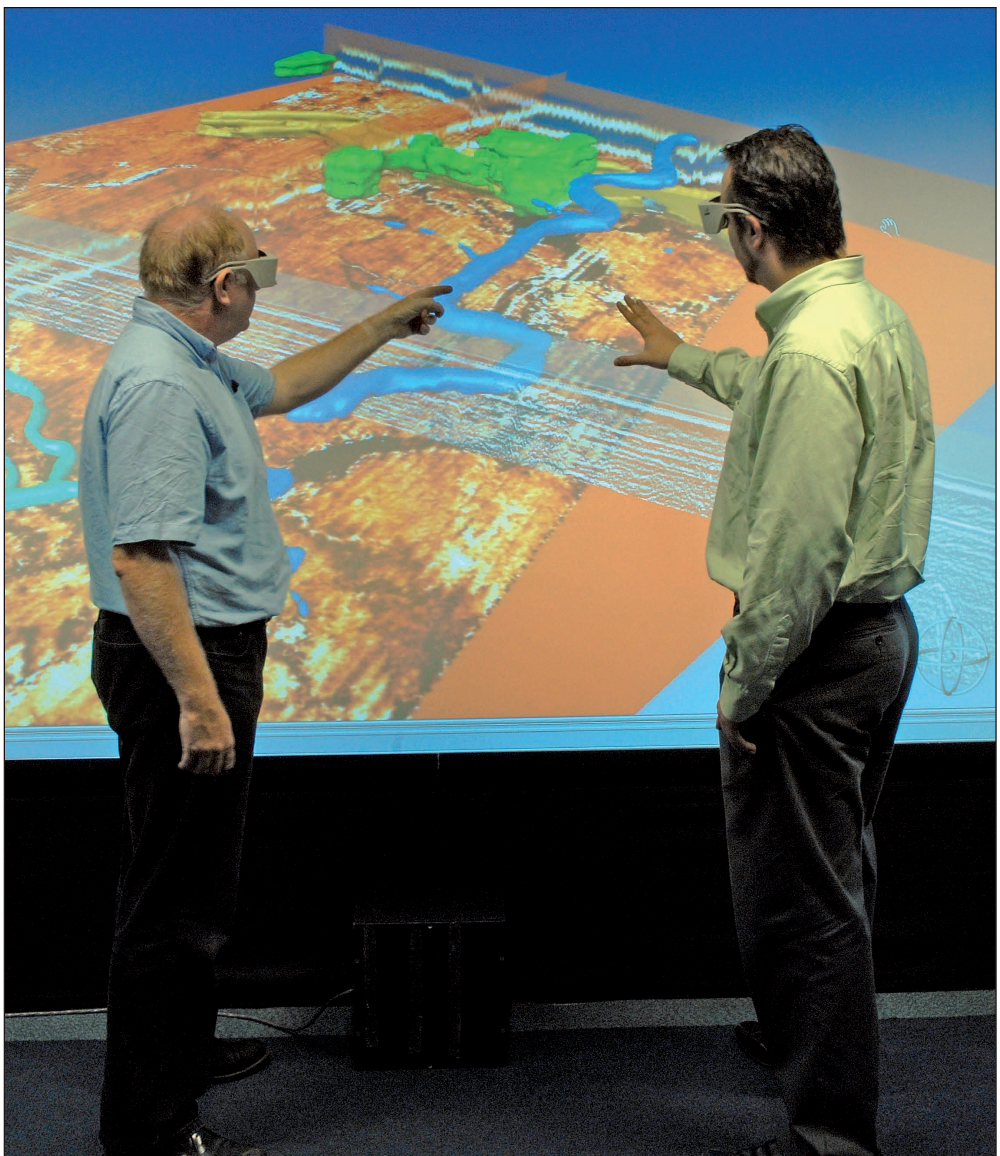


Figure 3.13 Horizontal slice across the full data set

computing laboratories in Britain. Here the data could be processed using powerful workstations running specialist seismic softwares and accessing the large amounts of data from dedicated storage machines over fast data cables. The results of analysis could then be piped into the centre's projection room and inspected by the team in 3D using the 4 ? 2m stereo screen housed in the centre, as shown in Figure 3.14. During processing, the data was divided up into areas for study. Team members were assigned specific areas to work on and the data cube was sliced into many hundreds, perhaps thousands, of individual horizontal and vertical slices and any features located were traced in terms of extent, depth and, where necessary, volume. This was not a trivial task. Team members laboured using powerful computers and a variety of processing algorithms and softwares to extract every bit of information that could be gleaned from the data. All the interpretations were then quality checked by the entire team and, over a year, a map of Doggerland began to emerge from the original shadowy and confusing images.[9]

Even with expert processing, not all areas within the survey were equally susceptible to study and it proved difficult to tease out any information from some areas. The south-eastern part of the study area, for instance, was particularly problematic and a sample of the data from this area is shown in Figure 3.15. Here, heavy striping that was almost impossible to remove marred the original survey data, and this obscured almost all the features that presumably existed in that area. The water column is also progressively shallower to the south and this created problems for generating usable data. In contrast, other areas were incredibly clear and, in the best images, the channels of individual rivers could be traced within valleys that lay deep below the seabed (Figure 3.16). It was clear

Figure 3.14 Group stereo viewing of seismic data at the VISTA laboratory



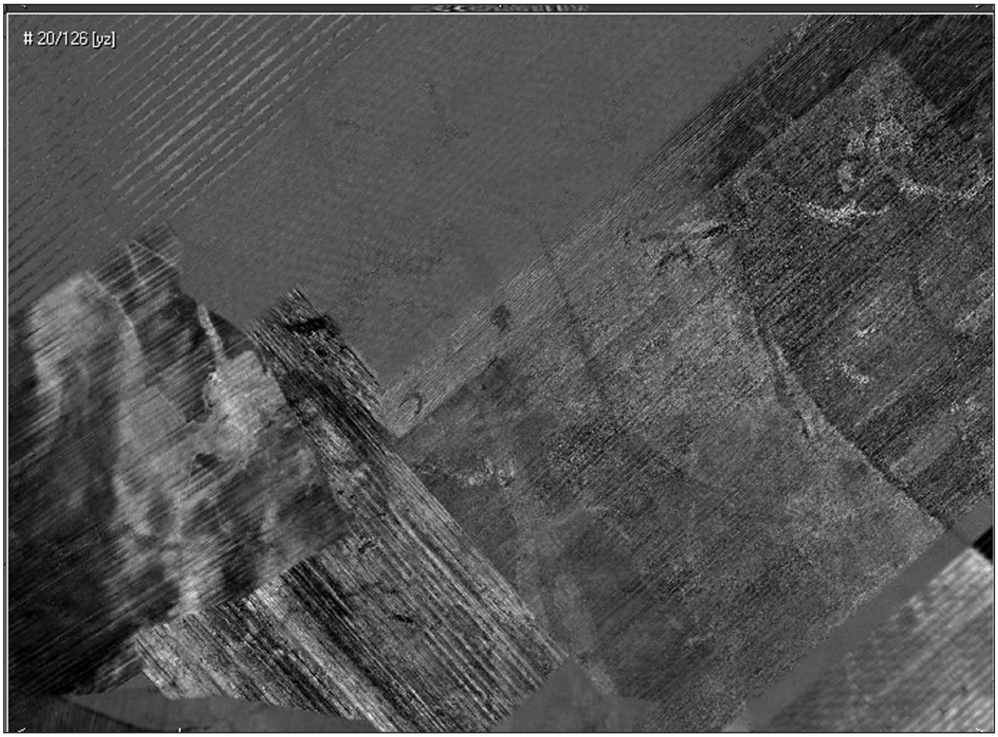


Figure 3.15 Heavily striped areas which mask underlying features

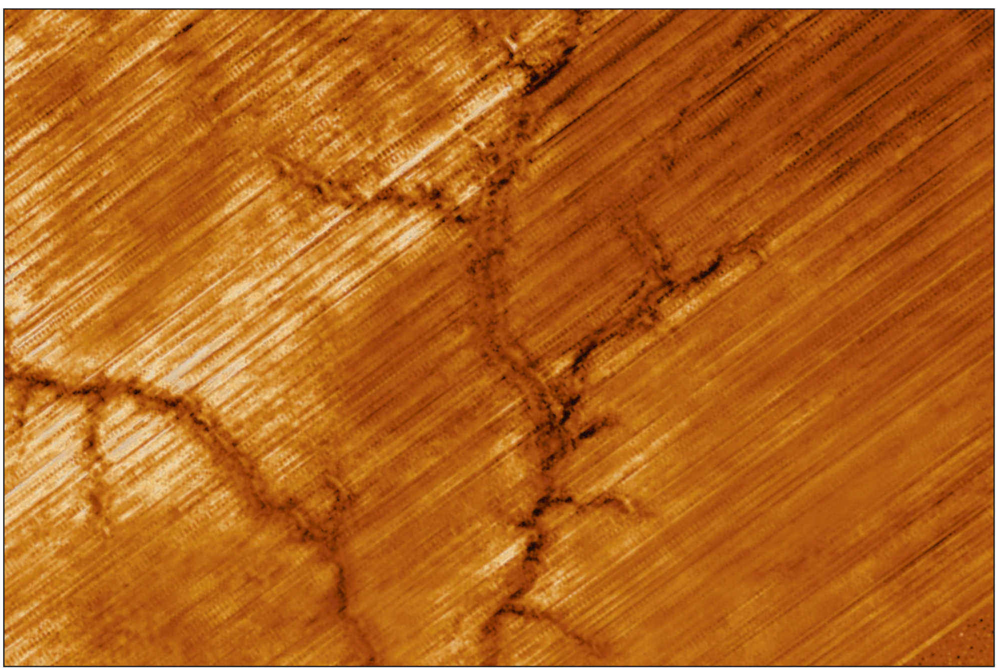
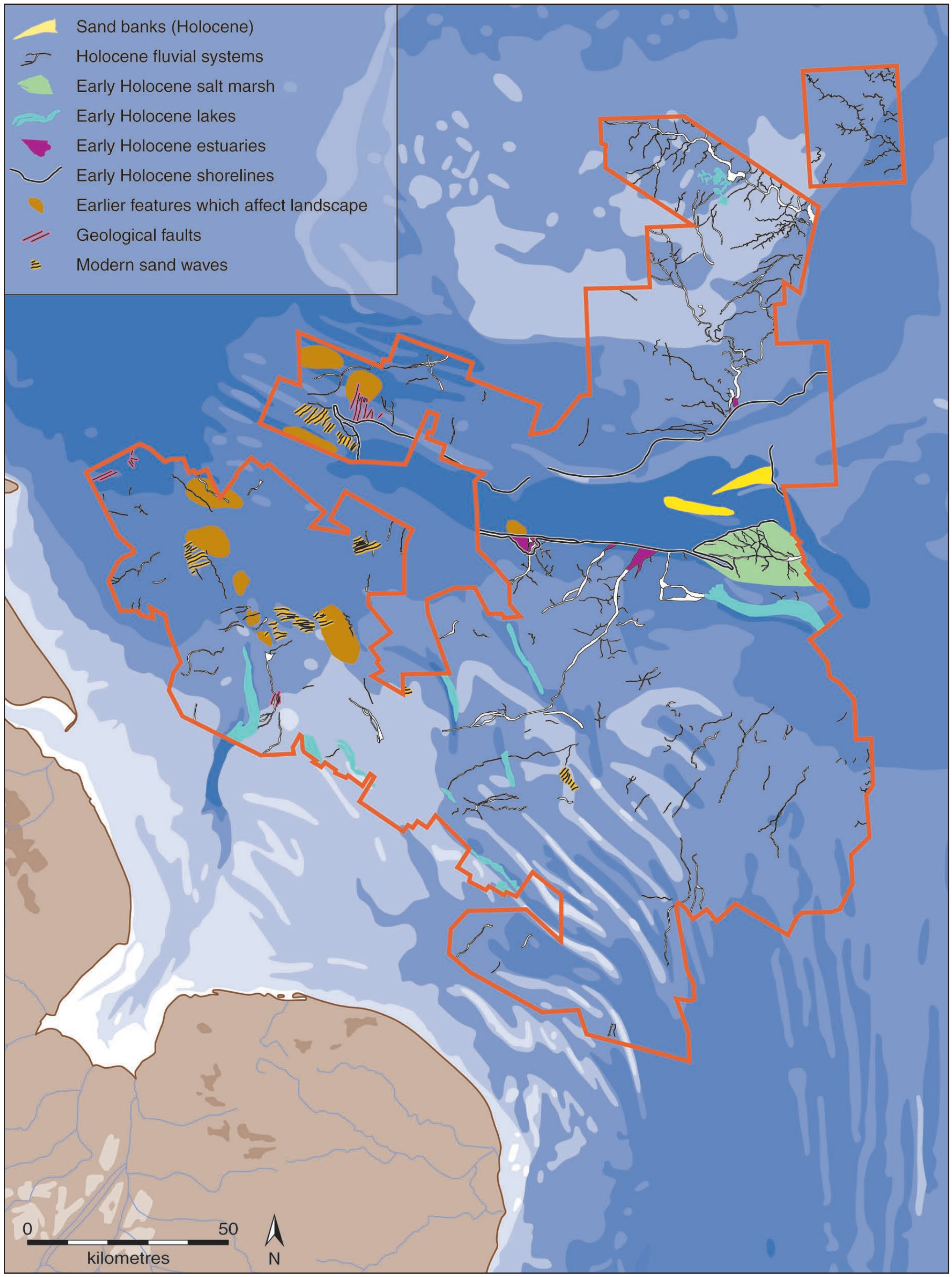


Figure 3.16 An extremely clear image of a submarine palaeochannel in the North Sea study area. The actual river channel can be seen as a dark line inside the river valley

from a very early stage in the project that the images produced by the analysis of seismic data were striking and, in the context of the previous complete lack of information, obviously important. However, there are limitations on the use of

Figure 3.17 General distribution map of features located beneath the North Sea



these images and it is important that these are appreciated before we look at the results. For instance, even where images were particularly clear it remains true that the data are of relatively low resolution. In archaeological terms, this type of seismic information is rather like having a low-resolution satellite image of the Mesolithic landscape. The smallest feature that you can detect with confidence may be 10m or more in size in the vertical plane and more in the horizontal plane. The data cannot, for instance, be expected to locate settlement of the sort found at Star Carr or, more recently, at Howick in Northumberland. The archaeological features at these sites, pits etc, are simply too small to be identified using 3D seismic data. However, even if we cannot see traces of human activity directly, what the data can do is to allow us to map landscape features and provide broad topographic information. This is important because Mesolithic societies were closely tuned to the economic base and our knowledge of terrestrial sites allows us to make a reasonable guess at how different landscape zones might have been used and where Mesolithic hunters and gatherers might have settled.

The general map of incised features identified across the whole of the study area is shown in Figure 3.17. In the first instance, the seismic data provided information on fluvial features, rivers, estuaries and lakes as well as related features including salt marshes and coastlines. Quantitative information on these features is provided in Table 3.1.

Table 3.1
Quantitative data for identified features

Coastline length observed	691 km
Marine area observed	1791 km^2
Lakes/wetlands observed	24
Salt marsh area	309 km^2
Intertidal zone area observed	293 km^2
Major estuaries observed	10
Total fluvial stream length	1612 km
Fluvial related features observed	305
Total area covered by fluvial features	526 km

The data, however, do not just contain channels or other incised features; they also hold information on the old ground surfaces that link all these features and across which man once walked. Standard horizontal or vertical slicing of data provides useful plans and profiles of specific features but these may not be of much use when you need to extract information on the land itself. Mother Nature only rarely creates land surfaces that conform so conveniently to the digital data we collect. Consequently a seismic horizontal plan view of data may include features and surfaces that, although at the same depth in the data block, may not be of the same age or related in any significant manner. Fortunately, analysts are not restricted simply to cutting the data blocks at right angles. If ancient land surfaces can be detected within a profile, specialist softwares allow interpreters to 'pick' the surface across adjacent seismic lines and then interpolate the complete surface from line to line. This creates, with some error, a surface that represents the old landscape. An example of a 'terrain model' extracted from the original pilot project is shown in Figure 3.18. This is a section across the Outer Silver Pit and shows the outline of the feature but because this is an arbitrary slice, the details of the feature are not clear. A vertical profile across the feature has been extracted and the original land surface has been 'picked' and

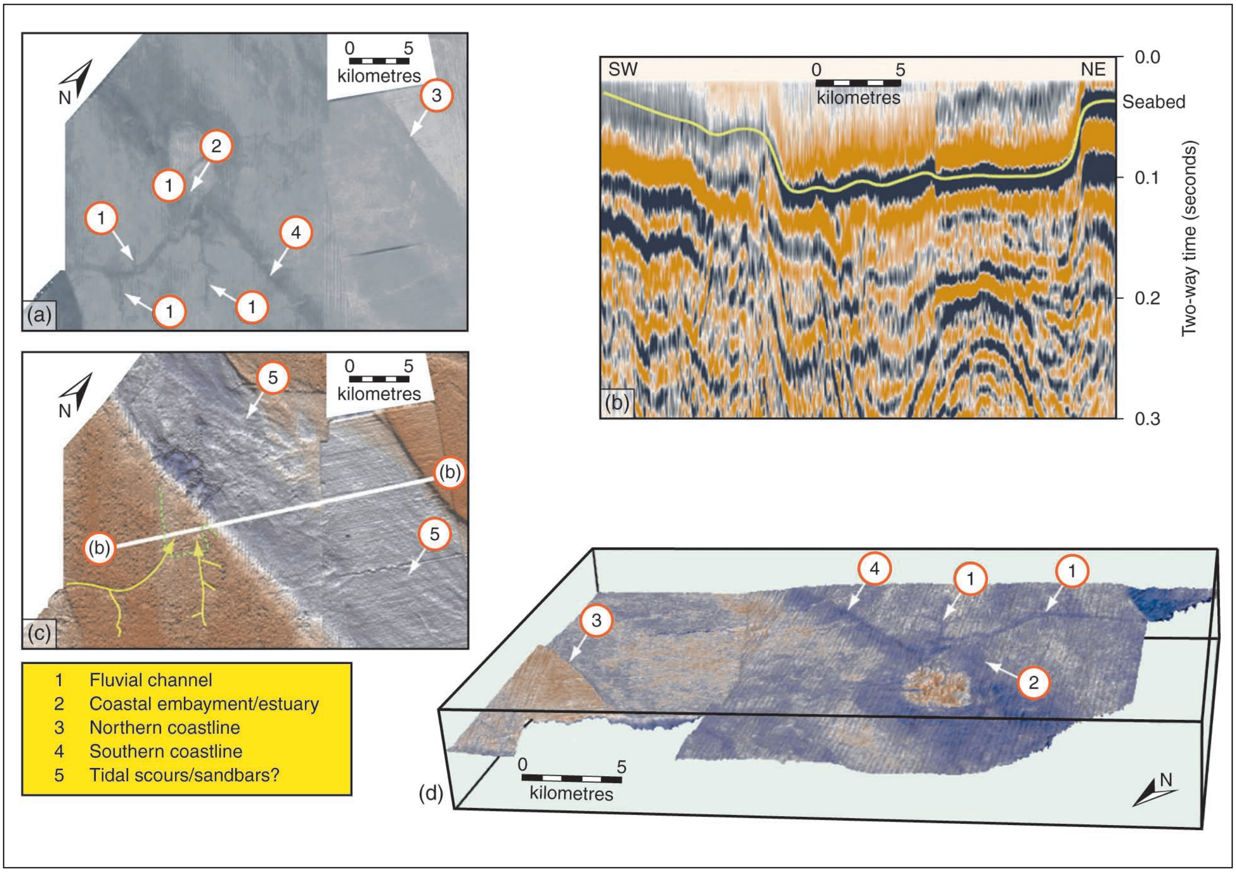


Figure 3.18 Picking a 3D surface across the Outer Silver Pit

outlined in yellow. This surface has then been extracted from across the entire data block and is shown as a surface within a cube. Because it is a 3D surface it can be illuminated in different ways and more detail provided. The final image is, again, a plan but because the whole surface has been extracted it has much more detail. Relatively subtle striations can be seen inside the channel and these have been interpreted as either tidal scours or sand bars.

There are other factors that also suggest that we can identify quite subtle features in this submarine landscape. Few people appreciate that geological salt movement is actually a major contributor to the geomorphology of the southern North Sea, but there are vast deposits of salt beneath the seabed created by the evaporation of ancient seawater. Deposits from the Upper Permian (*c* 260–251 million years ago) may be up to 1km in thickness.[10] Salt can be mobile and force its way into overlying deposits, causing uplift and fracturing. These processes, known as 'salt tectonics', are ongoing and can cause sudden, violent earth movements.[11] The 1931 'Dogger Bank earthquake', which measured 6.1 on the Richter scale, was the largest earthquake recorded in Britain and was probably a consequence of salt movement beneath the North Sea. Figure 3.19 shows the front page of the *Northern Echo*, which reported the event. Damage from the quake was recorded across the east of England; cliffs fell, a church steeple at Filey

Motor Insurance
Scottish Automobile and General Insurance Co. Ltd.

YORK EDITION

The Northern Echo

FOR RELIEF FROM RHEUMATISM
GENASPRIN
THE SAFE BRAND

F. No. 19,094 (FOUNDED 1869) MONDAY, 8 JUNE, 1931. ONE PENNY. F

ALL BRITAIN SHAKEN BY AN EARTHQUAKE.

THE GREATEST FOR CENTURIES.

ALARM IN THE NORTH-EAST.

PEOPLE RUSH FROM THEIR BEDS.

LITTLE DAMAGE AND NO LOSS OF LIFE.

An earthquake visitation—a rare occurrence in England—shook the country from end to end early yesterday. It is said to be the greatest that has been felt in this country since the 17th century.

From Aberdeen in the north to as far south as Jersey the shock was felt, the tremors lasting, in most cases, for some seconds at varying times round about 1.30 a.m. The shock, according to Reuter, was also felt in France, Belgium and America.

No serious damage was reported and no loss of life occurred.

WHAT EXPERTS SAY.

SHOCK CENTRED OFF EAST COAST.

"BRITAIN NOT COMING IN AN EARTHQUAKE ZONE."

HOW THE NORTH-EAST FARED.

NO SERIOUS DAMAGE.

HOW IT FELT AT SEA.

AS THOUGH ANOTHER SHIP WAS PASSING VERY CLOSE.

An Old-world Royal Court.

VICTORIAN POSIES RETURN TO FAVOUR.

PRINCESS MARIE LOUISE.

WHAT THE GERMAN TALKS MEAN.

CO-OPERATION IN TRADE AND FINANCE.

NO PACT.

CHEQUERS ARRAY OF EXPERTS.

Figure 3.19 The 1931 Dogger Bank earthquake

in Yorkshire was twisted, and one unlucky woman died of a heart attack. This is not an isolated incident: earthquakes and landslips are relatively common in the North Sea. One catastrophic collapse, known as the 'The Storrega Incident', occurred at about 6100 BC when 290km of the northern edge of Norway's coastal shelf slid into the deeps of the Atlantic in one of the largest known submarine landslides.[12] This caused a series of tsunamis to hit Norway and the east coast of the United Kingdom with devastating results for coastal settlements. At this time, Doggerland had probably been reduced by rising sea levels to one or more islands. What, if any, were the effects of the Storegga collapse this far south is unknown but if there were still people living on low islands the results are likely to have been catastrophic.

The effects of salt tectonics can be seen within the seismic data across the whole of Doggerland. Salt was clearly an important landscape process in the region and the most obvious features are linked with emerging salt domes. These features generally reveal themselves as ovoid features and, in plan, with a concentric ring structure as in Figure 3.20. Here an underlying salt flow has pushed up the land into what must have been a relatively gentle hill or hillock. It was clearly upstanding because the small stream to the east respects the hill and runs around it. However, in this case, the upswelling dome has also collapsed back in on itself, showing geological fractures known as collapse grabens. Presumably this must have resulted in a low rise in the shape of a ring with a central depression. One can guess that as inundation of the area occurred, groundwater would have risen creating marshes within the surrounding ring of higher land and then, perhaps, they were infilled as small lakes. The subtle effect of salt deep beneath the land surface can also be seen in Figures 3.21–3.22 where an upswelling dome has collapsed and a Holocene river has then followed the faults and incised a channel.

Clearly, there is a lot of information that can be gathered from the seismic data that gives us an insight into the detail of the landscape of Doggerland. When old land surfaces or a specific geomorphological feature can be identified, we can produce not only a map of the rivers and lakes but also a basic outline of the general shape of the land itself. However, there are significant pitfalls in doing this. The land, or seabed, is not fixed in time or space. Since the last Ice Age the removal of immense amounts of ice previously held in glaciers and ice sheets has caused Scotland and the northern part of England to rise whilst the south has been sinking. However, the eastern side of the southern North Sea has also subsided more rapidly that the west. Consequently, whilst the maps generated by seismic analysis provide general information on the relative shape of the land neither this information nor the contemporary bathymetry directly replicates the Holocene landscape. The final map for the area shown in Figure 3.23 therefore shows the relative topography of Doggerland rather than making any claim on the absolute height or shape of the land during the Mesolithic. Having said this, it is still correct to claim that this map, with its reconstructed rivers and hills, is a reasonable approximation of Doggerland and provides, uniquely, much-needed landscape detail of the lost lands beneath the North Sea.

With a degree of caution, the work at Birmingham allows us, for the first time, not just to explore the shape of the land but the characteristics and personality of Doggerland. Since the days of Clement Reid, it had always been presumed that

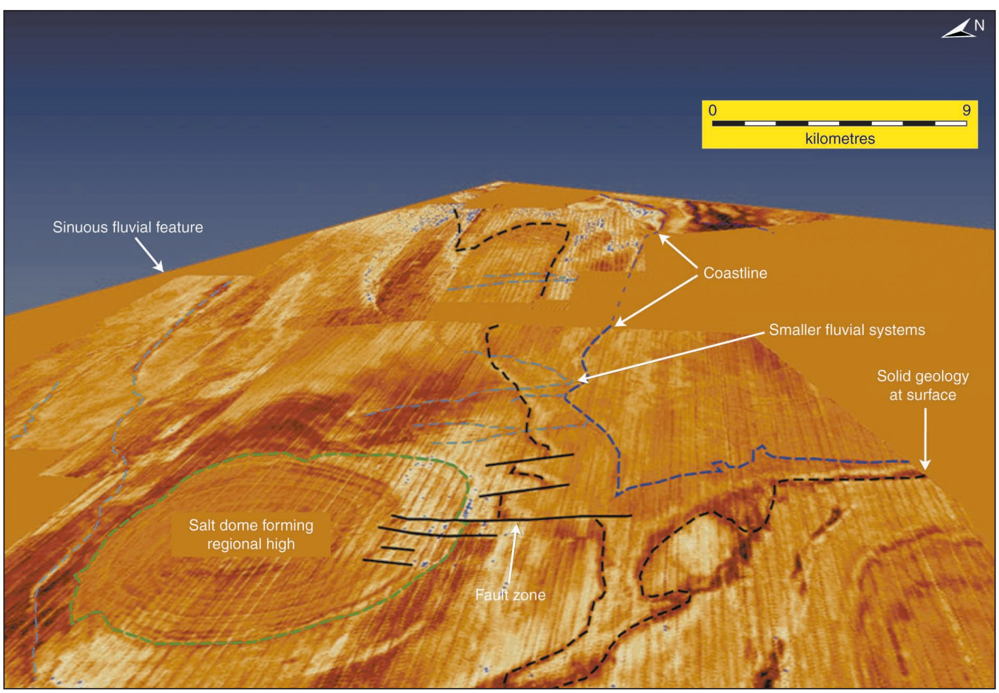


Figure 3.20 A salt dome at the west end of the Outer Silver Pit. Note that the river respects the dome, suggesting it was an upstanding feature

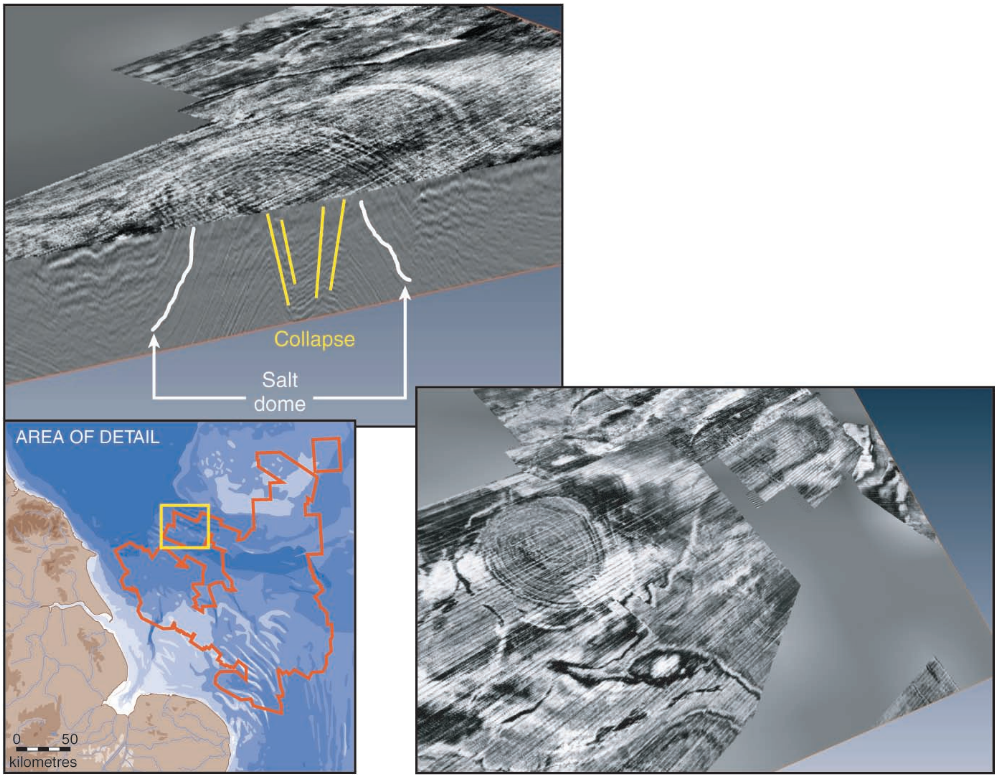
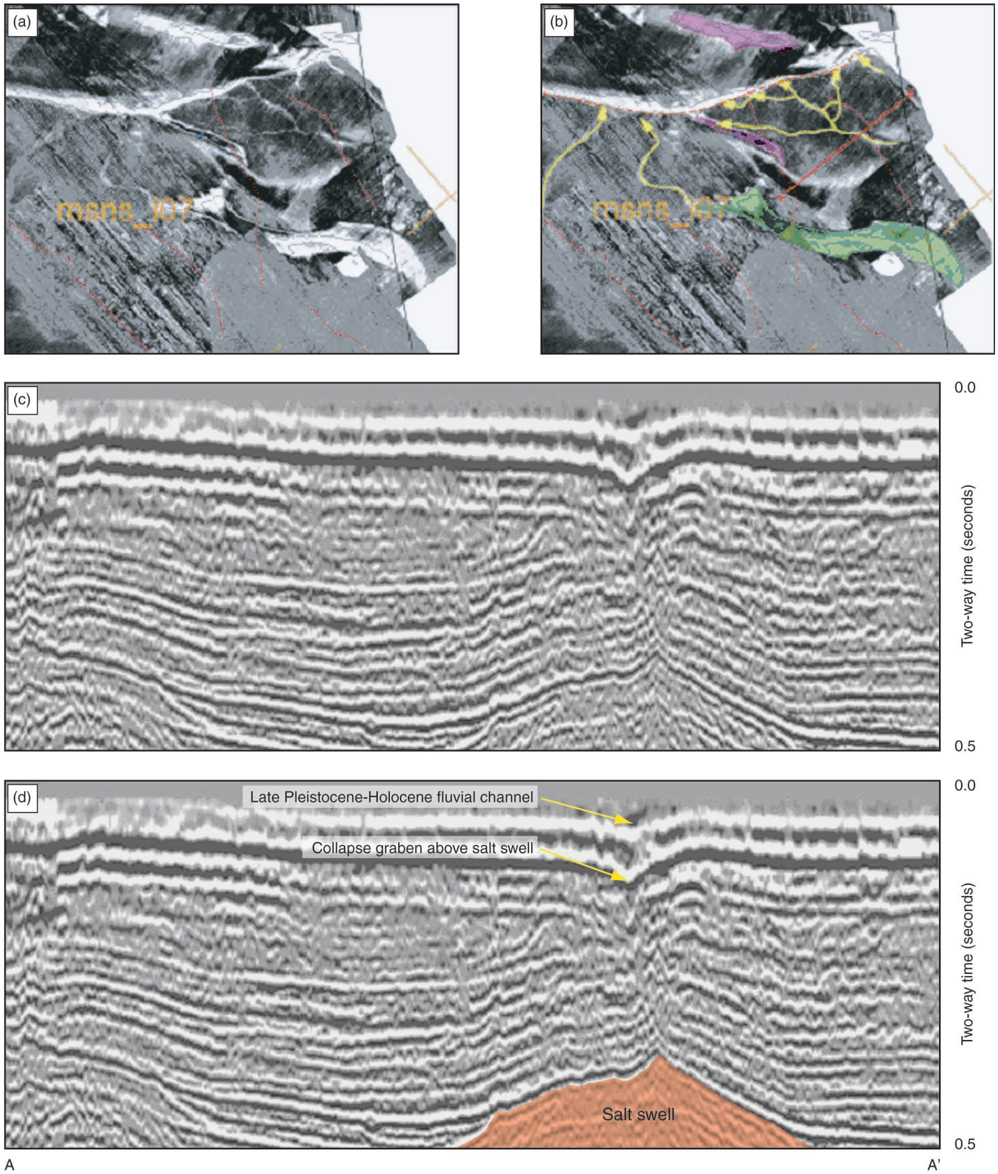


Figure 3.21 Detail of the salt dome at the west end of the Outer Silver Pit. Note that it exhibits graben collapse. Internal stresses are causing the emergent feature to collapse internally

the land was not only dominated by water and waterways but also progressively changed by water as inundation proceeded. In an area that had previously been *terra incognita*, the analysis at Birmingham has provided information on *c* 1600km of river channels and no fewer than 24 lakes or marshes, with the largest of these covering more than 300km^2, but even these impressive figures understate the watery nature of this landscape. The heart of Doggerland was a massive water body, mapped for more than 1700km^2, filling the Outer Silver Pit, the immense bathymetric depression described earlier in this chapter. Whilst the deeper history of the Outer Silver Pit cannot be resolved here it is important that we understand how it functioned during the Holocene. Its significance is clear in topographic terms as virtually the entire area that has been mapped as part of this project appears to drain into this massive feature. Archaeologists have long suspected that the Outer Silver Pit was a lake or possibly an estuary and assumed that it provided water, fish and other resources that would have been extremely attractive to Mesolithic communities. Two features provide important information on the complex history of this basin. In the extreme west of the Outer Silver Pit the trough appears to end in a low valley with a channel feeding, or leading from, what must have been a lake. This channel can be seen clearly in Figures 3.24 and 3.25.

However, two features, which look like large sand banks (Figure 3.26), were also located in the extreme eastern area of the Outer Silver Pit.[13] They are

Figure 3.22 Here a deep salt swell has collapsed and a Holocene river has followed the faults and incised a channel



extremely significant because analysis of the shape of these banks shows that they were formed during macrotidal conditions and therefore are unlikely to have developed in the still waters of a lake.[14] When these were created the Outer Silver Pit must have been a great estuary and the orientation of the banks suggests two major rivers or channels entering from the east and south-east, in the direction of Holland (see Figures 3.26 and 3.27). The seismic data also show that the underlying surface beneath each bank is very irregular and this indicates that the bottom of the estuary is actually scoured (Figure 3.28). This is important because it suggests that the strong currents that created the banks may have had some role in creating the Outer Silver Pit. This information also

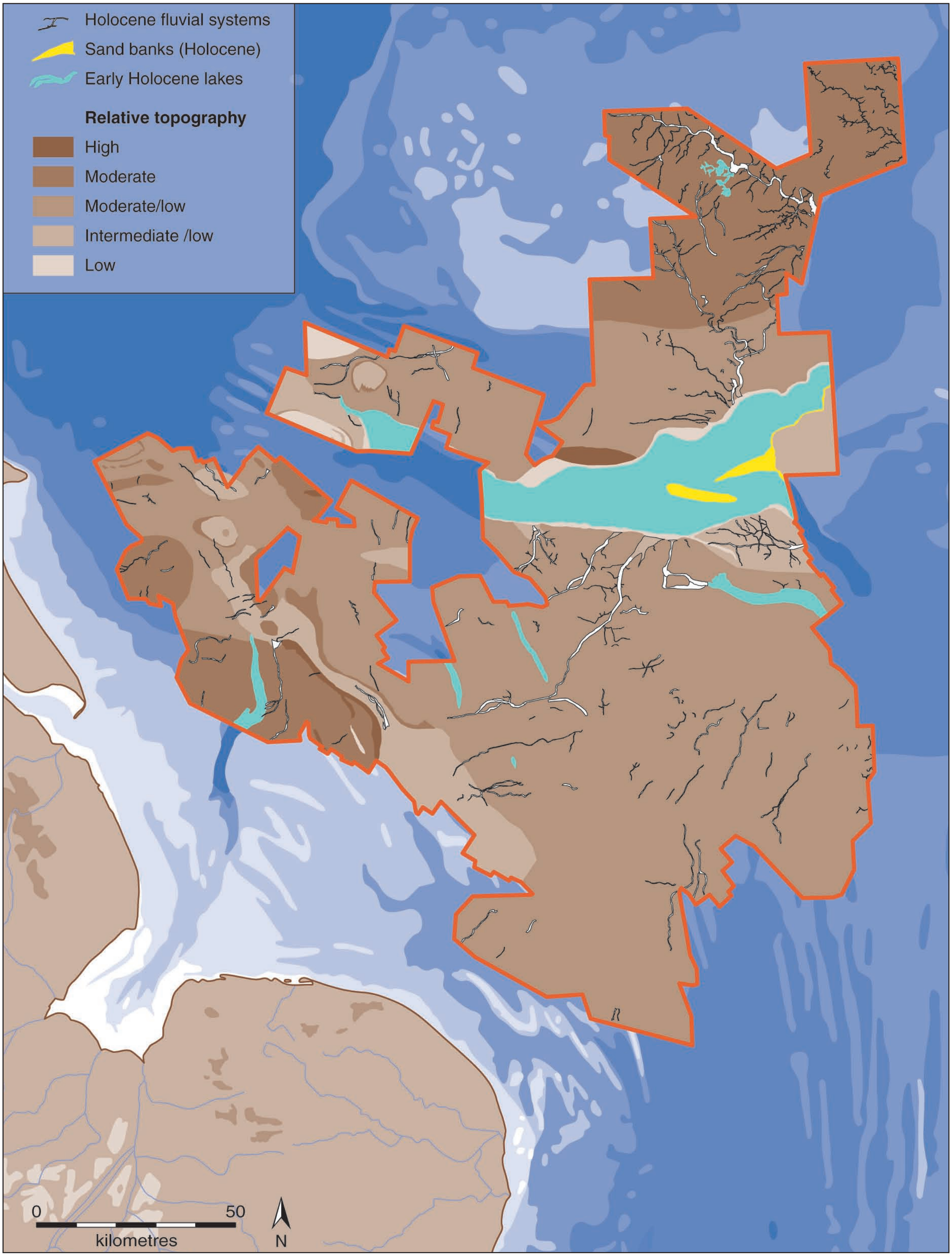
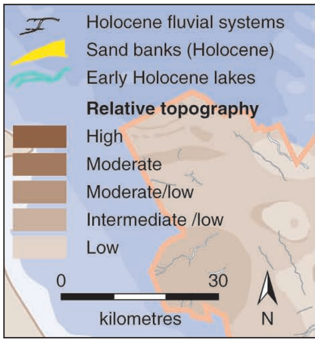

Holocene fluvial systems
Sand banks (Holocene)
Early Holocene lakes
Relative topography
High
Moderate
Moderate/low
Intermediate /low
Low
0
50
kilometres
N

Figure 3.23 The landscape of Doggerland

Figure 3.24 The Outer Silver Pit



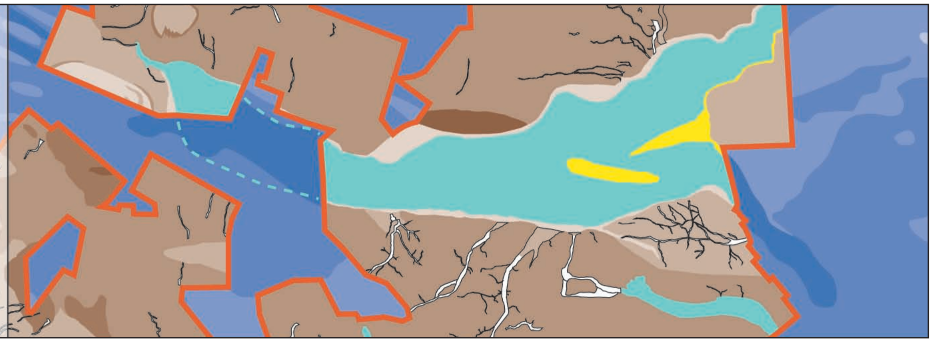
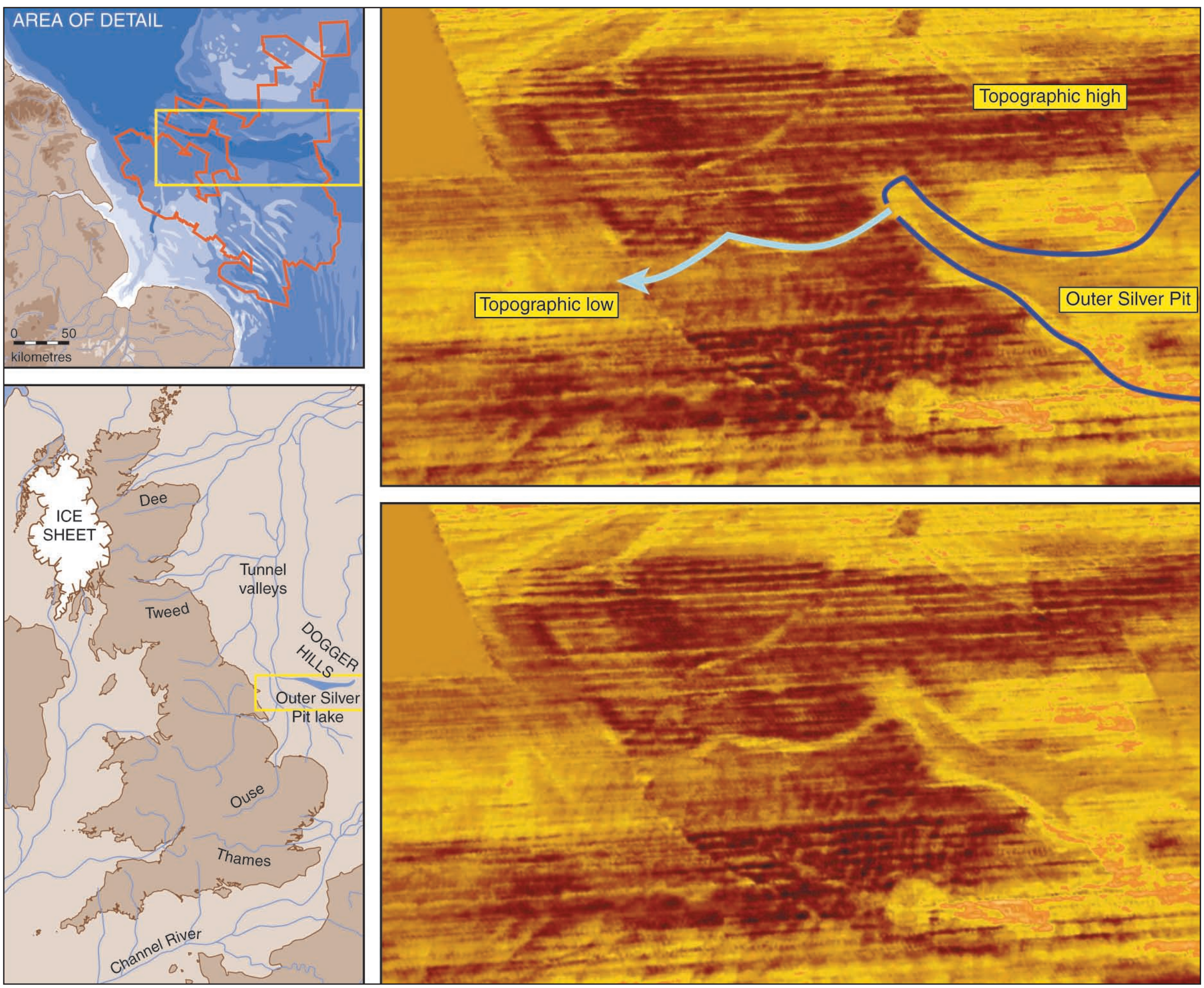


Figure 3.25 The channel at the western end of the Outer Silver Pit suggests that the deep had originally been a great lake during the early Holocene



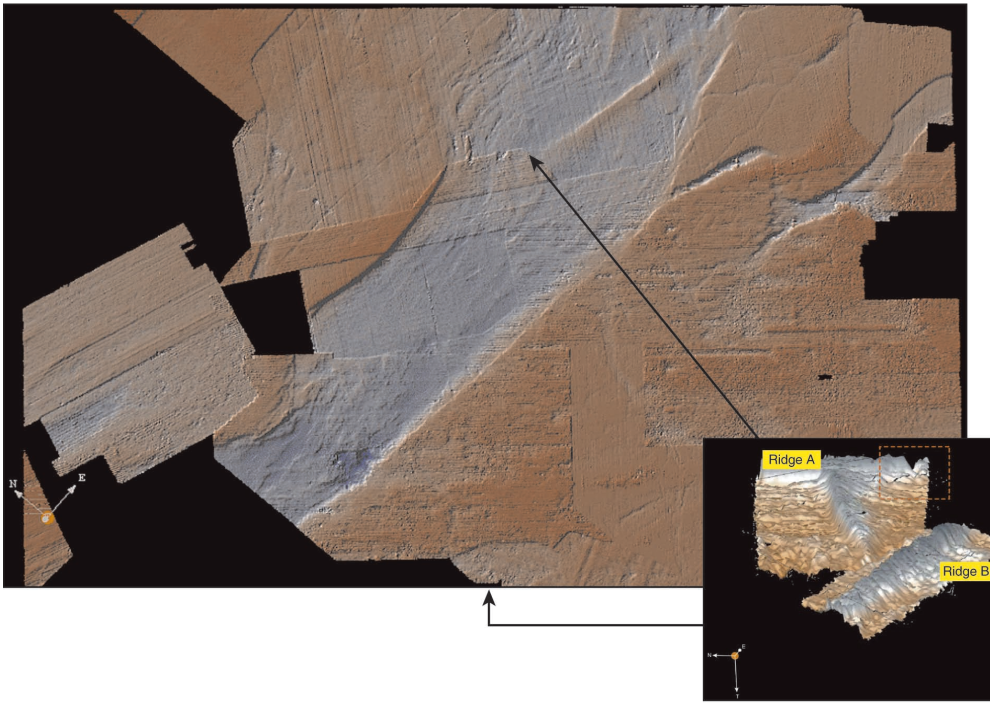


Figure 3.26 Large sand banks inside the Outer Silver Pit suggest that the lake was transformed into an estuary

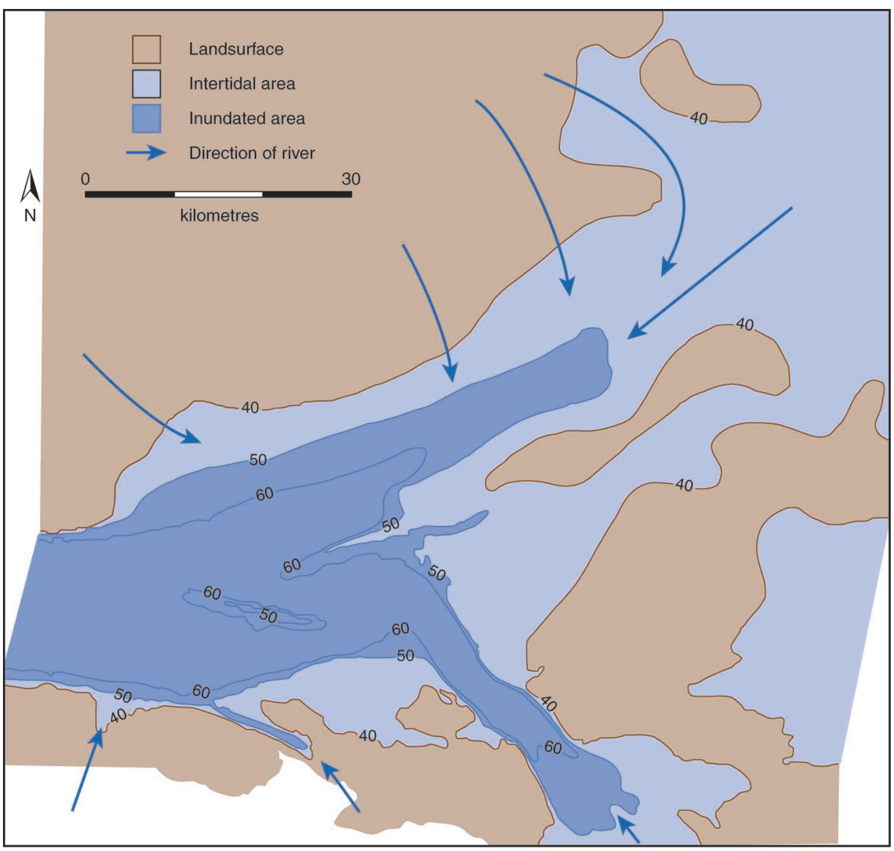


Figure 3.27 The probable configuration of the rivers entering the eastern end of the Outer Silver Pit

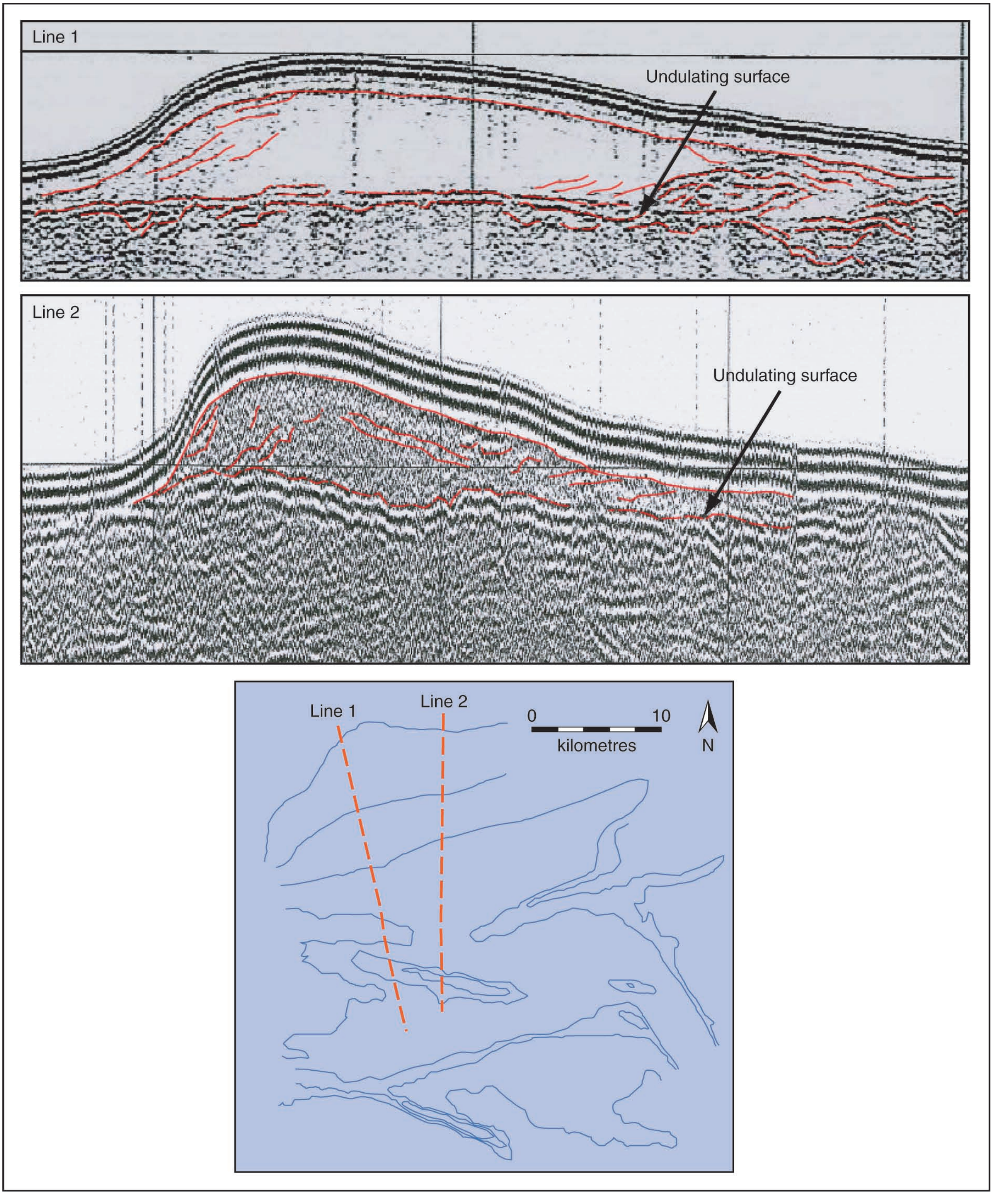
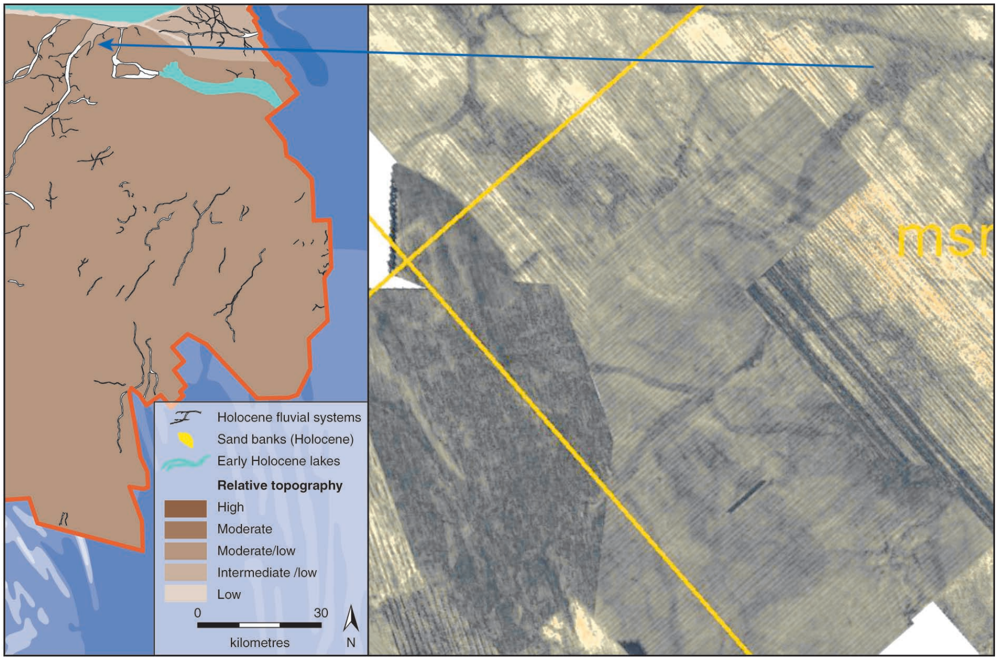


Figure 3.28 High-resolution slice across one sand bank showing that the underlying surface is highly irregular and possibly scoured by strong currents



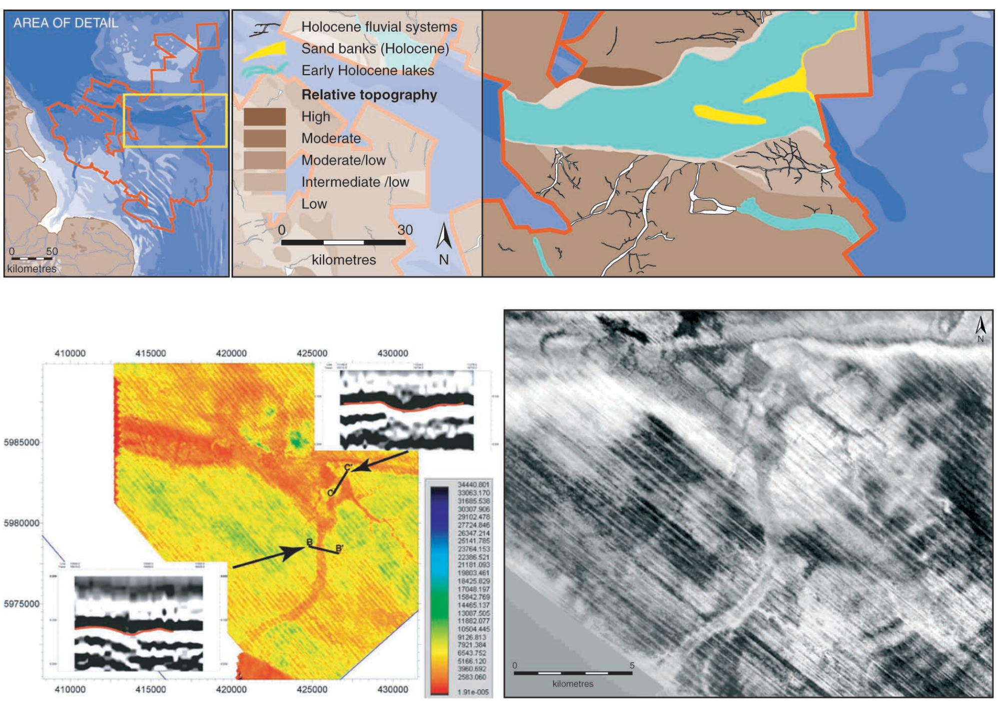


Figure 3.29 A simple estuary of a river flowing into the Outer Silver Pit

Figure 3.30 A complex estuary showing multiple channels indicates that the strong tidal currents may have removed the sediments related to its earlier lake phase that might have contained more archaeological and environmental information. As far as we can tell from the seismic data, the area contained within the Outer Silver Pit may be largely sterile in terms of surviving archaeological deposits. However, this does not mean we can say nothing about this feature. The scouring and the presence of the banks themselves suggests that the Outer Silver Pit was coursed by prodigious currents and if the Outer Silver Pit Lake was a gift to the inhabitants of Doggerland in terms of food and water, then the Outer Silver Pit estuary may well have acted as a considerable barrier to communities moving across the plain.

Whilst the probable lack of archaeological sediments in the Outer Silver Pit may be disappointing for archaeologists, the shores of the basin suggest a different story. Coastlines are, potentially, extremely important resources for hunter-gatherers. We have already seen that, in later periods, massive shell mounds on land testify to the importance of marine resources for food and the role of shell collection in particular. Consequently, these are likely to have been amongst the most productive areas for Mesolithic communities. The estuaries of the large rivers running into the Outer Silver Pit probably supplemented the potential of the shorelines. In most cases these estuaries are relatively simple features (Figure 3.29), but some seem to show a transition from single channels to larger complex features and it may be that we are seeing the impact of rising water levels transforming the rivers into marsh environments (Figure 3.30). However, the largest of these features, covering more than $300km^2$ is

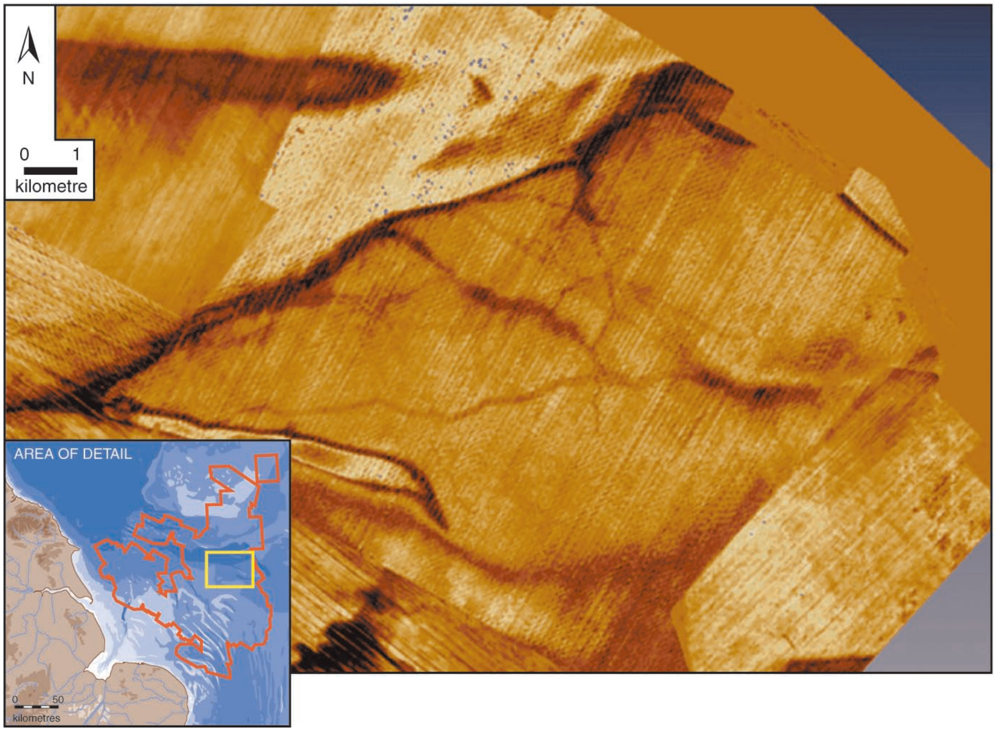


Figure 3.31 An area of interlocking water channels that has been interpreted as a massive salt marsh

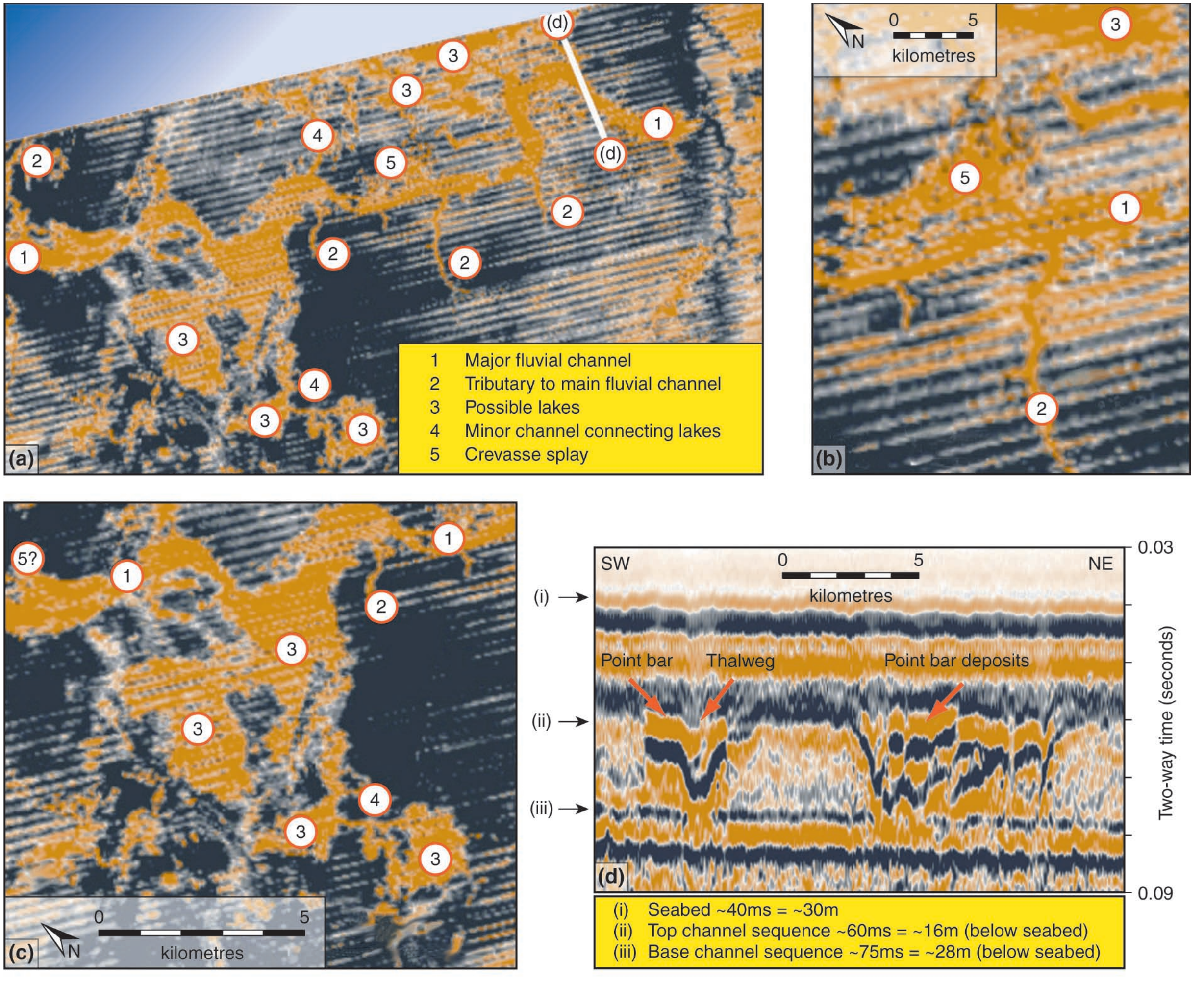


Figure 3.32 Detail of basins and riverine features associated with the Shotton River

characterised by multiple interlocking channels and most probably can be interpreted as a massive salt marsh (Figure 3.31). This must have been a major economic resource for Mesolithic hunters. Water, fish and birds would have congregated here in abundance, and reeds and other potentially useful plants could have been gathered from this area.

The rivers that fed these estuaries would have been equally important. Again they were sources of food but also fixed points and routes through the landscape. The best preserved, or more correctly, mapped, river systems lie to the north of the Outer Silver Pit. Three major river systems, including the Shotton River, flow from the relatively high lands that underlie the modern Dogger Bank (Figure 3.32). These rivers are set in wide valleys and are fed in turn by a complex web of smaller streams. The Shotton River itself links a series of interconnected shallow basins that may have held marshes or small lakes. The details provided here by the seismic analysis are exceptional and small features including crevasse splays can be identified. Crevasse splays are alluvial fans formed where an overloaded stream breaks through a bank and deposits its material on the floodplain, usually following a flood. Other major river channels meander, presumably across extremely slight gradients, to join the shore of the Outer Silver Pit.

South of the Outer Silver Pit, and beyond the large estuaries already noted, the seismic response is less good. Over much of this area only occasional hints of river channels can be identified, although the general seismic response suggests the area is a massive, low plain with few features that we can identify as being of Holocene date. There are, however, several features that deserve specific comment (Figure 3.33). These include major depressions adjacent to the large salt marsh described above. One of these depressions coincides with another marine deep known as Markham's Hole (Figure 3.34). Cross sections through this feature suggest that it reflects a partially infilled Pleistocene tunnel valley. The valley is so substantial that it must have been a significant feature during the Mesolithic and the seismic plan of Markham's Hole reveals a river channel that runs into the Outer Silver Pit, emerging from the northern end of the depression. It seems likely that Markham's Hole was also a large lake during the early Mesolithic and, unlike the Outer Silver Pit, it may contain substantial palaeoenvironmental deposits that archaeologists might consider coring for further information. Several similar lakes, also contained within earlier tunnel valleys, can be seen on the north-western edge of this great plain along with other major river valleys. Unfortunately, the seismic response in this area does not permit comprehensive mapping of these features.

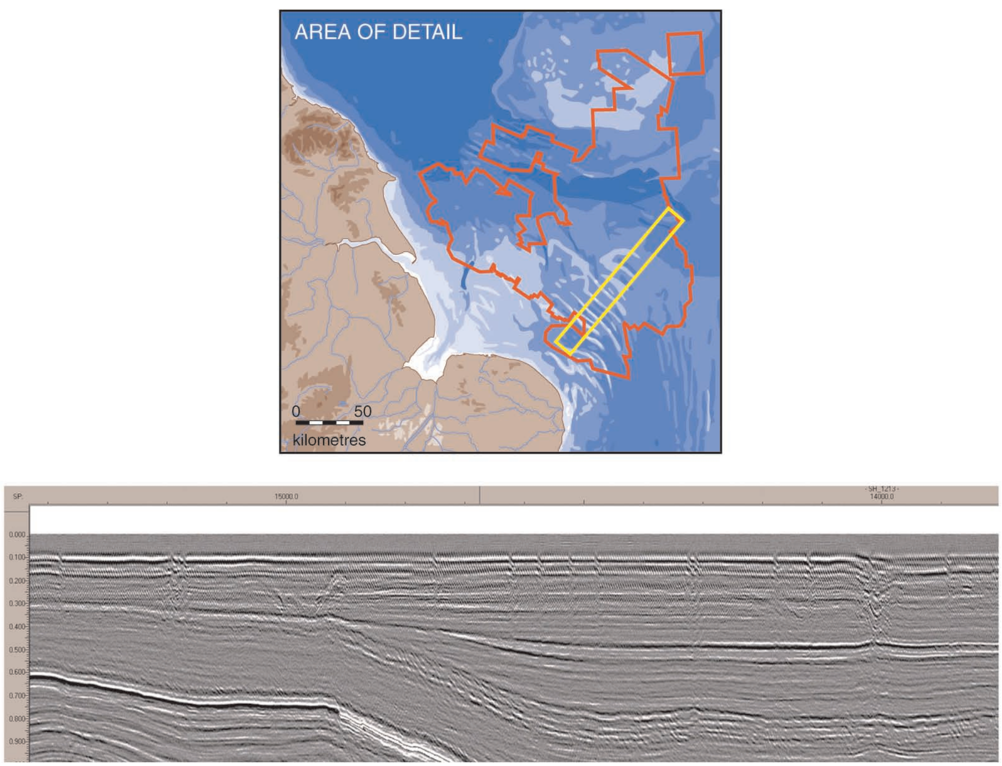


Figure 3.33 Seismic line spanning the southern part of the study area, showing that it appears to be a relatively homogeneous plain

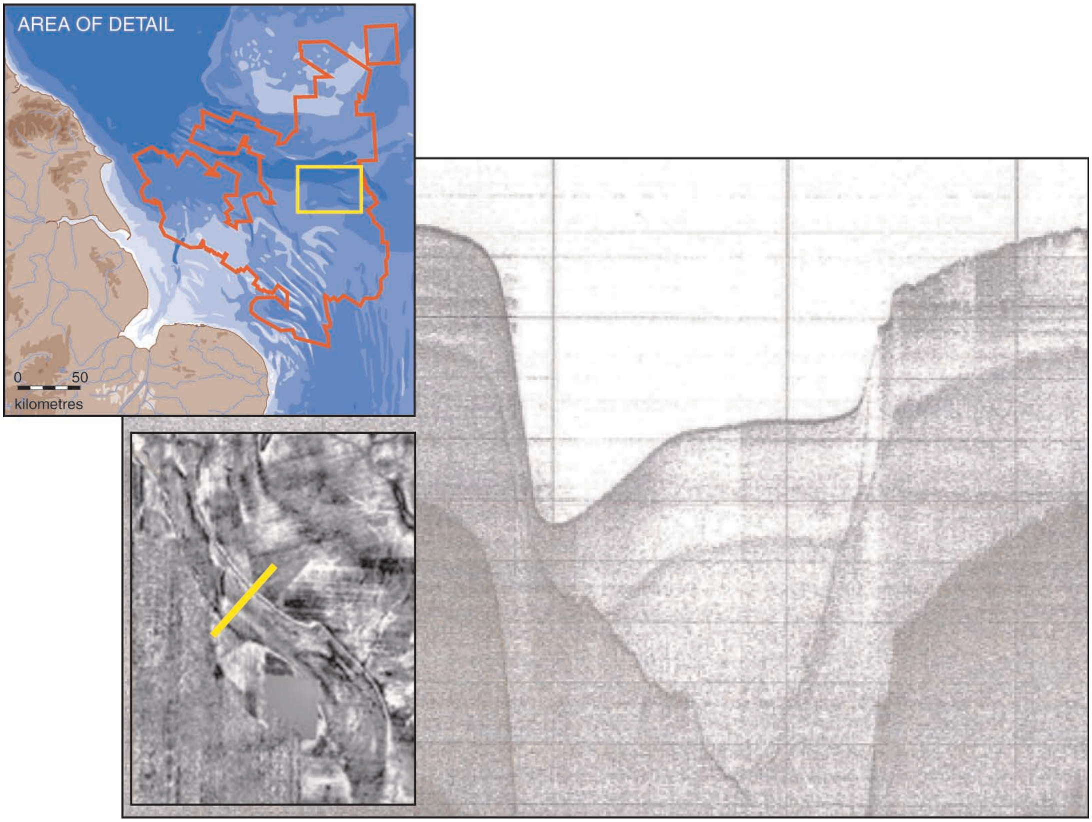


Figure 3.34 Plan and section across Markham's Hole

To the west of the study area the land rises gently but changes its character as it approaches the modern coastline. There are a number of topographic features which provide important information on the early Holocene landscape in this area. In the north-west a linear feature, known to geologists as the Flamborough Head disturbance, runs from the present coastline (Figure 3.35). This spur of chalk would have represented a significant Holocene landscape feature and appeared as a dominating, but low, ridge extending from the present coastline out into the North Sea. South of this ridge are several emergent salt domes and a long, low valley, probably containing a river, runs along the western edge of the study area. This is joined at one point by a smaller valley running in from west and out of the area we now call the Wash. This smaller valley is now associated with the Inner Silver Pit and also probably contained another lake during the early Holocene. Unfortunately, this basin also appears to have been scoured, presumably by water flowing from eastern England and through the Wash. The feature holds only limited potential for archaeological exploration.

The broad valley running along the western edge of the mapped area is very different in character from the rest of the landscape. It forms a distinct route across the grain of the land and at the point where it joins the Inner Silver Pit valley there is a distinct, low hill. One can imagine that this would have been a particularly appealing point in the landscape. This hill was, presumably,

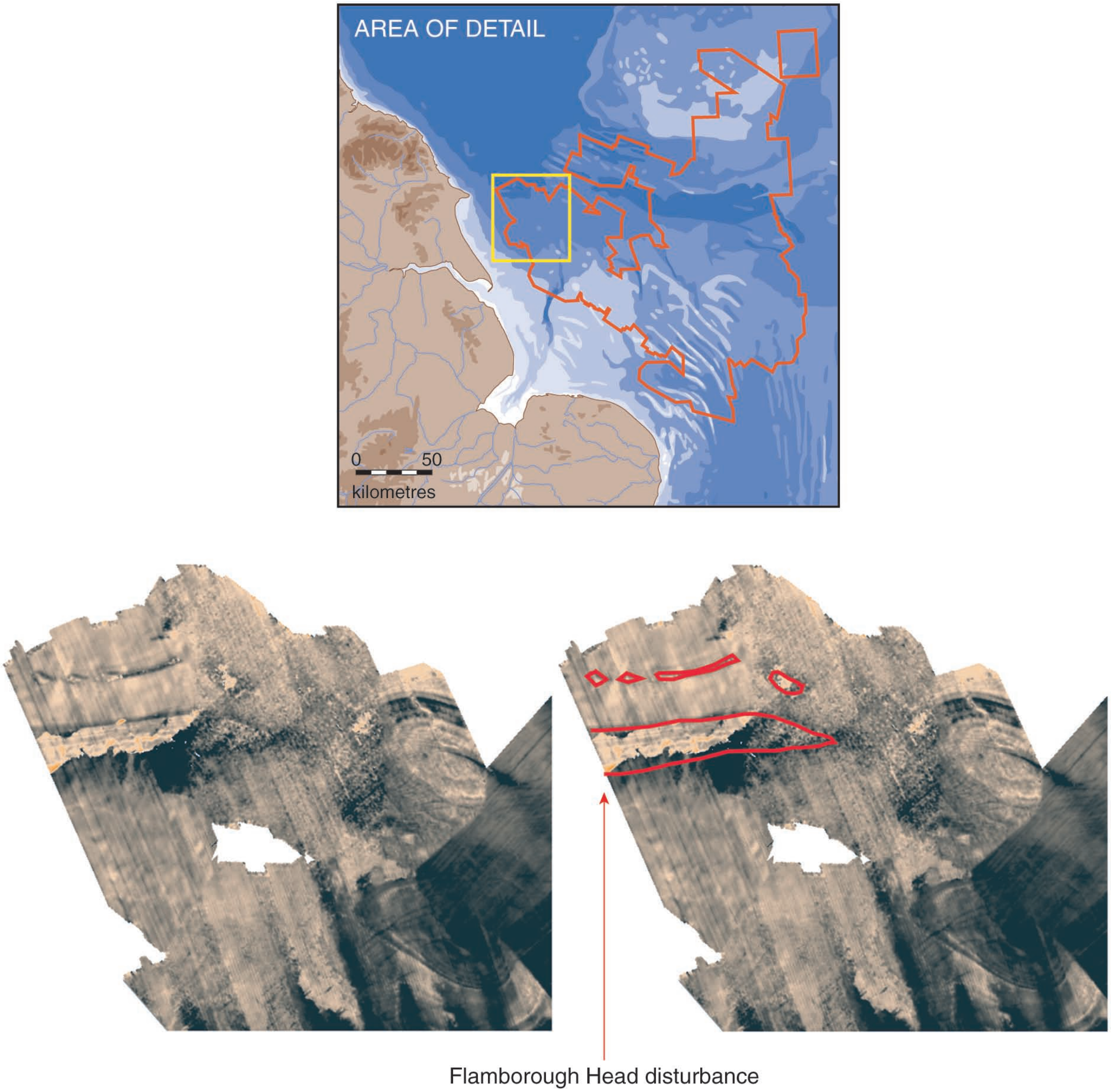


Figure 3.35 The Flamborough Head disturbance

comparatively dry and attractive for camps or more permanent settlement. It afforded opportunities for communication and the potential to watch for game moving within the valley itself (see Figure 3.36).

The map of Doggerland provided here is only a part of a larger, unmapped landscape and, admittedly, does not provide the detail that we might wish for in ideal circumstances. Despite this, interpretation of this landscape in terms of habitation potential and sediment survival will undoubtedly affect our understanding of the regional archaeology of all the countries bounding the survey area. The data also allow us to characterise the landscape and to begin to interpret the lost landscape with more confidence. Doggerland was clearly a massive plain dominated by water: rivers, marshes and coastlines. To the contemporary eye this environment might have appeared featureless and even unattractive, yet, to Mesolithic communities, Doggerland was a rich environment and provided a wealth of opportunities. Qualitatively, the features mapped are almost all areas where animal and plant resources that might be of value to hunter-gatherers are likely to be concentrated. Water is essential for all animals and where it is plentiful game will normally concentrate, providing meat for food, hides for clothing and shelters, and bone for tools. The opportunities to hunt would have changed with season and time across this landscape. As the climate ameliorated, and the sea rose, vegetation and environmental conditions changed. Whilst the colder, earlier period may have seen reindeer and horse hunted, this gave way to deer, pig, bear, wolf, hare, beaver, dog and many other mammals as the area became temperate.

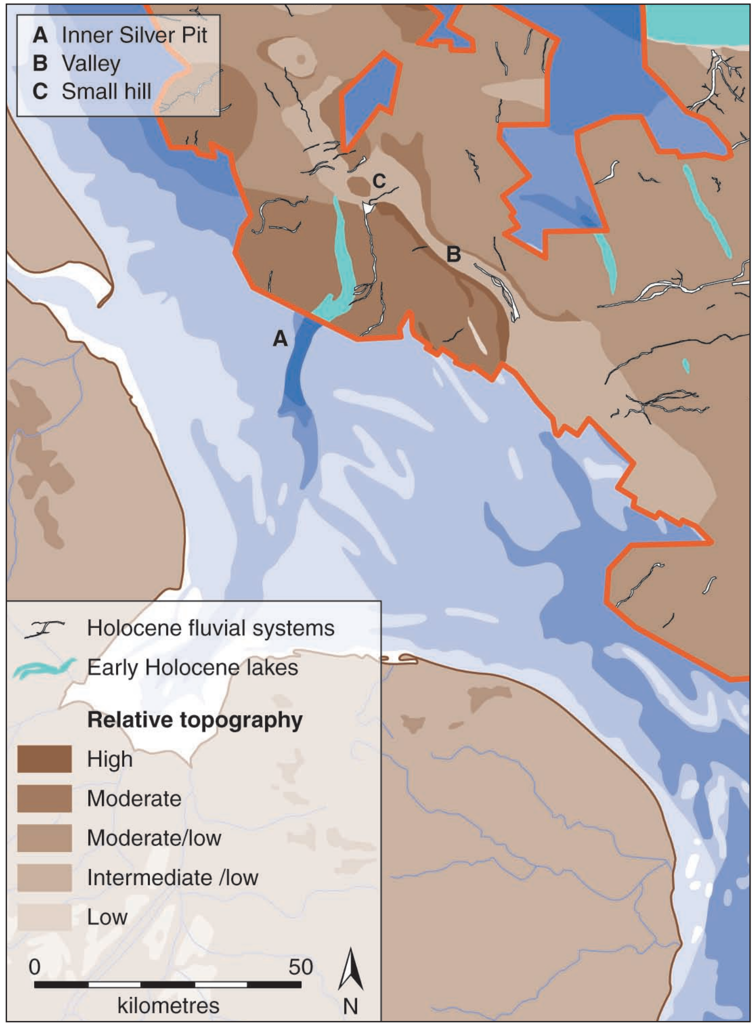
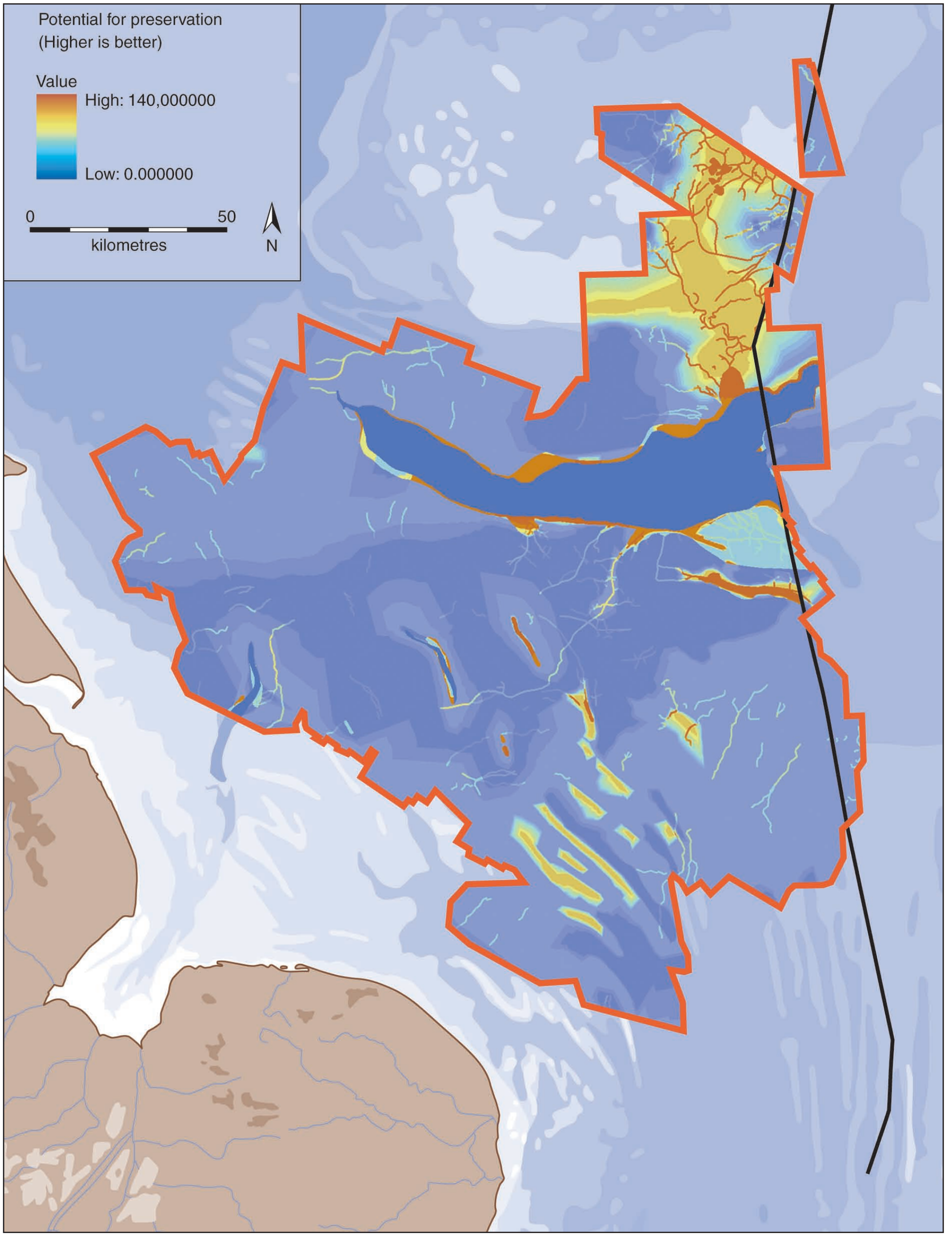


Figure 3.36 The western sector of the mapped area associated with the Inner Silver Pit and a large valley

Fish caught in streams and lakes, as suggested by the Colinda point, would have provided important annual and seasonal harvests. Sea mammals including seal may have been invaluable catches and shellfish could be gathered along coasts and beaches. Indeed, the large shell mounds found during the Mesolithic in Scotland testify to huge amounts of shellfish being gathered and consumed during the period. Birds would have rapidly colonised the wetlands and lakes as they formed ahead of flooding. Cormorants, mallards, grebes and cranes would have visited or lived in Doggerland, congregating in marshes and along coasts and rivers, providing flesh, eggs and feathers. Some environments provide specific plant resources. Reeds from marshes can be used for basketry and wickerwork. Fruit, such as raspberry and blackberry, may have been collected from bushes along with nuts including hazel, acorn and chestnut as they spread across the warming land. Herbs and other plants including sorrel, water lily and meadowsweet, and a variety of tubers or seeds, could have been used as food or flavouring or had medicinal uses. The deciduous woods emerging as a consequence of a warming environment would also have provided edible fungi but, more importantly, essential fuel for cooking and warmth.

Figure 3.37 Potential for preservation



We have already noted that permanent settlement may have been possible at Howick on the Northumberland coast at an early date during the Mesolithic and, at only a slightly later date, the annual salmon run on the Bann may have been so substantial that it supported semi-permanent settlement at least. Given the resources available in Doggerland, the great plain may also have provided opportunities for something approaching sedentism. Unfortunately, this is something that cannot be proven from the seismic data directly, but there are a number of models available to archaeologists that can provide clues as to how the landscape might have been used and therefore where to seek evidence for Mesolithic man. In Denmark a predictive model based on the coastal potential for fishing appears to provide a reasonably reliable way of finding Mesolithic settlement around the Danish coast.[15] However, the mapped Doggerland landscape is far more extensive and complex than a simple coastline. It might be possible to calculate the human carrying capacity of the Doggerland landscape using likely densities of animals and plants, but this work remains to be done. An alternative, and interim, position may be to consider where human activity is most likely to be concentrated on the basis of our current knowledge of the landscape. It is, for instance, clear that we can characterise the landscape on the basis of its archaeological potential in terms of likely evidence for human activity and also the potential for archaeological deposits to survive, and a first pass at this is provided in Figure 3.37.[16]

This illustrates data on the archaeological potential of identified landscape features integrated with the depth of overlying sediments derived from published sources. The potential of the archaeological features is, admittedly, relatively subjective but this produces a ranking of landscape features which archaeologists usually assume to contain archaeological material together with any indication from the seismic data as to whether there are surviving sediments. Areas with a lack of known features and an absence of significant sedimentation score relatively low. Areas that appear to have been scoured clean, including the main channel of the Outer Silver Pit, produce a value of 0. Areas with probable archaeological potential and with significant overlying deposits therefore score high. This is then combined with sediment data to produce a figure reflecting both these factors. Not surprisingly, this emphasises lacustrine environments, marsh areas and coasts, as these are areas, on the basis of known archaeology, that are most likely to be of prime archaeological interest.

With caution this map might support further, detailed exploration of the landscape, not by diving but by using ships to core for sediments that might provide archaeological evidence in the form of pollen or other proxy indicators for human activity. Areas that might have been expected to have significant potential, such as the Inner and Outer Silver Pits, are, following this study, no longer quite as attractive for future research although the estuaries and marshes surrounding the Outer Silver Pit may hold significant archaeological deposits. The areas around the large river systems to the north of the Outer Silver Pit, including the River Shotton, are emphasised overall, a consequence of the

River potential	Lakes	Marsh/wetlands	Coastlines	Deadzones/background
0 = Absent	0 = Absent	0 = Absent	0 = Absent	Scoured = 0
1 = Low	4 = Present	4 = Present	4 = Present	Landscape present = 1
4 = High				

Table 3.2 Ranking of features by relative archaeological potential

association of a dense network of major channels and protective sediments. These areas are likely to be of real interest in the future

In a perfect world, and with no limit on funding, the next stage of the project should be to take a boat equipped with a geological corer to recover archaeological samples to help us reconstruct the environment of Doggerland. Sadly, this option was never really available to the original project team.

Notes

1. Fischer 2004.
2. Bunch *et al* 2007.
3. Coles 1998.
4. Sherrif 1977; Kidd 1999; Praeg 2003.
5. PGS 2005. For the detail of the southern North sea survey see http://www.pgs.com/Data_Library/NW_Europe/Southern_North_Sea/SNS_MegaSurvey/
6. Original seismic data may also be available at 12.5m surface resolution, although most older data are usually collected at 25m or 33m intervals. However, 50m resolution data is most readily available for research and is usually used for extensive interpretation. This was therefore used by NSPP staff during the project.
7. Gaffney and Gaffney 2000.
8. Fitch *et al* 2007a. For details of the laboratory see www.vista.bham.ac.uk or visit the Institute of Archaeology and Antiquity web site (http://www.iaa.bham.ac.uk/) or Birmingham Archaeology web site (http://www.barch.bham.ac.uk).
9. Fitch, Gaffney and Thomson with Briggs, Bunch and Holford 2007.
10. Cameron *et al* 1992.

11. BGS 2007; Bruthans *et al* 2006.
12. Edwards 2004; Bondevik *et al* 2003.
13. Briggs *et al* 2007.
14. Briggs *et al* 2007.
15. Fischer 2004, fig 3.13.
16. Fitch *et al* 2007b.

Known unknowns! Reconstructing the climate and vegetation of the North Sea basin

As we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns – the ones we don't know we don't know.

Donald Rumsfeld, February 2002, US Department of Defence news briefing

Donald Rumsfeld's ruminations on the complexities of knowledge were not obviously aimed at the problems of reconstructing the climate and vegetation history of the North Sea basin but they could so easily have been! Whilst it must be fairly obvious that archaeologists have to understand about past climates when trying to reconstruct human lifestyles, the uncomfortable truth is that all too often our knowledge of these issues is characterised, at best, in terms of probabilities and only occasionally exceeds speculation. The available evidence for the Mesolithic environment of the North Sea, for instance, is poor even in comparison with the little we know about the traditional archaeology of Doggerland. This is mainly due to the fact that sampling of deposits for analysis in the area of Doggerland today is very difficult. It is also true that although many sediment samples have been taken in the past these were not taken for the purposes of understanding the recent archaeology of the region. In many cases the potential importance of sediments to archaeologists was rarely understood by the geologists, geomorphologists and marine scientists who took the cores and studied them.

The consequence of this general lack of understanding was that any assessment of the potential of the area was inevitably based upon our knowledge of those known terrestrial sites which had preserved deposits that were amenable to palaeoenvironmental analysis – in other words the sites 'we know we know'! Very few sites are actually available with environmental data for the period that Doggerland was a habitable region and the data are not without contention where they are available. As has been noted, the environmental data from Star Carr, which is the 'type site' for the early Mesolithic in Britain, have been the subject of debate and revision since they were published 60 years ago. Archaeologists are therefore in the awkward position of having to base their ideas about the environment of Doggerland on data extrapolated from terrestrial sites that were not necessarily well understood in the first place. In this context, Donald Rumsfeld's statement may begin to sound comprehensible!

Reconstructing climate change in the North Sea basin

Despite this pessimistic statement we can start a discussion on past environments with two of the great 'knowns'. We do have a reasonably clear understanding of how the climate of northern Europe and the British Isles generally changed as glacial conditions eased from 15,000 BC onwards. This is important because, regardless of whichever models are used for landscape development and later sea-level rise, the changing climate must have had a major influence on the landscape and the vegetation of Doggerland at this time. We also know that this was the period when much of north-west Europe was recolonised by modern humans.

How do we know about climate change at this time?

Our confidence in the timing and direction of climate change during this period comes from a number of sources. Originally, our understanding of the last glaciation was based on classic geological work from the Alps and across Europe. Here the terminal moraines (the last dump of material left by a glacier as it begins its slow retreat at the end of a glaciation) were counted and recorded, and glacial events were given very approximate dates. Most of this work was undertaken before radiocarbon dating. This suggested that there had been four glaciations during the Pleistocene that affected northern Europe. These were of equal age (about 40,000 years) and were separated by interglacial warm periods of around 10,000 years. Given that it takes around 20 years for present research to filter down to secondary schools, for many of us, this was our understanding of glacial cycles when we were children. Indeed some members of the North Sea research group still remember worrying about the coming glaciation as, 10,000 years into the interglacial, it was clearly due soon!

Since that time, our understanding of the last glaciation and how this could have affected the North Sea basin has changed radically.[1] We now have the

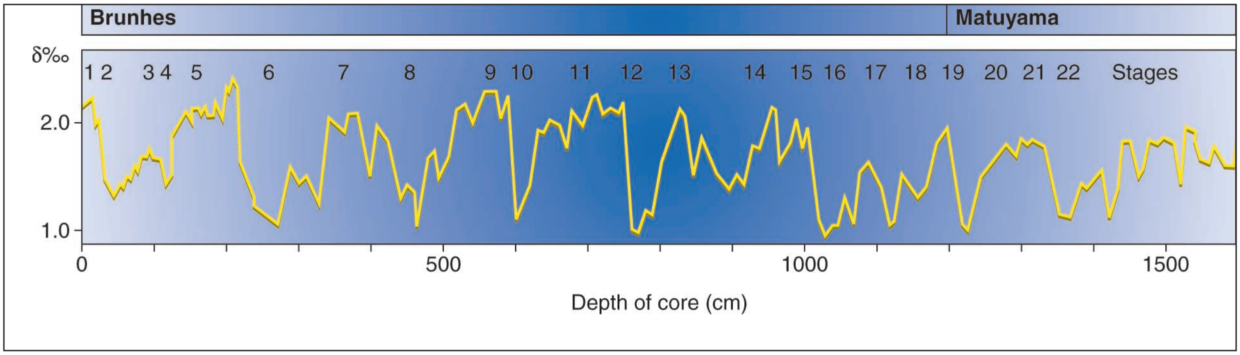


Figure 4.1. Oxygen isotope trace from deep-ocean sediment core C28–238

results from analyses of deep-sea cores taken from several of the world's major oceans.[2] Contained in this sediment are the remains of foraminifera, ocean-going protozoa, with a hard calcium carbonate coat or test. This coat is of great significance for climatic reconstruction because it contains two oxygen isotopes as part of its chemical make up. These are Oxygen 16, the normal isotope, and its slightly heavier cousin Oxygen 18. It appears that the ratio between these two isotopes changes over time. Furthermore, this variation is a response to the amounts of these isotopes present in seawater at any one time. It is now clear that this is a direct reflection of how much glacier ice is present on land. At times of glaciation, the lighter Oxygen 16 isotope becomes preferentially locked up in glacial ice, and so is less present in the open ocean. In effect, these isotopes and their variation across time are the perfect indicator for the timing of glacial conditions and climatic change.

Records of oxygen isotope values from cores taken from around the world's oceans allow a very accurate reconstruction of the timing and direction of glacial events. At present this forms a continuous record which goes back around 2.73 million years. In the last 880,000 years 22 isotopic changes are recognised, suggesting at least twelve warming and cooling cycles of various, unequal lengths.[3] These stages are known as Marine Isotope Stages (MIS) and have been numbered so that odd numbers are warm events and even numbers are glacial events. A diagram of the oxygen isotope trace for one core is shown in Figure 4.1.

This information has fundamentally changed our perception of climate change in the past. The old model of four equally spaced glacial stages clearly no longer holds. The climate was quite variable throughout the Pleistocene and, moreover, change from one cycle to the start of the next may have been rapid and dramatic. The unpredictability and extreme nature of past climate change has also greatly complicated our understanding of the past settlement of Europe.

The ocean cores are also key to our knowledge of climate change during the period we are concerned with in relation to Doggerland – the last 15,000 years or so. The cores clearly record three fluctuations during this period.[4] After 12,650 BC the climate seems to have entered a relatively warm period at the end of the Dimlington stadial (also known as the Late Devensian Glaciation or MIS 3). This warmer period represented by Marine Isotope Stage 2 is referred to as the Late

Glacial Interstadial (or the Windermere) in Britain. There appears to be a rapid jump in temperature at the start of the period followed by slow cooling over the next 2000 years. On the Continent there is clear evidence that this period of gradual cooling is punctuated by a short, sharp 500-year cold phase known as the Older Dryas at around 12,000–11,750 BC with a return to warmer conditions thereafter. However, there is less emphatic evidence for this sharp downturn in the British data, suggesting that there was a distinct difference in climate across this area of northern Europe at this time.[5]

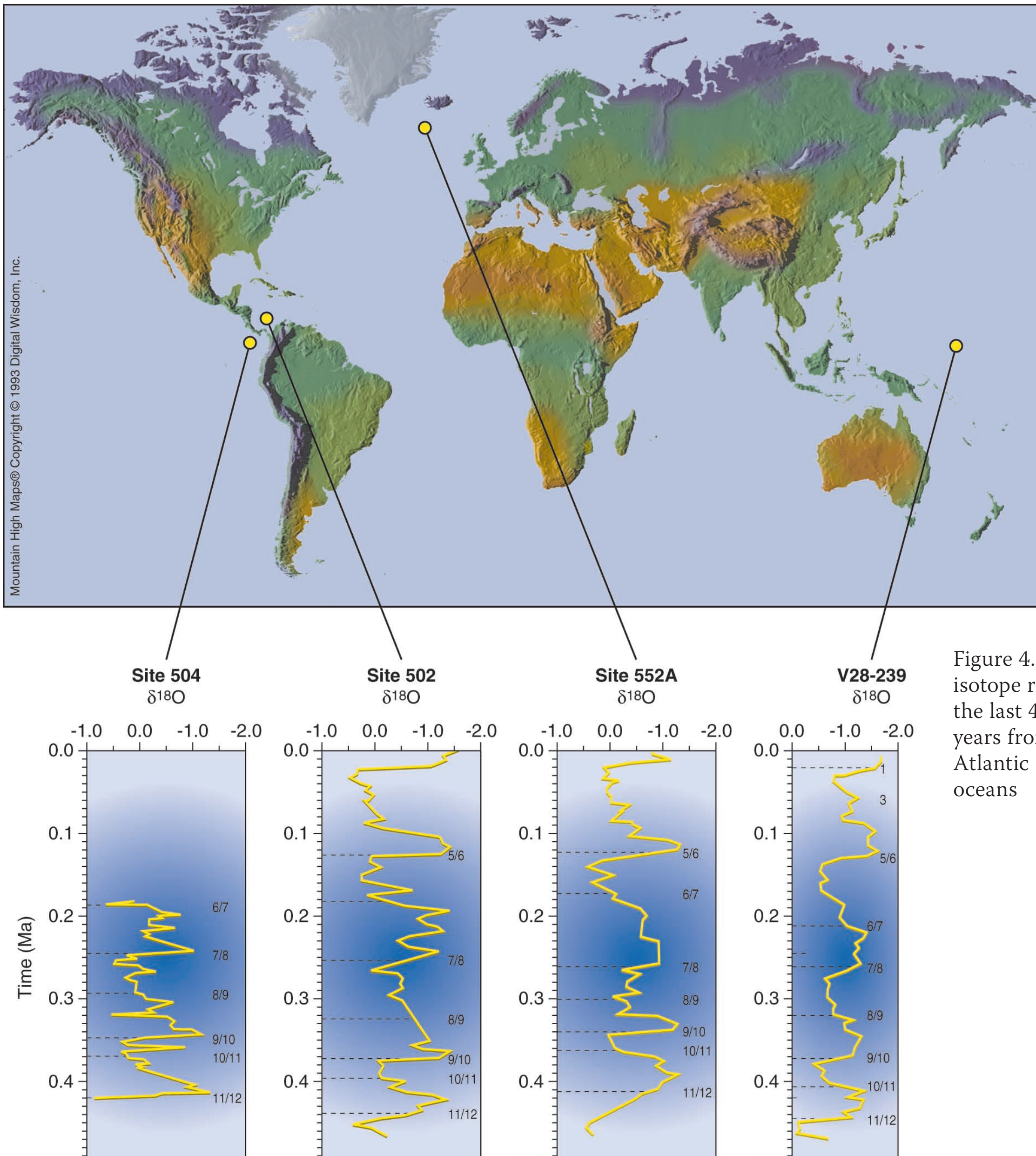


Figure 4.2 Oxygen isotope records for the last 470,000 years from the Atlantic and Pacific oceans

The oceanic record does, however, clearly show an extremely sharp and violent downturn in climate at around 10,950 BC that affects the entire area around the North Sea basin. This is called the Loch Lomond stadial in Britain and the Younger Dryas on the Continent. This in turn is followed by a sudden improvement in climate at around 9600 BC as we enter the present warm phase known as the Holocene – the geological period that we are currently living in.

These oceanic data have two clear problems. First, they clearly represent a description of events on a worldwide scale; this can be seen in Figure 4.2. This well-known illustration compares four cores from four different oceans and the general pattern is similar.[6] This is a problem, however, because our rather parochial interests are centred on Doggerland and specifically around the inland lake of the Outer Silver Pit. What we need is the local detail rather than the big picture. Equally, the actual dating and timing of events from the ocean core is a bit vague for our needs. For example, the core illustrated in Figure 4.1 was initially dated by reference to one of the periodic switches in the earth's magnetic polarity; this is known to have occurred at around 720,000 BC and is known as the Brunhes-Matuyama event. Dates more recent than this event are actually estimates based on depth down the core and the assumption that sediment rates were broadly similar throughout the period (the reader may remember that Clement Reid attempted a similar process on sediments to date the inundation of the North Sea and was dramatically wrong!). Consequently, whilst the procedure may be adequate when dealing with the vast periods of time represented by the totality of the core data, this becomes a rather inexact method when dealing with the relatively short time span represented by the Holocene.

Fortunately for us, there is a local and well-dated record for the North Atlantic that has become available in the last 20 years. This comes from various ice cores that have been sunk through the Greenland ice sheet.[7] Once again the principal indicator of direction and speed of climate change is the ratio of Oxygen 16 to Oxygen 18, but here we are looking at accumulation in local ice rather than a worldwide record and the dating of events is much more precise. Often the ice recovered in the cores is 'banded', these bands representing yearly accumulations of snow. Samples for analysis can therefore be taken from individual years and specific calendar dates worked out by 'counting back' from the top of the core. Of course, as with life, the story is not quite that simple. The ice cores only really record the direction of climate change rather than giving us a clear indication as to what this actually means in terms of degrees Celsius, although they do provide important information, as Figure 4.3 shows. Here, the combined data from two of the Greenland cores for the last 15,000 years clearly indicate two periods of warming and the 'cold snap' of the Younger Dryas (Loch Lomond) before the start of the Holocene. Equally, it shows that the onset of warming can be incredibly rapid, perhaps occurring in as little as 50 years.[8]

Fortunately, there is one source of information that does actually provide rather accurate temperature estimates throughout this period. Strange as it may seem, this is based on the recovery of the remains of insects, especially beetles.

Temperature reconstruction in the North Sea basin: almost a 'known known'

In the late 1950s, Russell Coope, also at the University of Birmingham, realised that the insect remains from the Pleistocene were not actually collections of unknown or extinct species but, essentially, modern insects. What was different, however, was the distribution of these insects in comparison with areas in which their modern counterparts are found today. This is interesting because beetles, as an order, have remained evolutionarily stable and their ecology and preferred habitats do not appear to have changed as a consequence. Coope realised that modern distributions were controlled by temperature. Consequently, if you know the temperature tolerances for a modern species and if the same beetle is found in a historic sample, then the temperature at that time must have been within the temperature tolerance of the modern beetle. One example will suffice: *Boreaphilus henningianus*, a small rove beetle, is common in many Late Glacial deposits throughout the Midlands of England. Its modern distribution is shown in Figure 4.4. Today it is essentially limited to the edges of glacial pools in 'arctic conditions' in the mountains of northern Scandinavia and Siberia (ie nowhere near present day Birmingham). From this we can deduce that at the time the deposits in the Midlands were laid down, the area was as cold as northern Scandinavia today.

Russell Coope collated the available beetle data in 1977 to produce a temperature curve for the last glaciation.[9] At the time, these results were greeted with a great deal of scepticism but they are now widely accepted. The results of his work have also been supported by the general trends seen in the ice core and deep-ocean sediment analysis.[10] Coope refined this technique further in 1987 when, along with co-workers, he used the overlapping ranges of a number of species at each site to increase the 'resolution' of the climatic reconstructions (this became known as the mutual climatic range (MCR) method).[11] This has produced an elegant and continuous temperature curve for the last 22,000 years, part of which is shown in Figure 4.5. Consequently, although the Greenland ice core data has produced much important information, the study of beetle remains is still the only way to achieve accurate temperature estimates for an 'inland' area.

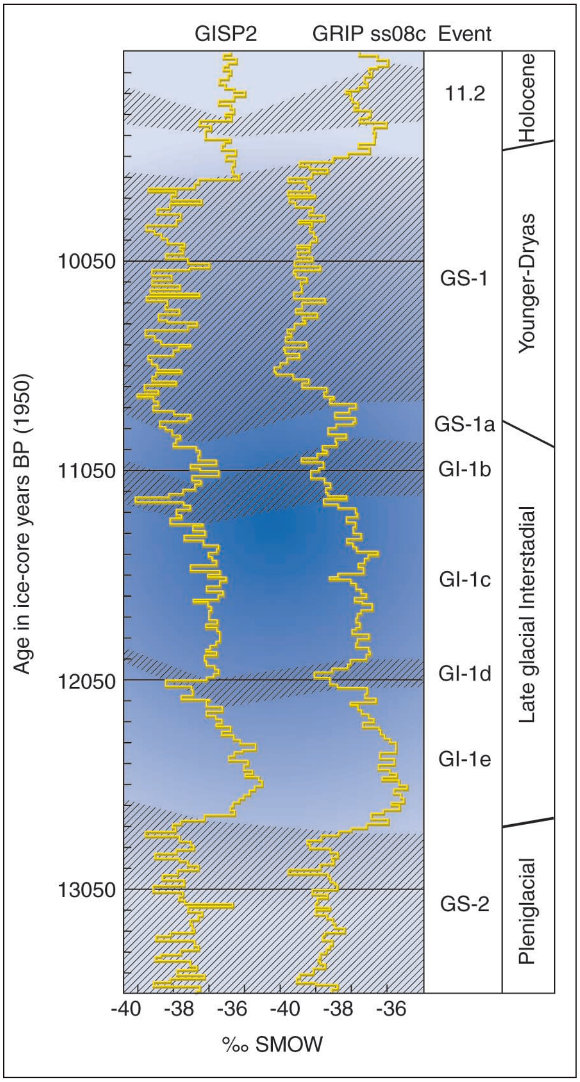


Figure 4.3 Oxygen isotope profiles over the last 15,000 years from the GISP2 and GRIP Greenland ice cores

Figure 4.4 The modern distribution of *Boreaphilus henningianus*

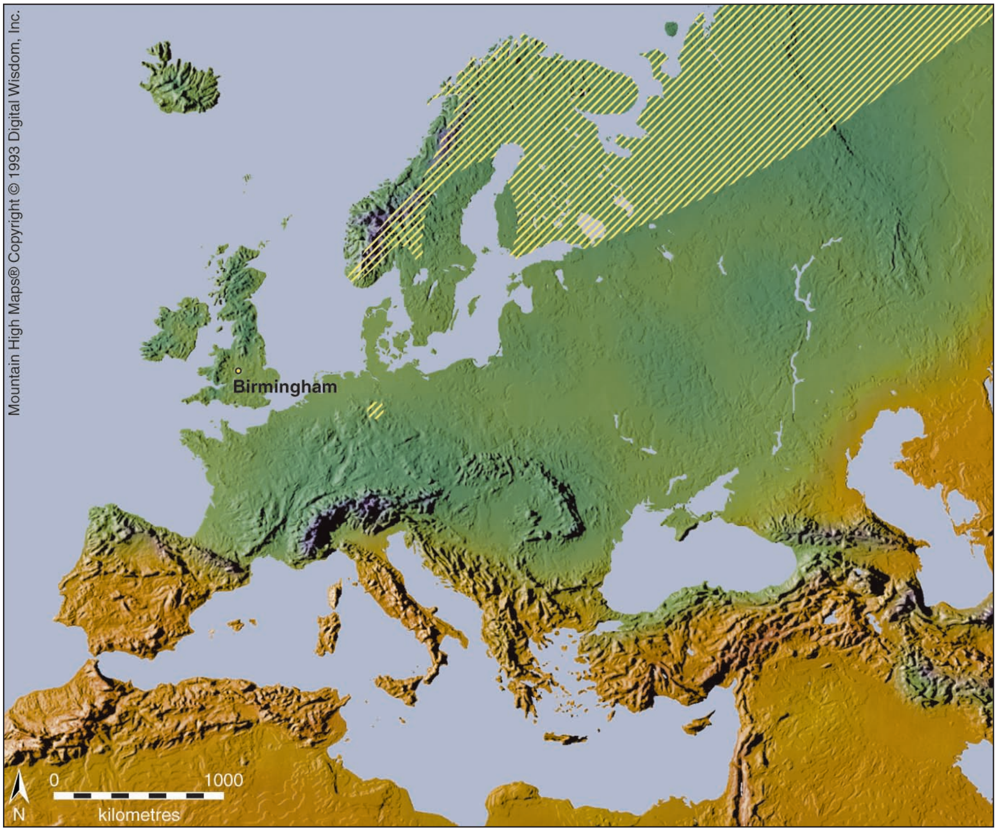
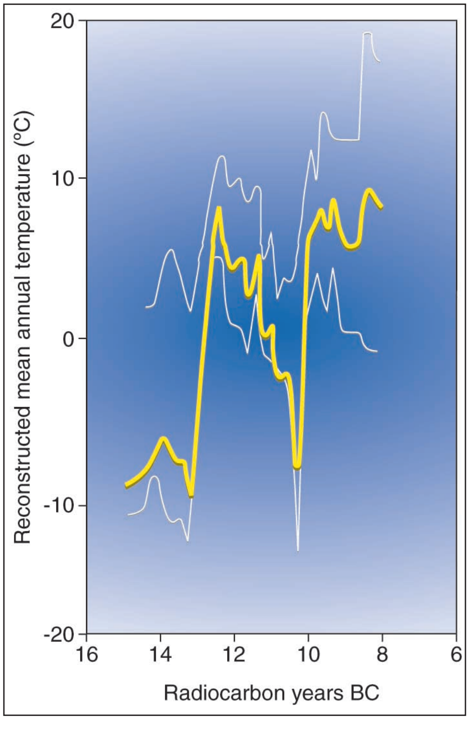


Figure 4.5 The temperature curve for the British Isles years reconstructed from Coleoptera



The insect data suggest that there is a rapid jump in temperature at the start of the late glacial, around 12,650 BC. At that time, the rise in average yearly temperatures is around 20°C (around 7°C in terms of maximum temperatures). This represents a rise from –10°C to +10°C in perhaps less than 50 years. In terms of midwinter temperatures, we may be looking at a jump from –40°C to something around the average for today. In Britain, between 12,650 BC and 10,950 BC, there appears to be a series of gradual step-like temperature declines ending in the sudden descent into the cold of the Loch Lomond (Younger Dryas) stadial. At this time conditions are so extreme that the temperature range for around 1500 years is similar to that during the full Dimlington glacial. At around 9500 BC there is a very rapid 20°C jump at the start of the Holocene. The reason for these rapid changes in temperature has been debated for the last 20 years, but the consensus view suggests that it is linked to a 'Heinrich Event' involving the disruption and re-establishment of the Gulf Stream, and therefore, the return of warm waters to the north Atlantic.

Reconstructing past landscapes of the North Sea

From the above it should be clear that, in terms of climate and temperature change in Atlantic Europe, we are dealing with a 'known known'. What is less clear is what is specifically happening on the ground in Doggerland. Two recent publications on insect faunas from across Europe have suggested that there may be some quite striking local variations across the present North Sea during this period.[12] In particular, it is clear that in the early phase of the Late Glacial between *c* 12,600 and 11,750 BC there is a very strong climatic gradient across Europe, with the area now known as Britain considerably warmer than areas to the east at the same latitude; this accords with the Older Dryas, a climatic period which is essentially 'missing' in Britain. This contrast largely disappears after this point when the variation in temperatures between Britain and the Continent is very much reduced and there is little trace of a substantial east–west gradient. These data also suggest that, during the warmer phases of the Late Glacial, continental climatic conditions are more influential and that the edges of the land mass are warmer and wetter than the interior. However, during the colder phases the climate was more oceanic in character.

What does this mean for Doggerland? In terms of climate and temperature we do have the clear 'known known' of the general trends in the data from the ice cores and the insect faunas, but it is equally clear that at certain times during this period, Doggerland sat in the middle of a gradient of rather variable temperatures and its exact climatic status remains unclear. This suggests that at these times the local climate of Doggerland may have the status of 'known unknown'. It would be truly important to obtain insect faunas and other climatic indicators from deposits of these dates from Doggerland to try to solve this puzzle.

Later climatic variations, during the greater part of the Holocene, probably had little subsequent effect or impact directly on the North Sea plain and the people who inhabited it. This period is often portrayed as one of relative climatic stability, with perhaps the one exception to this being the rapid global cooling event centred *c* 6200 BC known as the '8ka event'. This is seen in the Greenland ice cores and in a wide range of other environmental studies.[13] It has been suggested that average summer temperature at this time may have declined by as much as 1°C. This cooling is thought to result from the final collapse of the Laurentide ice sheet in northern America which released vast volumes of fresh water into the North Atlantic, and this in turn adversely affected the Gulf Stream. For the residents of the North Sea plain this may have been a fairly interesting time, not least because this cooling seems to be associated with a fairly rapid rise in sea level by around 1.5m. When combined with the 14–20m high Storegga landslide tsunami that swept the North Sea basin at around 6100 BC, this may not have been a good time to be hanging around on the remnant of the Doggerland plain unless you could run very fast.

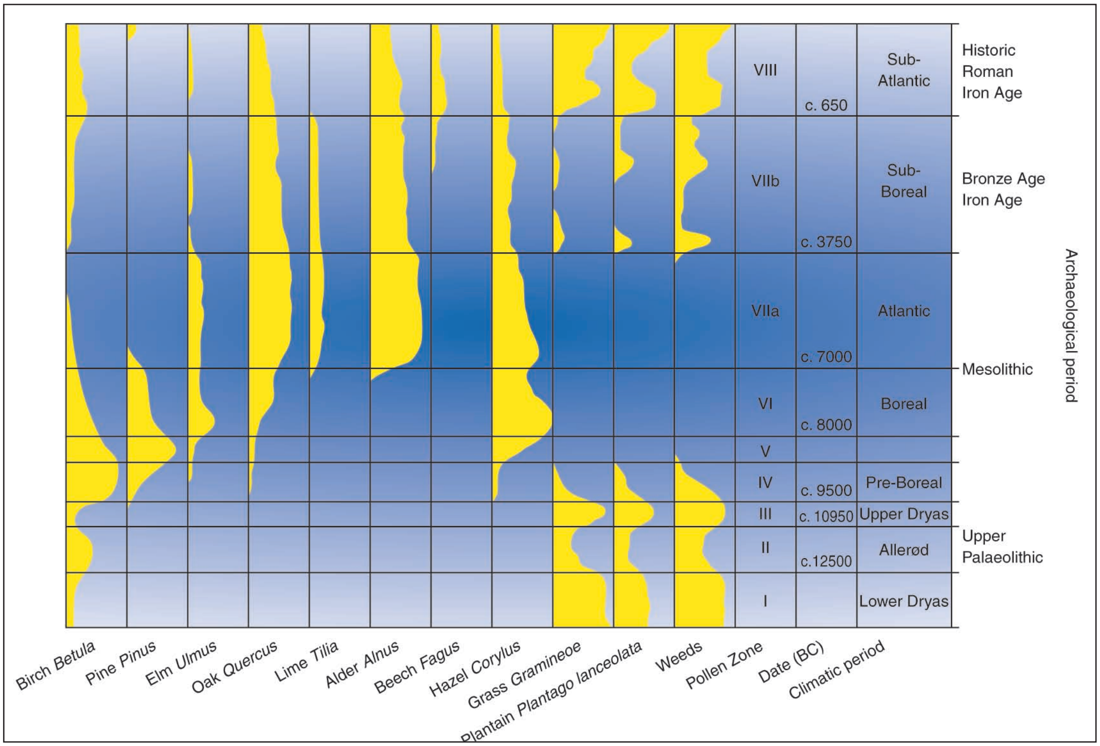


Figure 4.6. The pollen profile for the early Holocene from the British Isles

Reconstructing the vegetation of Doggerland

Despite this, the seismic survey described earlier outlined a number of potential landscape features preserved in the seabed around the Doggerland Hills. These have been interpreted in a number of ways. They include large river systems interspersed with low-lying hills and rises, extensive freshwater marshes and, as the Outer Silver Pit flooded, even the development of large areas of salt marsh. Although there are clear issues with the environmental data, we can presume some familiarity with these types of environments. Consequently, we can now consider whether, within the bounds of the environmental information we possess, we are able to visualise what these landscapes actually looked like.

Nearly 70 years of pollen analysis from sedimentary profiles, dating back to the work of Godwin, allows us to reconstruct an accurate picture of environment and landscape change in the period after 15,000 BC in the British Isles and on the eastern reaches of the North Sea.[14] Unfortunately, the local picture for the southern North Sea is less complete. Normally, the collection of material from an area for pollen analysis is quite straightforward. Drive about, find a suitably wet location, get out of the car, screw the pollen auger together and, after a bit of hard work, take the sediment sample and head back to base for analysis. Obviously this is complicated when the deposits of interest are covered by tens of metres of seawater and deep overlying sediments. Despite this, there have been attempts to look at pollen from various blocks of material from the bed of the North Sea retrieved in fishing nets or by dredging. In addition, there has been

1	Tundra
1a	Tundra 'xeric' variant
2	Birch forest
2b	Birch forest 'xeric' variant
3	Birch-conifer forest
4	Spruce-dominated forest
5	Northern mixed conifer-deciduous forest
5a	Northern mixed conifer-deciduous forest: *Pinus* variant
6	Mixed deciduous forest
8a	Montane mixed-conifer forest: *Pinus* (Haploxylon) -*Larix* variant
9	Mediterranean forest
10	Xerix Mediterranean vegetation
11	Steppe
11a	Steppe: treeless variant
12	Grassland
13	Mixed forest
13a	Mixed forest 'xeric' variant

1	Tundra
2	Birch forest
2a	Birch forest: *Populus* variant
2b	Birch forest 'xeric' variant
3	Birch-conifer forest
4	Spruce-dominated forest
5	Northern mixed conifer-deciduous forest
5a	Northern mixed conifer-deciduous forest: *Pinus* variant
6	Mixed deciduous forest
7	Montane mixed conifer-deciduous forest
8	Montane mixed-conifer forest
8a	Montane mixed-conifer forest: *Pinus* (Haploxylon) -*Larix* variant
9	Mediterranean forest
11	Steppe
11a	Steppe: treeless variant
12	Grassland
13	Mixed forest

Figure 4.7 Isopollen maps showing changes in vegetation over the postglacial

the odd attempt to look at 'peats' from geological cores taken in the north of the region[15] but little of this has taken place in the area of the Dogger Hills. Without material suitable for analysis from the area around the Outer Silver Pit, we can only speculate about local conditions based on our understanding of general trends in vegetation change. Consequently, we can merely suggest 'plausible' landscapes for Doggerland rather than 'actual landscapes'.

Figure 4.6 is a summary diagram showing the main changes in pollen from the British Isles over the last 15,000 years. This clearly shows the sequence of changes in vegetation type and therefore environment during this period. Figure 4.7 builds on this and is based on the collections of many pollen diagrams across western Europe. This work provides a series of maps of the main vegetation zones across northern Europe and shows how these have changed over the last 15,000 years.

The general sequence is reasonably clear. Steppe and tundra conditions (treeless, grass-covered, and often permanently frozen below the ground surface) existed in most of the area around the North Sea until around 12,650 BC. During the early Late Glacial, as temperatures began to rise, tundra was gradually replaced in East Anglia and the Low Countries with areas of scrubby birch, willow and juniper. This tree cover was probably sporadic, with groves set into grassy parkland. Low-lying areas were covered in wetland marsh vegetation such as sedge and reeds. Bryony Coles suggests that these types of vegetation probably spanned Doggerland at this time.[16] However, without any actual pollen diagrams available from the area for this date, this is an assumption, though a very plausible one.

We are, again, uncertain as to what happened to the vegetation cover of Doggerland during the Loch Lomond cold stage at around 10,950–9600 BC, although pollen analysis from around the North Sea basin does suggest that much of the area returned to tundra conditions.[17] Bryony Coles sees the area being used by reindeer hunters in this period.[18] After 9500 BC, as temperatures rapidly rose, we see birch woodland with some willow and hazel predominating at first, with pine becoming dominant later in the period. However, there is considerable variation in the preponderance of individual forests around the North Sea basin at this time. By 7000 BC much of the area is either under mixed conifer and deciduous forest or under dense mixed deciduous woodland. The latter mainly comprised of hazel, oak and elm at the start of the period, rapidly joined by alder and ash *c* 6000 BC and lime *c* 5500 BC. Now, in terms of the area around Doggerland we are actually very unsure of the specific form of woodland present or how fast this sequence of woodland develops in the area. This is primarily due to the lack of pollen samples from Doggerland but also because we have little idea how the low-lying, and presumably quite boggy, relief of Doggerland may have affected this sequence. In addition, the character of Doggerland was determined by a race between the migrating trees returning from southern Europe and rising sea levels across the area (see the sea-level curve in Figure 1.12). We cannot be certain whether the sequence postulated for the lands around the North Sea actually stands in Doggerland. Once again the importance of trying to obtain quality pollen spectra from the area becomes clear, as does the need for accurate dates to show how inundation progressed.

Does this level of detail actually matter? Yes, it does. The type of woodland present may well determine the resources, food and materials, available for use by humans. Mike Reynier has recently suggested that the type of woodland may also determine the 'tool kit' used by Mesolithic people, as well as how they chose to hunt and gather; this would influence their settlement pattern.[19] Other fundamental questions, most obviously whether the landscape had the potential to encourage some degree of sedentism, as seems to have happened at Howick, will also require this detailed information.

Another important and related issue, in terms of the forest history of Doggerland, is that we may not actually know what the Doggerland woodland looked like. The 'traditional' view of the early postglacial primeval forest is that there was a dank, dark and continuous blanket of trees stretching from eastern Europe to the coast of Ireland. This is the 'climax', primeval closed canopy or 'high forest' model that was advanced by Sir Harry Godwin and others.[20] Where openings in the forest were present, they resulted from the fall of dead trees, the actions of beavers or erosion. A typical idea of what this landscape could have looked like is shown in Figure 4.8 (well not quite, since there should be a lot more deadwood littered on the forest floor).

In 2000, Franz Vera published a book that fundamentally questioned this assumption.[21] Vera held that a large proportion of the landscape might have consisted of clearings and glades. Vera noted that oak and hazel occurred in relatively large proportions in the pollen diagrams of northern Europe; from his experience as a woodland conservation officer, Vera knew that these tree species

Figure 4.8. Dense canopy woodland in Epping Forest

Figure 4.9 Areas of cattle-grazed woodlands at Hatfield, Essex. The way that the wood is now broken into clearings and into patches of 'thicket' is clear

are light-demanding and favour the woodland edge. Equally, these species are declining in most woodlands in northern Europe at the present time, as 'full-canopy woodland' is re-established as the result of conservation-based woodland management. Vera suggested that there must be a missing factor which explains why oak and hazel survived in the early Holocene forest but have, eventually, given way to shade-tolerant tree species today.

He suggested that large-scale clearings were present, giving oak and hazel opportunities to thrive, and that clearings were opened up and maintained by large grazing mammals such as aurochs, bison and wild horse. Skeletons of these animals are found in deposits from this period, notably from the North Sea basin where they have been caught up in fishing nets in large quantities. Vera suggested, therefore, that not only have the pollen diagrams been 'misread' but also that the present model of the appearance of ancient woodland needs to be reconsidered. Figure 4.9 is from a grazed area of woodland at Hatfield Park in Essex; here the woodland has been opened out into grassland and shrubby areas of thicket woodland.

This is not a trivial point. It obviously has clear implications for our understanding of how areas including Doggerland may have appeared, functioned ecologically or were used by humans in the early postglacial period. For archaeologists it also changes our view of how Mesolithic people moved through the landscape and how they may have perceived its opportunities for settlement and exploitation. Essentially, it is the difference between a people living in dense woodland and those able to exploit a variety of resources in large clearings.

Consequently, whilst we have a general impression about how the vegetation of Doggerland changed, many doubts remain in respect of its specific appearance. In Rumsfeld speak, we are in the world of the 'known unknowns' and possibly even 'unknown unknowns'!

Reconstructing river valleys

If there are problems with interpreting what the Doggerland vegetation looked like, presumably we are on safer ground with respect to the various landscape features identified through the seismic analysis. After all, we know what rivers look like, don't we? Unfortunately, most people derive their impression of how river valleys looked in the past from how modern river valleys look today and therein lies the problem. Large modern rivers, including the Thames, Trent or Severn, run through broad alluvial floodplains, and the clays in the floodplains are now a major agricultural resource. Somewhere in the vast expanse of cultivated lands that exist in river valleys will actually be a river whose present course only takes up, perhaps, 10% of the available land in the floodplain. There is occasional flooding, but generally the river course is stable. This was not always the case. Work on the sedimentary and environmental records of the river valleys of Britain has clearly suggested that our image of a river valley is a relatively recent creation. Modern valleys, particularly those with clay fills, seem to date mainly from the late Bronze Age/early Iron Age (*c* 1000 BC) onwards.[22] They also appear to be a product of the expansion in agriculture that occurred at about this time and the associated increase in soil erosion that led to large amounts of clay and silt entering into the river valleys.

Throughout most of the period we are interested in valleys essentially contained rivers flowing across gravel and sands. Early in the period the rivers would have cut through this material relatively unopposed, constantly switching channels and course with the seasons. The whole of the floodplain could have

Figure 4.10 A glacially derived river

been covered with a network of such channels. An example of how the early rivers of Doggerland may have looked can be seen in Figure 4.10 (though without the mountains in the background!).

During the Holocene, these rivers would have changed. This is indicated by a number of studies from Britain that clearly show the nature of early Holocene larger river systems. Over time, silt would have built up in these valleys. Waterside vegetation and woodland would have developed and stabilised the channel sides, giving some degree of permanence to the course of the rivers. However, the rivers appear to have maintained a mesh-like appearance, with channels filling the whole of the available floodplain even though these could have been several miles across. These channels were relatively unstable and when they failed, they did so spectacularly. Once the bank sides collapsed in a storm or flood, the underlying sands and gravels would shift at speed. Channels would fail and rivers would shift violently across the floodplain. The result is an 'anastomosing' river system that occupies most of the valley floor. This produces a floodplain that bears no resemblance to those of today. Many channels are active across the valley floor at the same time. These run over gravel and sand channel bottoms marked by sequences of violent riffles and still pools. Where the channels have been breached, gravel and sand splays occur. Abandoned river channels are overgrown by meadows, grasslands and scrub woodland. Repeated and violent channel changes leave a maze of back channels, creeks and swamps. Flatlands can expand to become large areas of swamp, reed bed and carr woodland. Gallery woodlands of willow and, at a later date, alder dominate the channel sides, with more distant and stable areas developing groves of mixed deciduous woodland. The unique characteristics of this diverse landscape can be appreciated in Figure 4.11. Given the dominance of this kind of river system in

Figure 4.11 An anastomosing river

the past in Britain, similar environments must have been present in the area of the large river systems that dominated Doggerland.

The widespread basins and marshes seen in the seismic survey probably resembled the later Mesolithic and early Neolithic environment of the Somerset Levels, with extensive areas of dense reed bed, wet carr, willow, birch and alder woodland (the latter species later in the period). Open pools of water and marshes seem to have been a particularly attractive environment for early Mesolithic people. Where such environments can be proven within the archaeological record, for example 'Lake Pickering' at Star Carr in Yorkshire and 'Lake Bermondsey' in south London, both are surrounded by numbers of flint scatters.

These diverse environments, existing in close proximity, must have been a crucial resource for the Mesolithic communities of Doggerland. Deer, elk and other large animals would all have gathered here, attracted by areas of extensive browse and easy watering. Edible and usable plant resources would have been abundant. Wild fowl and fish of all types would have been there for the taking. Work by Michael Reynier suggests that the 'Deep Carr' types of the early Mesolithic tool kits are probably associated with such river valleys but that settlement is relatively impermanent.[23] Small base camps are set up for a few weeks and the resources in the area used as they are encountered and until they run out. This rich mosaic of environments would have made the river valleys of Doggerland an attractive place to settle and not merely a way of getting from A to B.

Reconstructing salt marsh environments

The seismic terrain model developed at Birmingham clearly suggests that once the rising seas breached the Outer Silver Pit Lake many of the areas around this

Figure 4.12. 'Low' salt marsh at Salthouse, Norfolk

Figure 4.13. 'High' salt marsh at Salthouse, Norfolk

inland sea might have become extensive salt marshes. These areas, constantly flooded by the rising and tidal waters, would have become wastes of sloppy, thick, grey estuarine clay and a maze of tidal creeks (see Figure 4.12). More stable areas would have supported salt marsh plants such as glasswort, sea lavender and the oraches. Higher, seasonally flooded land would have carried stands of low salt-tolerant grasses and reeds (see Figure 4.13).

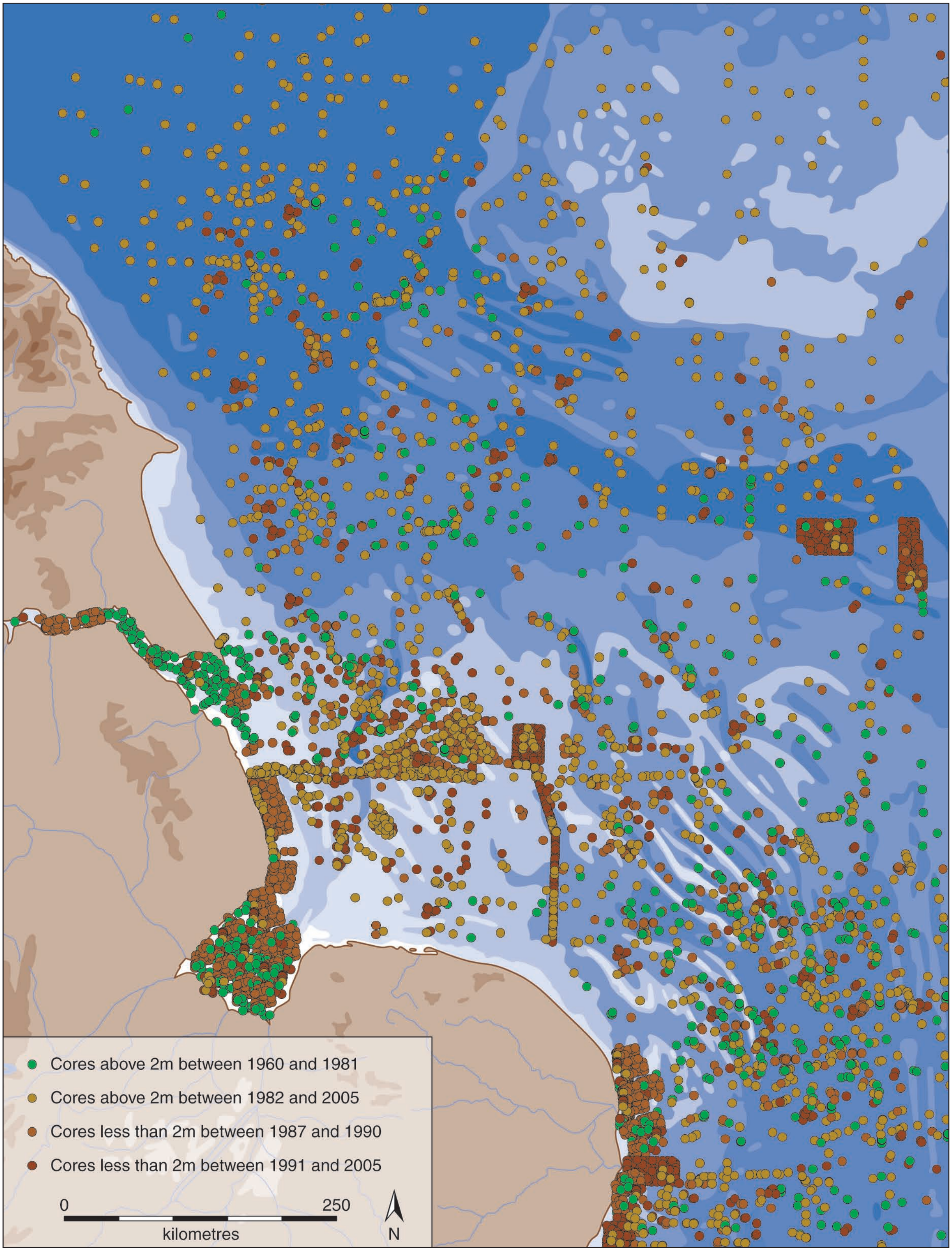
To most people coastal estuaries appear little more than wastelands. At best, following Daphne du Maurier, these bleak landscapes hold romantic associations with rum smuggling, isolation and escape, but it was not always so. For those from estuary areas there is the memory of the extensive numbers of drovers, carters and herdsmen who tended the large herds of sheep and cattle that used the salt flats only a few generations ago. Traditionally, these areas were used for summer grazing and fattening and were seen not as waste but as a resource. If you were to give a cow the choice of coastal meadow and inland field, it would pick the former. Salt marshes and mud flats are also splendid sources of shellfish and sea birds for eating. Daniel Defoe noted the attractions but also the problems of the Essex Dengie marshes in the Thames estuary in his tour of Britain, published in 1724. He noted 'in this inlet of the sea is Osey or Osyth Island, commonly called Oosy Island, so well known by our London men of pleasure, for the infinite number of wild-fowl, that is to say duck, mallard, teal and widgeon, of which there are such vast flights, that they tell us the island, namely the creek, seems covered with them, at certain times of the year'. However, 'those gentlemen who … go so far for it, often return with an Essex ague on their backs, which they find a heavier load than the fowls they have shot'.

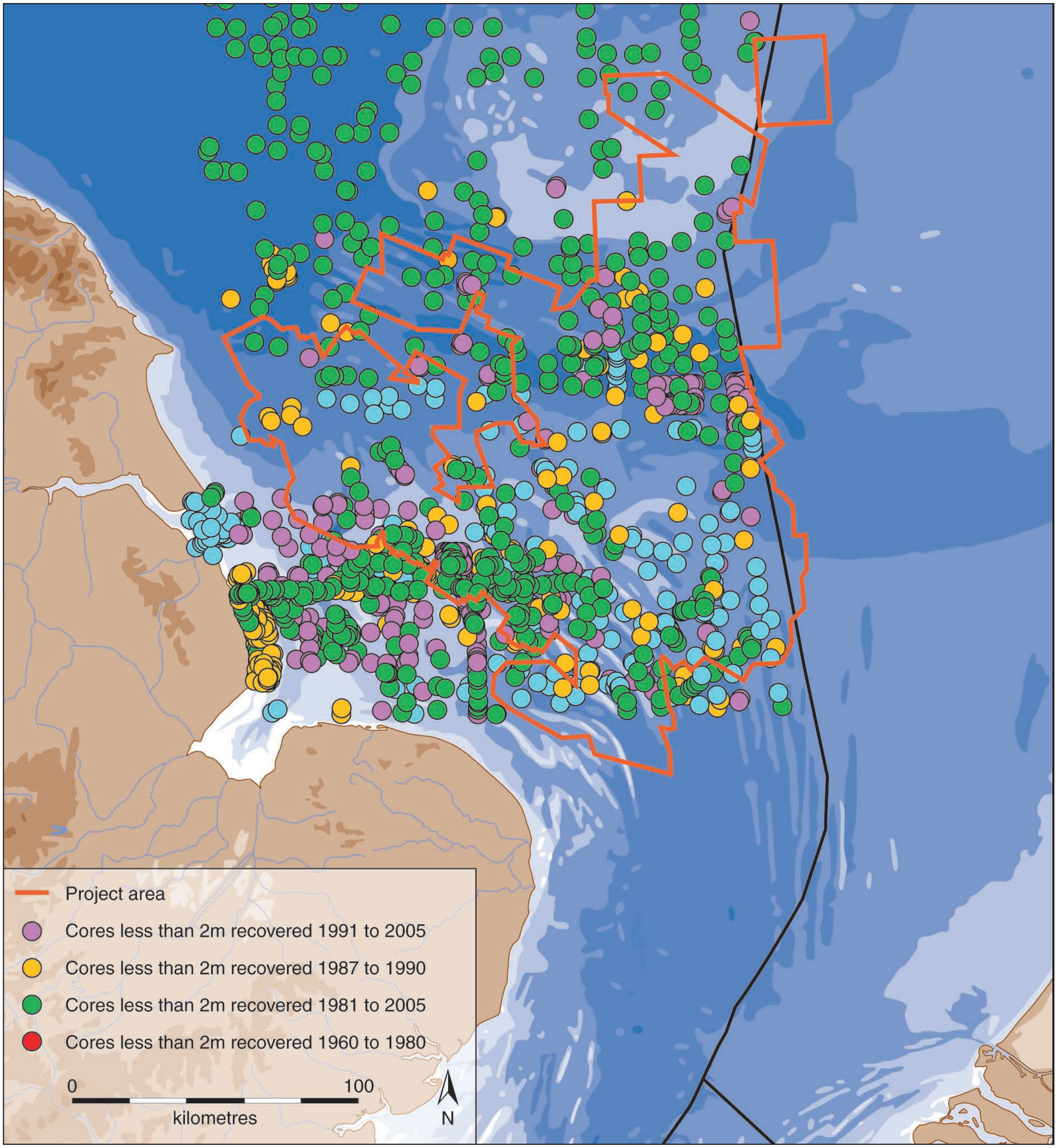
Figure 4.14 Core data held by the British Geological survey off part of the east coast of England

It is likely that this habitat was appreciated in the same way in periods past. Certainly, buildings on the Iron Age foreshore at Goldcliff in Gwent were used in a similar manner.[24] The large numbers of footprints recorded by Martin Bell at Goldcliff have already been referred to and they also suggest that this environment was an attractive one to animals and people.[25] Consequently, the formation of massive salt marshes around the Silver Pit Lake should perhaps not be seen as a loss of resource for humans at this time. In many ways they may have provided an increased opportunity for the inhabitants of the Doggerland Hills, much as they did for the people who may have walked across the Severn foreshores at the same date.

Plausible, but is this real?

The descriptions of climate and temperatures of Doggerland provided above are plausible. They are based, or extrapolated, from 'known knowns', as Donald Rumsfeld might have said. How the landscape may have looked, and what vegetation was likely to cover the landscape, are also reasonably plausible as these are also based on 'known knowns' – albeit with a scatter of 'known unknowns'! Further sampling of material from the seabed of the southern North Sea could help to resolve much of this. However, there is a problem that has been conveniently sidestepped up to this point. The narrative so far has simply assumed that the interpretation of landscape features from the seismic models, salt marsh, lake or river valley, is correct, but whilst the current interpretations of the data provided in the last chapter are plausible and indeed likely to be correct, they are not actually proven. Providing the necessary proof is not *per se* a problem. Using the results of the seismic survey it is possible to identify the location of a 'salt marsh' or a 'swamp' or a 'river valley' and to go to this area and retrieve sediments


Cores above 2m between 1960 and 1981
Cores above 2m between 1982 and 2005
Cores less than 2m between 1987 and 1990
Cores less than 2m between 1991 and 2005
0
250
kilometres
N



suitable for dating and analysis. Studies of pollen, plant macrofossils, diatoms and foraminifera would help to reconstruct the environment of these deposits, how these changed through time, and to prove the validity of our interpretation. Insect remains would indicate temperature, climate, degree of salinity and the nature of woodland. If such data were available, plausible reconstructions could then become probable interpretations.

Figure 4.15 Distribution of boreholes in the south North Sea basin

Figure 4.16 Cores examined as part of the project

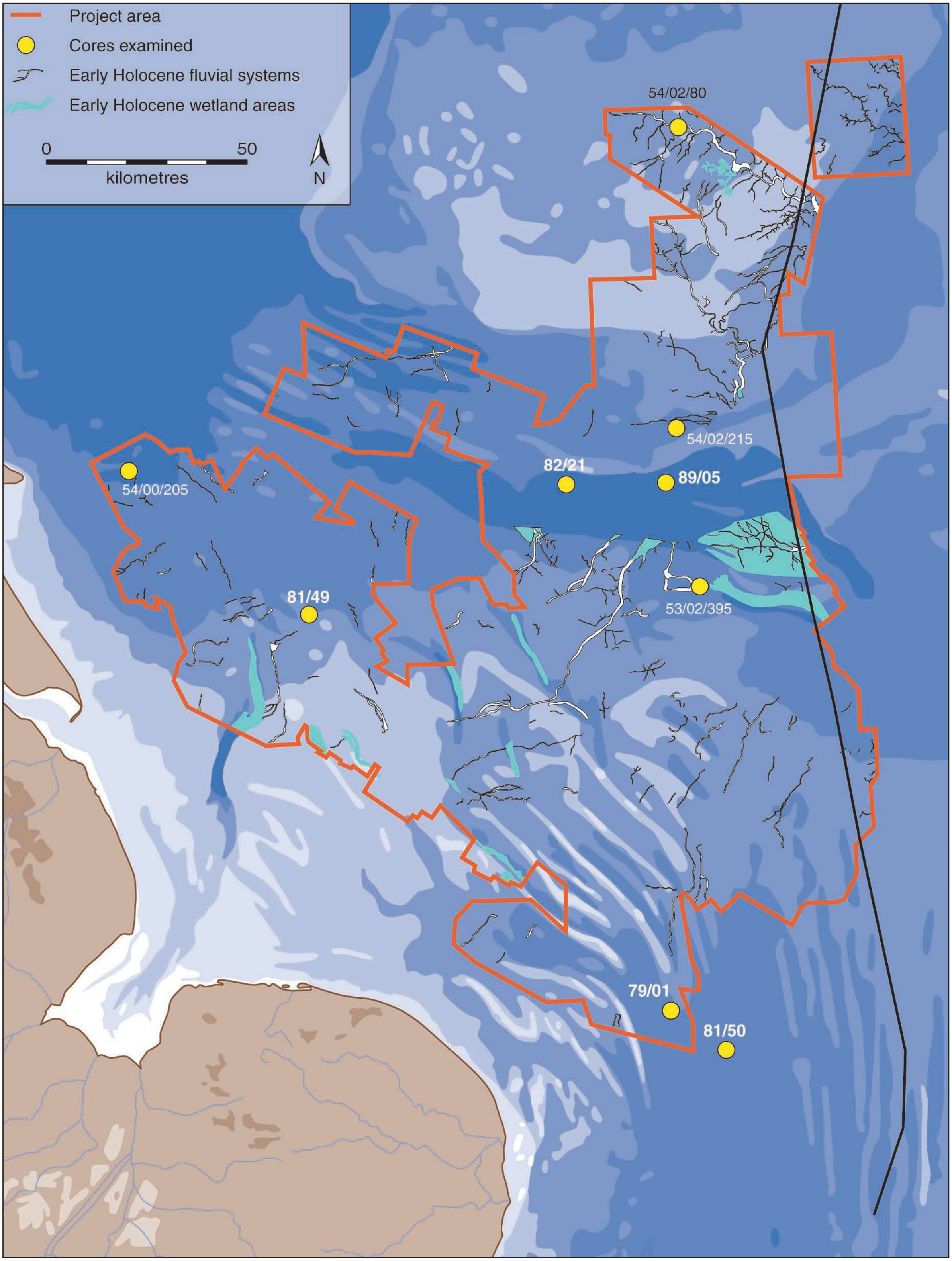

Project area
Cores examined
Early Holocene fluvial systems
Early Holocene wetland areas
0
50
kilometres
N
54/02/80
54/02/215
82/21
89/05
54/00/205
81/49
53/02/395
79/01
81/50

Figure 4.17 The early postglacial woodlands of the southern North Sea may have looked like the modern landscape of Abernathy Forest, Badenoch and Strathspey, Scotland

In the absence of funding to carry out original survey, a cost-effective alternative is to search out existing cores that might relate to features of interest and to analyse the sediments from these. The North Sea, of course, has been subject to innumerable surveys; sediment cores have been taken for many other purposes and these are frequently stored by the British Geological Survey (BGS) in a vast store at Loanhead, near Edinburgh. The amount of information held by the BGS is colossal. For marine areas alone, the BGS holds about 12km of geological cores and 15,000 seabed samples.

The available database at BGS was searched in 2006 and the relevant data were studied to see if they had the potential to produce dating materials – pollen, plant macrofossils and insect evidence – which would help close some of the gaps in our knowledge. Unfortunately, many of these cores were outside the area of the survey, or were not suitable because they did not actually penetrate the buried Holocene landscape. In addition, the records taken at the time indicated that only a few of these stored cores contained organic deposits suitable for sampling. Finally, despite the fact that thousands of cores had been taken from the southern North Sea, only nine cores were believed to be in areas that might provide suitable sediments and were available in the BGS stores at Loanhead. A trip to Edinburgh revealed that only five of these appeared to contain organic remains. These cores were sampled and analysed in Birmingham.

It rapidly became clear that the samples contained no material that could be easily dated. No remains of insects or plants were present and although pollen was preserved it was eroded and often present in very low concentrations. Similar material from a site on land would be rejected for analysis.

Despite these disappointments, pine, birch, oak and alder pollen were recovered and the presence of grasses and sedges does suggest the incidence of open habitats within woodlands. Well-known indicators of 'clearance' such as ribwort plantain and dandelions were present and openings in the canopy may reflect areas of wetter soil. Unfortunately, without an adequate dating framework, it is impossible to provide a precise age for this environment but the pollen spectra do suggest an early to middle Holocene date. For example, lime is absent from these cores but this is relatively common after the mid-Holocene. Elm, which is recorded in some of the samples, is usually present at higher values in the early part of the Holocene. However, given the problems associated with these cores, the results should be viewed with caution and it would be unwise to make detailed comment regarding the possible role of human communities in the landscape.

Why such a poor result? The primary problem is that the cores were not taken for archaeological purposes. Consequently, whilst they may have been taken from areas near significant features they probably did not actually penetrate or sample any of the deposits and landscape features, specifically the river valleys and marshes, which would contain organic sediments suitable for this kind of analysis. To be fair, this was not entirely a surprise. The cores were, effectively, random in their distribution and, in comparative terms, the exercise was rather like dropping twenty boreholes at random in an area the size of Wales and expecting these to hit the rivers Severn, Wye and Usk as well as the famous bog at Tregarron!

So are we back where we started? Not quite. The relatively poor results of analysis simply indicate that the existing core data is unlikely to answer the detailed questions we are now asking about Doggerland. Clearly, we need to carry out new work in order to recover sediments that can be analysed. This will be a requirement if we are to understand the interpretation of the seismic data, or the nature of climate and landscape change in Doggerland. Without this we can get no closer to understanding what opportunities there were for settlement and the exploitation of this landscape. To a certain extent this has probably been the situation ever since Clement Reid carried out the first analysis of 'moorlog' deposits nearly a century ago; the difference is that we now possess a map of the principal features of Doggerland itself. For the first time we have the capacity to identify deposits that might hold Holocene sediments with a degree of precision that will allow us to plan how to sample them in the future and that is a massive step in the right direction.

Notes

1. Lowe and Walker 1997a.
2. Shackleton and Opdyke 1973; Williams *et al* 1988.
3. Bassinot *et al* 1994; Imbrie and Imbrie 1979.
4. Lowe and Walker 1997a.
5. Coope 1977; Coope and Lemdahl 1995; Lowe and Walker 1997b; Lowe *et al* 1995.
6. Williams *et al* 1988.
7. Dansgaard *et al* 1989; Lowe *et al* 1995.
8. Bell and Walker 2005.
9. Coope and Brophy 1972; Coope 1977.
10. Coope *et al* 1988; Lowe *et al* 1995; Lowe and Walker 1997b.
11. Atkinson *et al* 1987.
12. Coope and Lemdahl 1995; Coope *et al* 1988; Lowe *et al* 1995.
13. Alley and Ágústsdóttir 2005.
14. Godwin 1975; Huntley and Birks 1983.
15. Ludwig *et al* 1981.
16. Coles 1998; Coles 2000.
17. Huntley and Birks 1983.
18. Coles 1998; Coles 2000.
19. Reynier 2005.
20. Godwin 1975.
21. Vera 2000.
22. Macklin and Lewin 2003; Knight and Howard 2005; Greenwood and Smith 2005; Smith *et al* 2005.
23. Reynier 2005.
24. Bell *et al* 2000.
25. Aldhouse-Green *et al* 1992; Allen *et al* 1997.

CHAPTER FIVE

Past worlds – lost worlds – future worlds

From wonderland to Sundaland

The results of research in the North Sea suggest that the southern North Sea hides one the most extensive, well-preserved early Holocene landscapes surviving in Europe. Despite this, the inundated prehistoric terrain of the North Sea basin remains one of the most enigmatic archaeological landscapes in the world. Unfortunately, the scale of loss of habitable land, perhaps an area greater than England during the Holocene alone, invites hyperbole. The inaccessibility of the inundated area and the lack of substantive knowledge about the human communities which occupied these lands also encourages speculation. This is not necessarily a problem but, unfortunately, mysterious cultures and lost worlds are a significant theme on the fringes of archaeology and, increasingly, attract uncritical attention from mainstream media groups. The current public interest in lost worlds may appear to be in complete contrast to the apparent indifference shown to Doggerland, until relatively recently, by much of the archaeological community. It would, however, be a mistake to dismiss this wider curiosity as simply a passing infatuation fuelled by media interest. The truth is that mankind has, for many reasons, always believed in or imagined lost worlds. These lands have taken many forms and have been set in many parts of the world.

What is notable, however, is that so many of these tales involve the catastrophic action of water. The loss of whole countries and peoples, frequently as an act of divine retribution on degenerate and ungodly societies, is linked to floods, tidal waves or simply lands sinking beneath the waves. The biblical floods, and that in the epic of Gilgamesh, are obvious and well-known examples of such accounts. The myth of Atlantis, recounted by Plato (*c* 428–347 BC), is a good example of how lost worlds have been created and expanded through modern interpretation. After centuries of speculation on the location of Atlantis the modern debate locating this particular lost world in the mid-Atlantic, as far as one can tell, derives from the writings of Ignatius Loyola Donnelly. Donnelly was an American politician, congressman, senator, and (failed) candidate for the vice presidency of the United States. He also founded the utopian settlement of Nininger, in Minnesota, which floundered in the, all too real, American economic panic of 1857. His book, *Atlantis: the Antediluvian World*, was published in 1882 and it set out with an aim to demonstrate the existence of Atlantis on an island in the Atlantic. He asserted, in his introductory chapter, that this was 'the true Antediluvian world; the Garden of Eden; the Gardens of the Hesperides; the Elysian Fields; the Gardens of Alcinous; the Mesomphalos; the Olympos; the Asgard of the traditions of the ancient nations; representing a universal memory of a great land, where early mankind dwelt for ages in peace and happiness'.[1]

Essentially, Donnelly misinterpreted the evidence for the mid-Atlantic ridge as the remainder of a submerged land but his work became a source of inspiration to many and remains in print after more than a century. Donnelly himself took inspiration from earlier publications on another lost continent, Lemuria, allegedly situated in the southern Indian Ocean. This land, proposed by the geologist William Blandford (1832–1905), was an attempt to explain shared geology and fauna around the Indian Ocean by way of a lost land bridge. The idiosyncratic toponym appears to have been provided by an English biologist, Philip Lutley Sclater, in 1864 and relates to his attempt to explain the distribution of fossil lemurs. He also felt that the evidence for these could only be explained by the previous existence of a land bridge in the region. These ideas were then adopted and adapted by the Theosophists, an esoteric group co-founded by Helena Petrovsky Blavatsky. Blavatsky,[2] whose colourful career included a spell as a circus bareback rider, claimed mystical guidance for her writings about the peculiar inhabitants of Lemuria. These were summarised by one commentator as 'bandy-legged, egg-laying hermaphrodite apes (some with four arms, some with eyes in the back of their head) and up to 3.7m tall'![3] This mysterious land was apparently destroyed by the gods as a consequence of the immoral behaviour of the Lemurians. Blavatsky published all this essential information in a two-volume work entitled *The Secret Doctrine* in 1888, which she claimed was culled from an Atlantean text, *The Book of Dyzan*. Blavatsky acknowledged that *The Secret Doctrine* was likely to 'be regarded by a large section of the public as a romance of the wildest kind': a prediction largely fulfilled. However, the Theosophists remain active and Blavatsky's contribution to the arcane literature of lost worlds still attracts adherents.

The Pacific, not to be outdone by the lesser oceans, was accorded its own lost land in 1926 when a British occultist, James Churchward (1851–1936), published *The Lost Continent of Mu: Motherland of Man*.[4] Although probably based on an earlier mis-translation of a Mesoamerican codex by antiquary Augustus le Plongeon, Churchward claimed that his primary source was a mysterious text that he had seen in an unidentified Indian monastery. Churchward elaborated

Figure 5.1 Ignatius Loyola Donnelly (1831–1901) and Helena Petrovsky Blavatsky (1831–91)

the history of the advanced 'Nacaal' culture of Mu in several books and, not surprisingly, this mysterious land was absorbed into fantasy writings including H P Lovecraft's Cthulhu tales and associated literature. Atlantis, Lemuria and Mu are obvious examples of the lost world tradition but the list could be extended. In recent years, Graham Hancock has been foremost amongst fringe contributors to the debate. In a BBC Horizon documentary, Hancock recounted alleged discoveries of drowned civilisations and sites in India and Asia, and this was published in 2002 as *Underworld: Flooded Kingdoms of the Ice Age*. Hancock has caused predictable controversy with his blending of science and, frankly, wishful thinking. Although this debate has undoubtedly proved a profitable line of enquiry for Hancock, the worldwide web has largely proved to be the battleground for claims, counter-claims and rebuttals centred upon varyingly dubious claims for the authenticity and antiquity of these lost civilisations.

The enduring allure of lands lost beneath the sea remains and archaeologists and geologists have a clear responsibility to confront the increasingly fantastic reconstructions of lost worlds that are sometimes provided to the general public as reality. However, the fact that these stories have retained their fascination probably suggests that they are symptomatic of much deeper concerns with mankind's current and future position in the world and that we should at least acknowledge that the phenomenon is worthy of study in its own right. Moreover, whilst discussing these controversial issues we should not forget that science is equally capable of creating its own myths. The debate regarding the inundation of the Black Sea is a case in point. In 2000, American academics William Ryan and Walter Pitman published *Noah's Flood: the new scientific discoveries about the event that changed history*. This suggested that the Black Sea was created in a 'mega-flood' in about 6075 BC, which raised the water level from –140m to about

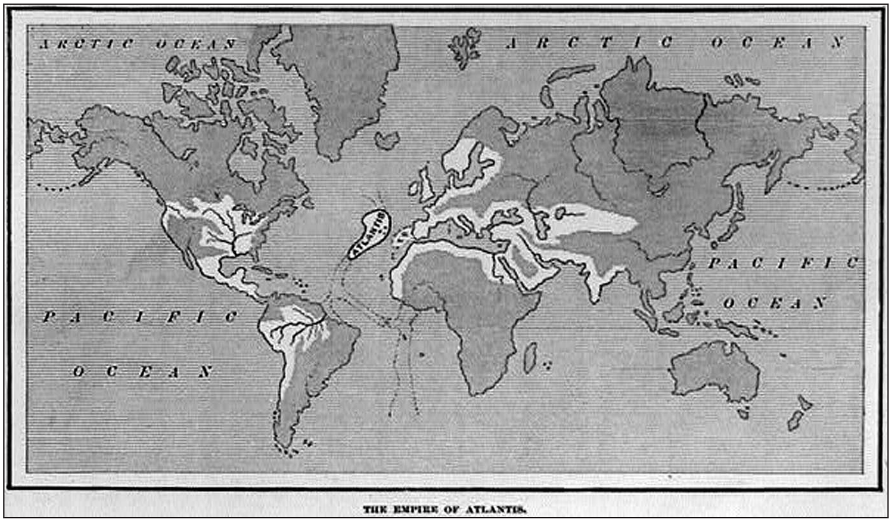


Figure 5.2 Donnelly's Empire of Atlantis

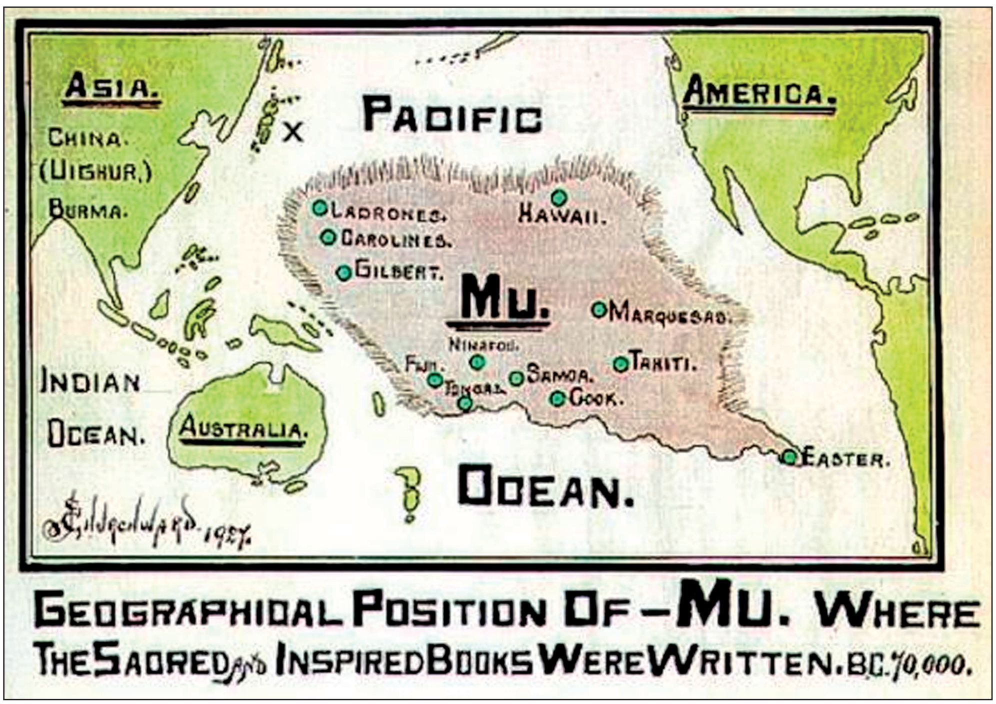


Figure 5.3 The lost land of Mu according to James Churchward

–30m. Geological evidence was interpreted to suggest that raised sea levels caused the breach of a plug connecting the Sea of Marmara and the Black Sea. Saline water flooded into the Black Sea basin at a staggering rate of 50km^3 per day and resulted in the permanent inundation of more than 100,000km^2 of habitable land in only a few years, rapidly transforming a largely freshwater lake to a marine environment. The effects of this nightmare event on the communities settled in the basin have been much discussed and, it has been suggested, this flood formed the basis of the biblical tale of Noah, that the rising waters forced the dispersal of early farming communities and, consequently, the spread of Indo-European languages into Europe.[5] But did inundation actually happen in this manner? Although the authors modified their position significantly following considerable criticism, other, equally valid, work now suggests that flooding of the Black Sea basin occurred as a series of slower events. Undoubtedly this had repercussions on the communities which may have utilised the inundated land but it need not necessarily have been the dramatic and deadly event previously believed. Whilst we should be assertive there is clearly a need for some caution in our criticism.

It is also important to understand that, irrespective of the hyperbole and speculation of Graham Hancock and earlier writers, the inhabited landscapes of the North Sea were, demonstrably, not unique. A vast amount of land was inundated across the globe at the end of the last glacial maximum. Much of the lost area may well have been confined to relatively narrow strips of land along coastlines. The evidence for coastal sites in these regions is likely to have been lost as a consequence of sea rise. Other areas may not have been inhabited at the time of inundation. However, at least two comparable 'lost lands' rank alongside Doggerland in historic terms but exceed it massively in terms of the areas lost to the sea. The country of Beringia equates with the vast inundated landscapes now associated with the Bering Straits, the coast around Alaska and northern Siberia, whilst Sundaland is associated with the Sunda Shelf and the coastal strips around Malaysia, Indonesia and the South China Sea. The archaeology of these regions is as rich as Doggerland. The difference, to date, is that the extensive remote sensing survey of the type carried out as part of this project remains to be done in these areas. Consequently, our knowledge of these regions is comparable to the North Sea prior to the work carrried out at Birmingham. In both cases the inundated land remains largely *terra incognita* and the cultural history is essentially inferred from terrestrial sites.

Beringia

Beringia is named after Vitus Jonassen Bering (1681–1741), a Danish explorer working for the Russian Tsar. From 1725 Bering explored the coast of north-east Asia and, in 1728, sailed into the straits, eventually named after him, between America and Asia. In 1741, Bering sighted the coast of Alaska but died on his return from this trip. He was buried on the uninhabited island, also named after him, in the Commander Group.

The idea that there might have been a land bridge across the Bering Straits, that was linked in some way to the peopling of the Americas, may have been suggested as long ago as 1590 by a Spanish missionary, Fray José de Acosta.[6] However, firm evidence for the existence of a land only emerged during the 19th century when the shallows of the Bering Straits and the Chukji Sea were mapped. Comparative studies of fauna and flora in Alaska and Asia suggested that the two areas were recently connected. The discovery of fossil remains including dwarf mammoth on islands such as the Aleutians also suggested that the habitable land area had been greater in the past. In 1937 a Swedish botanist, Eric Hulten,

Figure 5.4 Noah's Flood? The inundated area of the Black Sea

Figure 5.5 Beringia

proposed the name Beringia to describe the submerged area of land between Asia and Alaska. More recently John Hoffecker and Scott Elias, in their book *Human Ecology of Beringia*, have expanded the area to include adjacent lands as far to the east as the Verkhojansk Mountains and the Lena River in Asia whilst to the west the area includes Alaska and the lands up to the Mackenzie River in the Northwest Territory of Canada.

Hoffecker and Elias's 2007 summary of the archaeology of the region has demonstrated the antiquity of mankind's presence even in this truly remote and barren landscape and they have made a persuasive case that Beringia should be considered as distinct on cultural as well as geographical grounds. Their work makes it clear that the area could not have been colonised until modern humans evolved but also after they had mastered skills including sewing to produce complex clothing capable of protecting them from extremes of temperature. An important factor that limited human occupation during specific periods may well have been the availability of wood or other combustibles to make fire. The lack of wood and shrubs in the tundra was so severe that bone, including fossil bone, may well have been an important source of fuel. Consequently, human occupation may have spread into the northern parts of Beringia, and retreated, according to the availability of shrubs for use as fuel or for igniting bone.

The first humans appear to have moved into Beringia between 38,000 and 30,000 BC during a relatively warm spell, but the area appears to have been abandoned during the Late Glacial Maximum (25,000–23,600 BC) and it is only after 15,000 BC that the land was certainly reoccupied. As the temperature ameliorated, the late glacial megafauna disappeared and there seems to have been an increasing emphasis on hunting small mammals, birds and fish. There is an assumption that this would have been supported by a relatively complex set of tools including nets, snares, harpoons and darts. Most of these would have been made of bone, ivory, wood or other organic material. Unfortunately, as in Europe, the soils of the region rarely preserve such evidence.

Whilst it is generally assumed that the Beringia land bridge must have been used to colonise the Americas, there is considerable debate about how and when this occurred. Although the earliest evidence for settlement immediately south of the ice sheets is associated with the Clovis complex (about 13,000 years ago), the discovery of a site dated to 12,000–11,800 BC at Monte Verde in Chile has important implications for the original date of settlement. For some time it was assumed that the first settlers moved south when an ice-free corridor opened in the northern ice sheets but there no longer appears to be a corridor that can be matched with the dates for southern settlement. The current consensus suggests that settlement must have been achieved by groups of settlers moving along the coast, which may well have remained ice free throughout the last glacial period. This would open the door to a much earlier period of colonisation that could, conceivably, match the occupation dates from South America. Unfortunately, the evidence to prove such a process probably lies on the original coastline and this is now submerged beneath the Bering straits and the north Pacific.[7]

Sundaland

Sundaland may sound like a town in north-east England but the name actually refers to an inundated area of the South China Sea that includes the Sunda Shelf. This region contains the largest coastal shelves in the world and, following the last glacial maximum, the lost forests of Sundaland covered more than 2 million km^2. This area, which was not much smaller than India, linked the shallow coastal shelves of Malaysia with Indonesia, Borneo and even the Philippines, and the area is important in many ways. The eastern boundary of Sundaland is generally associated with the Wallace Line. This was defined by Alfred Russel Wallace (1823–1913), an English biologist and a rival of Charles Darwin. The line coincides with the easternmost extent of many of Asia's flora and fauna, and runs through the Malay Archipelago, between Borneo and Sulawesi. Significantly, although the Australian coast lay at least 100m below the current coastline at this time, Sundaland was never connected to Australia and the sea was always a significant barrier to colonisation of that continent.

Sundaland, like Doggerland and Beringia, was gradually lost to the sea and recent research on marine sediments suggests that the inundation was associated with major changes in the monsoon at 16,600–14,500 BC and 11,500–9600 BC, after which the barriers between the South China Sea and the Indian Ocean and Sundaland finally disappear. The palaeorivers of the area have been traced via bathymetry by Harold Voris at the Field Museum in Chicago, very much in the way Bryony Coles originally mapped Doggerland.[8] The great northern plain of Sundaland was dominated by the large 'Molengraaff River', named after Gustaaf Adolf Frederik Molengraaff (1860–1942), a Dutch explorer and geologist who died in a Japanese prison camp during the Second World War. The equally large 'East Sunda River' and its tributaries drained the southern plain into the sea near Bali. More recently, seismic studies, on a lesser scale than those described here, have begun to identify the course of these rivers in greater detail.

Whilst the maps of Sundaland provided by Voris superficially remind us of the landscape of Doggerland, in most other ways the area was never comparable. In absolute contrast with the great plains of the north, Doggerland and Beringia, Sundaland was never an arctic waste. Whilst the region suffered from the impact of rising sea levels, the climate 20,000 years ago was actually very similar to the present. The area was dominated by Asian tropical rainforests and mangrove swamp much as it is today. Not surprisingly the regional cultural record indicates considerable continuity right through to the introduction of agriculture and for a longer period amongst those indigenous groups that continued hunting and gathering economies. The artefact assemblages of the region, based on a variety of flake or cobble industries, are known generally as the Hoabinhian and have rather scathingly been described as containing 'some of the least impressive tools made by modern humans'.[9] This probably reflects the marginal use of stone in comparison with equally useful organic materials such as bamboo, although it may also indicate that the sites currently available to archaeologists are themselves marginal.

The relatively unattractive prospect of settlement in some of these sites

Figure 5.6 The maximum extent of Sundaland and its palaeorivers, based on bathymetry and land above the –120m contour line (after Voris 2000)

may be imagined by Professor Graeme Barker's description of the dangers (and pleasures) of working and living in the rainforest during the re-excavation of the famous Niah cave on Sarawak.

> The cave is an hour's walk and climb through the rainforest, in 100% humidity (the Harrisons called the deepest trench … the Hell trench because the conditions were so unbearable in the afternoon when the sun shone into it).
>
> All the specialist equipment has to be carried to the cave from our riverside camp every day, and then carried back in the evening, together with bags of sediment needed for botanical analysis by flotation and wet sieving (as there is no water in the cave).
>
> Add the cobras in the cave, the crocodiles in the river, and the poisonous ferns and millipedes in between, set alongside the overpowering beauty of the rainforest and the hospitality of the people, and you have an unforgettable and exhilarating experience.[10]

Despite the importance of the excavations at Niah, it remains true that the site has lost much of its archaeological and landscape context because of the loss of so much of its catchment to the sea. In 1999 Stephen Oppenheimer, a clinical paediatrician working in the region, raised awareness of the archaeology of the lost landscape of Sundaland when he published *Eden in the East: The Drowned Continent of Southeast Asia*. This impressive synthesis of the archaeology, material culture and linguistic evidence across this immense region made a cogent case for interpreting the drowned area of Sundaland as a cultural core associated with early agricultural and technological development. Oppenheimer makes great claims for the wider impact of inundation, some of which are extremely plausible, particularly in relation to the spread of Austronesian languages. More doubtful, perhaps, are his claims that refugees from this great flood were also responsible for the onset of early agriculture in the Near East. Whether or not one subscribes to these wider assertions, Oppenheimer's belief that most of the significant settlement and economic activity associated with the emergent Sundaland plain actually occurred on the lost coastline is plausible and comparable to the evidence for both Doggerland and Beringia.

The past as a foreign country

> *The past remains integral to us all, individually and collectively. We must concede the ancients their place … but their past is not simply back there, in a separate and foreign country, it is assimilated in ourselves and resurrected in an ever-changing present.*
>
> David Lowenthal, *The Past is a Foreign Country*, Cambridge, 1985

Dramatic loss of land was a global phenomenon at the beginning of the Holocene period, but the regional loss of more than 100,000km^2 of inhabited land in the North Sea left north-western Europe with a 'black hole' that, one way or another, has affected the archaeological development of most of the countries around the North Sea. For this reason alone, it remains essentially true that our current interpretative position regarding the Mesolithic in the maritime regions of north-western Europe partly stands as a consequence of the lack of information from the North Sea. Any statement relating to marine or coastal resource exploitation or its absence, in Britain at least, requires an adequate knowledge of events in Doggerland to achieve some degree of veracity. Thus although the seismic mapping has begun to allow us a dim glimpse of this lost country it would be wrong to think of the emerging landscape simply as an extension to the modern nation states of Europe. Doggerland may well have had a significantly different character, in cultural and environmental terms, in comparison with Britain and possibly all the surrounding countries. Moreover, given the resources and the diversity of Doggerland it is highly probable that the inhabitants of the plain may have regarded the hills of England as a less enticing place to live than the diverse lowlands of the North Sea.

Having made such an observation, it remains true that seismic analysis does not permit a fine-grained assessment of the regional archaeology in the manner we might expect on dry land. However, the results represent a Mesolithic landscape in a unique manner because these features have been preserved so extensively following inundation and with relatively little modification in comparison with terrestrial sites. Consequently, many of the natural features identified through this work, rivers, marshes or lakes, actually have the potential by inference or analogy to achieve substantive meaning in archaeological and cultural terms. Indeed, a few of the features may have been significant enough to define the very character of the land and therefore to have had a formative role in creating the communities that lived on the great northern plain. Paramount amongst these is the Outer Silver Pit. This basin dominates the mapped landscape not simply in its extent but also in the manner in which so many of the other features are linked to or drain into it. Surrounded by nearly 700km of coastline or, during an earlier period, lakeshore, it merges with ten major estuaries and a salt marsh covering more than 300km^2. The Outer Silver Pit must have acted as a prime economic resource for human groups across a massive area. Waterfowl, fish and other animals must have been abundant in this area, as would reeds or other vegetational resources that hunter-gatherer groups might require. In its later incarnation as a marine estuary, the Outer Silver Pit also provided a significant point of access to the marine resources missing from much of the English terrestrial archaeological record during the early Holocene. Whether a lake or a marine estuary, the Outer Silver Pit was a major, and perhaps the most important, economic resource in Doggerland. Presumably this is an area where archaeologists could seek evidence for intense utilisation of marine resources, and any differing social and settlement structures that might result from access to, or competition for, such resources. Here, for instance, we are most likely to find semi-permanent settlements that, currently, are represented in England by sites such as Howick.

Away from this imposing area of water, the 24 lakes or wetlands and the 1600km of rivers or streams recorded by project staff would have provided similar opportunities for hunter-gatherer groups. They also acted as paths and tracks through the landscape, many of which led into the hinterland which became island Britain. These features achieve further significance as volumetric and sedimentary analysis suggests that many of these areas are most likely to provide palaeoenvironmental evidence. It may be that we will never be able to explore settlement associated with these features but proxy evidence for settlement and land use gained through a programme of directed coring of these features and planned on the basis of the results presented here is a real possibility.

We can guess that the large, low valley in the west of the study area would have been attractive for a variety of reasons. The low hill, tentatively identified within this valley, suggests opportunities for settlement or even for hunting stands. Features associated with salt domes are also particularly interesting in landscape terms. In some cases upswelling domes would have formed low hills but, where there is evidence for graben collapse, the centre of these domes may have contained further wetlands or lakes. Such areas are, of course, attractive for

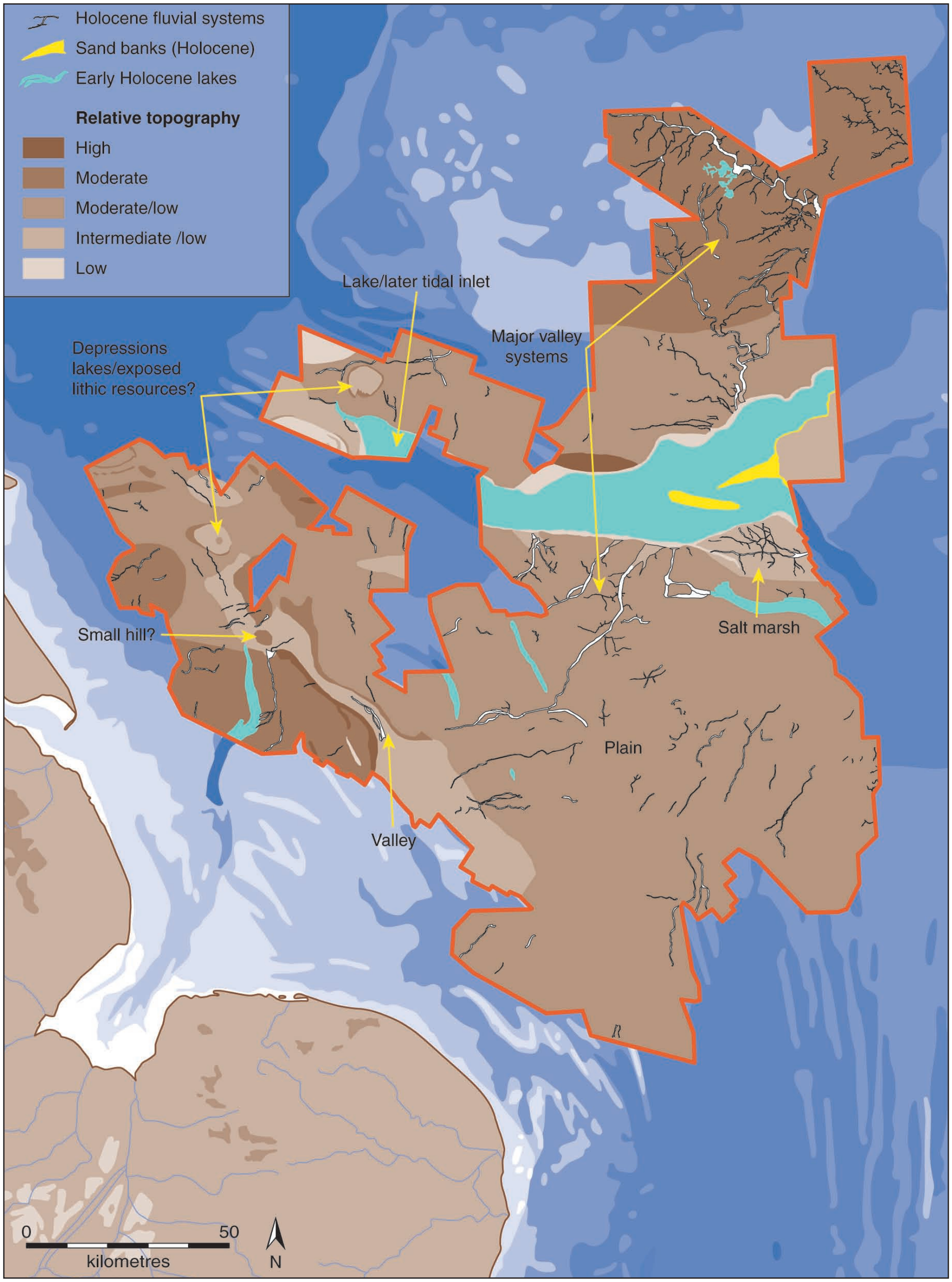


Figure 5.7 Major topographic or economic zones within the study area

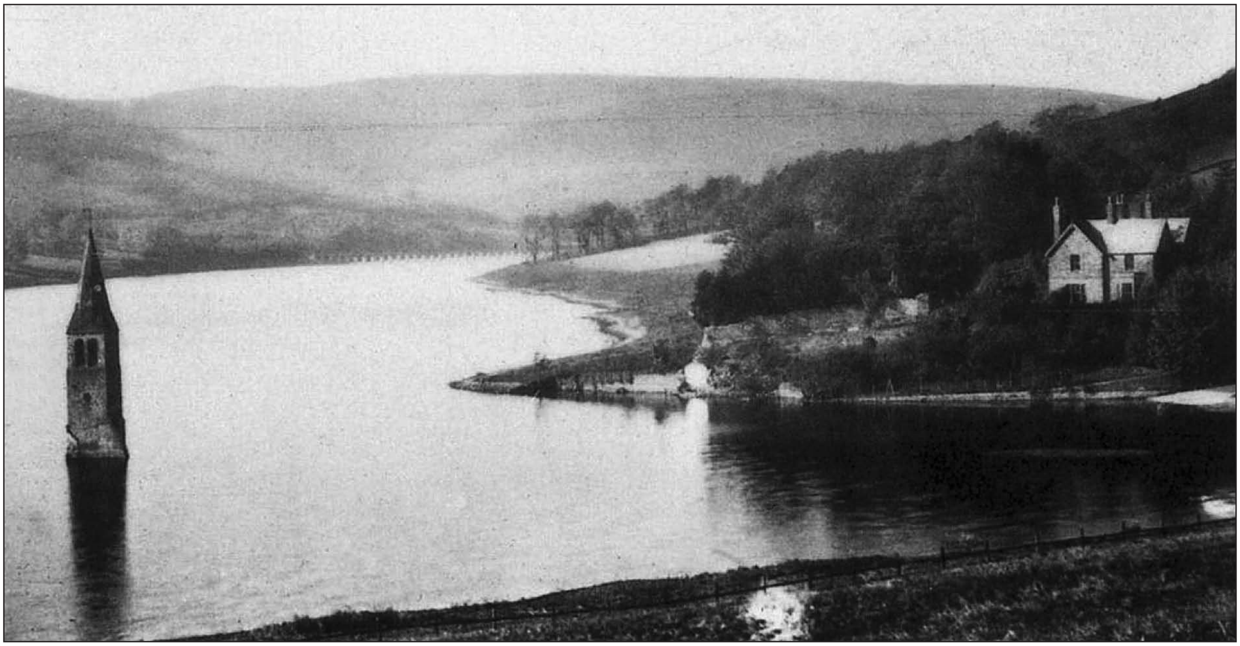
human groups and there is at least a chance that faults in these areas might also expose other useful resources including stone.

Figure 5.7 provides a general interpretation of the mapped landscape data made available through the project. Here it is important to stress that the character of the area cannot, of course, be represented simply as a sequence of rivers and lakes. It was a landscape in the fullest sense and we must not sidestep the responsibility of treating it as such. The area was, for instance, a plain but we should not imagine that it was featureless or devoid of meaning. The Mesolithic communities of the North Sea would have been sensitive to the subtle variability of their world and both the economic and social significance of landscape. They would have understood the great North Sea plain in a much more intense and personal manner, and groups and individuals would have been intimate with features of the landscape that we cannot detect using current technologies. Fundamentally, the emotive relationship between individuals and their surrounding landscape can hardly be understood through a study that can only vaguely discern the trend of the land or map its grosser features. It is, however, the best we possess and on that basis we must consider what implications may be drawn from the available evidence.

When considering the evidence from the North Sea one point should be appreciated – Doggerland was always doomed (Figure 5.8). The heartland of the Mesolithic in north-west Europe would have been constantly shrinking and this would have been obvious to its inhabitants. Sometimes slow then terrifyingly fast, the sea inevitably reclaimed ancestral hunting grounds, campsites and landmarks. Despite this, it is interesting to consider the effects that this loss may have had on the Mesolithic peoples, not only in negative terms, but also the new opportunities presented by landscape change. It has already been suggested that the emerging salt marshes may well have been regarded as a gift from the sea and, presumably, as in the Severn estuary, the footprints of the occupants and the record of their daily journeys are still probably preserved and buried deep in sediment. The legacy of this landscape and its loss may also have persisted through oral histories and folk memories, and ultimately occupied a special place in the cultural geography of the region.

Figure 5.8 Forest dying as a result of marine encroachment

It is possible that the Mesolithic occupants of Doggerland and the adjacent regions would have regarded water in a unique manner, as a place where the ancestors dwelt and thus an area of special



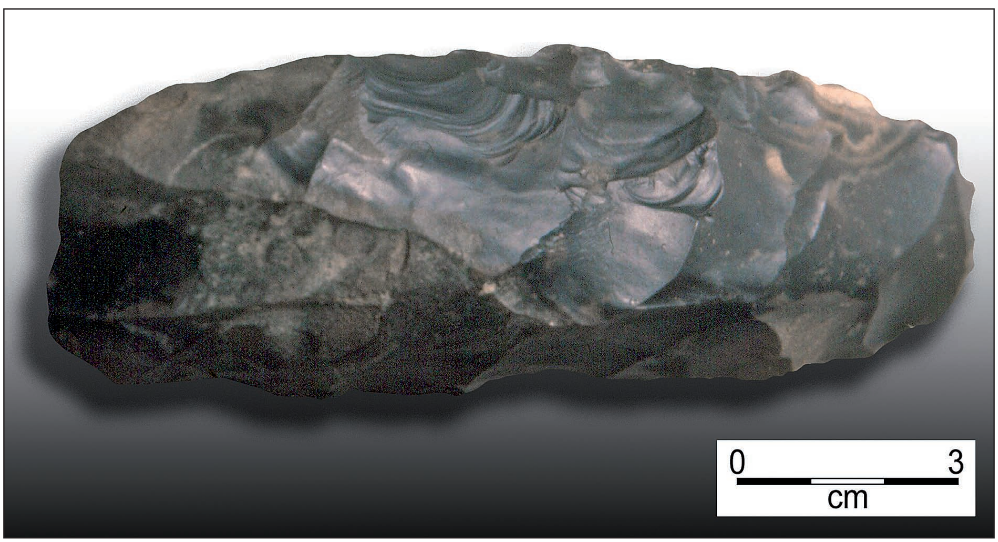


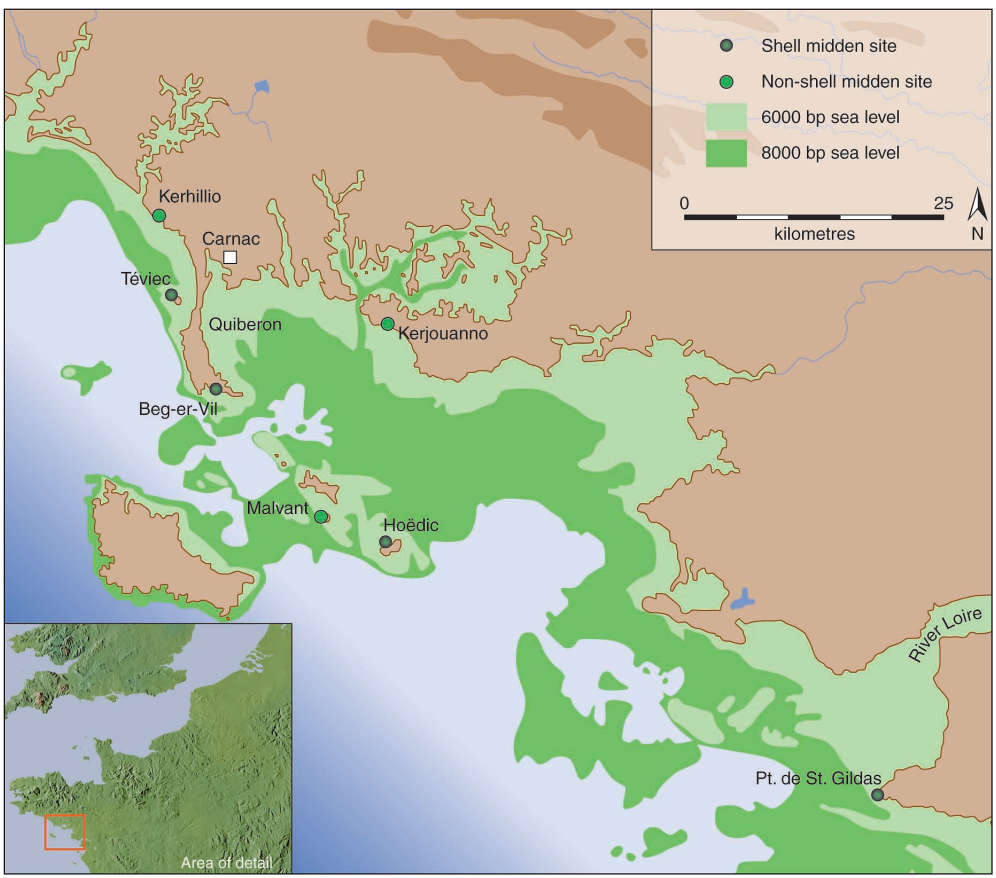
Figure 5.9 Derwent church
Figure 5.10 Thames pick from Thrupp

importance. At periods of low tide, these ancestral homelands could have been revisited and venerated. Similar analogues of people revisiting flooded homes persist into modern times and this may well be a phenomenon we will experience more frequently in the near future as the seas rise again. The famous village and church at Derwent, in Derbyshire, now lie beneath the Ladybower Reservoir and provides an obvious comparison (Figure 5.9). When reservoir levels fall, displaced residents and the curious can visit the lost village of their ancestors.[11]

What did Mesolithic people think when they saw dead tree trunks sticking out of the water and marking lands they had walked across with their parents. We can only guess but the link between water and special, or ritual, activities, is actually relatively common in many periods of history. Think of throwing money in a wishing well today. Archaeologically, the practice of deliberate deposition of objects in water is perhaps best known in later periods. Large quantities of Bronze and Iron Age metalwork appear to be deposited in watery places in a clearly ritualistic manner. Similar events occur in the Mesolithic. Specific stone tools, including the 'Tranchet' axe, were so commonly found in the Thames that they were originally known as 'Thames picks'.[12] Whilst their loss has been attributed to boating accidents and use in canoe manufacture, the large numbers involved, 549 recovered from the Thames by 1977, suggest that some of these deposits were deliberate and that there was something about water that required special acts and offerings.

Other finds also suggest unusual activities associated with water. A wild pig found at Lydstep Haven in south Wales not only had several microliths embedded in its neck, but the pig's body had been deliberately pinned beneath the water by a large tree trunk.[13] Even the 21 antler frontlets at Star Carr, whether interpreted as evidence for sympathetic magic or as hunting gear, may actually have been part of a special deposit at the water's edge. There is also a small, but increasing,

Figure 5.11 The Bay of Quiberon and the sites of Téviec and Hoëdic



body of evidence linking the deposition of human remains with water, including the recovery of a femur from a palaeochannel at Staythorpe in the Trent valley. The association of human remains with shell middens may perhaps also be linked with water or water-related activities. This, of course, ties in again with the general rarity of human remains in the British Mesolithic. This phenomenon really cannot be explained simply in terms of preservation. Animal bone is frequently found on Mesolithic sites. Clearly, if we cannot locate substantial evidence for the disposal of human remains in a period that lasted for around 5000 years, then we must assume the dead are being treated in a manner that leaves no archaeological evidence. Excarnation is one possibility. This involves exposing the dead to the elements or beasts rather than a formal burial and is well known anthropologically. Alternatively, whilst not excluding other processes including excarnation or even cannibalism, the dead may have been deposited in areas where archaeologists either do not look or cannot reach. Boat burials occur in Denmark, as at Mollegabet II, in southern Denmark, where a boat and corpse were deliberately interred beneath the waterline.[14]

It is, of course, possible that burial might also be part of a ritual that was not directly associated with the water but used water to isolate the dead. For instance, the Sami reindeer herders in Finland interred their dead on islands, ostensibly as a protective measure to confine the spirits of the ancestors to the island to stop them disturbing hunting and fishing grounds and to prevent them returning to settlements to bother the living. Interestingly, we may be able to identify similar practices in the archaeological record. Evidence from Europe points to alternative funeral practices which may be significant to Britain and Doggerland. Whilst human remains within coastal shell middens are recorded widely in Europe, the excavated funerary sites at Téviec and Hoëdic are located on small islands in the Bay of Quiberon, Brittany (see Figure 5.11).[15] Téviec has ten graves containing 23 individuals, while Hoëdic has nine graves containing fourteen individuals. Grave goods at the site include perforated shells, red deer antler, bone pins and flint implements. The dates from both sites fall generally between 6500 and 6000 BC. At the onset of use, the sites would have been high points on a coastal plain, but by the time of the latest burial, sea level changes had transformed these hills into islands. If burial in middens, in a formal manner or as part of ritual involving excarnation, was a widespread practice during the earlier Mesolithic of Britain, then much of the evidence is likely to be found along the extensive coast of Doggerland and is therefore currently unavailable for exploration.

Whilst the Breton cemeteries became islands over time, it is quite clear that Mesolithic communities were prepared to move the dead deliberately to special places isolated by water. The well-known Mesolithic island cemeteries at Skateholm in southern Sweden and Oleneostrovski Mogilnik in north-west Russia also provide evidence for past burial practices that suggest that the dead may have had to be isolated from the living. At both these sites, islands were chosen for the burial of the dead in large formal cemeteries. At Oleneostrovski Mogilnik the local Mesolithic communities transported the

Figure 5.12 Neolithic 'Michelsburg Culture' axe, one of two such axes from the Brown Banks

dead across Lake Onega for formal burial on an island between 6700 and 6000 BC.[16] There may have been as many as 500 interments on the island, often with grave goods including a wide range of stone tools, bone pendants and bear tusks. At Skateholm the cemetery contained 64 burials.[17] However, one should also note the evidence for violence from Skateholm. Injuries to the dead included head wounds and arrows embedded in the bodies. Indeed there is a growing awareness that violence may have been endemic amongst these communities. Steve Mithen, whilst discussing Skateholm in his book *After the Ice*, imaginatively describes a scene of hunter-gatherers returning seasonally to favoured fishing grounds and finding another group already in possession, and the violence that would have followed. As Mithen notes, southern Sweden was already losing its coastal strip to rising sea levels when Skateholm was in use and tension between competing communities, under pressure from the loss of land, must have increased. How much more would this have applied to the area of Doggerland? Pressure on the great plain was inexorable and ultimately disastrous for its inhabitants. There is another point of interest to be made here. As Doggerland was eventually lost to the sea, its remnants would have been visible as islands. Indeed it may have been possible to visit some of these landscapes during low tide. The association of the dead with coastal shell middens during the Mesolithic, and the lack of other evidence is, at the very least, suggestive that funerary practices similar to those we see in Europe may well have taken place in Doggerland but also that they may link with the absence of evidence in Britain.

Whether an equivalent to Skateholm might be found beneath the North Sea is a matter of speculation, although there are hints at least that such a place may have already been found. The Brown Banks are a series of low marine banks to the south of our study zone. The area has provided numerous finds of Palaeolithic and Mesolithic date. Recently this has included human remains dated to the Mesolithic. This in itself is interesting given the lack of funerary evidence elsewhere in Britain, but the recovery of two distinctive Neolithic stone axes from the Banks is provocative (see Figure 5.12).[18] These long and thin flint axes are found in small numbers in Britain but probably originate in Europe. They may have been lost at sea but it is equally possible that they were deliberately deposited on the Brown Banks. The Banks may well have existed as small islands or shallow sand banks exposed at low tide during the early Neolithic. The area could have achieved status as a special site, perhaps because of its association with earlier occupation or burial and the axes suggest that this status may well have continued into the Neolithic.

As the historic landscape was gradually lost to the sea, and Britain may well have separated from the Continent by *c* 5500 BC, it would be incorrect to suggest that separation was the end of Doggerland. Isolated islands, which must have existed for some time at least, may have continued to be populated as sea levels rose, but settlement would have become increasingly tenuous and migration from Doggerland must have taken place.[19] Disasters also occurred. Excavations at Howick may have located evidence for the Storrega tsunami of *c* 6100 BC.[20] The impact of a huge submarine landslip the size of Scotland may not have been as catastrophic in the southern North Sea as it appears to have been in Scotland and Norway but any remaining shallow islands may have been overwhelmed by a surge. Kevin Edwards' description of the events in Scotland is worth quoting

> Water from the northern North Sea would have rushed into the space. People on land would have noticed that the sea receded, probably as far as the eye could see, in a matter of tens of minutes. They may have thought that the newly revealed shellfish and stranded fish represented an amazing bonanza … or that 'Doggerland' had re-appeared! The seawater, having piled up in the depression, then begins to flow out again as a series of massive waves or tsunamis, travelling at 20–30m per second on shallow coasts. Four or five waves would have hit the coast over two or three hours, each separated by a strong backlash as water flowed back to sea. Any coastal settlements would have been flooded without warning, indeed the water depth would have been many metres, and people and animals would have been drowned. Coastal and estuarine areas, resources, and people would have been devastated.[21]

The consequences of such catastrophes are difficult to imagine today. Britain rarely experiences such extreme events and we tend to think of it as a safe place. However, whilst events such as the Storrega tsunami are dramatic, the gradual loss of Doggerland must have been disastrous for all involved. What happened to the groups who were displaced or to those who lived in the areas into which they migrated? It is possible that the pressure on populations forced out by rising sea levels pushed some into areas which had not previously been used or possessed relatively low levels of population. This may have been the case in areas including Norway and Scotland during the earlier period of inundation. Certainly the maritime character of these areas may have stimulated the development of technologies related to fishing and sailing that allowed the colonisers to survive in these new environments. The dates of the site at Cramond in the Firth of Forth (8500–8300 BC) suggest that settlement of these areas occurred rapidly after climate change and ice retreat made the land available for occupation. In contrast, the significance of population movement during the final periods of flooding has hardly ever received attention by archaeologists.[22] We can be certain, however, that the effect of the final inundation of the North Sea emergent landscape during the later Mesolithic would have been significant to all who lived on or adjacent to the North Sea plain.

Another effect of the broadening sea would have been to increase the distance travelled to maintain social contact and trade between communities divided by the new waterways. As sea levels rose, the dead trees that emerged at low tide might also have acted as invaluable, and socially imbued, reference points. For the sea traveller who passed through such a dead landscape, there may have been benefits. People or objects that passed through the lost lands of the ancestors may well have gained prestige as a consequence. Having said this, it would be wrong to assume that the loss of Doggerland necessarily left Britain isolated. In the first instance, one must note that the final breach with the Continent, at *c* 5500 BC, was actually quite late in the period. Moreover it was neither absolute nor, for much of the period, restrictive. The Norwegians have a saying that 'the land divides us but the sea unites us' and the archipelago of islands that must have existed between Britain and the Continent during the latest phases of inundation may also have served as waypoints, and sea travel could have occurred largely without losing sight of land.

If Britain was not in fact so separate or isolated from communities on the continental land mass, those apparent differences that do remain have to be considered in a different light. It may be more appropriate to consider whether the contrasting lifestyle of the British later Mesolithic was already in existence long before the loss of Doggerland and that the clues to how some aspects of social change occurred during the Mesolithic may lie on the great plain. One might speculate further: if we sought to identify critical events with the capacity to trigger profound social change during this period, the transformation of the Outer Silver Pit, which must have been the heart of Doggerland in terms of resources and human settlement, from a lake to a massive estuary might well be such an occurrence. The seismic evidence from the channel, in terms of sand bank development and tidal scours, suggests this became an inlet with fearsome currents. If there is a point when division actually led to separate development, it may have been when passage across the new channel, and the rivers that fed it, became difficult and dangerous. If social change, including precocious sedentism, was triggered, as Clive Waddington has suggested, by the loss of coastal lands then this may well have been felt first around the shores of the Outer Silver Pit and the effects rippled from there. Cultural relations that existed for centuries may have been disrupted at this point and new social practices would have been adopted to cope with conflict, emerging concepts of territoriality, and the loss of lands associated with ancestral possession. This must have been a turbulent time and the tipping point for change may well have been when Doggerland, a country that had been central to the cultural development of north-west Europe for perhaps 12,000 years, finally became a frontier. Island Britain may have begun to emerge in terms of evolving social separation well before it actually became a separate country.

Little Doggerland and the deeper past

Michael Reynier has recently described research into the early Mesolithic as currently 'listless', perhaps largely due to the difficulties presented by the archaeological record.[23] In part this may also be a consequence of our lack of knowledge of the prehistoric archaeology of the North Sea. Currently, the Holocene archaeology of the region is infrequently considered within the literature and the absence of available evidence is tacitly presented as evidence of absence. Consequently, the area appears to occupy a proximal role in the literature and our interpretative position. It remains true that only a few terrestrial sites are actually available to support our current interpretative models for the earlier Holocene,[24] and even fewer have provided adequate environmental evidence for this period.[25] This is a parlous position and we should be assured that the apparent density of sites that have been identified or explored in Europe, most notably in Denmark, will not actually fill this gap.[26] Few of these sites are located further than 5km from the coast and, whilst useful for comparison, these can never truly be used as a proxy for settlement more than 120km away, in the centre of the great North Sea plain.

The results of the work in the North Sea may therefore prove to be a wake-up call for new directions in research. The landscapes mapped here represent areas that would have been prime habitable zones linking and, perhaps, explaining much of the archaeological variation we see around the North Sea basin. In contrast, much of the present terrestrial archaeological record, which approximates the sum of our knowledge, in Britain at least, may better be represented as areas that were peripheral locations for the Mesolithic occupants of Doggerland.[27] The data supplied by the mapping programme provide significant support for a radical shift in our interpretative position for the Mesolithic in north-western Europe. Previously unimaginable, the Holocene landscapes revealed here allow us to discriminate between environmental zones, characterise areas of archaeological potential and, possibly, provide the opportunity to explore the southern North Sea with the likelihood of archaeological success. In doing so we can anticipate the exploration of an entirely new European country whose study may reinvigorate research into the Mesolithic and later Palaeolithic occupation of north-western Europe.

Despite the apparent success of the North Sea Palaeolandscapes Project, it should not be presumed that the research is either extensive or authoritative in spatial or chronological terms. The area studied does not represent the whole, or even the available, extent of land surfaces that could be investigated. The shoreline of the great North Sea plain would have extended north along the current shoreline of northern England and east to the Continent. Although there is the opportunity to research these landscapes further using the technologies described here, or even using more accurate and higher-resolution technologies, there are limitations. There is, for instance, a major gap in the availability of 3D seismic data in the north of England, and this is a real issue, for instance, when considering the larger landscape context of the recently discovered Mesolithic house at Howick. There is also a problem with carrying out extensive 3D

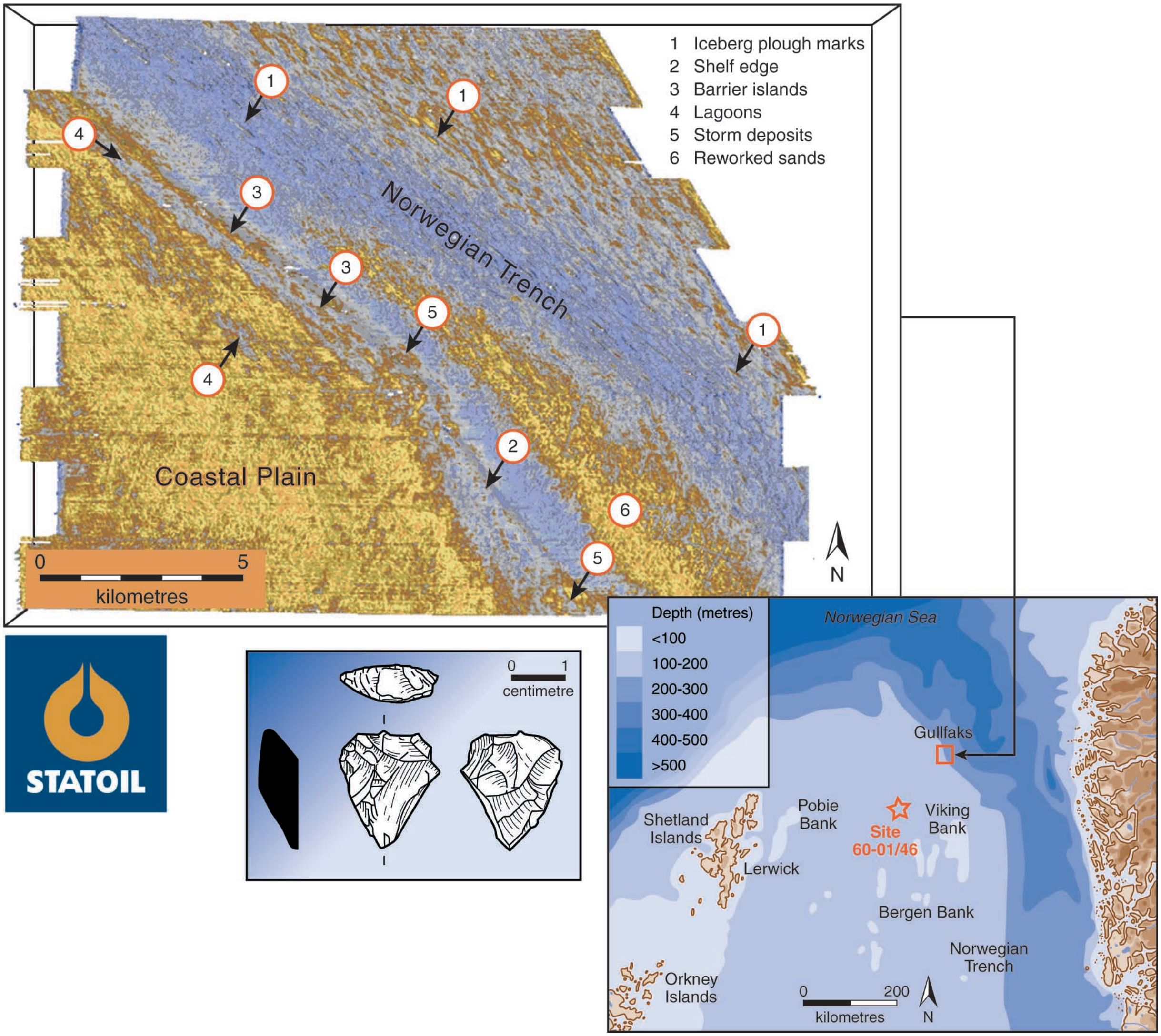
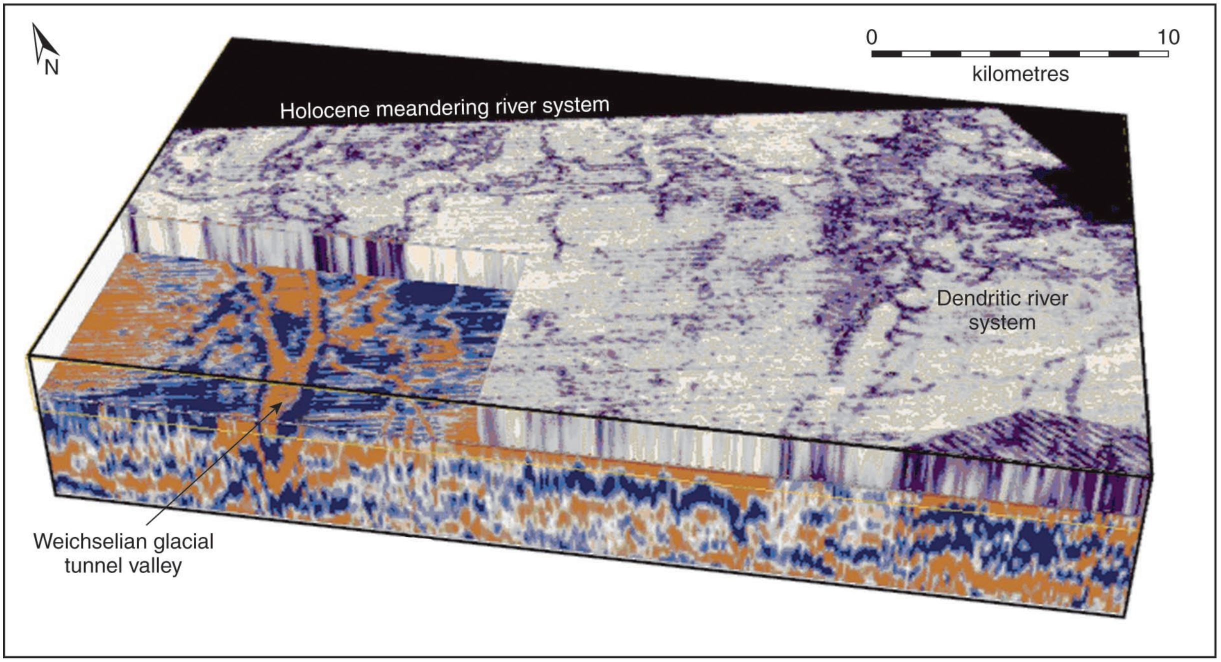


Figure 5.13 Probable later Palaeolithic land surfaces adjacent to the Norwegian Trench. The Viking Bank flint illustration is from Long *et al* (1986)

survey in shallow waters. Large boats cannot manoeuvre here and the seismic signal is generally poor in these areas. Consequently, there is a 'white band' which surrounds the modern coast and within which our knowledge of the palaeotopography and, by inference, the archaeology of the area, is severely limited. Most archaeologists would want to tie the map data from the sea with terrestrial archaeology in a seamless manner but this is not currently possible for the majority of the coast. Consequently, in the shallower marine areas there will be a reliance upon 2D seismics to fill this gap, with a concomitant loss of the extensive data associated with 3D data sets. In shallow waters traditional methods of marine prospection may be employed to effect (diving, high-resolution seismic survey etc), although the spatial extent of such new data is a limiting factor. As with the palaeoenvironment, there remains an urgent need to collect new data sets to fill these gaps.



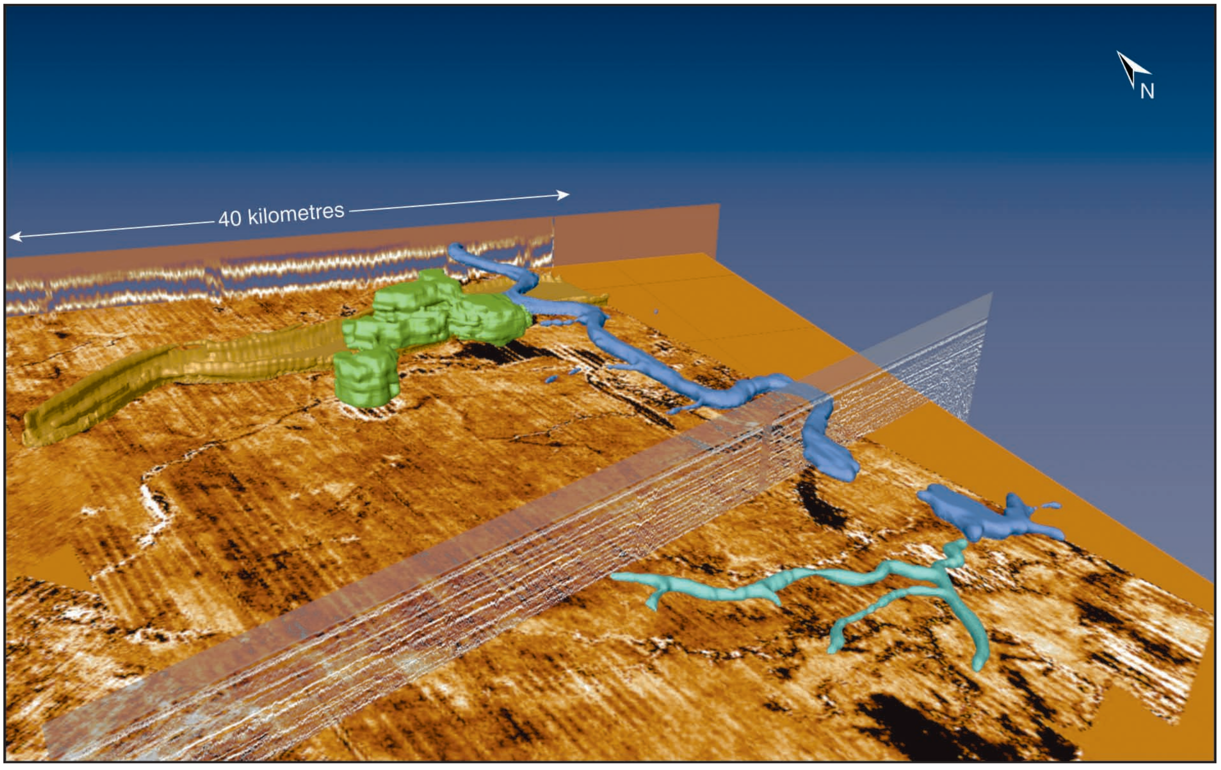


Figure 5.14 Seismic data cube illustrating chronostratigraphic relationship between the meandering Holocene river, now named the Shotton, and earlier features
Figure 5.15 3D image showing the Shotton in dark blue, depressions which may be marshes in green and an underlying tunnel valley coloured gold

There is one more very important point to be made in relation to the remaining archaeological potential of the North Sea. As you move north, the landscape that lies under the sea was inundated at an earlier period. Effectively you travel back in time as you move north. When you reach the Norwegian trench, hundreds of kilometres away from the Outer Silver Pit, this area was actually the coastline of Europe and Doggerland at *c* 18,000 BC. There is increasing evidence that this cold and unpromising land was not uninhabited during the late Palaeolithic.[28] The melting of the Devensian ice sheet north of Scotland would have been rapidly followed by marine inundation and much of the area to the north and west of Scotland would not have been available for occupation but the plain to the east of Scotland, bounded by the Norwegian Trough and including the hills now known as the Viking Bergen Banks, would have been part of this habitable land. This is a massive area of completely unexplored countryside, *terra incognita* at the scale of many countries. Not surprisingly, traces of occupation in these areas are few. Populations at this time must have been incredibly small and much of the area is now covered by water four or five times deeper than the deepest areas studied in the southern North Sea.[29] The chances of finding evidence in an area even more inaccessible than the lands further south is statistically so small that we might expect that it is unlikely ever to have happened – but it has! In a story reminiscent of the find of the Colinda harpoon in 1931, a vibrocore sample was taken from the area of the Viking Bergen Banks in 1979. When opened, out popped a single worked lithic recovered at a depth of 143m. The Viking Bank flint is the best evidence we have that this submerged land was also occupied and that there is more to find out about this older, deeper country. As part of this project, Dr Ken Thomson analysed one small area of 3D seismic data from the Gullfax oil field, slightly to the north of the Viking Bank find. Here we can see what may have been the first coastline of Doggerland, exposed when the ice had retreated but before inundation began *c* 18,000 BC (Figure 5.13): a coast with barrier islands and lagoons bounds a low, cold and windswept coastal plain. Deep in the Norwegian Trench are scars caused by icebergs ploughing into the base of the channel.

The results in the northern North Sea are remarkable, not least for their clarity. In the southern North Sea the images are less clear, in part because of its shallower water depth which decreases the quality of the imagery. The real story is that here, at the edge of Europe, is another, older country which still remains to be explored.

This older world is not limited to the far north. All areas south of this were also part of Palaeolithic Doggerland. Figure 5.14 shows a seismic data cube over the Dogger Hills. At the top of the cube is the Holocene river channel now called the Shotton River and buried beneath this is a deep late Palaeolithic tunnel valley. This is, perhaps, better appreciated in the volumetric model in Figure 5.15, which has been processed to strip away the sediments around the valley and river channels to show the relationship between the Mesolithic and Palaeolithic land surfaces.

There is even more to this. Actually the area of Doggerland was occupied deep

Figure 5.16 'Seahenge', a Bronze Age timber circle eroding out of peat deposits on the Norfolk coast. The debate over the future of this monument contrasts significantly with previous lack of discussion relating to the landscapes of Doggerland[31]

into the Palaeolithic. The earliest hominid site in Britain, at Pakefield, Suffolk, faced the North Sea plain 700,000 years ago and, as this book was written, 28 middle Palaeolithic hand axes dating to *c* 100,000 years ago have been dredged as a group off the East Anglian coast and these join a collection of similar tools from the North Sea.[30] There are deeper pasts and older Doggerlands to be explored but these are beyond the remit of this small book.

Doggerland: any future?

In any other context, the discovery of an unexplored prehistoric landscape of the scale associated with Doggerland would provoke an outcry demanding exploration and also preservation (Figure 5.16). If such a find were on land, the legal protection available could be implemented in a number of practical ways, mainly because terrestrial remains are accessible and they can be monitored for deterioration. Development plans can often be changed to protect specific areas and, in the last resort, excavation may be considered as an option to record any archaeological monument that cannot be preserved. Unfortunately, this is not the case in the deeper parts of the North Sea. The essential characteristics of the archaeology of the deep seas do not, in truth, encourage engagement or intervention. In management terms the archaeology has been defined by its general inaccessibility and the uncertainty concerning the nature, or even location, of any remains. This contrasts sharply even with inter-tidal or shallow marine zones where there is usually some opportunity physically to record known sites, to analyse their distributions and therefore to provide some degree of protection or management. The inaccessibility of the resource is such that few people have felt competent or willing to be vocal in defence of the prehistoric archaeology of the southern North Sea.

Table 5.1 Threats to the archaeology of the North Sea[34]

Area (%)	Source	Area (km^2)
54	Fishing	309,204
0.03	Aggregate extraction	180
0.01	Dredging proposal	72
0.001	Waste disposal	5.5
0.001	Sludge disposal	5.5
0.05	Platforms	313
0.05	Well head	300
1.5	Pipelines	8374
1.27	Cables	7322
0.05	Wrecks	284
0.0001	Cuttings disposal	0.5
56.95	Total	327,000

The depth of deposits, or water column, overlying the presumed North Sea landscape has generally ensured that the presence of archaeological deposits could only be inferred on the basis of contemporary correlates from terrestrial or shallow-water contexts.[32] Paradoxically, whilst there is a general assumption that the depth of water and overlying deposits might protect archaeological deposits, the archaeological material trawled from the area, which is generally our only guide to the distribution of deposits, presumably suggests continuing damage to relict deposits. However, as in Clement Reid's days, the biggest threat to seabed remains is undoubtedly fishing which affects about 54% of the surface area of the North Sea as a whole. Modern trawlers are comparable to deep ploughs in the damage they can do to the seabed. You may remember that the Colinda point was trawled in a cubic metre block of peat, which indicates the power of trawl equipment even at that time. The intensity of trawls by UK registered boats can be seen in Figure 5.17 but today the majority of archaeological material recovered by trawling comes from the Dutch sector. This reflects the different trawling technique used by Dutch fishermen who use beam trawlers to catch sole. This involves towing two large nets each with a heavy metal beam up to 12m long, sometimes with tons of 'tickler' chains which raise the fish, particularly sole, ahead of the nets. Not surprisingly these can gouge the surface of the seabed and they trawl literally thousands of pieces of archaeological material along with the fish (Figure 5.18). It is estimated that as much as 57 tonnes of faunal remains may well be scraped off the surface of the sea using this technique over

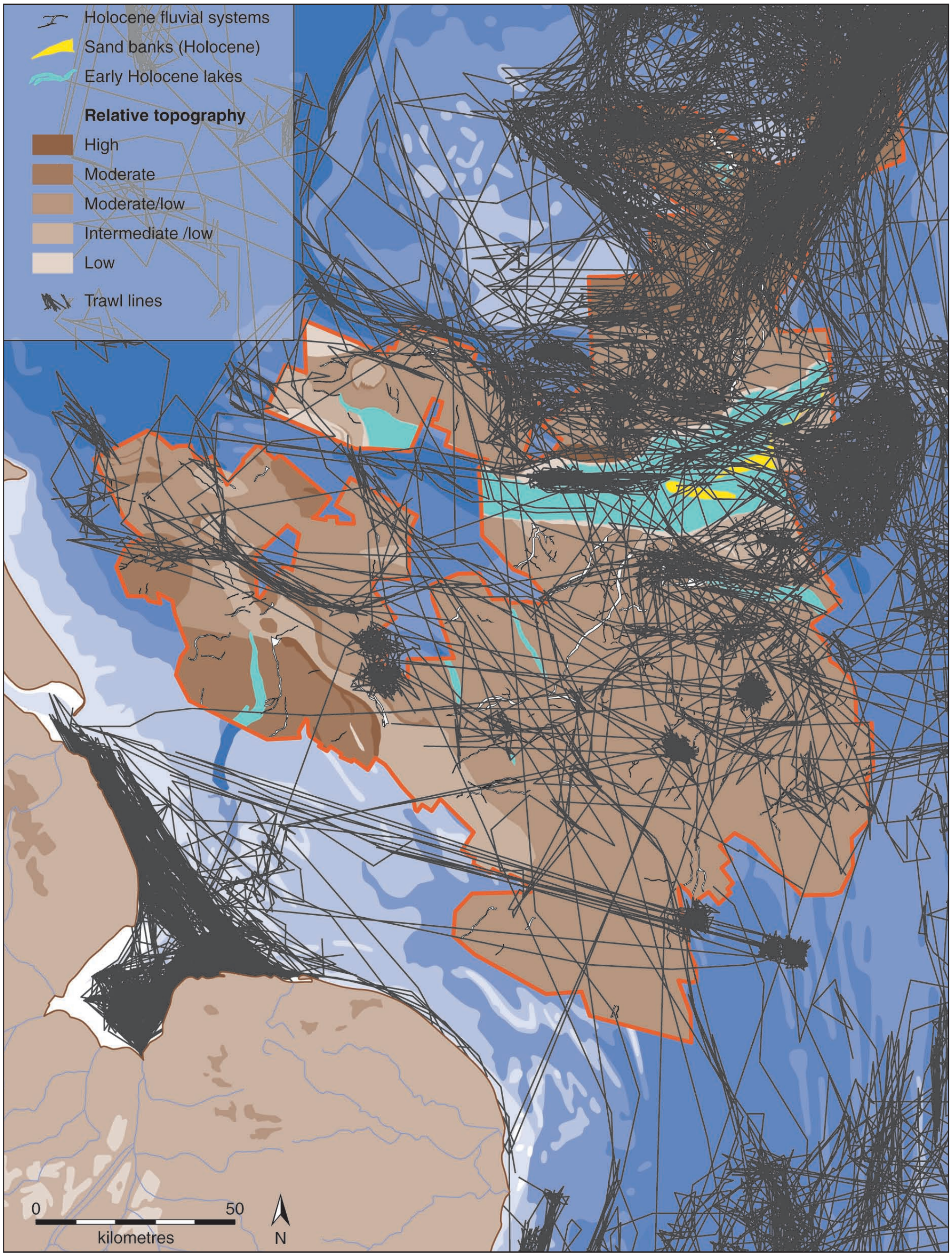


Figure 5.17 Fishing activity in the southern North Sea. This information shows the trawl lines collected by the DEFRA Vessel Monitoring System (VMS) during 2007 for UK vessels with a length of >15m deploying beam trawls, otter trawls and scallop dredges

a five-year period.[33] Although the Dutch archaeological service has an excellent relationship with the trawler crews, much must be lost on a daily basis, either dumped without record or, as one can see on eBay, sold to collectors.

There are other threats. The North Sea connects all of the countries in maritime north-west Europe and is one of the busiest sea-lanes in the world. The area is also a centre for oil and gas production, aggregate extraction, and, more recently, a source of alternative energy resources – wind or wave power. The sea

Figure 5.18 The sea's harvest: fossil bone trawled from the North Sea and landed in Holland

is peppered with marine infrastructure and criss-crossed by a network of pipes and cables.

Unfortunately, the truth is that it has been difficult to protect, or argue for the protection of, the archaeological landscapes of the North Sea because archaeologists were unable to demonstrate their existence. Perhaps it is best to illustrate this with respect to the study area itself. Figure 5.19 illustrates this area with the associated infrastructure and impacts overlain. One of the most

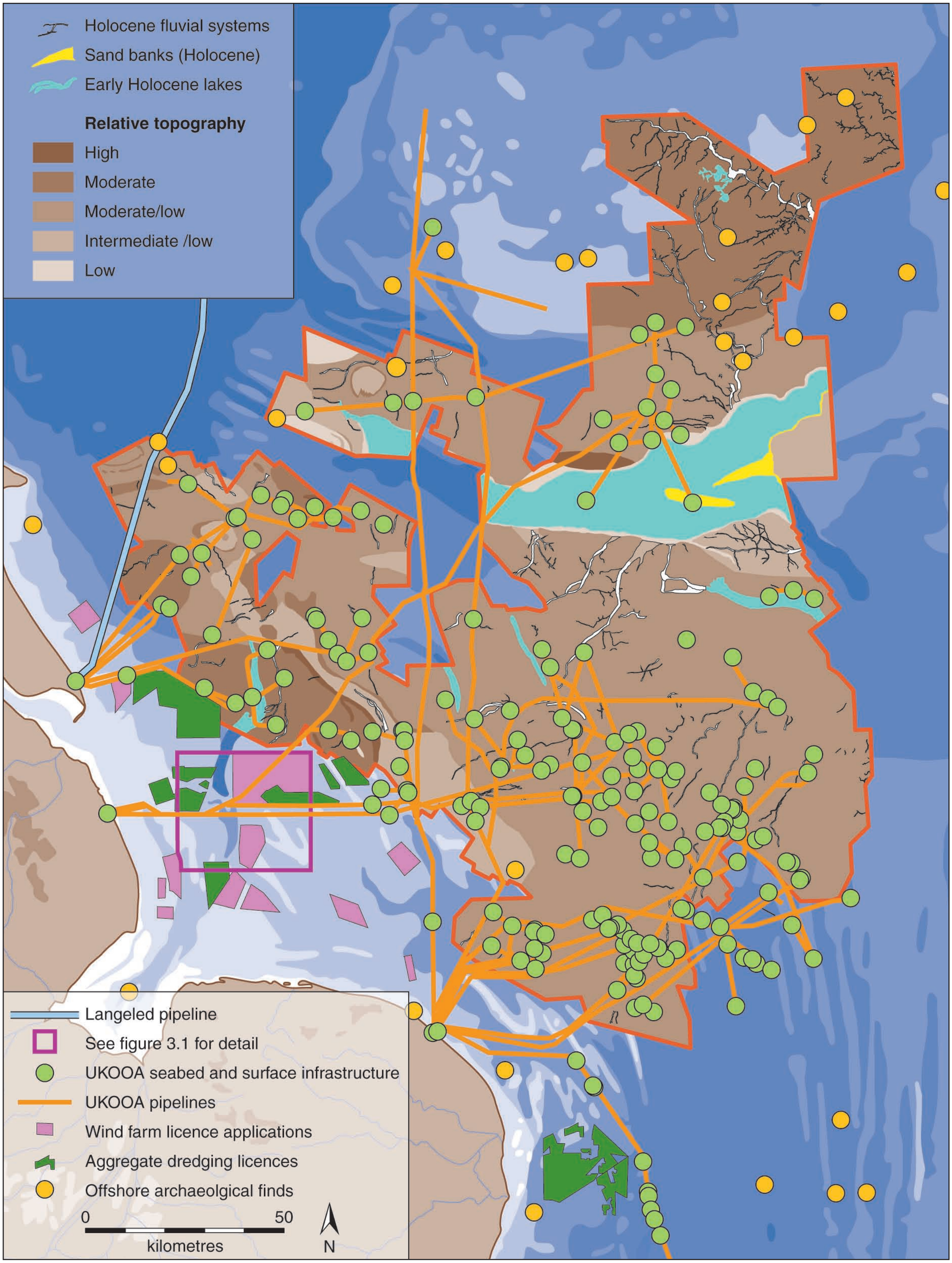

Holocene fluvial systems
Sand banks (Holocene)
Early Holocene lakes
Relative topography
High
Moderate
Moderate/low
Intermediate /low
Low
Langeled pipeline
See figure 3.1 for detail
UKOOA seabed and surface infrastructure
UKOOA pipelines
Wind farm licence applications
Aggregate dredging licences
Offshore archaeolgical finds
0
50
kilometres
N

Figure 5.19 Intense use of space within the southern North Sea

recent and significant developments in the area was the laying of the Langeled pipeline.[35] Built for Norsk Hydro, this brings Norwegian natural gas to the UK. The pipeline stretches 1200km from the Nyhamma terminal to Easington in England and is the world's longest underwater pipeline. This is without doubt a massive strategic investment as it will carry around 70 million cubic metres of gas per day, approximately 20% of Britain's total gas requirements. However, it was laid across the north-western part of the study area. This was clearly a significant opportunity for providing the badly needed evidence for Doggerland but the information presented here was not available at the time and the chance was missed.

Such facts become more pertinent when one considers the recent UK decision to move away rapidly from hydrocarbons and to replace these with renewables as part of its plan to combat climate change. The British government has declared its intentions to meet 15% of the country's energy from renewables by 2020. To achieve this the UK will have to raise its production of electricity from wind, wave and solar sources from its 2007 level of 5% to between 30% and 40%.[36] Although more expensive than land-based wind farms, marine generators are becoming a preferred solution because not only are they able to harvest the stronger and more reliable coastal breezes, they sidestep many of the planning objections by communities which see the massive windmills as disfiguring and damaging to local environments. The scale of the current proposals may, however, generate considerable debate and opposition. The planned 'London Array',[37] for instance, will comprise up to 341 turbines covering an area of 254km^2 situated off the Kent and Essex coasts (Figure 5.20). This lies outside the 12-mile territorial limit, which also marks the formal limit of responsibility for English Heritage, the Government's advisor on all aspects of the historic environment. Protection for these areas and much of Doggerland is problematic. Most of this area is protected

Figure 5.20 Wind turbines off Caister-on-Sea, Norfolk

in only a general sense by the United Nations 'Convention on the Law of the Sea', which states that signatories have the duty and right to protect archaeological resources 'and shall co-operate for this purpose', whilst the UK never ratified the UNESCO 'Convention on the Protection of the Underwater Cultural Heritage'. This means that there is no international regulatory framework for the marine historic environment beyond the territorial limits.

In the face of the planned exploitation of the country's coastal shelf it is clear that the archaeology of Doggerland has never been under such threat and that the statutory protection currently available for an archaeological landscape as large as England is doubtless inadequate. There is a real danger that damage to archaeological deposits, first recorded by Clement Reid, may escalate massively with the proposed developments and that archaeologists may not have the opportunity to explore this lost land.

Given the scale of the threat, it is important to stress that the British government is currently reconsidering its position on marine protection and has released a white paper for comment.[38] It is not clear how extensive protection can be provided for the landscape discussed here but several points are of importance. Firstly, the problem is not limited to British territorial waters or those parts of the coastal shelf controlled by Britain. The archaeological extent of Doggerland reaches beyond the median line of the North Sea and contacts, seamlessly, the national boundaries of those countries with a North Sea coastline. There will have to be an international agreement on the future of the archaeology of the North Sea involving all stakeholders. One wonders, given the archaeological and environmental significance, whether an application for World Heritage status should be considered. A second point is that archaeologists cannot, and should not expect to, stop development in the North Sea. In particular, the growing crisis relating to climate change will demand that marine resources contribute to the nation's energy requirements. Archaeologists will have to provide some realistic methodology to assess the archaeological potential of the area and to assess threats to this resource in a manner that permits us to balance the inevitable development of the area with the requirement that we protect our archaeological heritage.

An earlier chapter provided information on the potential of the landscape for preservation on the basis of the information we mapped from the seismic study (Figure 3.37). However, this procedure is not necessarily adequate to support the management of the archaeological resource in its totality because it only really tells us about the archaeological features that we know about and that were mapped from the seismic data. There is an important archaeological maxim that 'absence of evidence is not evidence of absence' and we should not be misled into thinking that the available mapping is adequate for management. In some areas the resolution of the seismic data may simply be too coarse to provide useful information, whilst the technique itself may be inapplicable for a number of reasons in other areas. We need to identify those problematic areas that may contain unidentified features and might also be under threat. It is possible to provide mapping which combines our current knowledge of threat

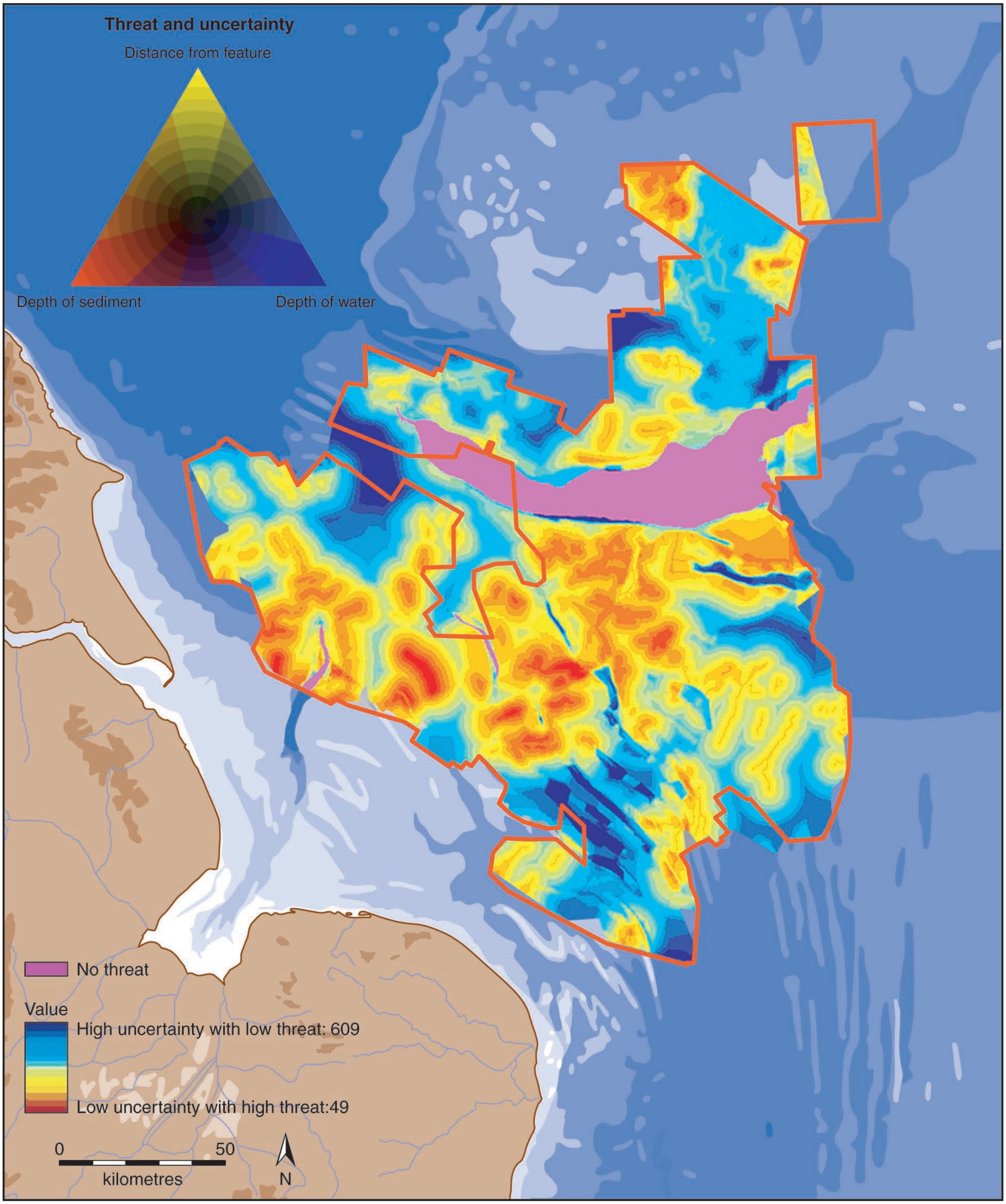


Figure 5.21 Potential threat to archaeological deposits combined with uncertainty of knowledge of archaeology

with an assessment of the uncertainty of absence of archaeological features.[39] Figure 5.21 is a map which shows threat to the archaeological resource combined with uncertainty of knowledge of the resource. Uncertainty here is a single measure linked to the horizontal distance from any known feature and the potential accessibility (ranked according to the overlying depth of sediment and water column). This map provides a continuous assessment across the study area in which areas of high threat and low uncertainty (shallow water column or sediments proximate to identified features) grade into areas with low threat and high uncertainty (greater water column or sediments at an increasing distance from known features). This procedure results in a simple but highly effective form of management tool sometimes referred to as 'red flag' mapping because it highlights potential threat to archaeology without needing to identify the archaeological features themselves. In contrast to the earlier map, this process highlights significant areas in the southern and western parts of the study area as zones that might contain features which are not amenable to current mapping technologies, but which may be more prone to development threat. These are areas where urgent archaeological action may be required in the very near future.

Not waving but drowning: Doggerland and climate change

Climate is what you expect; weather is what you get.

Attributed to Mark Twain

Finally what is there to be learnt from the fate of Doggerland in respect of our current changing climate?[40] We know that between 18,000 and 5500 BC there was a sea-level rise of more than 140m. There have, however, throughout the history of the world, been times when sea levels have changed and, through continental drift, periods when whole continents have morphed and moved. During the 20th century, global sea level rose by around 20cm, a rate that may be higher than at any time since the loss of Doggerland. The driver for the current sea-level rise is incontrovertible – the climate is changing and the Earth warming. As this book was written at the end of 2007 the United Kingdom has just experienced a year with no summer but which was also one of the mildest on record. Indeed the previous six years were also the warmest on record and the prediction for 2008 was for another record-breaking year (Figure 5.22). The Earth overall has warmed by 0.74°C over the last century and about 0.4 °C of this warming has occurred since the 1970s. Rising temperatures have resulted in the enhanced melting of ice held in glaciers and ice sheets, and the expansion of the water mass itself. All of this leads to change in average global sea levels.

Although there has been considerable debate concerning the extent of change there is now a substantial scientific consensus and the 4th report of the Intergovernmental Panel on Climate Change in 2007 suggests that we may experience an increase in the average surface temperature from 1.8 to 4°C and an associated rise in sea level of up to 50cm by 2100, depending on the model

Figure 5.22 Ranked mean temperatures by year for the United Kingdom[41]

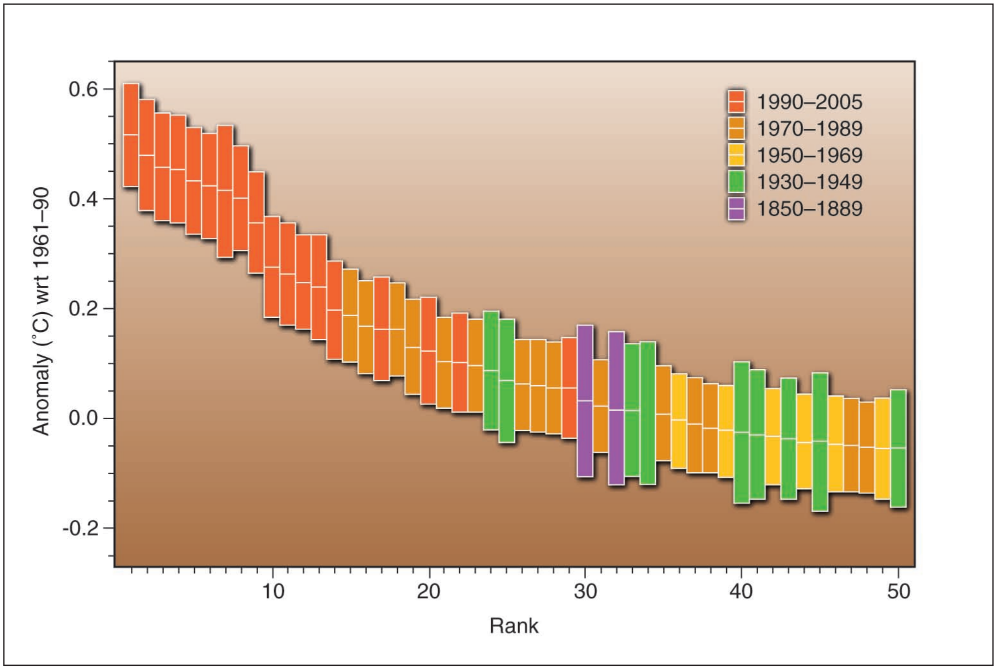
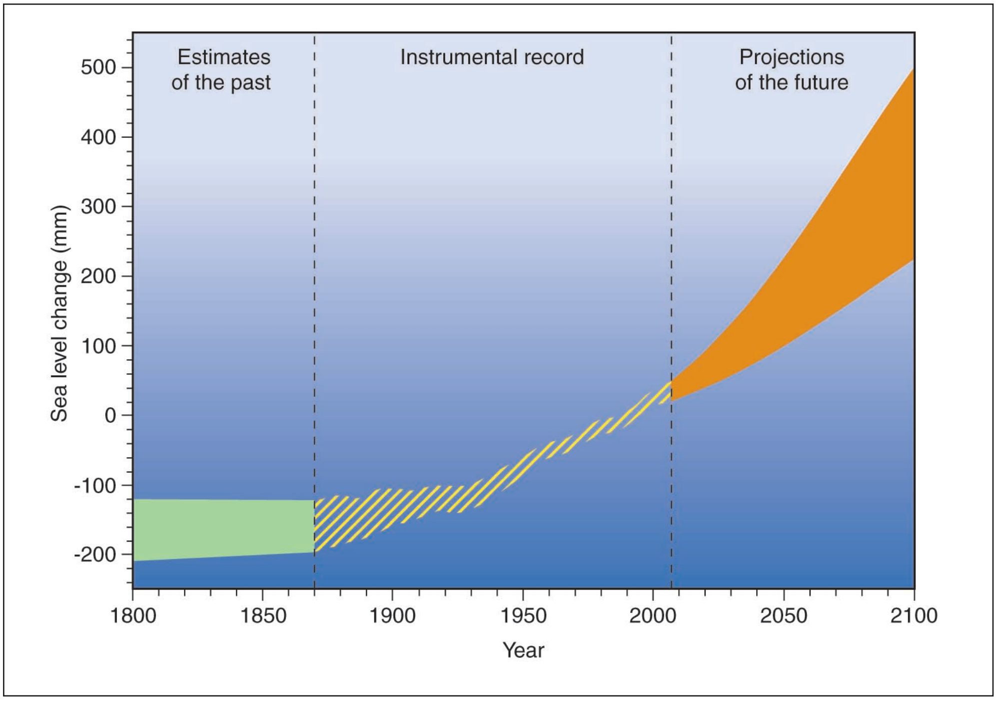


Figure 5.23 Time series of global mean sea level (deviation from the 1980–99 mean) in the past and as projected for the future



used (Figure 5.23). Equally worrying is the increasing evidence that the current pattern of sea-level rise has substantial inertia and will continue beyond 2100 for many centuries. Irreversible breakdown of the West Antarctica and/or Greenland ice sheets, if triggered by rising temperatures, would make this long-term rise significantly greater, ultimately questioning the viability of many coastal settlements across the globe. The impacts of predicted change are likely to be dramatic and unpleasant. This may, initially, seem to be a repeat of the events that led to the loss of Doggerland.

However, whilst the world may, at last, be facing the truth about the scale of climate change, there still remains some debate about the reasons for such dramatic events. It has to be acknowledged that the Earth's climate periodically experiences natural change.[42] Variations in the planet's orbit, known as Milankovitch cycles, are certainly an important factor in global climate change. Cool periods identified within these cycles generally coincide with the onset of glacial episodes, but there are other agents or events that may act as tipping factors. The changing configuration of the Earth's land masses has a major role in triggering, if not specifically causing, glacial events. For instance, the raising of the Himalayas and the creation of the Tibetan plateau 35 million years ago may well have been a factor in general Pleistocene cooling and the onset of Antarctic glaciation. The high Tibetan plateau (with an area four times the size of France) encouraged local glaciation and promoted wider cooling; it certainly changed global weather patterns and enhanced the effect of the monsoon. Other changes associated with rapid uplift may also have affected the cycle of release of greenhouse gases. These gases are, primarily, water vapour (H_2O), methane (CH_4) and carbon dioxide (CO_2) and we now believe these have a role in trapping solar energy within the atmosphere and causing heating. The uplift of the Himalayas probably promoted chemical weathering and redeposition of carbonates via their solution in the great rivers of the region. This would have effectively trapped a key greenhouse gas, carbon dioxide, in marine sediments and further reinforced the pattern of cooling during the Pleistocene.

Whilst the link between the key greenhouse gases and climate change is now generally accepted, it is not always certain whether these gases have, in critical periods of the past, caused change directly by acting as tipping agents or simply

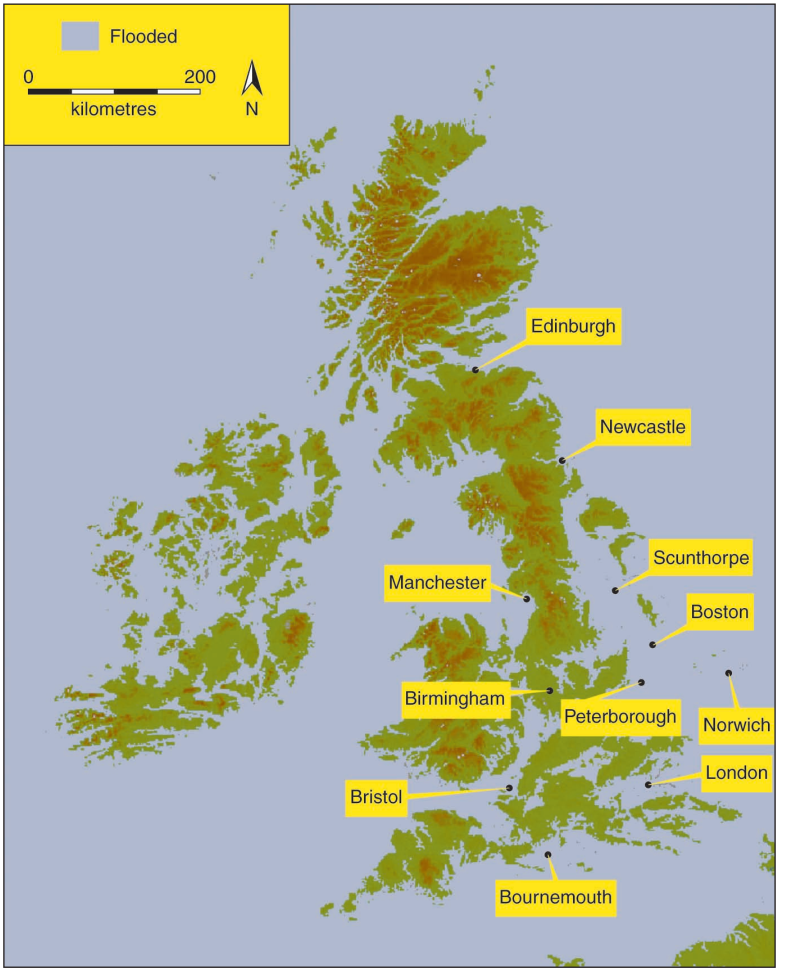


Figure 5.24
The effects of uncontrolled global warming and sea-level rise?[45]

reflected change. Indeed, all of these options may have been true to some extent and at different times. Volcanic activity regularly releases massive amounts of CO_2 into the atmosphere, although this is generally balanced by the effect of chemical weathering. It is also possible that the massive release of methane stored, for instance, as hydrates in ice crystals within arctic or tundra environments might also act as a tipping factor in temperature changes. The potential impact of such events in the past is underlined by isotopic analysis of marine sediments that suggest a sea temperature rise of 7–8°C may have been linked with catastrophic methane release 55 million years ago. If methane does not directly precipitate change it may well amplify the effects of rising temperature. Consequently, the potential impacts of releasing vast amounts of gas that are currently stored at high latitudes, and especially within the rapidly warming tundra, may well cause future concerns.

However, the current phase of warming and its association with a historically unprecedented rise in greenhouse gases is not likely to be a natural event. Indeed, on the basis of our understanding of past climate trends, and our knowledge of recent volcanic activity, the Earth should have been entering a period of cooling. Instead the world is actually getting warmer. For many people the link between modern global warming, the rise of greenhouse gases, industrial development and, specifically, the use of carbon-based fuels is rapidly becoming an established, if still disputed, fact. Indeed, the International Panel on Climate Change (IPCC) has asserted that the majority of observed and predicted change over the next century will be due to mankind's activities.[43] The consequence of predicted change will be severe globally and regionally – even discounting some of the hyperbole evident in media reaction to climate change. The widely distributed map, shown as Figure 5.24, illustrating mainland Britain as a series of islands following sea-level rise, is dramatic but requires uncontrolled temperature rise and the melting of the East Antarctic ice sheet, an event which is not certain to happen and is unlikely to occur for thousands of years.

The Hollywood climate change blockbuster *The Day After Tomorrow* envisages a different scenario. A 'Heinrich Event' occurs when ice flows and fresh meltwater, released into the North Atlantic, disrupt the Atlantic Meridional Overturning Circulation (commonly called the Gulf Stream). This is part of the world's oceanic conveyor belt that redistributes heat across the globe and specifically carries warm upper waters north and returns cold deep waters south. In the film, the Gulf Stream, which moderates Britain's climate, shuts down and precipitates a glaciation. This has happened in the past, with effects that have lasted decades or thousands of years. The sudden release of 9300km^3 of meltwater from the north American ice-dammed Lake Agassiz, coincided with the 'H0' Heinrich event and the relatively short, but severe, cooling associated with the Younger Dryas. Recent research suggests that the Gulf Stream has recently slowed down by as much as 30% but also that a catastrophic event is unlikely – in this century at least.[44]

Such observations, however, do not detract from the serious impacts that will occur as a consequence of global warming and climate change. Figures 5.25 and

5.26, taken from the IPCC briefing notes for policy makers, provide a succinct and worrying synthesis of the predicted impacts. Rising temperatures and increasing climate instability, linked with melting ice and rising sea levels, threaten millions. Heat-related mortality in Europe is likely to increase a hundredfold due to climate change; malaria and dengue fever will spread as a consequence. It is *likely* that up to 20% of the world population will live in areas where river flood potential could increase by the 2080s. By 2020 between 75 million and 250 million people are projected to be exposed to increased water stress due to climate change and conflicts over control of water are likely to occur as a consequence. Economic activity will be increasingly compromised across the globe and the world's poorest areas may well be most severely affected. Africa, in particular, is likely to suffer disproportionately and by 2020, in some countries, yields from rain-fed agriculture could be reduced by up to 50%, affecting food security and exacerbating malnutrition. Wheat and maize production in India may decline by 2–5% and rice production by 5–12% in China. Endemic morbidity and mortality due to diarrhoeal disease, primarily associated with floods and droughts, are expected to rise in east, south and south-east Asia. A reduction of global economic output by 3.4% ($7 trillion), caused by climate change and global warming, is expected by 2200.

The natural world will also be hit hard. Approximately 20–30% of plant and animal species are likely to face an enhanced risk of extinction if increases in global average temperature exceed 1.5–2.5°C. By the 2070s, significant areas of Brazil and central southern Africa could lose their tropical forests. If so, the region, which currently absorbs carbon dioxide at the rate of some 2–3 gigatonnes of carbon (GtC) per year, may actually become a net carbon source adding about 2 GtC annually to the atmosphere by the 2070s, reinforcing the effects of climate change.[48]

The warnings are stark. 'Unmitigated climate change would, in the long term, be likely to exceed the capacity of natural, managed and human systems to adapt.'[49]

In the face of such a potentially catastrophic future what then is the significance of the fate of Doggerland and other inundated areas of the world – Beringia and Sundaland? Clearly the sea-level rise that resulted in the loss of these vast areas of land was caused by natural rather than anthropogenic factors. The loss of such extensive areas, whilst devastating to communities who lived there, was never likely to be an extinction event. Ultimately, the Mesolithic communities of the great plains were flexible and mobile. Suffering there must have been, but the communities moved and adapted. Modern society does not have that luxury. Ours is a crowded world with a current population of around 6.6 billion people. The population in the near-coastal zone (within 100m elevation and 100km distance of the coast) has been calculated at between 600 million and 1.2 billion, or 10–23% of the world's population. Sixty percent of the world's 39 metropolises with a population of over 5 million are located within 100km of the coast, including twelve of the sixteen cities with populations greater than 10 million. Globally, coastal populations are expected to increase rapidly, while

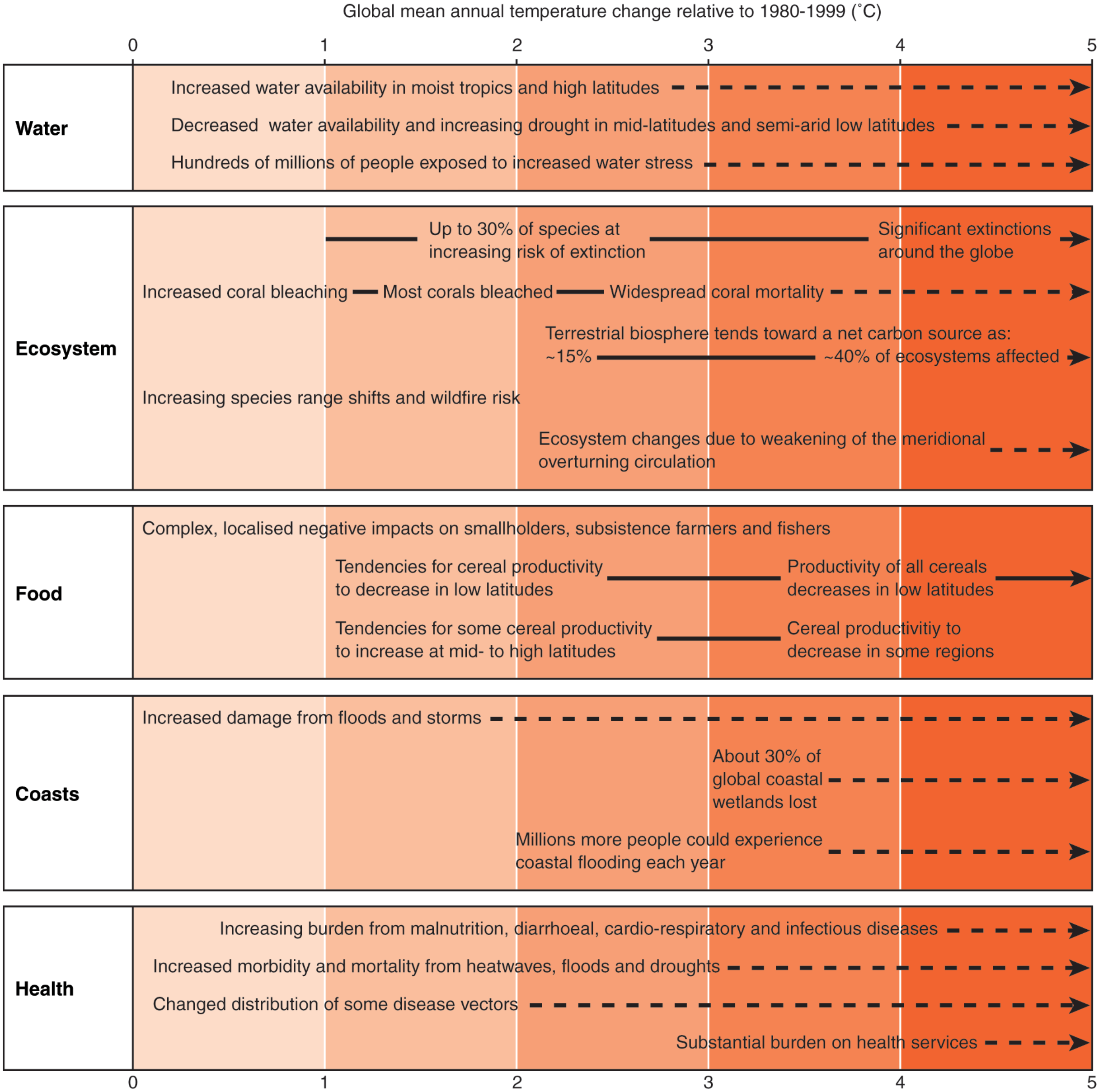
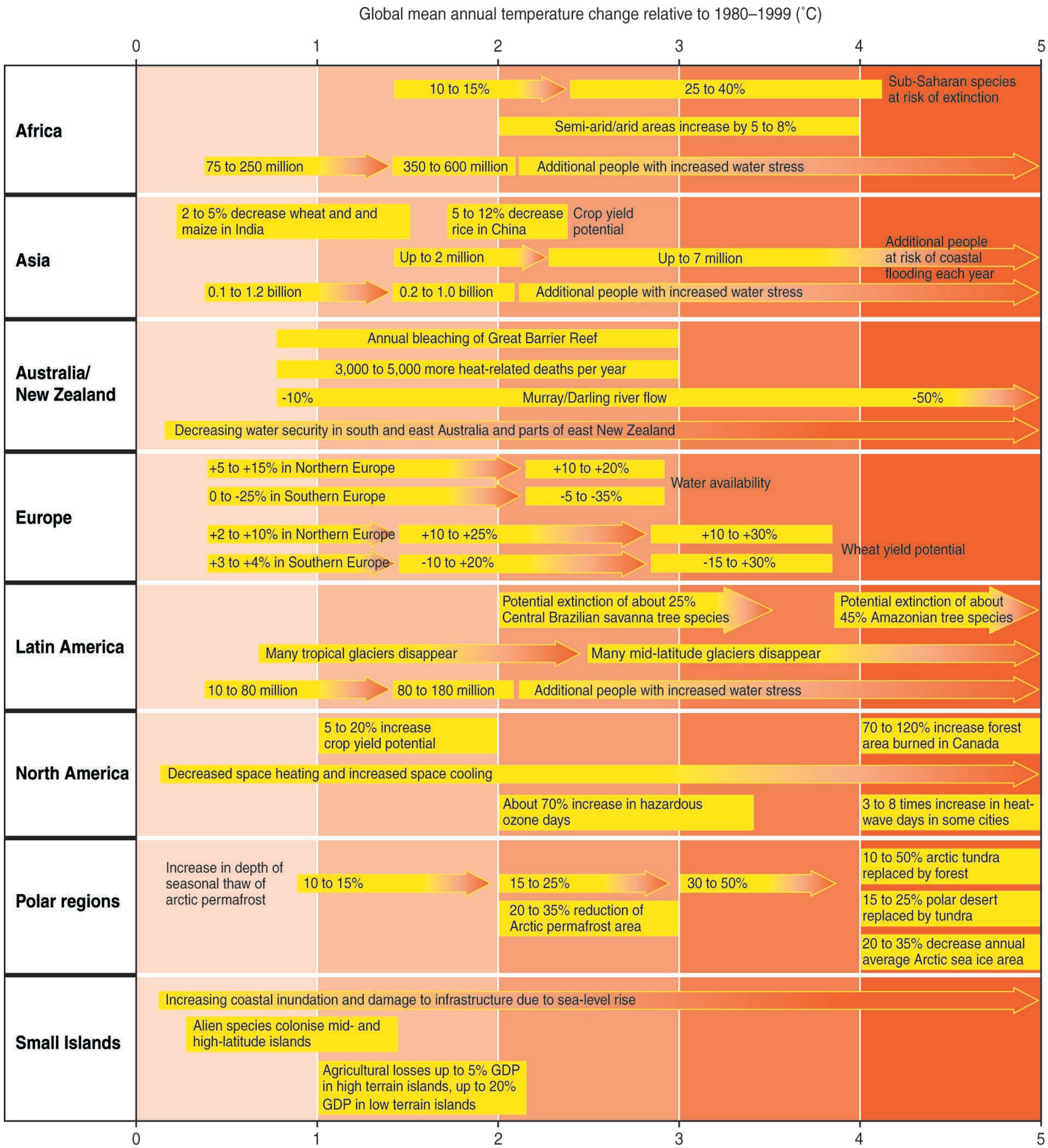


Figure 5.25 Examples of impacts associated with global average temperature change[46]

the same coastal settlements are at increased risk of climate change. Unlike the inhabitants of Doggerland, we have nowhere else to go and, in that sense, the fate of the Holocene landscapes and peoples of the North Sea may yet be a significant warning for our future.

There is another and final point that should be made. Mankind is only slowly waking up to its responsibilities as custodian for the Earth and the events of 10,000 years ago, although undoubtedly dramatic, may appear as a distraction in comparison with the emerging concern for our own future. Equally, our



exploration and mapping of uncharted rivers and hills in Doggerland also brings with it a responsibility for the surviving archaeological heritage and this may be considered a microcosm of mankind's attitude towards the planet. The archaeology of the North Sea has remained essentially untouched following its loss to the sea more than 7000 years ago. Whilst all things must pass, the

Figure 5.26 Examples of regional climate change impacts[47]

greatest threat to the prehistoric landscapes of the southern North Sea is, in the end, the inconsiderate and unrestrained actions of mankind. Whilst it is easy to be overwhelmed by the sheer scale of the surviving historic landscape in the North Sea, the heritage of the region is nonetheless fragile. Our previous lack of knowledge has permitted unsympathetic development and poorly managed exploitation. Having rediscovered 'Doggerland', the United Kingdom, and all the countries bounding the North Sea, must assume the responsibility associated with our shared heritage. How we respond to such an unprecedented challenge will be judged by future generations.

Notes

1. Donnelly 1882 (http://www.sacred-texts.com/atl/ataw/ataw101.htm). Donnelly also popularised the belief that Shakespeare's plays were the work of Francis Bacon in *The Great Cryptogram*. Sprague de Camp, although probably best known for his reworking of Robert Howard's *Conan the Barbarian* tales, also enjoyed debunking pseudo-historical works including Atlantean tales (http://www.lspraguedecamp.com/). His book *Lost Continents* provides an authoritative review of Atlantean and related literature through to its revision in 1970. Many of the more recent sources are located on the worldwide web and are both voluminous and wearisome.
2. Blavatsky 1888. For information on Helena Blavatsky and her idiosyncratic writing see the Theosophists' web site (http://www.theosociety.org/pasadena/sd/sd-hp.htm). A full list of her published work can be found at http://www.blavatsky.net/blavatsky/hpbArticles.htm.
3. Keith Matthews maintains a web site on cult and fringe archaeology (http://www.

kmatthews.org.uk/cult_archaeology/introduction.html). His pithy assessment of the physical charms of Lemurians is to be found at http://www.kmatthews.org.uk/cult_archaeology/lost_continents_2.html.

4. Churchward 1926.
5. A link between the catastrophic impact of Black Sea flooding and the spread of agriculture has recently been claimed by a team from the University of Exeter (19 November 2007). 'Noah's Flood' kick-started European Farming?, Science Daily. Retrieved 1 April 2008, from http://www.sciencedaily.com / releases/2007/11/071118213213.htm and http://www.exeter.ac.uk/news/newsnoah.shtml.
6. Hoffecker and Elias 2007.
7. The debate about the colonisation of the Americas continues but with evidence for earlier settlement gradually gaining the upper hand. During April 2008 the University of Oregon announced that human coprolites from the Paisley Five Mile Point Caves in the state had produced dates earlier than Clovis by *c* 1000 years (Thomas *et al* 2008). Waters and Stafford (2008) have discussed the implications of recent dating evidence for pre-Clovis period sites. As this book was edited for publication samples of chewed seaweed from the Monte Verde II site in Chile have also produced dates for human occupation between 14,220 to 13,980 years ago (http://www.vanderbilt.edu/exploration/stories/monteverde.html).
8. Voris 2000.
9. Mithen 2004, 348.
10. Words from the Director (http://www.le.ac.uk/archaeology/research/projects/niah/index.html).
11. Cosgrove *et al* 1996. The loss of Derwent has been fictionalised both as a radio play and in Berlie Doherty's 2003 book *Deep Secrets* (Puffin). A brief resumé of UK villages lost to reservoirs can be seen on the BBC web site at http://www.bbc.co.uk/insideout/eastmidlands/series4/east_midlands_reservoirs.html.
12. Chatterton 2006, 112. Similar deposits may also occur in Scandinavia (Karsten 1994).
13. Chatterton 2006, 105.
14. Grøn and Skaarup 1991; 2004.
15. Schulting 1996.
16. Mithen 2004, 168–72.
17. Mithen 2004, 174–5; Larsson 1988.
18. Jan Glimmerveen pers comm.
19. Coles 1999.
20. Boomer *et al* 2007.
21.

Edwards 2004, 67. See also Bondevik (2003) for investigation of settlements at Fjørtoft, western Norway, which was covered by a tsunami sand deposit of *c* 15cm.

22. Coles 1999, 54.
23. Reynier 2005, 1.
24. Milner and Woodman 2004, 5.
25. Whitehouse and Smith 2004.

26. Fischer 2004.
27. Morrison 1980.
28. It is important to note that the area of the North Sea was exposed as dry land on a number of occasions during the period that north-west Europe was populated by early humans. As this book goes to print there is considerable debate about the date of 28 hand axes dredged from Area 240, *c* 13km off the coast near Great Yarmouth in Norfolk. Provisional study of the axes suggests that they may be *c* 100,000 years old, whilst a tranchet flake scar on one axe has suggested links with earlier industries at Boxgrove (*c* 500,000 years ago). Source: *British Archaeology*, May/June 2008, **100**, 7.
29. Edwards (2004, table 4.1) notes that the population for the whole of the British Isles may have been *c* 20,000 people or even fewer (although some have argued that this estimate may be too low).
30. http://www.independent.co.uk/news/uk/home-news/neanderthal-treasure-trove-at-bottom-of-sea–793678.html.
31. Pryor 2002; Champion 2000.
32. Flemming 2004.
33. D Mol pers comm. Fishing continues to throw up remarkable finds. In 2000 a Dutch fishing boat recovered the lower jaw of a sabre-toothed cat, presumed to have become extinct around 300,000–400,000 years ago. In fact the bone was radiocarbon dated to *c* 28,000 years ago. This suggests that the North Sea habitat may well preserve unique social and eco-systems. Mol *et al* 2008.
34. Dix *et al* 2004, table 1.
35. The Langeled pipeline was undoubtedly a major engineering achievement with a significant strategic role (http://news.bbc.co.uk/1/hi/business/3835441.stm; http://nds.coi.gov.uk/environment/fullDetail.asp?ReleaseID=234477&NewsAreaID=2&NavigatedFromDepartment=False), although some doubts have been expressed regarding its actual potential to resolve UK energy needs (http://www.rigzone.com/news/article.asp?a_id=34870). An archaeological assessment was carried out in advance of the work, and a number of important finds resulted during construction, but it is doubtful that the assessment procedures were adequate in the light of the NSPP results (http://www.norway.org.uk/culture/heritage/gassco.htm).
36. As this book went to print, the British government committed the UK to cut greenhouse gas emissions by 80%, rather than 60%, by the middle of the 21st century. The impact of this decision in terms of future commitments to renewables is uncertain but the increase must suggest a significantly greater investment and therefore environmental impact as a consequence.
37. http://www.londonarray.com/.
38. http://www.defra.gov.uk/marine/pdf/legislation/marinebill-whitepaper07.pdf.
39. Fitch, Gaffney and Thomson 2007.
40. The voluminous reports of the IPCC are currently the definitive statement on the scientific basis of our knowledge concerning climate change. The technical reports are probably best avoided but the summary for policy makers is an excellent, if scary, read (Soloman *et al* 2007). However, Dimento and Doughman (2007) have produced a very accessible account of the implications of climate change. With

respect to the implications of climate change on past societies Fagan (2004) provides a readable account of global climate change after 18,000 BC but has little detail related to the North Sea. Burroughs (2006) provides an authoritative account of the detail of prehistoric climate change and drivers.

41. UK Met Office (http://www.metoffice.gov.uk/corporate/pressoffice/myths/2.html)y
42. Burroughs 2006; Macdougall 2004.
43. Solomon *et al* 2007.
44. The NERC RAPID Project (http://www.soc.soton.ac.uk/rapid/kt/kt_sci2007.php) and UK Climate Impacts Programme (http://www.ukcip.org.uk/news_releases/THC_Sept07.pdf).
45. Benfield UCL Hazard Research Centre http://www.benfieldhrc.org/climate_change/sea_level_rise/sea_level_rise.htm.
46. Solomon *et al* 2007, fig 7.
47. Yohe *et al* 2007, 828, table 20.8.
48. Source DEFRA e-Digest statistics about: Climate Change (http://www.defra.gov.uk/environment/statistics/globatmos/gagcc.htm).
49. Solomon *et al*, 2007, 19. WGII Perspectives on climate change and sustainability, 20.7, SPM (http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf).

Glossary

Allerød: a European period toward the end of the last glaciation, during which temperatures in the northern Atlantic region rose from glacial to almost present-day level. The Allerød corresponds to Pollen Zone 2. The Greenland marine isotope record suggests the Allerød to be after *c* 12,650 BC and before *c* 10,950 BC.

Antediluvian: a term derived from the Latin for 'before the deluge' and used to describe a period of time that preceded the Great Flood of Noah as related in the Book of Genesis in the Bible.

Atlantic: a European climatic period dating to *c* 6650 to 2350 BC. This was a warm and moist period of the Holocene in northern Europe and generally warmer than today. As the warmest period of the Holocene, the Atlantic is often referred to as the Holocene climatic optimum.

Auroch: the *Bos primigenius* or 'primeval ox' is an extinct, very large type of cattle prevalent in Europe.

BGS: British Geological Survey.

Blade: a stone artefact twice as long as it is wide. Blades were often retouched to form different tools.

Boomer: a device for high-resolution seismic reflection profiling used to identify and map larger objects beneath the seabed at depth.

Boreal: a European climatic period dated to *c* 8300 to 6650 BC. In peat bog sediments, the Boreal is also recognised by its characteristic pollen assemblage. It was preceded by the Younger Dryas, the last cold episode of the Pleistocene, and followed by the Atlantic, a warmer and moister period than our most recent climate.

Bushcraft: a popular term for wilderness or survival skills in Australia, New Zealand and South Africa, and practised by hunter-gatherers. Bushcraft has gained considerable popularity as a pastime in the United Kingdom due to the popularity of Ray Mears' survival television programmes.

Carr: a phase in the succession from true fen wetland to woodland characterised by emergent woody species, shade-tolerant herbs and understorey plants. Fens are characterised by their alkaline chemistry as opposed to acidic bogs.

Catastrophism: the concept that the earth has been formed or transformed at critical times by sudden, short-lived, violent events that might be global in scale and in contrast to the evolutionary, uniformitarian processes more commonly accepted today. Catastrophism is often associated with mythical events or religious creeds but there is increasingly an acceptance of decisive catastrophic events that might have cataclysmic impacts on the human race (eg meteorite impacts).

Chirp: a high-resolution seismic reflection profiling device or method generally used to identify and map features less than 0.5m in size.

Creationism: a belief that the universe, earth, mankind, all plants and animals were created in their original form by a deity, divine being or force. The Judaeo-Christian faiths may accept the account of the creation of the earth laid down in the Book of Genesis literally, and in opposition to evolutionary beliefs.

Deep Carr: an early Mesolithic microlithic tool type, generally more slender than those found at Star Carr. Deep Carr assemblages are often found in lowland valleys and are possibly indicative of a different social group or culture.

Devensian stage: used by British geologists and archaeologists to refer the most recent extended cold period, *c* 80,000–10,000 years ago. It was only cold enough to allow ice sheets to develop on the British mainland during its later stages.

Diatoms: unicellular algae found in oceans, freshwater and soils. Their decomposition in sediment and recovery via cores provides a method of analysis of past marine environments.

Dimlington Stadial: an extreme cold phase between 22,000 and 13,000 years ago when ice sheets and glaciers developed across northern Britain and extended south to the Midlands. This may well have driven humans south and out of Britain.

Ethnography: the branch of anthropology that describes specific human cultures and societies; it is frequently based on descriptive accounts of social life and culture and detailed observations of what people actually do. There is considerable argument amongst anthropologists and ethnographers, however, concerning the practise and methodologies required for successful ethnographies.

Epipaleolithic or 'peripheral old stone age': a term used regionally for hunter-gatherer cultures that existed after the end of the last Ice Age and before the Neolithic.

The Fenland: an area in Cambridgeshire, England, named after its distinctive 'fen' landscape. These alkaline wetlands, covered wholly or partially with water, produce sedge, coarse grasses or other aquatic plants. The district may have covered a very large area but is today restricted to *c* 500km^2 of mostly agricultural land.

Fishing leister: a composite fish or eel spear, often with three or more barbed points.

Foraminifera: single-celled marine animals (protozoa), which frequently secrete a carbonate shell. They are usually less than 1mm in size, but some are much larger. Foraminifera are an ideal guide for palaeoenvironmental analysis. They respond rapidly to environmental changes and individual species indicate specific environments.

Gilgamesh: the fifth king of Uruk. He ruled *c* 2600 BC. He became the central character in the *Epic of Gilgamesh*, one of the best-known works of ancient literature, which contains an early version of the flood myth.

Günz Glacial: the name used in the Alps for an early Pleistocene glacial stage. It appears to have been an alternating period of cold and warm phases rather than a continuous ice age and occurred around 600,000 years ago. It is correlated with the Beestonian Stage used in the British Isles (MIS 16).

Holocene: the geological epoch beginning *c* 9600 BC to the present. The Holocene is part of the Quaternary period. It has been identified with MIS 1 and can be considered an interglacial. This period is intimately connected with the rise of modern human civilisations.

Interglacial: a warm stage between cold stages.

Interstadial: a short warmer phase which alternates with colder stadial phases during a glacial period.

Loch Lomond Stadial: a brief cold period between 10,950 and 9600 BC, following the Bølling/Allerød Interstadial. In Europe it has been called the Younger Dryas and most recently Greenland Stadial 1 (GS1).

Linnean Society of London: a society for the study and dissemination of taxonomy and natural history. The Linnean Society was founded in 1788, taking its name from the Swedish naturalist Carolus Linnaeus. It publishes a zoological journal, as well as botanical and biological journals.

Littorina Sea: a geological brackish-water stage of the Baltic Sea, which existed *c* 6500–2500 BC and followed the transitional stage of the Ancylus Lake. At its largest, *c* 3240 BC, the sea contained twice the volume of water and covered 25% more in terms of the area it does today.

Maglemosian: a culture of the Mesolithic period in northern Europe (*c* 7500–6000 BC). The actual name came from an archaeological site in Denmark found in 1900, named *Maglemose* (translated as 'big bog') at Mullerup on western Zealand. During the following century a series of similar settlements were excavated from England to Poland and from Sweden to northern France.

Marine Isotopic Stages (MIS): alternating warm and cool periods in the earth's palaeoclimate, deduced from oxygen isotope data reflecting temperature curves derived from data from deep sea core samples. Each stage represents a glacial, interglacial, stadial or interstadial. Interglacials are odd-numbered; glacials are even-numbered, one for each stage, starting from the present and working backwards in time.

Microlith: a small stone tool usually about 3cm long or less. Microliths were either produced from small blades (microblades) or made by snapping normal large blades in a controlled manner, which leaves a diagnostic residue known as a microburin. Microliths may be characterised according to the geometic forms they take – notably various kinds of triangles, trapezes, etc. The shape and size of microliths may be used to date assemblages of tools. It is likely that these small pieces of flint were set into wood or bone to form composite tools such as barbs on arrows, graters or other equipment.

Milankovitch cycles: the effect of changes in the earth's orbit around the sun and its effects on solar radiation and climate. These cycles were named after Serbian civil engineer and mathematician Milutin Milankoviæ. The eccentricity, axial tilt, and precession of the earth's orbit vary and those on a 100,000-year basis drive glacial cycles.

Mindel Glacial: the glacial period dating between *c* 410,000 and 380,000 years ago. This is often called the Elster Glaciation in northern Europe, and the Anglian in the UK.

Moorlog: a term applied by North Sea trawler men to lumps of peat recovered in their nets from the sea floor.

NSPP: North Sea Palaeolandscape Project.

Older Dryas: a cold, dry stadial in northern Europe, roughly equivalent to Pollen Zone 1c, and identified as the penultimate stadial of the Pleistocene. The Older Dryas was preceded by the Bølling and followed by the Allerød interstadials. The Older Dryas is 'centred' around 12,000 BC and is 100 to 150 years in duration.

Orogeny: the geological process of mountain building associated with upward folding of the earth's crust as a consequence of plate tectonics or related processes.

Palynology: the analysis of contemporary and fossil plant pollen as an aid to the reconstruction of past vegetation and climates.

Permian: a geological period that extends from 280–230 million years ago. It is the last period of the Palaeozoic era.

PGS: Petroleum Geo-Services (www.pgs.com).

Pinger: a high-resolution seismic reflection profiling device. Pinger profiling is generally used to resolve features less than 0.5m and lacks the depth penetration of other methods, such as Boomers.

Pleistocene: a geological epoch dating 1,800,000 to 9500 BC and associated with the world's recent period of glaciations. It follows the Pliocene and is succeeded by the Holocene epoch. The end of the Pleistocene corresponds with the end of the Palaeolithic age used in archaeology.

Pliocene or Pleiocene: a geological period extending from 5.3 to 1.8 million years ago.

Pre-Boreal: climatic period usually ascribed to *c* 9600–8300 BC, which begins with a sudden rise in temperature. This point varies according to latitude. During this period, forest replaced the open tundra landscapes in northern Europe, and forest-dwelling animals spread from southern refugia as new climax ecosystems developed.

Quaternary: a geological time period following the Pliocene and lasting from *c* 1.8 million years ago to the present. The Quaternary includes two main subdivisions: the Pleistocene and the Holocene.

Radiocarbon dating: a technique used to estimate the age of a piece of organic matter obtained by using the known decay rate of the radioactive isotope of carbon (carbon–14). This isotope is absorbed by animals and plants whilst they live but decays after death. Because the concentration of the carbon isotope is not constant, the results have to be calibrated against a graph showing decay values against time. These graphs are created from analysis of samples with known historic dates. Unfortunately, the calibration graphs still have 'wiggles' which frequently mean that samples have to be assigned to a date range rather than a specific date. This and other factors require radiocarbon dates to be assigned an error estimate and the sample may fall in a range that varies from decades to hundreds of years according to the sample and its true age.

Consequently, when dates are published it is important to understand whether they are calibrated or uncalibrated, as the difference between the two formats can be very large. To make matters more complex, scientists have adopted a convention that dates are frequently provided as years before the 'present' – or BP. When this occurs, however, the reader must understand that the present is defined as AD 1950! So dates may actually be presented as uncalibrated and calibrated historic dates (BC-AD/Cal. BC-AD) or calibrated/uncalibrated dates before 1950 (BP/Cal. BP). In this book all dates are presented in calibrated historic format.

Remote sensing: generally involves the acquisition of information about an object or phenomenon, by the use of a sensing device that is not in physical contact with the object. This may mean the device is housed in an aircraft, satellite or ship. Within terrestrial archaeology a variety of hand-held or carriage-mounted sensors are frequently used. Sensors include active and passive formats depending upon whether they simply record reflected or emitted energy/radiation or whether the sensor itself is an emitter. The most common land-based techniques include magnetometry and aerial photography (passive techniques) and resistance/resistivity and radar (active techniques).

Riss Glacial: an alpine glaciation of the Pleistocene which occurred between 200,000 and 125,000 years ago. The British equivalent of this period is termed the Wolstonian glaciation but because of the debate over the age of the type locality of these sediments, scientists currently prefer to talk about the pre-Devensian but post-Anglian glaciation.

RMS slice (Root Mean Square slice): a product of seismic analysis. It works out the root mean square of the amplitude within a section of the seismic data located between two selected time slices. The resultant image highlights anomalous areas which may be of interest and therefore aids geomorphological analysis.

Sami: an indigenous people of northern Europe inhabiting an area that encompasses parts of northern Sweden, Norway, Finland and the Kola Peninsula of Russia. Traditionally, the Sami had a variety of livelihoods: fishing on the coast and in the inland lakes, trapping animals for fur, sheep herding, etc. The best-known livelihood is reindeer herding, but this is now a minority activity. The Sami are frequently used as a source of ethnographic analogy because they are the only existing community in Europe to have retained aspects of a hunter-gatherer lifestyle.

Sparker: a high-resolution seismic reflection profiling device. Sparker profiling is utilised to identify and map larger objects beneath the seabed at depth, due to its greater penetration as compared to other sources such as Chirp.

Stadial: an intense cold stage within a glacial often corresponding and alternating with warmer interstadials. The intensity of cold associated with the first known stadial in Britain resulted in the formation of cirque glaciers in upland Britain including the Lake District, north Wales and Loch Lomond.

Storebaelt or *Great Belt:* one of three straits in Denmark that connect the Kattegat to the Baltic Sea. The others are Oresund and Little Belt, which are smaller. The Storebaelt is *c* 60km long and 16–32km wide. It contains two major islands: Sprogø in the north and Langeland in the south.

Terrain Model: a digital representation of the earth's topography and sometimes called a digital terrain model (DTM). DTMs are often used in the production of digital relief maps. A DTM can be represented as a raster (a grid of squares) or as a triangular irregular network. DTMs are commonly built using remote sensing techniques. They may also be created from traditional land survey.

Thermohaline Circulation (THC): a circulation of the waters of the oceans driven by variation in temperature and salinity. The resulting movement of large water masses transports energy (in the form of heat) and matter (solids, gases and material in solution) around the globe and has a major impact on the climate. In the Atlantic the Gulf Stream, a wind-driven surface current, moves north from the equatorial Atlantic Ocean. The waters cool and eventually sink at high latitudes and the dense, cold water flows south along the sea floor supporting considerable mixing between the ocean basins. The circulation has a significant regulating effect on the formation of sea ice in the North Atlantic and it is speculated that the failure of the circulation in the North Atlantic, called a Heinrich event, may trigger cold periods such as the Younger Dryas.

Tranchet axe: a stone tool characterised by the removal of a flake, as wide as the tool itself, parallel to the final cutting edge. The technique provides a single sharp edge.

Tundra: a treeless landscape of a periglacial region consisting of mosses, lichens and low-growing shrubs.

Uniformitarianism: the theory that natural processes operating in the past are comparable or correspond with those that can be observed operating in the present: 'the present is the key to the past'. Although current as an idea from the 18th century, the term appears to have been coined in 1832 by the English polymath, William Whewell (who also coined the term catastrophism). The basic principles of uniformitarianism were formalised in Charles Lyell's *Principles of Geology*, published in 1830.

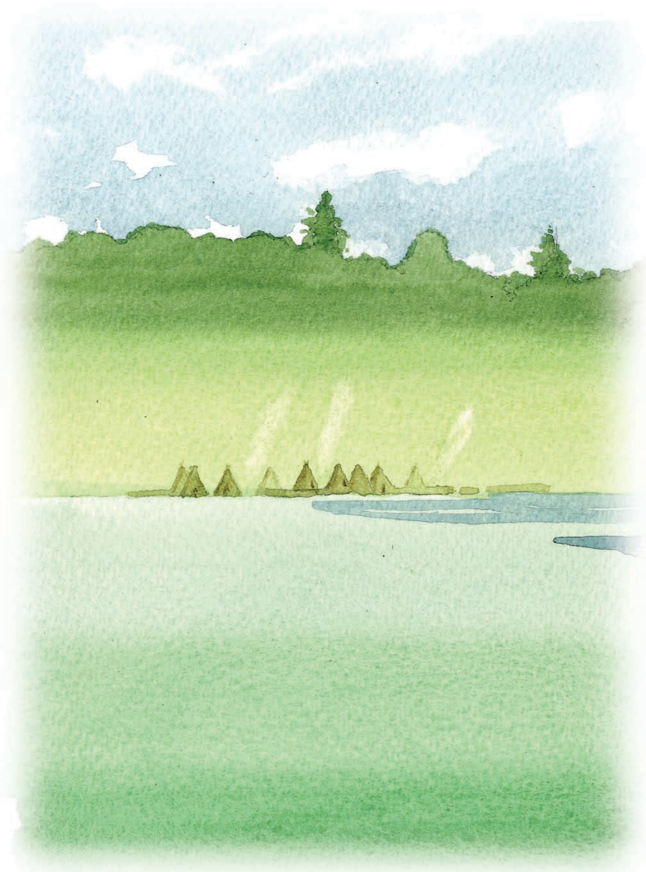
Upper Palaeolithic: the period between 40,000 and 10,000 years ago, when stone tool assemblages made by anatomically modern humans (*Homo sapiens sapiens*) appeared in Britain.

UKOOA: United Kingdom Offshore Operators Association.

Windermere Interstadial: a warm period which dates to *c* 19,600–16,600 BC. It is often correlated with the Bølling-Allerød Interstadial in Europe.

Würm glaciation: a glacial episode *c* 24,000–9600 BC. At the height of Würm glaciation most of western and central Europe and Eurasia was open steppe-tundra, while the Alps presented solid ice fields and montane glaciers. Scandinavia and much of Britain were under ice during the late Devensian and Dimlington stadial.

Younger Dryas: see Loch Lomond Stadial.



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Colour indicates a key text

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Index