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The scope of Strategic Environmental Assessment of North Sea Area SEA5 in regard to prehistoric archaeological remains

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Cover: Retreating glacier and floating sea ice on the coast of Spitsbergen, 2002. This shows the coastal landscape that might have existed in the SEA5 area during glacial retreat about 14,000 years ago.

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Executive Summary

Prehistoric submarine archaeological remains back to a date of about 12,000 years ago, Palaeolithic, Mesolithic and Neolithic, could occur with low probability anywhere in the SEA5 area between the northern mainland coast and the eastern boundary of SEA5. The existence and possible survival of prehistoric sites is complicated by the rapid and continuing uplift of the east coast of Scotland and the immediately adjacent shelf in the Moray Firth, the fact that ice sheet covered part of the seabed obliterating most artefacts earlier than about 20,000 years BP, and that the seabed towards the median line has subsided, and was associated with extensive sea-water lakes and floating sea ice during the glacial maximum. The combination of post-glacial sea level rise which terminated about 5000 years ago, and the continuing subsidence of the outer shelf, with uplift of the mainland, creates a complex sequence at coastal sites, some of which may have been dry land over 5000 years ago, then covered by the rising sea, and are now uplifted again relative to a constant sea level. Known submerged prehistoric sites in Orkney, Shetland, Viking Bank, the Yorkshire coast, and Denmark, show that prehistoric sites from the last 5-10,000 years can survive marine transgression. The strong current conditions in the SEA5 area, the exposure to North Atlantic storms, the thin sediment cover in many places, and the large areas of exposed bedrock, make the exposed areas of the shelf statistically poor prospects for the survival of prehistoric deposits *in situ*, other than in submerged caves and gullies. Within sheltered sea lochs and enclosed bays of the east coast of the Shetlands, Orkney and Fair Isle, in submerged gullies, and locally thick sediments, survival is quite likely. Deposits in open shelf gullies are likely to have been transported and re-deposited. Evidence from the northern North Sea and the Russian Arctic suggests that some prehistoric peoples may have occupied the exposed shelf area during late glacial periods utilising Inuit-style survival methods, and butchering marine mammals. If this proves to be the case, there may be unexpected occurrence of earlier prehistoric sites, Late Palaeolithic, on the north-east shelf. Pipe entrenching is the process in the oil and gas industry which is most likely to disturb prehistoric archaeological deposits. Commercial site investigation using acoustics and coring could provide beneficial new archaeological data. The paper concludes with tentative suggestions for discussion of protocols and a reporting regime.

Contents

1. Overview of the legislation and agreements (Scottish, UK, EU and international) that apply to marine and maritime prehistoric and archaeological remains off the coast of Scotland

1.1 UN Conventions, European laws and directives, UK legislation, Scottish legislation, and non-statutory codes and procedures all apply to coastal and offshore marine, maritime and submarine archaeology. Historic Scotland for Scottish Ministers has responsibility for archaeology within the 12 nautical mile Territorial limit, and SEA5 is thus partly within Scottish Waters. Outside the Territorial limit the continental shelf is UK jurisdiction, but Historic Scotland is necessarily extending its interest in this area, in the same way that English Heritage is taking some responsibility for submarine archaeology beyond the 12 nautical mile (nm) limit off the English coast (Flemming 2004, in press).

1.2 In this report there will be no analysis or discussion of the state of shipwreck archaeology. There are an estimated 26,500 historic losses over 100 years old and 13,500 wrecks in UK Territorial Waters (English Heritage 2002, para. 4.3), and in Scottish waters the Protection of Wrecks Act (1973) is administered by Historic Scotland. There are many more wrecks in deeper water further offshore. Many of the same international legislative documents apply to all types of marine archaeology, whether of shipwrecks, abandoned single artefacts, or submerged sites of previous human occupation. However, the emphasis of the present report is entirely on the subject of submerged sites where human beings and early hominids previously lived or hunted on terrain which was at that time dry land, or where they exploited fish and shellfish on the coast which is now submerged. Sites discussed are all older than 2,000 years, and mostly older than 4,000 years. It must not be assumed that the comments made or conclusions reached in this paper would apply in exactly the same way to shipwrecks on the sea bed.

1.3 Legal regimes will be reviewed from the global and UN level successively downwards in scale to the regional and local, and non-statutory agreements or codes. When reporting the status of legislative documents which may or may not have been signed on behalf of the UK Government or UK agencies I will not comment as to the reasons, nor as to likely changes in policy. All terms such as "underwater cultural heritage", "maritime archaeology", "marine archaeology", "submarine archaeology", "nautical archaeology" etc., will be deemed to have equivalent meaning. Nothing stated in the following discussion should be interpreted as an attempt to define strict legal obligations. It is an attempt to show by analogy, and in plain language, how prudent anticipation of future events leads to a consistent view of the responsibilities of regulatory authorities and operators.

1.4 The United Nations Convention on the Law of the Sea (UNCLOS) was negotiated continuously from 1968 through to 1982 when the Convention document itself was agreed. The Convention became recognised international law when it had been ratified at national level by 65 states, and was ratified by UK on 25 July 1997. Although UNCLOS entitles the coastal state to declare an Exclusive Economic Zone out to about 200 nm from a coastal baseline, and to declare an extra 12 nm Contiguous Zone outside the traditional 12 mile Territorial Sea, the UK has decided not to opt for either of these legal rights.

1.5 The Articles of UNCLOS directly concerned with marine archaeology are 149 and 303 (See Annexe 1). Article 149 applies only to archaeology in the International Area outside national jurisdiction. Since, by definition, SEA5 defines a part of the UK Continental Shelf these circumstances do not apply. Article 303(1) stipulates that all states have the duty and right to protect archaeological resources found at sea "and shall co-operate for this purpose". This Article is completely open-ended, with no geographical boundaries or distinctions between different economic or jurisdictional zones. Since the UK has signed UNCLOS, and has a designated Continental Shelf which includes SEA5 which is periodically licensed for the exploitation of both hydrocarbons and aggregates, it follows that Article 303 applies in a general sense to SEA5.

1.6 The UNESCO Convention on the Protection of the Underwater Cultural Heritage (UCPUCH) (General Conference, 31C, 2001) is an international and globally applicable document which has been passed by UNESCO General Conference, but has not been ratified by sufficient countries to become international law. It has not been ratified by the UK. It is probable that the necessary number of signatories to make the Convention into agreed International law may never be obtained.

1.7 There is considerable tradition, at least in the field of international legal conventions concerning the sea, for complex documents to be discussed for many years, and for those draft clauses or principles which have consensus acceptance to become the guidelines by which people act, while other principles are neglected, ignored, or rejected, long before agreement or ratification of the final document. Thus the UNESCO Convention should prudently be considered in terms of the "going rate" for the levels of national regulatory control which the coastal state might be obliged to assert on its Continental Shelf, and similarly for the obligations of operators exploiting or utilising the resources of the Continental Shelf.

1.8 The Preamble to UCPUCH states that UNESCO is conscious "of the need to respond appropriately to the possible negative impact on underwater cultural heritage of legitimate activities that may incidentally affect it". This is the situation which applies to SEA5 and to this Report. Underwater cultural heritage is defined, as in most other documents, as traces of human existence which have been partially or totally underwater for at least 100 years. UCPUCH is designed to be compatible with UNCLOS (UCPUCH, Article 3)

1.9 UCPUCH (Article 4) states that underwater cultural heritage shall not be subject to the law of salvage, unless this is authorised by the competent authorities, and the cultural heritage materials have maximum protection. UK Salvage Law only applies to shipwreck, including articles associated with shipwreck, and so salvage law does not apply to prehistoric material on the UK Continental Shelf whether outside or inside Territorial Waters, even if the raised material is landed at a British port.

1.10 UCPUCH (Article 5) states that signatories should use the "best practicable means" to prevent or mitigate adverse effects to underwater cultural heritage caused by legitimate activities under their jurisdiction. Again, although UK has not signed, the general indication of this Article is clear. A point of uncertainty and ambiguity regarding this clause is the extent to which it is completely open-ended, requiring apparently unlimited commitment to ensure that no damage is done, and to what extent a common-sense judgement should be applied regarding the chances of an unknown site lying in the path of some legitimate commercial activity. This obligation is dealt with more specifically in UCPUCH (Article 10.4) which applies directly to the Continental Shelf

1.11 The UNESCO Convention concludes with a set of Rules Concerning Activities Directed at Underwater Cultural Heritage. The preferred means of protecting cultural heritage sites is protection *in situ*. For prehistoric sites this is sensible, provided there is no erosion, since only a few sites need to be excavated, and it is sufficient in most cases to document the type of site for research purposes. In the southern and central North Sea the volume of Pleistocene terrestrial mammal bones recovered by bottom trawlers is sufficient to support a modest trade in sorting and dispersing the bones to museums, research groups, collectors and fossil shops (Post and Kompanje, 1995; van Kolfschoten and Laban, 1995; Post *et al.*, 2001; Glimmerveen et al., 2004; van Kolfschoten and van Essen 2004). Some of the bones have been adapted as tools by humans (Louwe Kooijmans, 1970-71; Post, personal communication 2002). The flow of material recovered by fishermen in Scottish Waters is likely to be much smaller, but not zero. Since the bones and fossils are inevitably disturbed by bottom trawls (van Kolfschoten and Laban, 1995) it is better that the disturbed and recovered material should be monitored by palaeontologists and archaeologists than simply lost. The combination of erosion and disturbance by trawling needs to be assessed fully before deciding that an archaeological site can be safely left *in situ*. Most of the remaining Rules refer to the planning and conduct of projects conducted by specialist archaeologists to study or excavate sites of underwater cultural heritage.

1.12 The European Convention on the Protection of the Archaeological Heritage (Revised) (The Valetta Convention) was agreed by the Member States of the Council of Europe in 1992, and became law on 20 March 1992. It has been ratified by the UK, and in Scotland the lead body is Historic Scotland. Most of the Articles concern archaeology on land, control of the trade in antiquities and the prevention of looting. The Valetta Convention (VC) applies "underwater" (Article 2.ii). Historic Scotland implements VC, and has programmes for coastal archaeology, analysis of erosion and its impact on archaeology (Historic Scotland Archaeological Procedure, Paper 4, 1996) and offshore submarine archaeology, which is covered by the Policy Paper "Conserving the Underwater Heritage" (Historic Scotland, 1999). The latter paper mentions "...remains of structures which were originally built wholly or partly underwater, such as fishtraps and crannogs and also the remains of human activity which originally took place on dry or marshy land which has since been inundated, either by water levels rising relative to land or by marine or fluvial erosion." This clearly includes submerged prehistoric sites inundated by rising post-glacial sea level. The legally stated limit at present is out to the 12 mile limit of

Territorial Waters, but serious research concern is applied to the problems of marine archaeology in deeper water out to the median line. The Ancient Monuments and Archaeological Areas Act 1979 gives powers to schedule monuments within the Territorial Seas. The Protection of Wrecks Act (1973) is administered in Scotland by Historic Scotland for Scottish Ministers, and this applies out to the 12 mile limit. However, HS takes a pragmatic interest in submarine archaeology throughout the continental shelf area, as would be required by the Valetta Convention.

1.13 In VC the archaeological cultural heritage is also linked with the concept of "historical and scientific study" (Article 1.1) and "research into mankind and the related environment" (Article 1.2.i). This suggests an analogy with the many Articles of UNCLOS relating to scientific research. Article 1.3 of VC states that it applies whether on land or under water.

1.14 VC (Article 2) provides for "archaeological reserves" on land or under water. VC (Article 5) spells out at length the consultation which should take place between planning authorities and developers to avoid damage to archaeological remains. The implications are relevant, by analogy, to procedures which may be recommended on the UK Continental Shelf in SEA5. DTI implements European Directives on protection of the environment, and notes that EU does require that operations on the continental shelf include submarine archaeology and prehistoric remains in the environmental assessment (EU 2001). In the context of submarine prehistoric preservation DTI has drawn the attention of operators and archaeologists to the Pipeline Act 1999, Schedule 1. Also, to the European regulations (EU 2001) from which the following is an extract (Annex 1, para. (f)) requiring an assessment to consider, *inter alia*:

> "the likely significant effects on the environment, including on issues such as biodiversity, population, human health, fauna, flora, soil, water, air, climatic factors, material assets, cultural heritage including architectural and archaeological heritage, landscape and the interrelationship between the above factors;"

1.15 The terms of reference for this report require consistence and compatibility with the Guidance Notes on protecting the offshore heritage produced by BMAPA and RCHME (Wessex Archaeology, 2001) and BMAPA and English Heritage (2003). In practice there is no aggregate dredging in SEA5, and the authority of RCHME does not apply in Scotland. Nevertheless, it is reasonable that the principles established in those documents should be taken into account, as, equally, the policy statement of English Heritage in response to its formal appointment as the body responsible for implementing the Valetta Convention in England (EH, 2002, Taking to the Water). These documents are discussed in the DTI report on SEA3, and will not be further analysed in this report. To all intents and purposes, on pragmatic grounds, the policy of HS itself indicates compliance with VC, with no inconsistency between Scottish and English sectors.

1.16 Three components of UK law apply directly to marine archaeology in Scotland: The Ancient Monuments and Archaeological Areas Act 1979; the authority of the Receiver of Wrecks, which applies only to shipwreck (Coastguard and Maritime Agency, Department of Trade, Merchant Shipping Act (1995)); and the Protection of Wrecks Act (1973) administered by Historic Scotland in Scottish Waters.

1.17 The Royal Commission for Ancient and Historical Monuments for Scotland (RCHAMS) maintains an archival record service documenting all archaeological sites, and this is accessible to the public and scholars through an internet search system known as CANMORE and CANMAP. RCAHMS runs a Maritime Project of the National Monuments Record of Scotland (NMRS) which seeks to document maritime sites, defined as ships, boats, and crashed aircraft, but not built structures or prehistoric sites. (Unpublished paper issued by MP of NMRS, 2002). The University of St Andrews has created a data base and GIS system analysing all coastal archaeological sites which are, or could be, threatened by coastal erosion. The Moray Firth section of this data base has been reviewed in Section 2 of this report.

1.18 HS grant aids the Nautical Archaeology Society in Scotland. The Archaeological Diving Unit at the University of St Andrews has conducted survey work on a range of wrecks in Scottish Waters. Heriot Watt University runs diving courses at Scapa Flow which include training for marine archaeology. Most organisations concerned with marine archaeology in the UK meet through the activities, conferences, workshops, and projects of the Nautical Archaeology Society

1.19 The Protection of Military Remains Act (1986) has the principal concern to protect the sanctity of vessels and aircraft that are military maritime graves. In 2001 the Secretary of State for Defence announced that 16 vessels within UK jurisdiction would be designated as Controlled Sites, and 5 vessels in international waters would be designated as Protected Places. The purpose of this safeguard is not primarily archaeological, but MoD liaise closely with DCMS and Historic Scotland in the process of site designation.

1.20 The previous paragraphs have reviewed a range of international and national documents which pertain to UK Territorial Sea and Continental Shelf. The SEA5 area does not abut on the Median Line with Norway, but terminates west of the median line. Nevertheless, since the northern North Sea is bordered by Norway, Denmark and Germany, a prehistoric marine archaeological programme within the SEA5 area is likely to require collaboration with some of these states. Some of these states may have signed and ratified the same documents, or documents which the UK has not ratified, and collaborative projects in the North-West Approaches and northern North Sea should be based on adequate preliminary consultation on these matters. English Heritage convened a workshop in May 2003 on international collaboration on prehistoric archaeology in the North Sea, and the proceedings will be published during 2004 (Flemming, 2004).

1.21 It is good practice for government agencies, planning authorities, and industry representatives to develop non-statutory guidance, recommendations, or codes of practice for the protection of archaeological sites which may be disturbed. Consultation may take place through scholarly organisations such the Council for British Archaeology (CBA), or the Nautical Archaeology Society. For example the consultation phase of the Mineral Planning Guidance for On-Shore Oil and Gas and Coalbed Methane Development included circulation of the relevant archaeological paragraphs to the CBA in 1999-2000. Discussion of the draft specifically referred to the importance of wetland and inter-tidal archaeology, and the importance of Mesolithic activity on the Dogger Bank. The British Marine Aggregate Producers Association (BMAPA) collaborated with the Royal Commission on the Historical Monuments of England (RCHME) to produce a Consultation Document (Wessex Archaeology, 2001).

1.22 The BMAPA/RCHME code discusses Environmental Impact Assessment (EIA) which should include a description of the measures envisaged in order to avoid, reduce, and if possible remedy significant adverse effects on the historic environment. By analogy, broadly equivalent principles may be applied to monitoring and managing the archaeological impact of the offshore Oil and Gas Industry. There is reference to prehistoric sites from Palaeolithic to Mesolithic. Pre-dredge surveys and evaluation may be needed. Dredging exclusion zones can be implemented around areas where the presence of prehistoric assemblages has been confirmed. Although it may be possible for a suitably experienced archaeologist to visit onshore screening plants periodically to carry out a visual search for stone tools and other human artefacts, such procedures appear unlikely to be productive. Copies of reports on any sites located and the measures taken should be lodged with the appropriate Curators and the NMR and NMRS as appropriate. A Guidance Note on marine aggregate dredging and the historic environment has been published by BMAPA, EH, and Wessex Archaeology (BMAPA and English Heritage 2003), and a background paper on Palaeolithic and Mesolithic archaeology and marine aggregate dredging by Wenban-Smith (2002).

1.23 Summary of legal situation and the prudent practices to adopt in the Scottish Waters of the UK sector

No Government agency in the UK has been formally allocated the responsibility to monitor, manage, or protect the prehistoric cultural heritage on the UK Continental Shelf outside Territorial Waters. Within Territorial Waters the responsibility rests with Historic Scotland in Scottish Waters, and both Historic Scotland and English Heritage are concerned to protect the cultural heritage beyond that limit in their respective adjacent areas of the UK Continental Shelf. Through signing UNCLOS, the UK is duty bound to observe the stipulations of UNCLOS Article 303, while the draft UNESCO Convention indicates the responsibilities which are, by general consensus, deemed to be reasonable in regard to prehistoric cultural heritage on the Continental Shelf. The principles of the Valetta Convention, broadly interpreted, might apply on the Continental Shelf since it does apply underwater, but no UK agency has been statutorily designated to implement it outside Territorial Limits. It is therefore prudent, though not legally binding, for all parties, government agencies, regulatory authorities, commercial operators, and voluntary bodies to act as if their standards of conduct were to be judged, in broad measure, by the standards of those documents.

1.24 During 2003 an international meeting of prehistoric archaeologists from countries bordering the North Sea was held under the auspices of English Heritage. Senior representatives of English Heritage were present, and recommendations agreed at the end of the meeting were circulated in writing to obtain confirmation from all concerned. The following extract from the proceedings edited by Flemming (2004) indicates the direction in which agency responsibilities may evolve. The wording has presumably been discussed with Historic Scotland.

> **"Recommendations to English Heritage**
>
> (i) English Heritage, in co-operation with the other appropriate UK Home Country heritage agencies, should be encouraged to accept the responsibility to undertake the care of the submarine landscape out to the edge of the UK Continental Shelf, and should consider the necessary legal and administrative steps to do this.
>
> (ii) English Heritage in co-operation with the other appropriate UK Home Country heritage agencies, should continue to co-operate with other UK government regulatory bodies to ensure the protection of submarine prehistoric sites and the submerged prehistoric landscape, including consultation with DTI, DEFRA, CEFAS, and BGS.
>
> (iii) English Heritage in co-operation with the other appropriate UK Home Country heritage agencies, should act as the expert bodies of reference in regard to the DTI and offshore oil and gas, European Directives, and other industrial liaison including advising other agencies regarding mitigation required to limit damage caused by offshore aggregate extraction, windfarm installations, pipelines, coastal engineering, and fisheries to the submarine prehistoric heritage."

2. Overview of known and likely areas with prehistoric archaeological remains, with mapped indications of relative likelihood of the presence of remains (sensitivity mapping) and with hotspots identified

2.1 During the last million years the British landmass has been connected by dry land to the mainland of Europe for far more time than it has been separated by sea. The earliest occupation of the British mainland by hominids, *Homo heidelbergensis*, occurred about 500,000 years Before Present (BP) (Pitts and Roberts, 1997). and recent evidence suggests that it could be as early as 700,000 years BP. Human and proto-human artefacts may therefore have been deposited in sediments or caves on the continental shelf at any time in the last half million years whenever the glacial control of world sea level caused the floor of Scottish UK continental shelf, to be dry, and outside the limits of the ice. In practice, most of the Scottish UK continental shelf was covered by successive ice sheets, and so early archaeological deposits are unlikely. However, some archaeological deposits are known to have survived over-running by ice sheets (Ashton *et al.,* 1992) at the southern edge of the ice, where river valley sediments were displaced in blocks, but retained their integrity, permitting palaeoecological studies and artefact retrieval. This was at High Lodge, Mildenhall, Wiltshire. If artefacts can survive ice sheet impact in unconsolidated deposits, there is a greater chance that deposits within caves could survive, which might be more typical of the Scottish shelf. This argument may apply also to the cave at Creag nan Uamh (see next para.). Most of the Scottish ice sheet melted before the rising sea covered the exposed continental shelf, and thus there was a period of maximum dry land area. This maximum condition is shown in Figure 1.

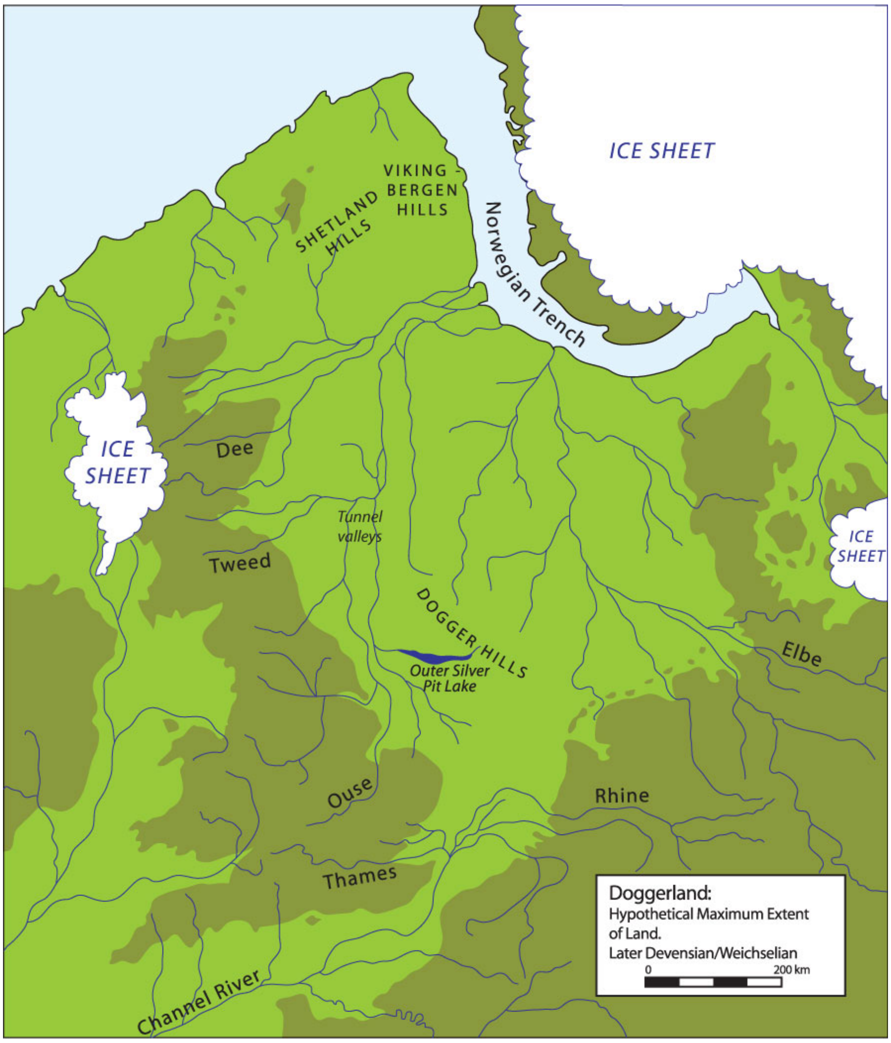


Figure 1 This map is a speculative reconstruction of the river courses across the North Sea floor, the Channel, and the Irish Sea at the Late Glacial cold stadial when the area of dry land was a maximum. Map devised by B.J. Coles and S.E. Rouillard, Copyright permission granted.

2.2 The generally accepted earliest date of human occupation in Scotland after the last, Devensian, glaciation, is at about 9000 years (Wickham-Jones, 1994, p.46-47). This means that we are dealing almost entirely with the periods known as Mesolithic, and Neolithic (after 5500 years BP), and passing into the Bronze Age at about 3800 years BP, and Iron Age at 2800 years BP (Turner, 1998b, p.20). Older human artefacts than this have not been found on the Scottish mainland coasts, or on the islands, with incontrovertible dates. However, poorly dated remains of accumulated reindeer horns from about 900 antlers were found in 1926 in the cave of Creag nan Uamh, Inchnadamph, Sutherland, along with a possible ivory spear point (Wickham-Jones, 1994, p.43). The antlers have been studied more recently, and date over a period from 44,000 to 22,000 BP, and it is not at all certain that their accumulation was caused by man. These deposits, whatever their precise origin, show that there were ample supplies of reindeer, a basic food commodity in the Palaeolithic, in northern Scotland just before the peak of the last glaciation, the Devensian.

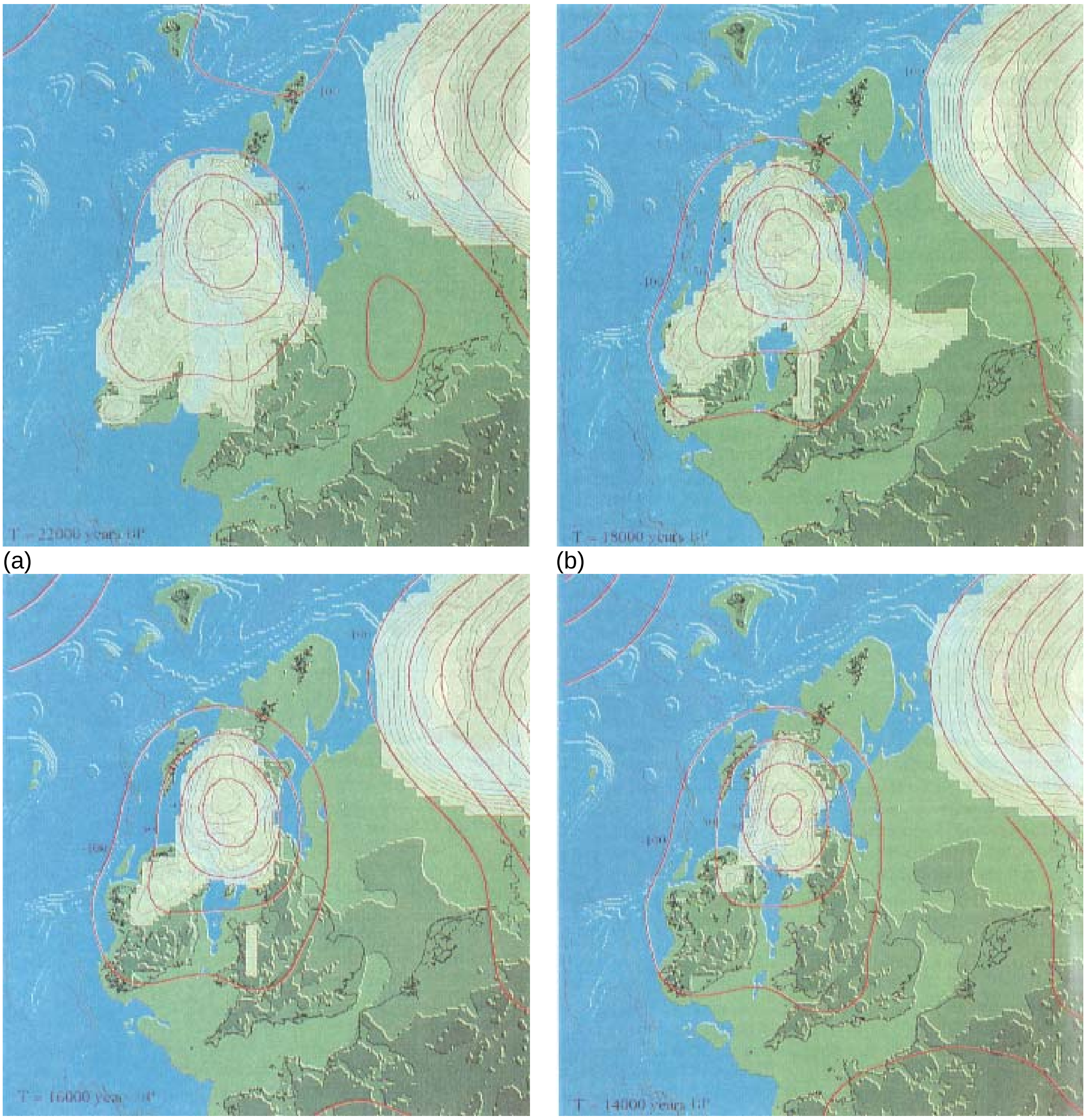
2.3 The possibility or probability that humans were living in the northern borders of England and around the fringes of Scotland before 10,000 BP is being investigated at the University of Newcastle by Dr Penny Spikins through a project entitled "Submerged Archaeological Landscape Team" (SALT). A post-graduate dissertation by Miriam Cantley entitled "Is there a convincing argument for late-glacial occupation of Northern Britain?" (University of Newcastle, web-site, 2004) is directly relevant to the present assessment. This work is not yet complete.

2.4 An extraordinary richness of cultural remains and very advanced complex Neolithic and Mesolithic structures have been found on many of the islands, off the west and north coast, and, for the present paper, it is worth postulating that there may be earlier materials on the sea floor. That is, the first occupiers of Scotland could have arrived on the outer shelf while the sea level was still tens of metres lower than at present, and that, as the sea level rose, and the ice retreated, the sparse population migrated landwards and upwards, finally occupying the mainland of Scotland, and the residual upper peaks on the shelf which became the outlying islands, including St Kilda, Orkney, and Shetland. A small component of this retreat is already proven, since the sea level was about 40-50m lower relative to the land around the Western Isles and Shetland when the first documented sites were occupied about 9000 years BP. The question is, how much earlier could people have arrived in Scotland? Also, where did the first people after the Devensian Ice Age come from? This problem has been raised previously in the report on prehistoric archaeology in SEA4 (Flemming, 2003).

2.5 The occurrence of human remains in southern Britain is mainly south of the southernmost extent of the multiple succession of ice sheets which grew and waned about 6 times across northern Britain in the last half million years The sequence of such multiple glacial indicators is best detected at the edge of ice sheets, where the successive ice limits may differ and not overlap. Near the centre of a thick ice cap, such details are usually very indistinct. All the ice caps centred on the Scottish Highlands, and the ice sheets extended to the edge of the continental shelf to the north and north-west. Thus, off the north coast of Scotland only two distinct phases have been detected. The earliest is broadly equivalent to the so-called Anglian glaciation about 0.4 million years BP, and the younger is equivalent to the Devensian, which had a maximum extent about 22,000 years BP (Stoker *et al.*, 1993).

2.6 Figures 2 and 3 (Lambeck, 1995, Shennan *et al.*, 2000b) show the sequence of ice sheet limits, coastline, and the impact of rising sea level on the British Isles, including the northern islands. At 22,000 BP Scotland and the western Isles are covered by the ice sheet, with Orkney just on the edge, and small ice sheet on Shetland (Woodcock and Strachan, 2000). The ice sheet extended to about 2^{o}W, leaving a large ice-push ridge at this position (Andrews *et al.*, 1990, p.70), with a shallow ice-covered sea to the east, with scattered islands of high ground. By 18,000 the extended Orkney-Shetland shelf is dry land, with a glacial sea area linking that shelf to the main North Sea exposed shelf. This sea would have been covered in floating ice. By 14,000 the ice cap has retreated almost completely to the modern coastline of Scotland, and by 12,000 BP the ice has entirely melted, although there is a brief period of renewed ice cover, the Loch Lomond stadial, around 10,000 BP. Since humans are certainly present in northern Scotland and the islands by 9,000 BP, it is clear that they may have been present for several thousand years earlier, and would probably have been exploiting sea mammals as the food base (Wickham-Jones, personal communication, 2003). Coastal human habitations have been found submerged off the coast of Denmark as early as 12,000 BP (Fischer, 1991, 1995, 1997).

2.7 Lambeck (1995) and Shennan *et al*. (2000a, 2000b) have produced models which combine the compensation for the addition and removal of the weight of ice (Glacial isostatic correction) and for the removal and addition of weight of water (Hydro-isostatic correction) during the rising sea level (see Figs 2 and 3). In Figures 2(a)-2(d) we see the north British ice cap melting rapidly from 22,000 to 14,000 years ago. As the weight of ice is removed the land rises faster than the global sea level, so that the area of dry land increases throughout this period, both northwards and south-westwards. By 12,000 years BP the sea is beginning to overflow the land (Fig. 2(e)) and, although a small ice cap forms briefly around 10,000 years BP, the sea continues to rise faster than the land, forming deep bays and gulfs penetrating into the North Sea, isolating Dogger Bank, and separating the Straits of Dover about 7,000 years BP (Fig. 2(h)). Figure 3 shows the final inundation of the north west shelf separating all the islands, and the progressive flooding of the North Sea area, from which people may have migrated along the coast into Scotland.



(a) (b) (c) (d)

Figure 2 *Isobase maps of predicted shorelines, shoreline locations and ice sheet limits for selected epochs. (a) 22,000 years BP corresponding to the adopted time of maximum glaciation over the British Isles, (b) 18,000 years BP corresponding to the time of the onset of deglaciation of the large ice sheets, (c) 16,000 years BP, (d) 14,000 years BP.*

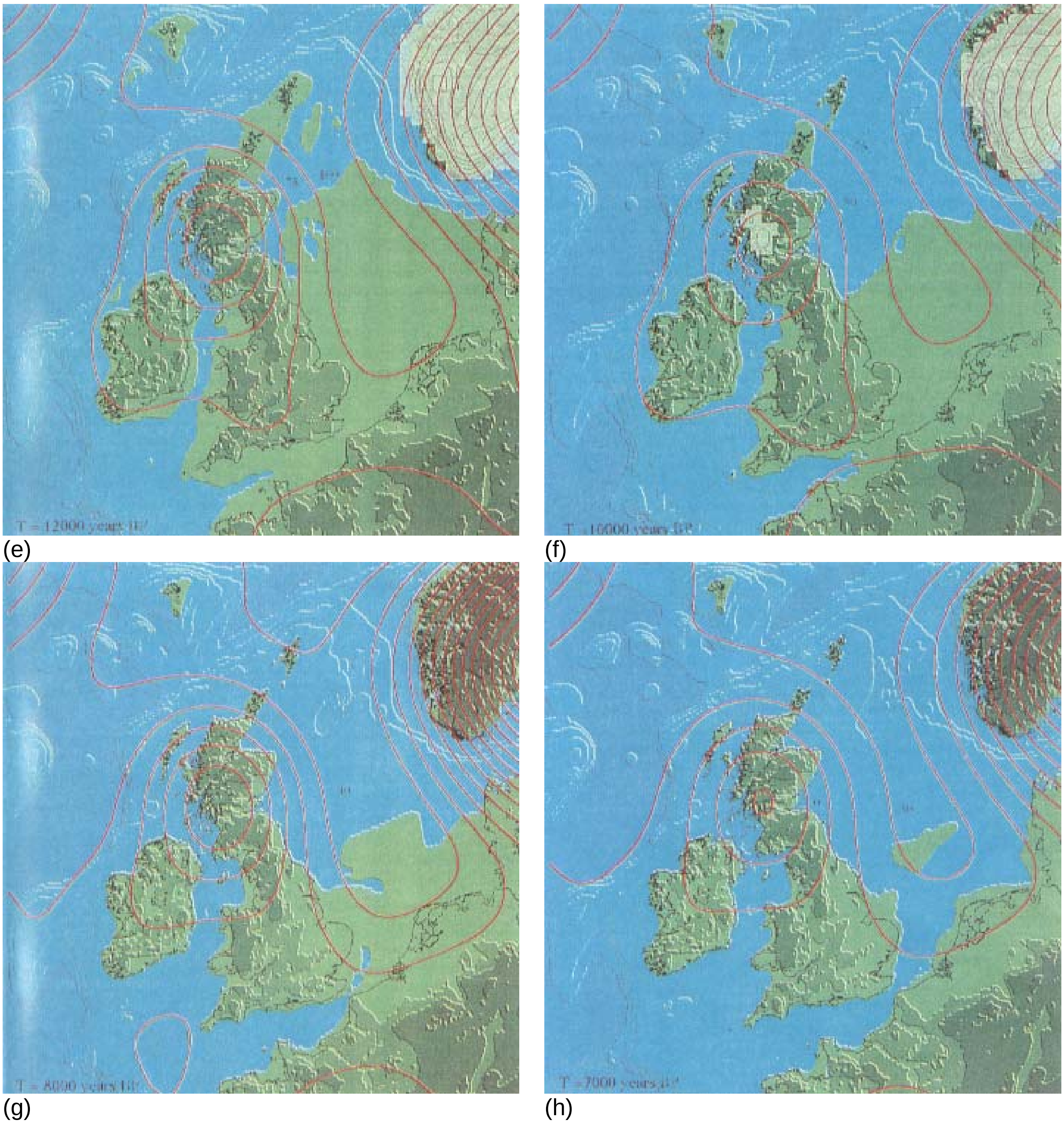


Figure 2 continued *(e) 12,000 years BP, (f) 10,000 years BP, (g) 8,000 years BP, (h) 7,000 years BP. The maximum ice heights for these epochs are: 1,500m at the time of the glacial maximum at 22,000 years BP, 1,400m at 18,000 years BP, 1,300m at 16,000 years BP, 1,000m at 14,000 years BP and 400m at 10,000 years BP. Palaeowater depths are also indicated with contours at 50, 100, 150 and 200m. Isobase contour intervals are 50m for (a) to (d), 25m for (e) and (f) and 10m for (g) and (h). (After Lambeck, 1995).*

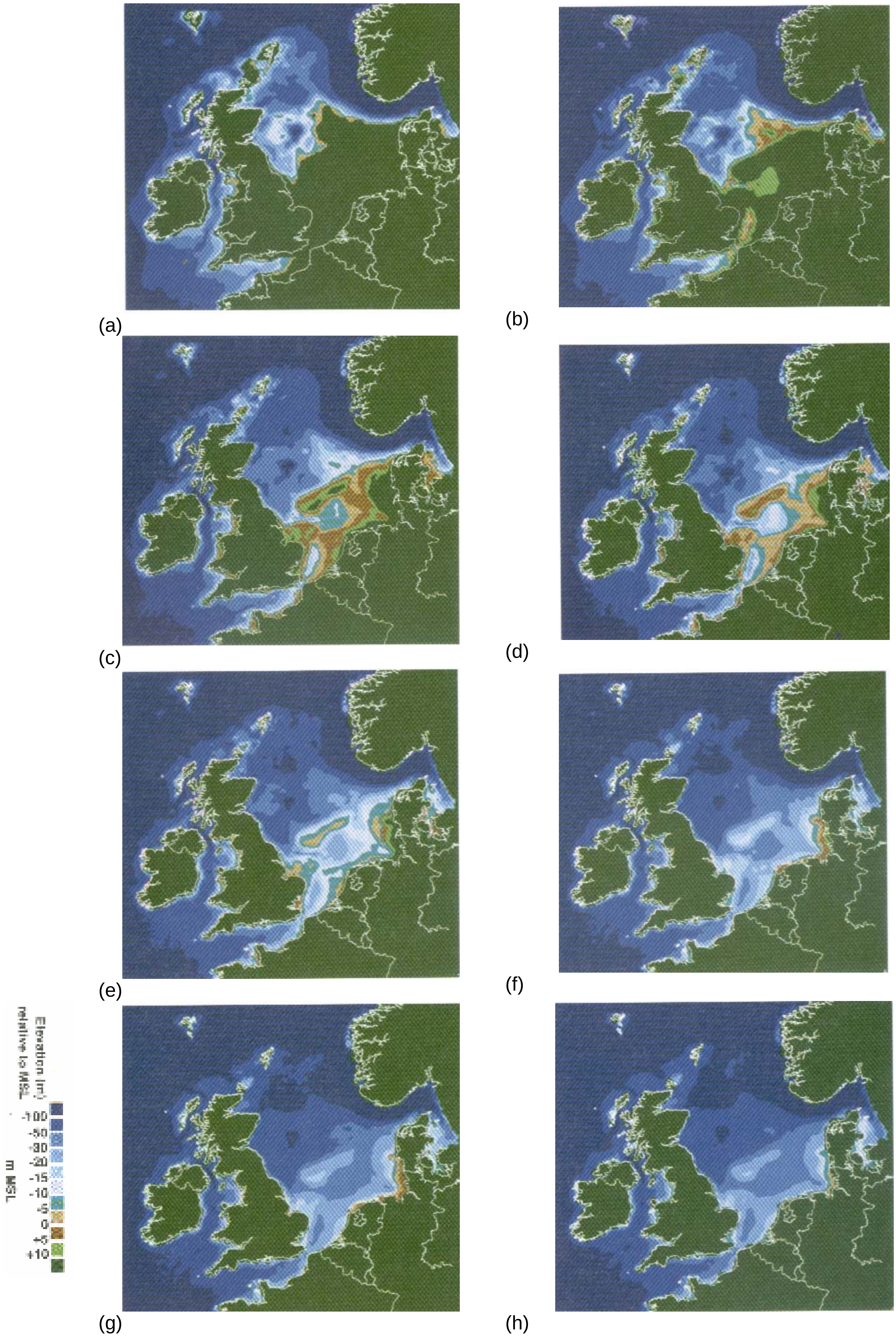


Figure 3 *Palaeogeographic reconstructions of Northwest Europe (a) 10,000 years BP, (b) 9,000 years BP, (c) 8,000 years BP, (d) 7,500 years BP, (e) 7,000 years BP, (f) 6,000 years BP, (g) 5,000 years BP, (h) 4,000 years BP. Elevations (metres) relative to MSL, depths below MSL are given as negative. (After Shennan et al., 2000b).*

2.8 Smith *et al.* (1999, p.1) (see Fig. 4) show the most recent analysis of the uplift of the Postglacial Shoreline around the Scottish coast. The uplift of 12m has occurred since about 6850 radiocarbon years BP, while the stable isobase indicates stability since about 5000 radiocarbon years BP. The contours can be derived for almost the whole landmass of Scotland because of the intensely indented coastline, and the long sea lochs (Flemming, 1982). From the point of view of the prehistory of SEA5 it is fundamental that the zero isobase coincides almost exactly with the northern coast of Sutherland, and curves round to the east cutting through Wick and Fraserburgh, crossing the Moray Firth at the seaward side, and then curving down seaward of the Firth of Forth towards Berwick. Eastward of this isobase the seabed is subsiding, and this is consistent with the occurrence of more than 100m of Quaternary sediments east of the 0^{o} longitude (Andrews *et al.,* 1990, Fig. 56).

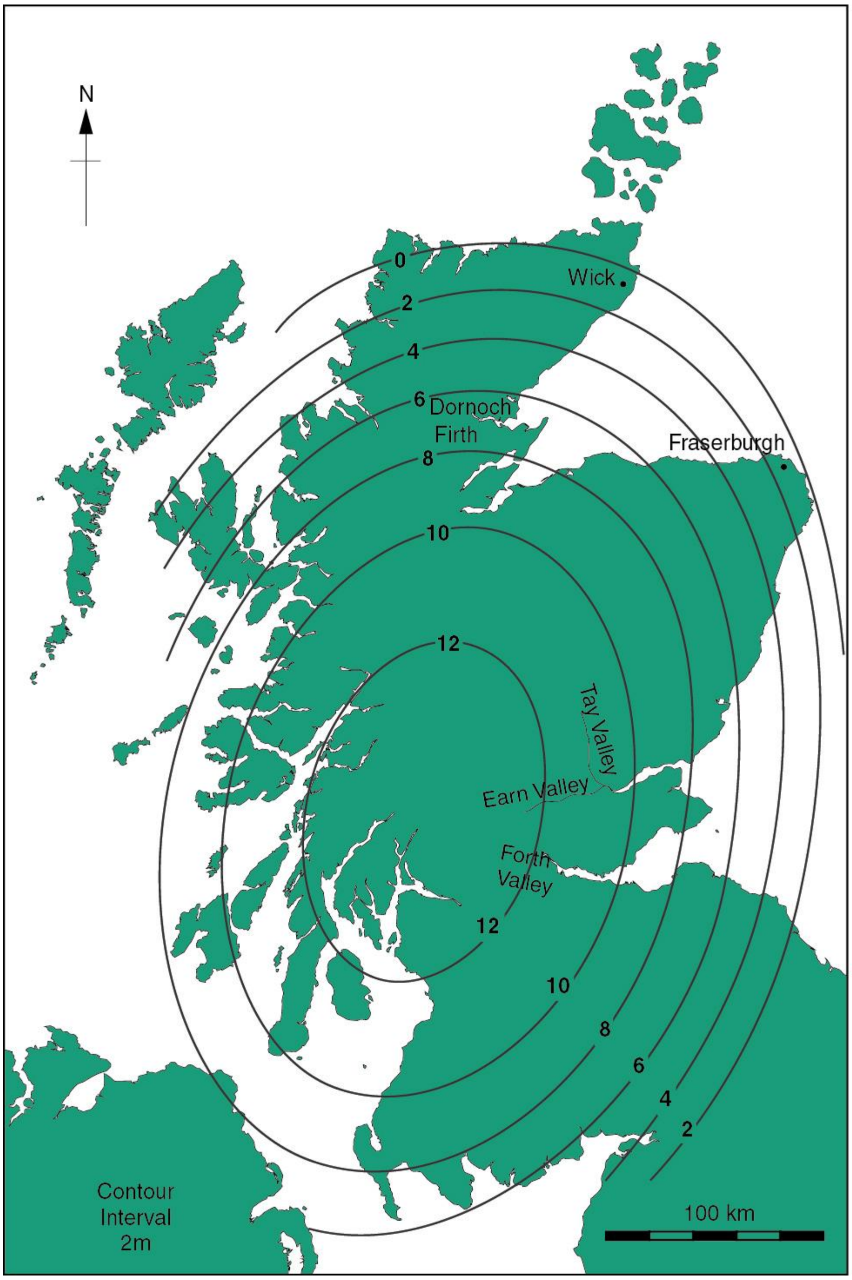


Figure 4 *Contours of elevation of the main postglacial shoreline above present sea level***.** *Elevation in metres. (From Smith et al., 1999).*

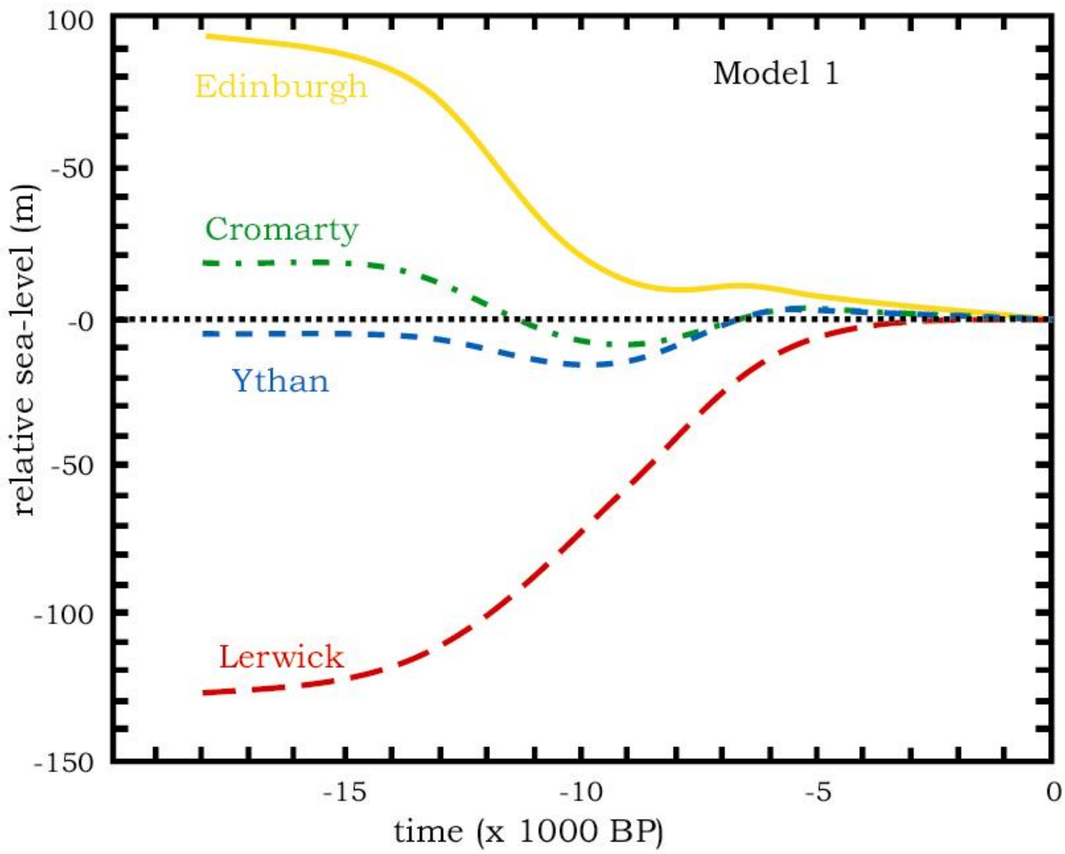


Figure 5 *Predicted relative sea level curves for the last 20,000 years based on ice model ARC3(BRI) at four sites in Scotland. Note Edinburgh and Cromarty are uplifted by post-glacial isostatic rebound creating a relative drop in sea level. Lerwick in Shetland is exposed to continuous relative rise of sea level. (After Lambeck, 1991).*

2.9 Because the shallow coastal waters of SEA5 range from the inland heads of the Firths where the land uplift is 8-10m out to the headlands of Wick and Fraserburgh on the zero-isobase, the rate of relative sea level change varies radically at different points on the coast. Areas of the seafloor may have been dry land 10-12,000 years BP; flooded by the rising sea around 7000 years BP; and then exposed again a few thousand years later by the isostatic uplift of the land. Figure 5 shows a range of relative sea level curves predicted by Lambeck (1991). Edinburgh has been continuously uplifted more rapidly than the rising sea for the last 15,000 years so that the sea level has been relatively dropping throughout that time. At Lerwick, Shetlands, on the north-west limit of SEA5, the land has been sinking continuously since the ice melted so that the relative sea level has been continuously rising. Comarty and Ythan are interesting because their rate of uplift has been closely similar to the sea level rise, with the sea level relatively falling from 14,000 to 9,000 BP, dropping below the present coastline, rising again to a maximum above the present coastline at about 5000 BP, and then dropping gradually to the present level.

2.10 Figure 6 shows a magnified detail of the process for Ythan, from Smith *et al.,* (1999, Fig. 15). Between 9000-8000 calibrated years BP the relative sea level rose 8m to the present coastline, and then continued to rise to a maximum relative level of about 4m above the present coast at 5000BP, and then drops slowly towards the present shore level as the land continues to rise. These descriptions of oscillations of relative level observed on the present coastline are described in order to illustrate the point that similar relative oscillations occurred over the whole seabed area within the 0m isobase in Fig. 4., and probably for some distance beyond it, since the hinge-line will have migrated inwards with time.

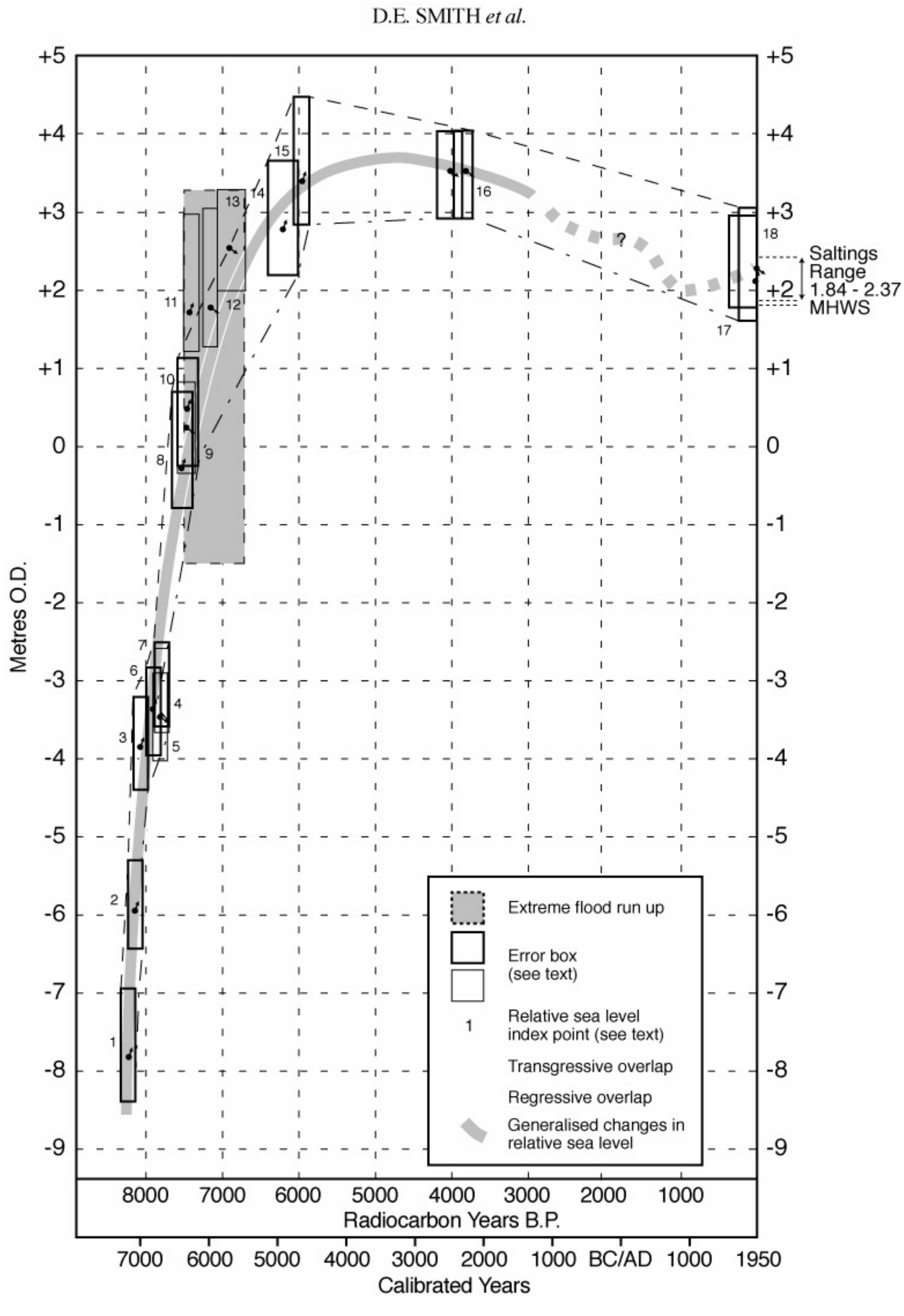


Figure 6 *Graph of relative sea level change since 8300 radiocarbon years BP in the lower Ythan valley (From Smith et al.,1999).*

2.11 Fitzhugh (2002) sets out the strong evidence for early human exploitation of the food resources of the circum-polar zone, using life-strategies similar to modern Inuit or Eskimos. Zhokhov Island, north of Siberia, in the Laptev Sea, is the northernmost Arctic site occupied at 8400 years BP (Pitulko, 2001). Excavations at the Mamontovaya Kurya site on the Usa River, inside the Arctic circle, revealed stone tools and carved mammoth tusks nearly 40,000 years BP (Pavlov *et al*., 2001). The exploitation of marine mammals, especially seals, walruses, and cetaceans must be considered for peoples living in circum-polar conditions. Anyone who has seen a walrus haul-out will know how clumsy the animals are on the beach. They would have been the most attractive prey for any peoples who chose to live on the northern or north-west margins of Europe during peak glaciation, or as early as, say, 12-14,000 years

BP. The reported recovery by Dutch fishermen of walrus bones showing signs of cut-marks and butchery from 56^o North in the central North Sea (Klaas Post, personal communication) strongly suggests this possibility. This type of culture may correlate with the otherwise curious retrieval of a lithic artefact off the Viking Bank from a depth of 145m (Long *et al.,* 1986). Wickham-Jones has pointed out (2003, personal communication) that the availability of large quantities of fat from marine mammals is an important component of a glacial climate diet, since the hunter-gatherer diet inland tends to be too lean to support human survival in extreme cold.

2.12 Pitulko *et al.* (2004) show that modern humans were living in the Russian Arctic at 72^o North on the delta of the Yana River about 30,000 years BP. Tools of stone and bone were found. The area was never covered by thick ice, and remained suitable for large herbivores throughout the last glaciation. This site, and others of similar age (Pavlov *et al.,* 2001) show that people were living in the high Arctic before the last glacial maximum. In the region of Scandinavia, in the areas where the ice cap and glaciers were presumably similar to present conditions at the last interglacial, any population would have been forced to migrate outwards as the ice thickened and grew in extent. While humans may have exploited floating sea ice and the peri-glacial tundra for terrestrial and marine mammals, they cannot have existed very close to the ice cap itself, or in the land areas actually covered by ice. This argument applies equally to any population of Scotland after the last interglacial, if any. Thus determination of the limit of the ice sheet at different dates is critical to understanding where people might have lived, exploiting an Inuit-style of life on the outer margins of the continental shelf during the glacial maximum.

2.13 In northern peri-glacial conditions the availability of protein for prehistoric peoples close to the shore was higher than in the hinterland (Momber, 2000, 2001; Fischer, 1995). At glacial maximum when the sea did not penetrate far into the North Sea area any inhabitants would have depended on large mammals such as mammoth and reindeer. Typical maps and discussions of the food base tend to emphasise the availability of terrestrial mammals on the continental shelf (e.g. Barton, 1997, p.134). Fischer (1995, 2002) has added the importance of coastal fish and shellfish. Later, Mesolithic peoples would have benefited from the resources of wetlands and estuaries. Flemming (1996) summarises the reasons for prehistoric peoples being attracted to the coast, and estimates that, as sea level fell, vegetation and fauna would colonise the exposed land close to the shoreline within a few decades. Bailey (2003) has recently summarised the strong case for coastal dwelling during prehistoric times.

2.14 Human remains in south Wales have been found a few km from the ice front (Woodcock, 2000, p.404), so cold itself was not a deterrent. Palaeolithic hunters required fresh water, food supplies, a supply of flints, bone and wood to make weapons and tools, some timber, shelter, skins for clothing, and a secure position which might have to be defended, with good routes of access, and the option to move or migrate with the seasons, or with changing supplies of fish, shellfish, or mammals. Mesolithic settlements were often positioned so as to be convenient to fish traps and fish weirs on the coast. Knowledge of these requirements has been used with great success by archaeologists in the UK and Denmark to predict and interpret submerged Mesolithic sites (Andersen, 1980; Pedersen *et al.,* 1997; Momber, 2001; Coles 1998, 1999, 2000; Fischer 2004). Hunting kill sites, flint quarries, flint-knapping sites, settlements, camps, shell middens, charcoal from fires, and shelters, tend to cluster round shorelines, estuaries, lagoons, headlands and promontories.

2.15 This places a premium on identifying accurately the ice limits, shorelines and rivers at each date, and especially those shorelines where the sea level was locally constant for hundreds or thousands of years, relative to the local land. Under these conditions rivers would tend to create stable estuaries, and perhaps barrier bars or lagoons and wetlands, waves would erode substantial rock terraces, cliffs, and caves, and shallow water sediments or peat could accumulate. Because of the doming of central Scotland the previous shorelines with terraces and caves have been uplifted in many areas, and several occupied caves are known on raised terraces around Oban (Wickham-Jones, 1994 p.71-73).

2.16 Off the east coasts of the Shetlands, Fair Isle and the Orkneys, one would expect to find submerged caves or materials trapped in gullies and cracks in the bedrock. Various combinations of floating sea ice, rocky shelters, ample terrestrial mammals such as reindeer, or marine mammals such as seals, walrus, otter, and cetaceans, depend on the exact local topography. The most probable ice limit is shown by Hall and Bent (1990, Fig. 4) (see Fig. 7). Assuming this to be the approximate case, all the seabed within SEA5 north of Fraserburgh was either covered by land ice on the fringe of the Scottish ice cap, or was under seawater and floating sea ice, at the time of the last glacial maximum. Andrews *et al.* (1990, Fig. 60) indicate scattered small islands emerging from the sea ice, typically a few tens of km across. They add to the figure the phrase "Areas of exposed land may be more extensive than shown". This suggests a complex terrain of sheltered sea almost totally protected from the North Atlantic storms, dotted with islands, covered with floating sea ice, and bordered to the west by the grounded Scottish ice cap.

2.17 South of Fraserburgh the situation changes because the Scandinavian ice sheet extended across the Norway trench onto the UK shelf as far west as the Greenwich meridian, and a substantial dry land area of tundra was exposed between the Scandinavian grounded ice and the sea-lake (Fig. 7). This dry land continued widening to the south and east over the southern North Sea basin, and was continuous with the land which is now Germany and France (See Fig. 2, a-d). The river Elbe discharged across this shelf to the north, and probably other rivers drained the landscape, as in northern Russia today. The combination of extensive land to the south, the proximity of the ice sheets, the large sea-lake, and the scattered islands projecting from the floating ice suggest a complex area which could have supported humans exploiting both sea mammals, fishing, and land mammals.

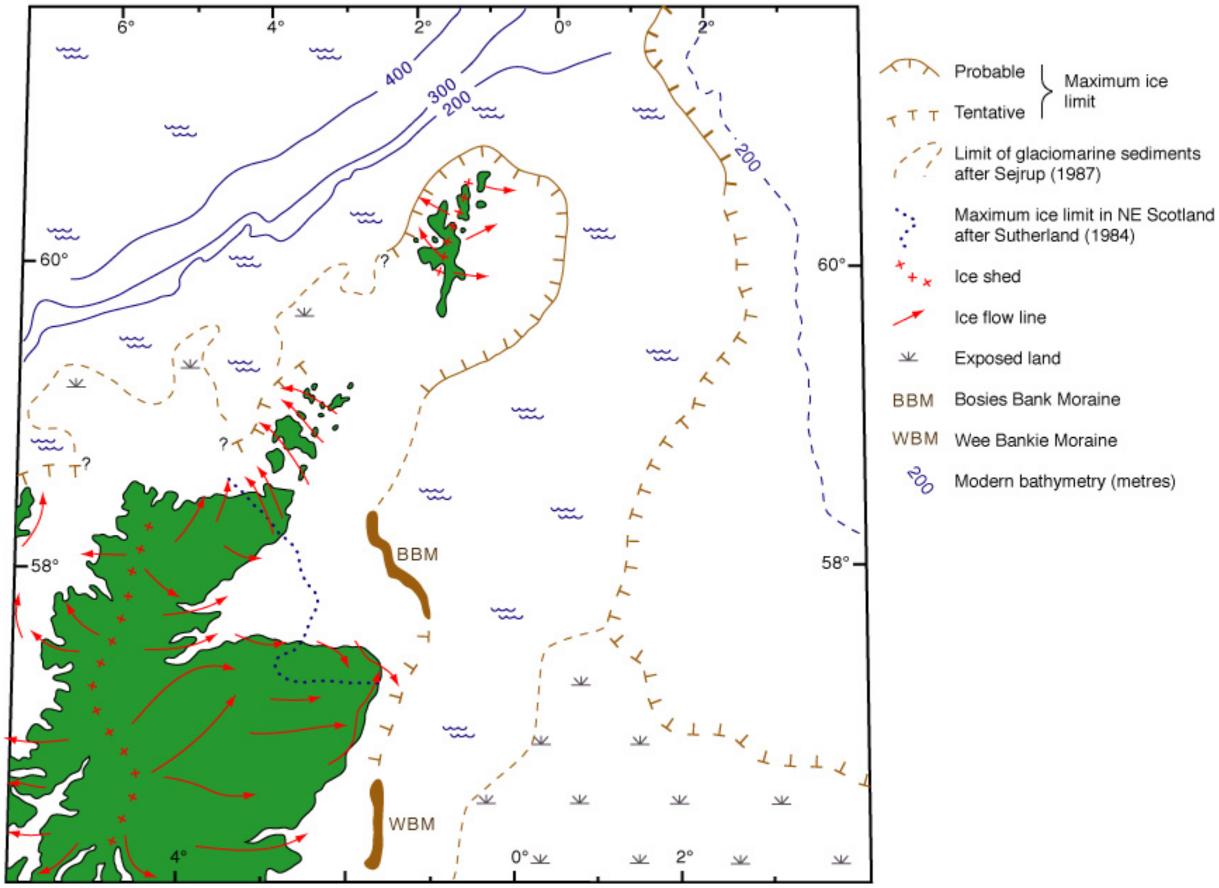


Figure 7 *Reconstruction of the Devensian maximum ice limits, showing the sea lake extending southwards parallel to the ice edge of the Scottish ice cap. Note dry land to the south and south-east. (From Hall and Bent, 1990).*

2.18 Dawson (2003) has provided a data base of 374 known archaeological sites on the coast and in the intertidal zone in the Moray Firth area between Nigg to the south and the Tarbat promontory north of Cromarty. The oldest dated site on the list is a crannog from the third century BC. All other antiquities are much more recent, mostly of the 16-19th century AD. There are a few undated fish traps and crannogs, but these could be mediaeval. By comparison, on the north coast of Scotland, and on the Orkneys and Shetlands, there are many tens of prehistoric sites on the coast. This is consistent with the model suggested in Figures 5 and 6, where SEA5 was under water for much of the time, exposed around 10,000 to 7000 years ago, drowned again, and only recently uplifted from the sea.

2.19 Taphonomy is the study of the changes which occur to deposits after primary burial. Archaeological materials may be covered by metres of sediments which protect them indefinitely, or eroded by ice, eroded by rivers, eroded and scattered by surf action on a beach, eroded by bottom action of storm waves in shallow water, eroded by tidal currents, chemically altered, or disturbed by trawling, dredging, entrenching, or drilling. There is insufficient space in this report to discuss all the processes, conditions, and topography which are most favourable in every combination of circumstances for the survival of an archaeological artefact *in situ* which is submerged for at least part of its existence. The typical conditions for the survival of known submerged archaeological prehistoric sites are presented in a table by Flemming (1983a, p.161-163) classified as Ria, Lagoon, Estuary, Sheltered alluvial coast, Exposed accumulating beach, Submerged sea caves, Karstic caves, and Islands and archipelagos. Each site is classified in terms of depth, age, tidal range, current, wind fetch, and estimated wave action. Peat and submerged forests are important indicators, and Figs 19 and 20, in Louwe Kooijmans (1970/1), illustrate the widespread occurrence of peat on the floor of the North Sea. (See also the analysis of the SEA3 area, Flemming, 2002). Earlier analysis of North Sea peat is provided by Jelgersma (1961). Submerged peat has been reported in Shetland (Mykura, 1976, p.110-111; Turner, 1998a, p.67), while the rocky terrain is suitable for the preservation of submerged caves. Occupied prehistoric caves are known on land in the area of Oban, and on the island of Ulva (Wickham Jones, 1994, p. 71-73). In view of the work of Pitulko *et al*. (2004) it is important to consider the effect of sea water rising over archaeological deposits in permafrost, which would indicate the possibility of good preservation of artefacts.

2.20 Although other factors also apply, for example ice scour, glacial erosion, frost shattering, and normal subaerial erosion processes, the critical period for survival of an archaeological deposit is the time when the surf zone starts to impact on the site, and the ensuing few hundred years as the sea level rises over the site, and coastal shallow water waves are breaking over the site, or washing into a cave mouth. Favourable factors for survival in the deposit area include:

- Very low beach gradient and offshore gradient so that wave action is attenuated and is constructional in the surf zone.
- Minimum fetch so that wave amplitude is minimum, wavelength is short, and wave action on the seabed is minimum.
- Original deposit to be embedded in peat or packed lagoonal deposits to give resistance and cohesion during marine transgression. Drowned forests and peat are good indicator environments.
- Where deposits are in a cave or rock shelter, roof falls, accumulated debris, concretions, breccia, conglomerate formation, indurated wind-blown sand, all help to secure the archaeological strata.
- Local topography contains indentations, re-entrants, bays, estuaries, beach-bars, lagoons, near-shore islands, or other localised shelter from dominant wind fetch and currents at the time of transgression of the surf zone.
- Frozen ground or permafrost enclosing archaeological deposit at time of inundation.

2.21 This brief analysis demonstrates that survival or destruction of an archaeological deposit, whether originally inland or on the coast, depends acutely upon the local topography within a few hundred metres or a few km of the site. Generalised coarse resolution maps tend to omit the details which show the necessary local topographic clues. The BGS 1/250,000 maps, although they are primarily designed to present sediment data, provide a much more accurate representation of topography, with isobaths at 10m intervals, than the Admiralty Charts. Additional high resolution swath bathymetry would be enormously valuable in detecting probable sites. It is no coincidence that the most prolific area of proven submerged Mesolithic sites is between the islands of the Danish archipelago, where many hundreds of sites have been mapped and sampled by the National Museum Maritime Archaeological Institute, and the National Forest and Nature Agency, assisted by amateur divers. Further submerged Baltic sites have been discovered in sheltered waters off the coast of northern Germany (Lubke, 2001, 2002). The Bouldnor Cliff site in the lee of the Isle of Wight on the Solent is protected in the same way. Off Gibraltar a hook-shaped submerged promontory contains caves facing inwards towards the land which would be protected from waves while the sea level rose (Flemming, 1963; 1972), and similarly protected sea caves have been found in the Bay of Villefranche (Flemming, 1972). The ability to reconstruct the conditions under which North Sea archaeological sites were formed and buried has recently been improved by the sophisticated analysis techniques of Praeg (2003) and Gaffney (2004). Praeg (*op. cit.*) has used seismic imaging to detect buried glacial tunnels under modern sediments. Gaffney (*op. cit*.) has re-interpreted extensive sub-bottom seismic records to detect the changes in sediment characteristics indicating buried river valleys. This technique has exposed a wide meandering river draining northwards from the north-east flank of the Dogger Bank.

2.22 The factors in the previous paragraphs are those which promote survival of the original deposit *in situ*. However, if an archaeological deposit is buried under 5-10m of mud or sand it will not be discovered, except in very unusual circumstances. Thus the final requirements for survival and discovery are:-

- Low net modern sediment accumulation rate so that the artefacts are not buried too deeply.
- No fie7lds of sand waves or megaripples over the site.
- Ideally, a slight change in oceanographic conditions so that the site is being gently eroded to expose deposits when visited by archaeologists. (This factor is sufficiently common in known sites to be a serious factor, and should not be regarded as an unlikely fluke).

2.23 Potential discovery "hot-spots" in the SEA5 cannot be listed exhaustively at this stage. The steps needed to create high resolution local sensitivity maps can be identified, and are discussed later in this section. In principle the key factors are:-

- "Fossil" estuaries and river valleys.
- The flanks of banks and ridges which have been proven to have peat layers, or which are likely to have peat layers.
- Valleys, depressions, or basins with wetland or marsh deposits.
- Nearshore creeks, mudflats, and peat deposits.
- "Fossil" archipelago topographies where sites would have been sheltered by low-lying islands as the sea level rose.
- Niche environments in present coastal zones, wetlands, intertidal mudflats, lochs, and estuaries.
- Caves and rock shelters in re-entrant bays, fossil erosional shorelines, submerged rocky shores protected by other islands, or in archipelagos.
- Deposits of sediments formed within, or washed into rocky gullies and depressions.
- "Fossil" coastal sites comparable by analogy to modern Inuit migratory sites, adjacent to sea ice, giving access to marine mammals as a food resource.
- Areas of permafrost containing archaeological deposits which were then inundated, and protected by other factors listed above.

2.24 The changes in and survival of an archaeological site, and the chances of discovery, depend on the present conditions of winds, waves, and currents in the area, and the water movements on the seabed.

Waves

The waves which are most likely to destroy and scatter a submerged site, either during the marine transgression, or under the present conditions, are the winter storms combined with heavy swell from the open Atlantic. SEA5 is much more protected from such extreme wave exposure than SEA4. The Orkney-Shetland ridge provides a barrier to the major storms from the west and north west, and only the wave field forced from the north and east has a direct impact. The result is that the wave climate is similar to that of much of the central North Sea, with a significant wave height of 4-5m attained only 10% of the time in winter in the open water at the eastern and northern margins of SEA5 (Draper 1991). Closer to the land the significant wave height drops to 3m at the approaches to the great firths, and to 2m within the mouth of the Moray Firth and Firth of Forth. Sand waves occur in the northern part of SEA5 showing that waves and currents combined are moving modern sediments rapidly on the seabed. However, further south, and closer to shore, the sediments appear more stable, and artefacts embedded in Quaternary deposits, or on the interface between Quaternary and Holocene or modern sediments, would be protected from disturbance.

Currents

The tidal range is of the order of 3-4m along much of the SEA5 coast, and tidal streams in the north east area where the tide flows through the gaps in the Orkney-Shetland ridge have velocities of 2-3m/sec. This area correlates with the seabed of bare bedrock with very little sediment. In the Moray Firth the currents drop to 1.0-1.2m/sec, with a further peak of 1.8m/sec round Fraserburgh. In the southern half of the Moray Firth this is associated with 10-20m thickness of Quaternary sediments. Further offshore the currents over the whole SEA5 are of the order of 0.8-1.0m/sec (Blackham *et al*., 1985). Where the currents have exposed the bedrock human artefacts would only survive trapped in gullies or caves. Over much of the area of SEA5 the currents have been strong enough winnow out fine mud or clay, but this process would leave lithic artefacts in place.

2.25 Interpretation of archaeological prospectivity depends on separating modern bedforms and banks of mobile sand and sand waves from earlier Devensian gravel, clay, moraines, drumlins, or peat, eliminating areas of bare rock or extremely thin modern marine sediments over bedrock, and identifying erosional features associated with fossil cliffs and caves. Since the earliest inhabitants of the Scottish continental shelf may have been living in a culture similar to that of the Inuit peoples of Greenland and northern Canada and Alaska, we also need to search for the traces of sheltered sea bays and gulfs which may have been covered by sea ice. In these environments marine mammals would have prospered.

2.26 The British Geological Survey (BGS) collaborated with its opposite numbers in Netherlands and Norway during the 1980s and 90s to produce a series of seabed sediment maps for the UK Continental Shelf at a scale of 1:250,000. These maps, and the associated cores, are an essential tool for assessing the archaeological potential and sensitivity of areas of the sea floor, providing classification of surface sediments by grain size, thickness of active marine sediments, thickness of Holocene deposits, standard cross-sections, information on tidal currents, sand waves and sand ripples, carbonate percentage, and other items of information which vary from sheet to sheet. Some sheets, but not all, include copious technical notes, sections, core profiles, and analysis of sources, references, and comments on the various facies. All sheets show positions of platforms and pipelines at date of publication. Notes on some of the most relevant sheets follow (from north to south). This analysis refers only to the geological, sedimentary, and taphonomic conditions relevant to primary occupation in the area, and the preservation of sites. Many of the sheets also contain islands where archaeological remains are known on shore, or in the intertidal zone, and these features, where relevant, are described in Section 3.

2.27 List of BGS sheets and their significance

The following sheets of the BGS Bottom Sediments series are wholly within the SEA5 area, or overlap it. In order to give a fair impression of the seabed sediments and the archaeological potential of the region I have included most of the data out to 1°E, although SEA5 does not extend this far east at all points on its boundary.

Shetland: 60-61°N, 0-2°W. BGS, 1998. The Shetland islands consist of largely Devonian Old Red Sandstone and Precambrian Lewisian metamorphic rocks and granite. Archaeological prospects within the archipelago, in the sea lochs and intertidal areas were analysed in the DTI report on SEA4 (Flemming 2003). The islands are very rich in prehistoric archaeological remains. Out to a depth of 100m the isobaths indicate irregular topography with re-entrants and small valleys, although the upper surface is often classified as "smooth featureless rock platform". The most prospective areas would be those where echo-sounding or swath-bathymetry show a pattern of submerged headlands, valleys, or steep terrain which could be penetrated by caves.

Halibut Bank: 60-61°N, 0-2°E. BGS, 1985. Patches of sandy gravel at 130m, sloping gently westwards towards a depression at 150m water depth, consisting of muddy sand. A worked flint was found in a sediments core taken on this slope (Long *et al.,* 1986) in Vibrocore number 60+01/46. For details see Long *et al.,* (1986) and discussion in Flemming (2003, section 4.2). The discovery of a flint artefact so far north was regarded as anomalous in the 1980s, but in the last decade artefacts as old as 30,000 years BP have been found in the Russian Arctic (Pitulko *et al.,* 2004), thus showing that tribes adapted to circum-polar ice-edge existed in the far north before the last glacial maximum. Such peoples may have existed between Scotland and Scandinavia, although this is hypothetical at the moment.

Orkney: 59-60°N, 2-4°W. BGS, 1994. Over the Orkney-Shetland Platform currents are often greater than 1.0m/sec in the open sea and greater than 2.0m/sec in the channels between islands. Archaeological prospects within the archipelago, in sea lochs, and intertidal areas was discussed by Flemming (2003, sections 3 and 4). The islands are very rich in prehistoric remains on land. Seabed Quaternary deposits being largely gravels, sandy gravel, and gravely sand, it is probable that there is a strong lag effect, with the possibility of stone tools and bones being embedded. The low gradients generally mean that wave action during transgression will have been heavily attenuated, and the depressions in the shelf are interesting as possible traps for slowly moving large particles, or stone artefacts.

Fair Isle: 59-60°N, 0-2°W. BGS, 1990. The sea floor over the Fair Isle Ridge consists of gravel and sandy gravel in a thin layer over bedrock. Tidal currents are typically 1.0-1.5 m/sec. Quaternary deposits are very thin or absent, except close to the west side of Sumburgh Head, where the Witch Gravel Formation occurs. Sand waves exist to the west and south west of Fair Isle. In view of the minimal sediment cover and the strong currents, archaeological prehistoric materials are only likely to occur close to Sumburgh Head or Fair Isle, or trapped in rocky gullies. To the east the seabed slopes down to 80m depth within 5-10km of the Fair Isle Ridge, then undulates at 100-140m throughout the area, with hillocks and depressions. The Fair Isle Ridge out to a depth of 80-90m is bedrock covered with a very thin layer of Quaternary deposits, often less than 1m thick. Channels incised in the bedrock trend NW to SE and are infilled with Quaternary sediments. Sidescan records indicate gravel ridges throughout the area, consistent with the strong tidal currents and North Atlantic waves. At the SE corner of the sheet there is a gully dropping to 200m, with a small pit at 300m, suggesting a glacial tunnel, partially filled with sandy mud.

Bressay Bank: 59-60°N, 0-2°E. BGS, 1987. Undulating topography at 120-150m depth, with local hillocks and depressions. Mostly muddy sand, grading into sand at the eastern edge of SEA5. High ground at Bressay Shoal, and thin sand over Quaternary deposits. A north-south elongated depression at 0° 38'E, 59° 15'N drops to 180m depth, and is filled with sandy mud. This is probably a glacial tunnel. In general the modern marine sediments are only a few cms thick in this region, and Quaternary deposits a few metres thick. Prehistoric materials could be preserved in the Quaternary layers, but it is not possible to detect them at present, and predictive models are not yet available for this type of terrain.

Caithness: 58-59°N, 2-4°W. BGS, 1987. The Orkney Ridge is swept bare by tidal currents of the order of 2.0m/sec. The rocky coast of Caithness slopes to 40m within a few km of the shore, and the seabed undulates to 70-90m across to the eastern margin of the area, with small outcrops of bedrock. Modern sediments are mostly gravely sand and large patches of sandy gravel. A closed valley depression trending east-west at the SE corner of the sheet drops to 120m, and is probably a glacial tunnel. The Bosie Bank Moraine underlies the sediments of the south-eastern margin of the sheet (Hall and Bent, 1990, p.8-9). There are areas of sand waves east of the Pentland Firth.

Bosie's Bank: 58-59°N, 0-2°W. BGS, 1988. The seabed slopes in an undulating manner from a depth of 70m in the SW corner of the sheet to 140m along the eastern edge. There are elongated depressions or channels about 10-80m deeper than the surrounding sea floor, about 10km long and less than 1km wide, oriented more or less N-S, and varying from NNW-SSW, with the deepest channels dropping to 140-220m. These are probably sub-glacial scour and melt-water channels, which have not been filled by modern marine sediments. In the eastern half of the sheet there are scattered gas-vent pock-marks. The modern sediments are very thin, usually less than 1.0m, and consist mostly of sandy-mud and muddy-sand, with small patches of sand, and sandy gravel. The thin modern sediments mean that it is relatively easy to sample the Quaternary deposits, but there are very few indicators which suggest where human occupation may have occurred during the relatively short time that the seabed was exposed between deglaciation and inundation. It would be interesting to try and reconstruct the landscape at the period when the closed depressions were freshwater lakes, and well clear of the ice front.

Moray and Buchan: 57-58°N, 2-4°W. BGS, 1984. There is rocky gravel and clean sand close to the southern shore of the Moray Firth, and over-deepened basins to 90m and 200m near the north eastern limits of the sheet. The Quaternary deposits within the Moray Firth range in thickness from 0-70m, and consist of Devensian tills and pebbly tills. There are patches of Flandrian clay and soft muds. Modern marine sediments are mostly less than 1.0m thick, and grade into muddy sand and sandy mud at the northern limits of the sheet. The extreme thinness of the modern sediments suggests that any archaeological or palaeontological materials associated with the exposed land prior to inundation would be accessible, if they have not been eroded.

Peterhead: 57-58°N, 0-2°W. BGS, 1984. The coast off Peterhead drops to 40m and then more gradually to 100m depth, within 30km, of the shore. Hall and Bent (1990, p.8-9) suggest that the eastern limit of the Devensian ice sheet was at the 100m isobath on this part of the coast. The Bosie's Bank Moraine intersects the northern margin of this sheet, but is not detectable either in the topography or the surface sediments. Most of the sector is sandy gravel or gravely sand, with gravel concentrated on the high ground.

Tay and Forth: 56-57°N, 2-4°W. BGS, 1986. The maximum depth at the eastern limit of the sheet is around 60-70m, with one pocket depression to 90m. Along the coast rocky ledges extend to a depth of 30-40m. Recent discoveries on the Yorkshire coast (Spikins, 2003) indicate the prehistoric materials can survive trapped in gullies and ravines in coastal rocky topographies. Beyond 40m the seabed is mostly sand, with some sandy mud and gravely mud in the Firth of Forth. There are axial deepened valleys extending seawards along both the Firth of Tay and Firth of Forth, Modern sediments are usually less than 1.0m thick, but there are occasional patches of muddy sediments a few metres thick. The currents in the area are strong enough to winnow and transport medium sands. There is a high lithic gravel content in the residual deposits, especially on bathymetric highs. This is a possible environment for lithic artefacts to remain with the natural gravels.

Marr Bank: 56-57°N, 0-2°W. BGS, 1984. At the north-western margin of the sheet there are many pits and depressions down to 110m, although most of the area is much shallower at 70-80m. The western half of the sheet is mostly patches of gravel and sand, with occasional pure gravel. This area coincides with the Wee Bankie Moraine (Hall and Bent 1990, p.8). It is noticeable that the moraine shows very little evidence in the bathymetry, although it is dramatically clear in the sediment composition. The eastern half of the sheet is mostly clean sand. There is one over-deepened pit at 120m at 56°30' N, 0° 10'W. The clean sand and coarse gravels in this area are consistent with the currents, with velocities of 0.35 to 0.5m/sec at spring tides. The identifiable moraines and pits provide an understandable landscape within which archaeological deposits might be deduced when we have further type evidence.

2.28 Summary of Section 2

At first sight the SEA5 area is a poor prospect for the conservation of submarine prehistoric remains, but this is partly because of the complexity of its late Pleistocene history, and the spatial variability. As the ice retreated any population which had been living further south on the plains of the North Sea basin could have moved northwards first to have access to the sea lake, and then along the borders of the sea lake towards the open Atlantic. This is consistent with the finding of a flint on the Viking Bank, dating from about 11,000 BP (Long *et al*., 1986). Any remains of cultures based in this area before 9000 BP are likely to be offshore.

3. A brief history of the known/inferred human prehistoric movements and uses of SEA5 including a brief chronology

3.1 Figure 8 illustrates in summary the times when Britain was an island or when it was connected to the mainland of Europe, and the related stages of sea level change, glaciation, and human occupation. The number of years when Britain was an island is very small compared with the time when it was a peninsula. One of the curiosities of the archaeological record is the apparent absence of humans in Britain at the peak of the last interglacial, Oxygen Isotope stage 5e (Fig.8), when conditions were slightly warmer than today, and continuing to 60,000 BP.. There is ample evidence that people were living in northern Europe and Russia 40,000 years ago, well before the last glacial maximum, and, in the present context, the archaeological questions relate to how these populations reacted to the onset of glaciation, followed by deglaciation. What proportion of the population stayed in the peri-glacial regions, and what was their balance of hunting between marine mammals and terrestrial fauna?

3.2 There is a strong appreciation amongst scholars and research workers at Historic Scotland, RCHAMS, and various university groups in Scotland and elsewhere, of the importance of submarine prehistoric occupation sites on the Scottish shelf. For several decades crannogs have been surveyed and excavated in freshwater lochs, and in recent years prehistoric structures in the intertidal zone, and immediately offshore have been located and documented. Submarine peat and other indicators have been identified within the archipelagos of Shetland and Orkney (Turner, 1998a). Wickham-Jones (1994) and Spikins (AHRB grant proposal, University of Newcastle upon Tyne) have addressed the problem of early occupation of the Scottish continental shelf. The discovery of a single flint tool off the Viking Bank at a depth of 145m (Long *et al*., 1986) confirmed that people could have been living this far north on the exposed continental shelf very soon after the ice retreat, and before complete deglaciation of the Scottish Highlands. Wickham-Jones (1994, p.54) has suggested that the re-occupation of the northern shelf during the melting of the Devensian ice sheet was by a combination of migratory movements up the west coast from England and Ireland, up the east coast from England and mainland Europe, including from the occupied areas in the central North Sea, and from the east or north-east, where people may have been living on the ice edge, or had recently re-occupied the margins of Norway and Denmark below present sea level. By the time of the Mesolithic and Neolithic cultures the people of Shetland and Orkney had developed architectural sophistication to rival anything else in the whole or Europe.

3.3 Ole Gron (2004) has analysed the ethno-archaeology of present tribes living in Siberia, and compared their hunting methods and seasonal priorities with the conditions which would have applied in the North Sea area about 10,000 BP. The analysis of reindeer seasonal migration patterns, and the presence of large Hamburgian reindeer kill-sites in Germany and Holland, contemporaneous with lesser finds of reindeer antlers in England, suggests that larger herds were migrating east-west across the North Sea plain. The herds spent the summer in the hills of Britain, and returned to the European plains in winter.

3.4 Another recent find relevant to the occupation of the northern North Sea is the reported submerged coastal site at Brown Bay, near Newcastle, where Mesolithic artefacts have been found by divers in gullies between ridges of rock. This is interesting, partly because of the northerly location, but also because it seems to confirm that prehistoric artefacts can survive on a rocky bottom without the protection of a stable layer of soft sediments (Spikins, 2003).

3.5 The proven prehistoric archaeological use of SEA5 is very meagre, and the challenge now is to try and understand this complex area which is, or could be, the key link between the demonstrable occupation of central and southern Europe during the last glaciation, and an arctic culture which, so far, has left very little record.

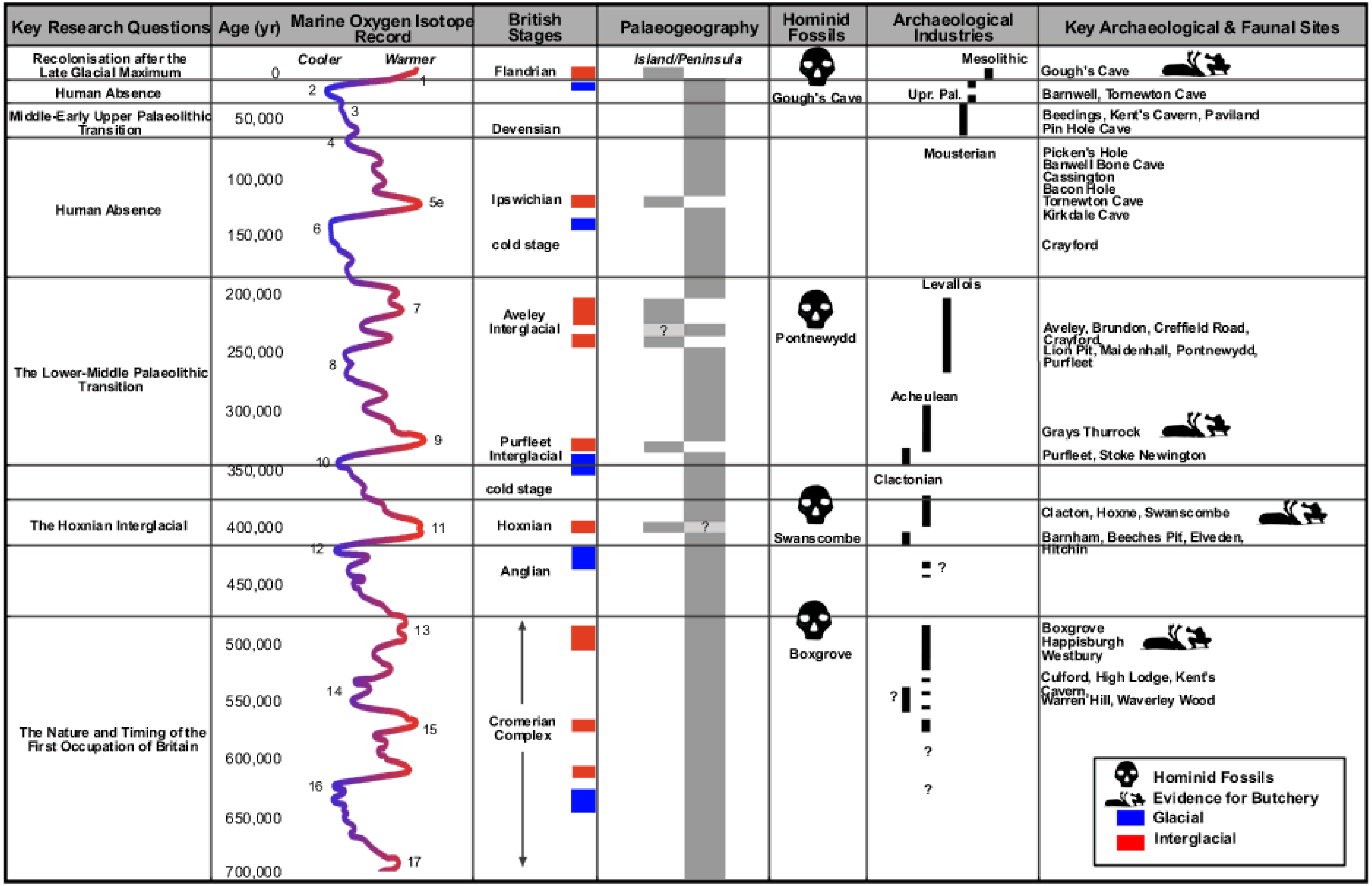


Figure 8 *Condensed summary of factors defining the human occupation of Britain in the last 0.7 million years. Sea levels, ice ages, island/peninsula, fossils, archaeological tool industries, and key sites. From: Chris Stringer (2004) , web site for AHOB, Ancient Human Occupation of Britain.*

4. Nature of the remains known and likely to be encountered from the different periods and uses of SEA5

4.1 No submarine prehistoric artefacts have been found in SEA5, and the reasons for this have already been presented. The bathymetry is shown in Fig. 9. Due to the thick deposits of glacio-marine sediments from the ice edge, the existence of over-deepened tunnel-valleys under ice, and the subsequent infilling by modern marine sediments, the seabed topography is not a clear indication of the landscape when the shelf was exposed, or the fluvial drainage pattern. If people were hunting and fishing around the margins of the sea lake there may be remains of fish spears or harpoons, similar to that found between Leman and Ower Banks in the southern North Sea (Louwe Kooijmans, 1970-71). Fossil bones of butchered animals, or artefacts made of bone, may also be retrieved, as in the central southern North sea.

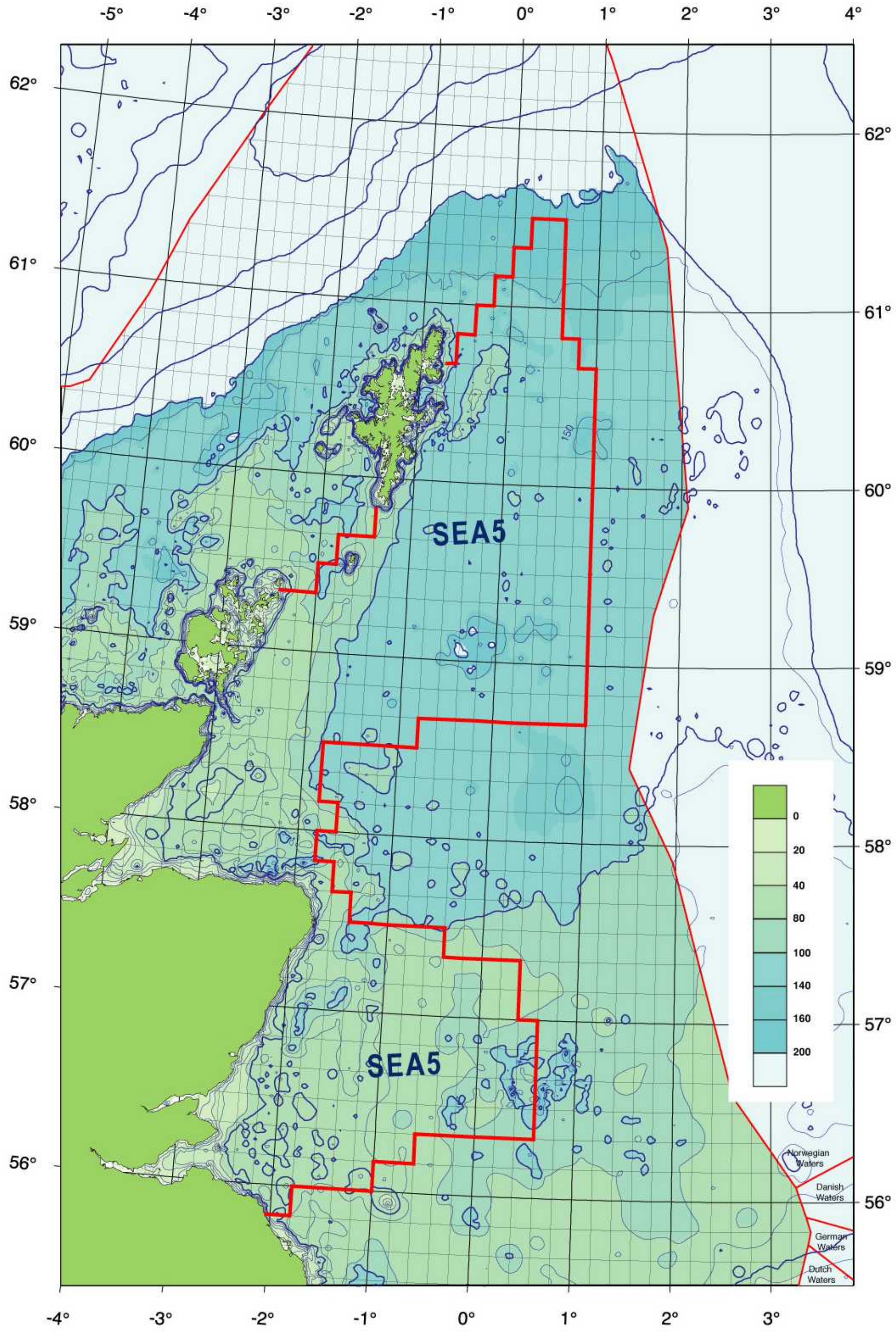


Figure 9 *Bathymetry of the SEA5 area.*

4.2 MacSween and Sharp (1989) describe the major prehistoric sites in Scotland, and the plot of mainland sites (Fig. 10) shows that very few of them are close to the coast, unlike in Orkney and Shetland where many structures are clearly built to exploit the coastal topography (Flemming, 2003). The issues concerning types of sites and structures which have been found on the shore, and underwater in SEA2/3 and 4 have already been outlined by Flemming (2002,2003) and will not be repeated here. Wickham-Jones (1994,p.33) indicates on a map that a tanged point of early date was found between Perth and St Andrews, but the exact date and location are not given in that publication.

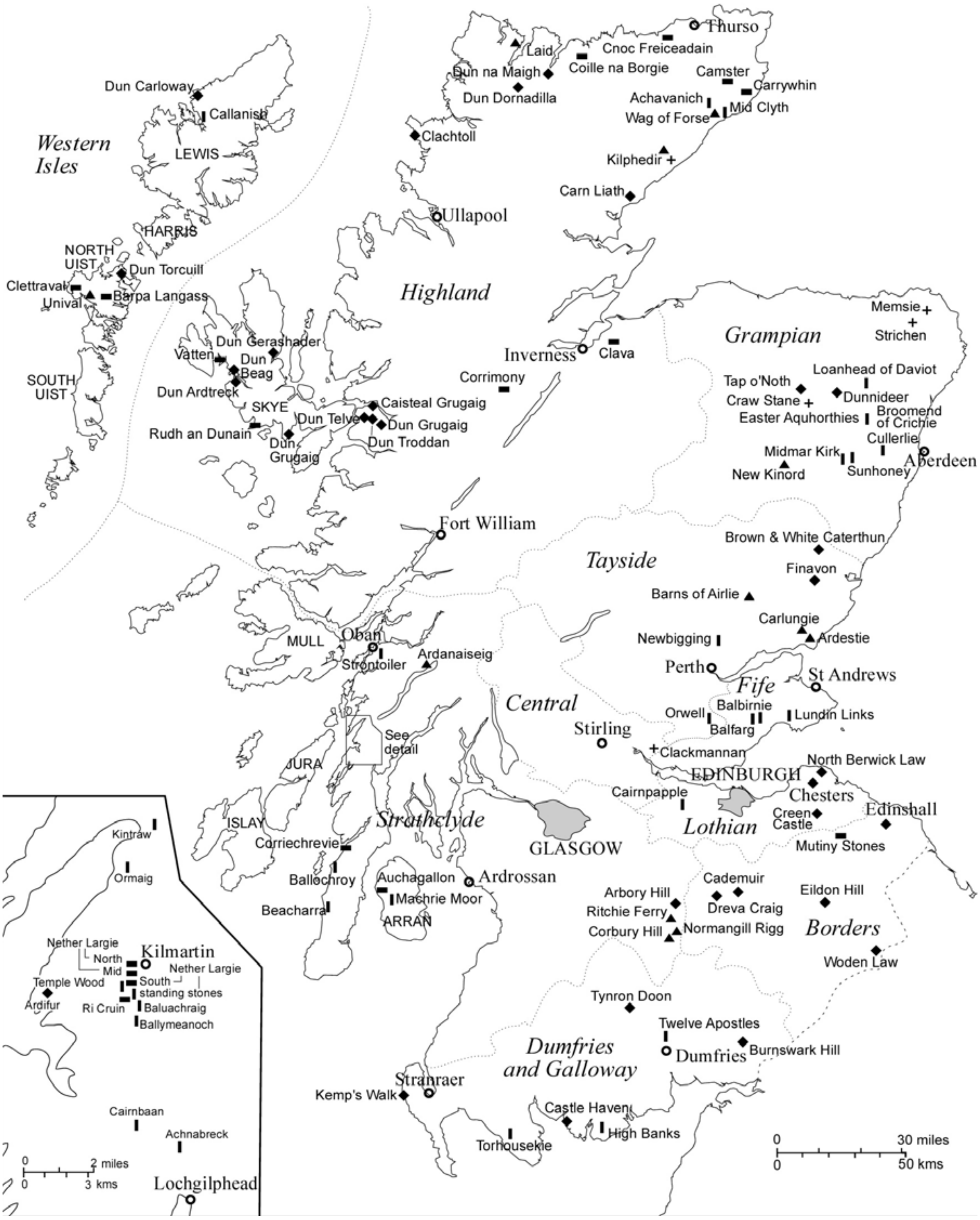


Figure 10 *These maps show in very general terms the distribution of the major prehistoric sites in Scotland. Databases quoted in the text indicate that there are many more small sites, often concentrated very close to the modern shoreline. (From MacSween and Sharp, 1989).*

4.3 An event which needs to be taken into account especially in SEA5 is the Storegga Submarine Slide, which occurred off the coast of Norway in about 7200 BP, and caused a tsunami which has been detected in coastal sediments on land on the east coast of Scotland (Dawson *et al.,* 1988; Long and Holmes, 2001) (Fig. 11). At the date of the submarine landslide the sea level was still 20-30m below present, and Dogger Bank was a promontory connected to north Germany, while the land bridge from the Netherlands to the Humber coast had recently been inundated (Fig. 3d and e). For reasons explained in paragraphs 2.9-2.10 above, much of the east Scottish coast was close to a similar relation to sea level as it is now, since both were rising at about the same rate. The tsunami wave locally may have penetrated several hundred metres inland, with a run-up of 1-2m in open area, and much greater in enclosed lochs. Long and Holmes (2001) suggest that the human impact would have been small, due to the low population (*op.cit*. p.365). The impact may have been greater on the north shore of the Dogger Bank, if people were living there, and in the estuary of the Elbe.

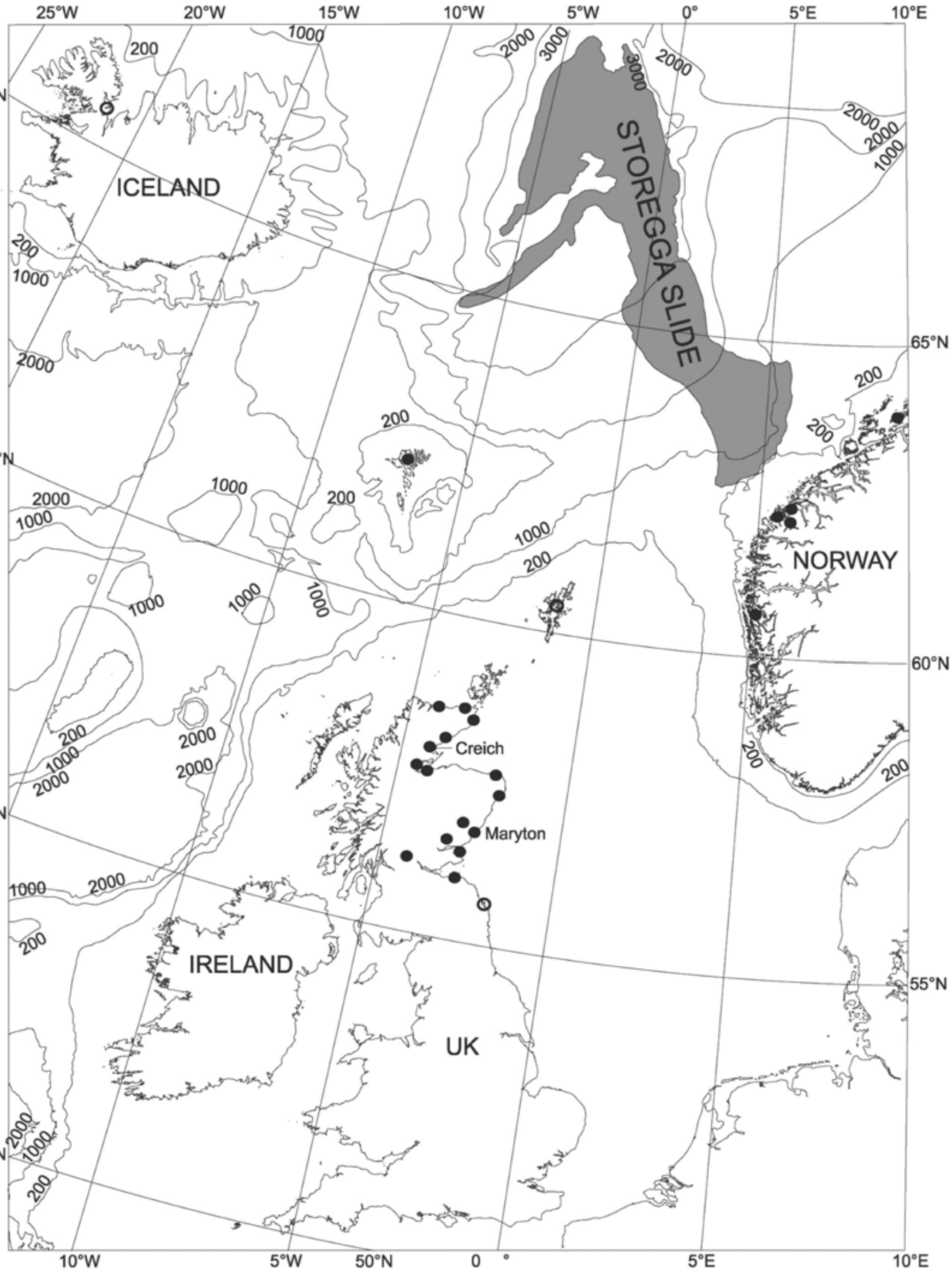


Figure 11 *Map of tsunami deposits attributed to the Storegga Slide. Solid dots - sites dated to about 7200 yBP. Open dots - sites undated.*

4.4 To illustrate the kind of occupation which may have occurred in the northern North Sea in the period around 10,000-9500 BP we can consider the research conducted in Denmark and the proposals put forward by Anders Fischer regarding the probable occupation pattern (Fig. 12). In this model the people lived dominantly on the coast, and supplemented their diet with seasonal reindeer hunting camps in the interior. Movement between these two locations followed the rivers, probably using boats. (Fischer 2004).

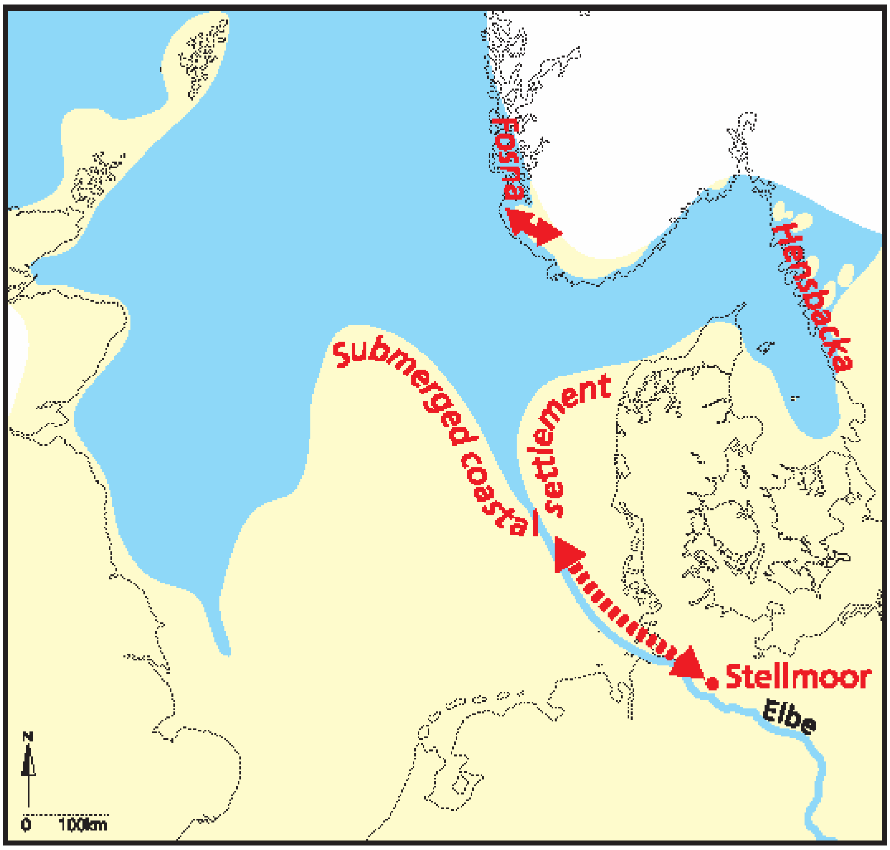


Figure 12 *A model of settlement patterns in the eastern North Sea at about 10,000 to 9,500 BP. People moved seasonally between the coast and inland. The Ahrensburgian coastal habitation is well documented in Norway and West Sweden, where it is known as Fosna Culture and Hensbacka Culture respectively. The map is partly based on Lambeck (1995), Coles (1998) and Bang-Andersen (2003). (From Fischer 2004).*

4.5 Viking Bank is just outside SEA5, towards the median line. Vibrocore number 60+01/46 obtained as part of a BGS programme in the UK shelf produced a worked flint from a point 150km north-east of Lerwick, near Viking bank, in a water depth of 143m (Long *et al*., 1986) (Fig. 13). The artefact has been submitted to the National Museum of Antiquities of Scotland. This artefact is unique on a global scale, both in terms of its water depth, and its distance from the present shore.

4.6 The location of the core was 60^{o} 42.3'N, 1^{o} 40.3'E. The core location appears on the BGS sediment map for Halibut Bank. The artefact is made of fine, dark grey patinated flint, and is 21mm long, weighing only 2.6g. It has been retouched to make a steep face, and may also have been broken by accident. Scrapers of this kind exist at a number of sites, and it can be attributed to the Upper Palaeolithic (Long *et al.* 1986, p.59). The core was 1.7m long, and consisted of 50cm of silty sand overlying 10cm of pebbly muddy sand with many shell fragments and frequent whole shells. Beneath this is 1.0m of clay with shell fragments, and a basal layer of poorly sorted pebbly sand. The flint was found 28cm below the surface in the Holocene silty sand. Long *et al*. (*op.cit.*p.57) conclude that the layer is a lag deposit formed when the marine transgression reworked sediments in shallow water, and the flint comes from a nearby archaeological site on land exposed prior to the transgression.

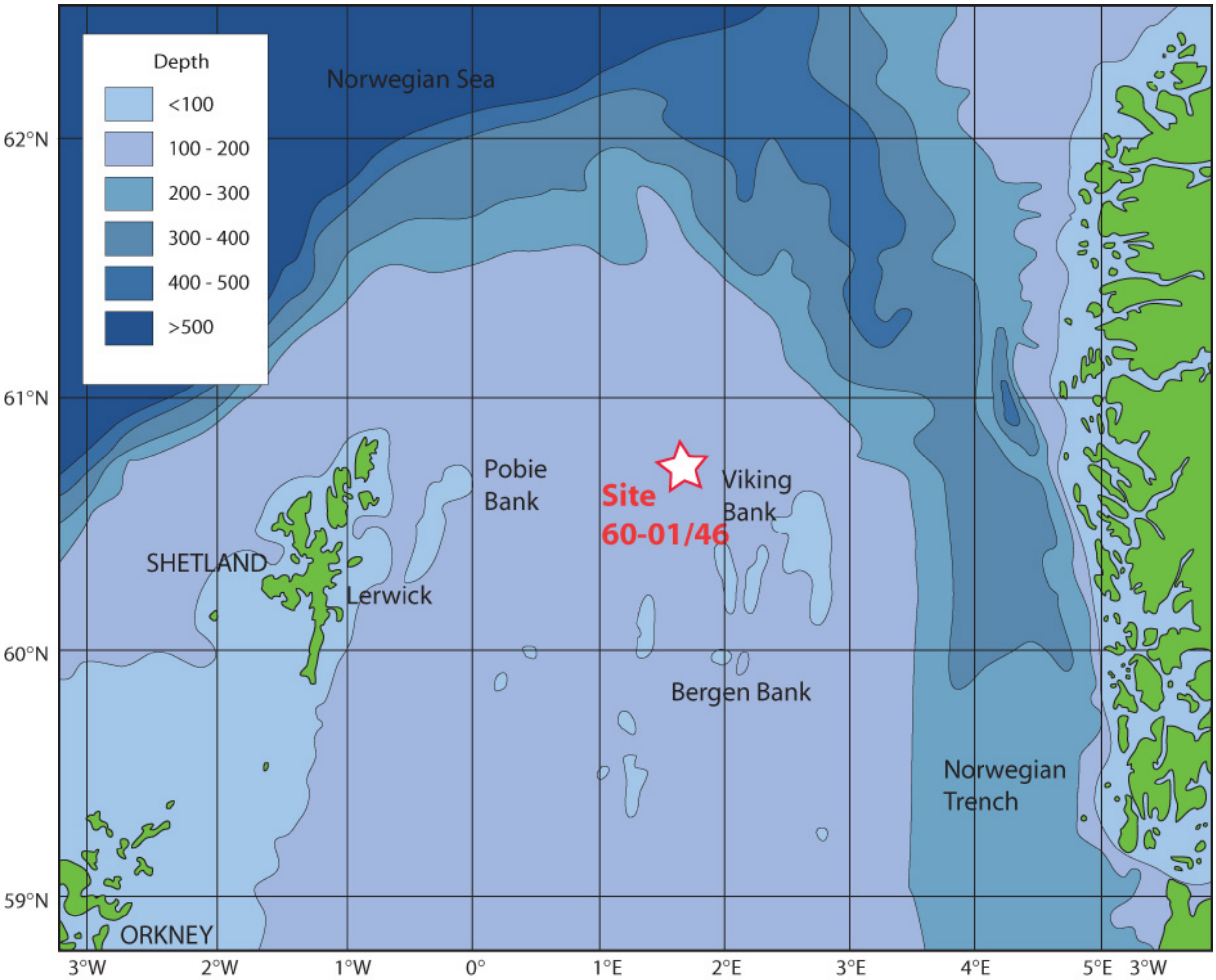


Figure 13a *Bathymetric map of the Northern North Sea showing site 60+01/46 and localities referred to in the text. (Contours in metres below sea level).(From Long et al.1986).*

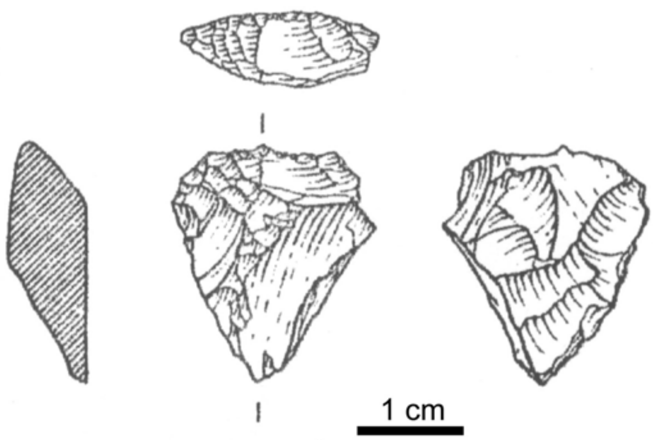


Figure 13b *The flint artefact (From Long et al. 1986).*

4.7 The lowest indicators of sea level on the present seabed are at depths of the order of 180-190m, dating from approximately 15-16,000 years BP (Carlsen *et al.* 1984). The position of the ice caps and sea can be seen on Fig. 2, c & d. As the local ice caps retreat the land comes up faster than the global sea level so that the dry land area is at a maximum around 16,000 to 14,000 years BP (Fig. 2d). Peacock (1995,p.1040) dates the gravel and shell-hash layer below the Holocene sands in the core to about 11,000 years BP. Around this time band the flint tool could have been lost on the continental shelf at the observed location (Fig. 2e). By 11,500 years BP a sea level stand caused a wave-cut platform to the north of the sample area, and the Viking and Bergen Banks existed as islands (Rise and Rokoengen, 1984). The sea level subsequently rose rapidly, and there was little subsequent deposition, although there was reworking of shallow sediments.

4.8. In conclusion of this section, SEA5 is a more difficult area in which to predict the occurrence of prehistoric remains than either SEA2/3 or SEA4. The close proximity of the Viking flint is important, as are the various pieces of circumstantial evidence from northern England, Germany and Denmark. The rich coastal prehistoric remains of Orkney and Shetland also lend credibility to the thesis that there could be further submerged artefacts in SEA5. Several projects and proposals are being developed this year (2004) regarding prehistoric research on the coast of Scotland and around the Dogger Bank, and in the next few years we have a better understanding of the regions bordering SEA5.

5. Consideration of the potential impacts of oil field operations on submarine prehistoric archaeological remains

5.1 SEA5 is a very difficult area for submarine prehistoric archaeology apart from the sea areas within the archipelagos of Orkney and Shetland, and the immediately adjacent waters shallower than about 30m. Within this area the prospects are quite good that artefacts may remain trapped in bedrock gullies, or in caves. In view of the sophisticated structural techniques and the range of symbolic features such as standing stones and cairns, there could be interesting and valuable discoveries beneath the sea close to the islands. In deeper water, it would be very difficult for sports divers or research divers to find archaeological remains, and it would be very expensive to conduct academic research projects.

Offshore hydrocarbon prospecting and exploitation have several phases of activity which could impact on submarine prehistoric archaeology.

i) Coring of seabed to investigate pipe routes and foundation engineering for platforms.
ii) Emplacement of platforms, concrete gravity, jacket or jack-up. Consider the total footprint of the platform, and associated support systems.
iii) Permanent anchors for semi-submersible platforms.
iv) Pile driving.
v) Drilling and running casing.
vi) Pipe entrenching.
vii) Coastal entrenching, terminals, docks, shoreside structures, jetties.

5.2 The total area of sea floor disturbed, excavated, or drilled in the course of these activities is small compared with bottom trawling, aggregate dredging or beach replenishment, but there is always a chance that a single core may penetrate a prehistoric site, as in the case of the Viking Bank core, or that a trench for a pipeline will intersect one or more prehistoric sites over the tens or hundreds of km of burial. All shallow sediment cores sampling the top 1-10m of sediment in sensitive areas should be checked routinely for prehistoric materials.

5.3 The excavated sediment from pipe entrenching machines is not brought to the surface, but is ploughed or jetted to the side of the trench, there is thus no chance at present to investigate the occurrence of prehistoric artefacts in the sediments. Consideration should be given to some way of monitoring this process, either by recovering sediment, or close video inspection by ROV. Prehistoric artefacts have been retrieved from 50m depth by ROV and clamshell grab (Josenhans *et al*., 1997) off British Columbia.

5.4 Trawling and dredging both disturb the upper 0.5-1.0 metre of sediments over large areas, but are outwith this report. The offshore aggregate industry already has a very healthy collaborative relationship with the academic archaeological community, and indeed funds from the industry provide support for some very important excavations. Many land excavations have been started by good observations from industry workers. Louwe Kooijmans has shown that fishermen also can become prolific sources of information and assistance in retrieving subsea archaeological materials. The Solent fishery demonstrates the same point, with some of the local fishermen having collections of flint tools which are catalogued by the County archaeologist, but left in the possession of the finders.

6. Consideration of the opportunities presented by oil and gas operations in an area for site/artefact identification, e.g. seismic survey, sub-bottom profiling, coring, ROV

6.1 The previous discussion shows that, given sensible preparation, briefing, and mutual understanding offshore industries can actually serve the archaeological community. It is not within the terms of this report to make specific proposals of this nature, especially since the cost implications and time lost (if any) are not immediately apparent. However, on the assumption that some staff time, funds, and assistance might be available, the following paragraphs show that activities of the offshore oil and gas industry could be positively helpful, with appropriate monitoring.

6.2 Acoustics

Acoustic surveys of various kinds can contribute to the discovery of submarine prehistoric sites, but, to date, only through circumstantial identification of likely topographic and stratigraphic conditions. No acoustic system has yet been used successfully to demonstrate that a particular structure or surface feature contains worked flints, shell midden deposits, charcoal, carved wood, or bones. Swath bathymetry, side-scan sonar, and conventional shallow sub-bottom profiling can identify a drowned beach ridge or river valley, or similar features of archaeological relevance beneath a few metres of modern sediments. Recent data analysis by Gaffney (2004) at the University of Birmingham has shown that river valleys and beaches can be revealed in 3 dimensions beneath overlying sediment, permitting subsequent visualisation. This technique should be applied whenever possible to review the possible locations of prehistoric settlements on rivers, estuaries, and in sheltered bays.

6.3 Chirp technology can show fine-scale stratification which gives strong clues, but physical sampling by core, grab, or diving, or ROV has always proved essential to establish existence of a submerged prehistoric site. No cross-correlation check has been carried out using high frequency, high resolution acoustics over known submarine prehistoric sites to test signatures of anthropogenic materials. The Danish experience, where acoustics are used routinely to select optimal diving sites on the basis of topography suggests that no such direct signature yet exists. Ongoing work in Norway and Denmark indicates that some data on this problem will soon be available, at least regarding large features such as wooden posts Consideration of the wavelength of high frequency sound, which is of the order of 4-15 mm in the frequency range 400-100 kHz, suggests that the resolution could not distinguish shapes at the level required to identify worked flints. Medical type acoustics at 4 MHz has a penetration of only 20-30cm.

6.4 Coring, grab samples, and site investigation

Coring and sampling of seabed sediments can identify sedimentary facies, and detect material such as peat, beach gravels, clay, deltaic muds, and organic materials indicating age, and pollen indicating vegetation, temperature, and shells indicating salinity. BGS cores and commercial cores which have been archived provide a massive body of data which has not been exploited archaeologically. In future, any planned core or grab sample investigation by offshore operators should be checked against the list of archaeologically sensitive areas, and in the high-probability archaeological zones the cores must be examined for archaeological signals.

6.5 Dredging and pipe entrenching

Bulk movement of seabed sediments has the potential to damage prehistoric sites in the SEA5 area very seriously. Paradoxically, in the SEA5 area, this may be the only way that archaeologists could ever discover sites in water more than a few tens of metres deep. As mentioned in para. 5.3 such operations should be monitored or sampled at intervals to check for artefacts or designated indicators.

6.6 Avoidance

Acoustic systems and seabed sampling create the potential to gain advance warning of the probable presence of prehistoric sites, and hence to plan avoidance of intervention. Avoidance would usually increase costs for the operator. Repeated instructions to avoid newly indicated potential sites would complicate logistics and add more to costs. Over-sensitive thresholds for site avoidance would ensure that no artefacts were recovered, and no sites discovered for archaeological research. It follows that avoidance criteria should be set at a coarse, non-sensitive level. Mandatory instructions to divert or delay operations should only be considered after human artefacts or mammal bones have been recovered. Even then it is possible that the decision would be to monitor operations and the sediments disturbed on a 100% basis, rather than avoid the site.

6.7 Preservation in situ

The legally preferred method of preserving submarine archaeological sites is *in situ* (see Section 1.11). Strictly speaking this means no disturbance at all, but discovery and research does involve disturbance, unless the artefact is on the surface. The objective is to balance over time the sum total of acquired and published knowledge and the sum total of preserved artefacts left *in situ* for future generations. Research excavation underwater increases knowledge but destroys sites. Undiscovered sites represent future knowledge, but present ignorance. The marine environment in SEA5 is high energy, with strong tidal currents close to the coast, and exposure to storms from the north. Waves and currents erode sites constantly, if they exist, so that there is a powerful argument to discover and excavate sites, monitored under academic supervision. This approach differs from the management protocols of the Danish archipelago, where hundreds of submerged sites are known, and the great majority are preserved *in situ*. Preservation *in situ* in the open sea area of SEA5 is indistinguishable from deliberate neglect, unless it can be proved that sediments are stable or accumulating over the site.

6.8 Conclusion to section 6

Offshore oil and gas operations, and the sub-contracted services, present a good opportunity to discover and record submarine prehistoric sites in SEA5, outside Territorial Limits. Regulations and Avoidance criteria should be set a level such that acoustic surveys and sampling systems have the maximum chance of physically proving the existence of archaeological sites.

7. Summary of existing practices regarding the reporting, investigations and protection of prehistoric and archaeological remains

7.1 The Outer Continental Shelf legislation in the USA requires offshore operators to conduct extensive pre-disturbance and avoidance surveys before starting operations, so as to protect prehistoric archaeological sites, as well as shipwrecks. By the early 1980s the situation was attracting severe criticism because hundreds of millions of dollars had been spent, and no prehistoric artefacts had ever been found on the outer shelf, and no academic search was being conducted for remains. During the same period American marine archaeologists working on minuscule budgets, and usually assisted by large teams of volunteers, were studying palaeo-indian prehistoric sites in water depths up to 10-20m at many locations on all sides of the USA (e.g. Stright, 1990; Cockrell and Murphy, 1978; Ruppé, 1981). Flemming (1981) wrote to comment on the absurdity of this position. UK regulations should avoid repeating this mistake.

7.2 The assumption behind a strict code of *in situ* preservation us that academic institutions or statutory regulatory bodies will both discover, classify, and excavate sites, and have sufficient funds to prove or disprove the existence of artefacts in high-potential areas. For the SEA5 area outside the internal waters of the Orkneys and Shetland and outside Territorial waters this is incorrect. Only commercial companies can justify the cost of seabed work in these conditions. It is therefore preferable to allow commercial companies to proceed in the manner which is technically and economically the most efficient, and to monitor the archaeological impact. When the existence of a site is certain, then academic resources should be deployed to monitor, and, if suitable, excavate.

7.3 BMAPA and English Heritage (2003) have developed a detailed protocol for the management of archaeological sites impacted by aggregate dredging, and the principles developed in that document could be adapted to the offshore sector. Notwithstanding the fact that aggregate dredging is not a major industry in Scottish Waters, this document still provides a valid basis for assessing obligations offshore. Expert groups such as the ADU, the Hants and Wight Trust for Maritime Archaeology, and the Nautical Archaeology Society in Scotland, should be consulted. Sites need to be reported and studied whenever possible. Procedures could be recommended consistent with BMAPA and RCHME schemes in England to encourage and promote the reporting of sites with a minimum interference with work schedules. Notice of intention to carry out operations or to disturb the surface sediments in key areas is the major step. Within Scottish Waters the recording of sites would presumably become part of the NMRS managed by RCHAMS.

7.4 The work of Louwe Kooijmans and van der Sluis produced hundreds of palaeontological finds, and some prehistoric artefacts, in less than 10 years by collecting materials reported by Dutch fishermen who were fishing on the UK side of the median line (See the SEA3 Report, Flemming, 2002). Post (personal communication) has confirmed that many tons of Pleistocene terrestrial mammal bones are landed by Dutch fishermen each year. Further documentation of the palaeontological finds from the southern North Sea are provided by Glimmerveen *et al.* (2004). A few finds (Dogger, 1832, Leman/Ower 1932) were also reported by UK fishermen. But the discrepancy is not really explicable. There must be material in many other areas, even allowing for the different geology and sedimentary regime in the northern North Sea and north-western approaches, where active modern marine sediments are sparse. Preliminary enquiries suggest that Scottish fishermen are retrieving small quantities of palaeontological items, and this line of analysis should be followed up so as to identify the areas which may have supported *in situ* mammal populations, and where bones have been transported into areas by glacial transport or post-glacial run-off. If an *in situ* fauna can be identified, this would be an indicator towards the possibility of human occupation. In this sense, all industries offshore which have the potential to impact or disturb prehistoric archaeological materials may provide data which impact on the management of offshore prehistoric archaeology as a whole.

8. Recommended mitigation measures to prevent damage to prehistoric and archaeological remains from oil and gas activities. These should draw on, and where appropriate be concordant with, draft guidance produced by BMAPA and RCHME

8.1 The objective is to achieve a constructive and positively beneficial relationship between the offshore oil and gas activities in sector SEA5, and the archaeological research community, and associated legislation, both national and international. As already pointed out, the marine aggregates industry is minimal in Scottish Waters, and the equivalent body to RCHME in Scotland is RCHAMS. Nevertheless, the obligations and procedures worked out by BMAPA and RCHME do exist, and DTI has instructed in the terms of reference of this report that the recommended procedures for the offshore oil and gas industry should be consistent, both in terms of contiguous geography and as between different industries.

8.2 The following comments are intended to suggest the areas of discussion which might promote and maintain such a relationship. None of these comments should be regarded as assuming any particular outcome of that discussion process.

8.3 The first question to consider is whether any known areas within SEA5 should, on the present evidence, be restricted in such a way that offshore hydrocarbon activity of any kind should be curtailed or banned. Since Historic Scotland already has the responsibility to manage and protect sites out to the 12 mile limit, this discussion will only apply to the sea bed beyond that limit. Notwithstanding possible legal arguments which could suggest that such pre-emptive restrictions might be desirable, we need to consider the practical effects for archaeology, in addition to the economic and industrial impacts. The experience with the OCS legislation on archaeology in the USA shows that when such regulations are rigidly enforced, large sums of company money are spent in pre-disturbance and avoidance surveys, and no archaeological artefacts are ever discovered. Meanwhile cash-strapped archaeological teams struggle to recover deposits of prehistoric artefacts found in the coastal zone, usually assisted by sports divers. Since so many known artefacts have been retrieved in European waters by commercial activities from at least three major industries (Fishing, aggregate dredging, and port engineering), an overly restrictive policy would be self-defeating for archaeology, as well as expensive for industry.

8.4 The legal point of view might be that commercial exploitation of resources will disturb unknown archaeological sites, and may do damage before work is halted or diverted. Therefore exploitation should be restricted, or subject to exhaustive pre-disturbance surveys. While this may prevent commercial damage to sites, it also ensures that no sites will be discovered by archaeologists, while natural wave and current erosion will progressively destroy deposits anyway. In the high energy hydraulic regime of SEA5 the archaeological resource is continuously declining.

8.5 It is therefore in the interests of long term preservation of the archaeological sites, and in the interests of acquisition of archaeological knowledge, that we use industrial and commercial activities as a means of identifying archaeological prehistoric sites in the offshore area. On the coast and in shallow water and sites discovered will usually be known to the local authorities, and in most cases documented by RCHAMS and HS. The approach suggested here of encouraging and then monitoring industrial activity would only apply further offshore, perhaps outside Territorial Waters. There should be a logical continuity of the protocols at the Territorial Limit.

8.6 The ideal structure would require or encourage the industry and its sub-contractors to check whether their activities are in archaeological prospective zones, and to identify, and report, when their activities positively detect prehistoric artefacts, or, in the case of acoustic surveys, provide very strong evidence. If this can be achieved at minimal or acceptable cost/delay to industry, then there is a positive advantage in allowing operators to start activities in zones of archaeological potential, while avoiding positively identified sites, if any. The recent development of methods for reconstructing the Quaternary drainage pattern and landscape under modern sediments from existing archived seismic penetration surveys (Gaffney, 2004) suggests that this method should be used in those cases where there is any probability of seabed disturbance impacting prehistoric sites.

8.7 It may sound heretical to encourage industrial activity in all cases, but the conditions and circumstance in the SEA5 area need to be treated realistically. There is no comparison with the Danish situation where complex and relatively undisturbed sites, each with thousands of artefacts, are known to occur with a spacing of the order of 1-5km. This report has shown that SEA5 is one of the least prospective for archaeological material over much of the North Sea. Periods of occupation were bracketed in narrow time zones between retreat of the ice and successive periods of inundation and uplift. Even if there were originally quite a dense scatter of artefacts in the SEA5 seabed there are no means now for finding sites in the complex topographic conditions of low hills, moraines, rocky outcrops, gullies and depressions by surface observation. High resolution acoustics, both swath bathymetry and sub-bottom profiling would be useful, but some form of disturbance, dragging, dredging, coring or excavation is essential if we are to find anything at this stage. In coming years, if and when we know much more, this situation may alter, and limited areas could be strictly protected for future controlled research

8.8 The guidance notes for the aggregates industry have been formally published (BMAPA and English Heritage, 2003) in a booklet prepared by Wessex Archaeology, and illustrated with a number of excellent graphics showing types of prehistoric materials that have been found in the sea, and relating these to date and sea level. The guidance notes cover legislation, statutory controls, possible effects of aggregate extraction, obtaining archaeological advice, application procedures, assessment, evaluation, archaeological investigation, mitigation, and monitoring. An equivalent guide could be produced for the offshore oil and gas industry and its contractors.

8.9 In the SEA5 open waters it would be extremely difficult to mount a major excavation with strict site stratigraphy, and it is probable that, in the near future, academic activity would be limited to analysis of finds by commercial operators, and occasional dives to check for surface finds, possibly the Heriot Watt diving group on Orkney. When more sites are located and understood, excavation might become advisable, especially if a site revealed a major item such as a bog body in peat.

8.10 The success of this approach depends upon many more people in the commercial sector being aware that prehistoric artefacts could (admittedly with low probability) be present in almost any sediment recovered form the seabed in SEA5, and learning to recognise artefacts of flint, bone, and antler. It has been suggested that stone tools are so obscure that non-experts would never learn to recognise them. I doubt if this is true, and recognition kits or guidance notes could be distributed or posted as notices at very little cost. Since the older tools tend to be larger, there is a greater chance of recognising those artefacts which are the least likely to be found.

8.11 Excavation procedure: The responsibility for excavation of offshore sites rests with the archaeological authorities and the university research community. Any plans for excavation or submarine survey for archaeological purposes would be conducted in accordance with the standards of safety normal for offshore operations, and diving would be conducted in accordance with HSE regulations. This paper cannot comment on funding in regard to offshore archaeological projects.

Acknowledgements

In May 2003 English Heritage organised a Workshop entitled "Submarine Prehistoric Archaeology of the North Sea", and the proceedings are now in press, due to be published later in 2004 by the Council for British Archaeology. The papers presented at that Workshop have prompted me to think speculatively, but I hope responsibly, about the complex of events controlling human cultures in the northern North Sea during and since the last glacial maximum. Some of the ideas presented in this report are based on those papers, which I have cited with credit to the authors. Any distortion or misinterpretation of their writing is my fault.

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Annexe 1 - Articles 149 and 303 of UNCLOS

Article 149. Archaeological and historical objects

All objects of an archaeological and historical nature found in the Area shall be preserved or disposed of for the benefit of mankind as a whole, particular regard being paid to the preferential rights of the State or country of origin, or the State of cultural origin, or the State of historical and archaeological origin.

Article 303. Archaeological and historical objects found at sea

1. States have the duty to protect objects of an archaeological and historical nature found at sea and shall co-operate for this purpose.

2. In order to control traffic in such objects, the coastal State may, in applying article 33, presume that their removal from the sea-bed in the zone referred to in that article without its approval would result in an infringement within its territory or territorial sea of the laws and regulations referred to in that article.

3. Nothing in this article affects the rights of identifiable owners, the law of salvage or other rules of admiralty, or laws and practices with respect to cultural exchanges.

4. This article is without prejudice to other international agreements and rules of international law regarding the protection of objects of an archaeological and historical nature.

Annexe 2 - Acronyms

AMS	Accelerator Mass Spectroscopy
AHOB	"Ancient Human Occupation of Britain" project
BMAPA	British Marine Aggregates Producers Association
BGS	British Geological Survey
CBA	Council for British Archaeology
DCMS	Department of Culture, Media, and Sport
DTLR	Department of Transport, Local Government, and the Regions
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EU	European Union
HS	Historic Scotland
MoD	Ministry of Defence
NAS	Nautical Archaeology Society
NHA	National Heritage Act 2002
NMR	National Monuments Record
OCS	Outer Continental Shelf, (legislation, USA)
RCHME	Royal Commission on the Historical Monuments of England
RCHAMS	Royal Commission on Historic and Ancient Monuments for Scotland.
ROV	Remote Operated Vehicle
TttW	"Taking to the Water". Policy statement of English Heritage, 2002
UCPUCH	UNESCO Convention on Preservation of the Underwater Cultural Heritage
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea 1982
UNESCO	United Nations Educational, Scientific and Cultural Organisation.
VC	Valetta Convention, European Convention on the Protection of the Archaeological Heritage (Revised) 1992