Chapter 12
Heritage Management and Submerged Prehistory in the United Kingdom

Andrew Bicket, Antony Firth, Louise Tizzard and Jonathan Benjamin

Introduction

Knowledge of (at least partially) submerged prehistoric sites in the UK has existed since at least the early nineteenth century (e.g. Dawkins 1870); however, recent decades have yielded considerable advancement in the study of submerged prehistory in the UK. One of the major drivers of research in submerged prehistory in the UK has been the Marine component of the Aggregates Levy Sustainability Fund (ALSF, referred to as MALSF below), which ran between 2002 and 2011 (Bicket 2011). The Aggregates Levy is the tax on aggregates (sand and gravel) extracted from the many offshore licence areas (owned in the UK by The Crown Estate) that are concentrated mainly in the east, south and west coasts of England and Wales (Fig. 12.1). A proportion of the levy was redistributed as funding for research into the impact of aggregate dredging upon the environment. Conducted primarily as a form of mitigation, funded research topics included oceanography, hydrography, ecology, maritime and aviation archaeology and submerged prehistory. As a consequence, much of the existing large-scale research in submerged prehistory has

A. Bicket (✉)
Coastal & Marine, Wessex Archaeology, 7/9 North St David Street,
Edinburgh, EH2 1AW, UK
e-mail: a.bicket@wessexarch.co.uk

A. Firth
Fjordr Limited, Post Office House, High Street,
Tisbury, SP3 6LD, Wiltshire, UK
e-mail: ajfirth@fjordr.com

L. Tizzard
GeoServices, Wessex Archaeology, Portway House, Old Sarum Park,
Salisbury, SP4 6EB, UK
e-mail: l.tizzard@wessexarch.co.uk

J. Benjamin
Department of Archaeology, Flinders University, GPO BOX 2100,
Adelaide, SA 5001, Australia
e-mail: jonathan.benjamin@flinders.edu.au

A. M. Evans et al. (eds.), *Prehistoric Archaeology on the Continental Shelf,*
DOI 10.1007/978-1-4614-9635-9_12,

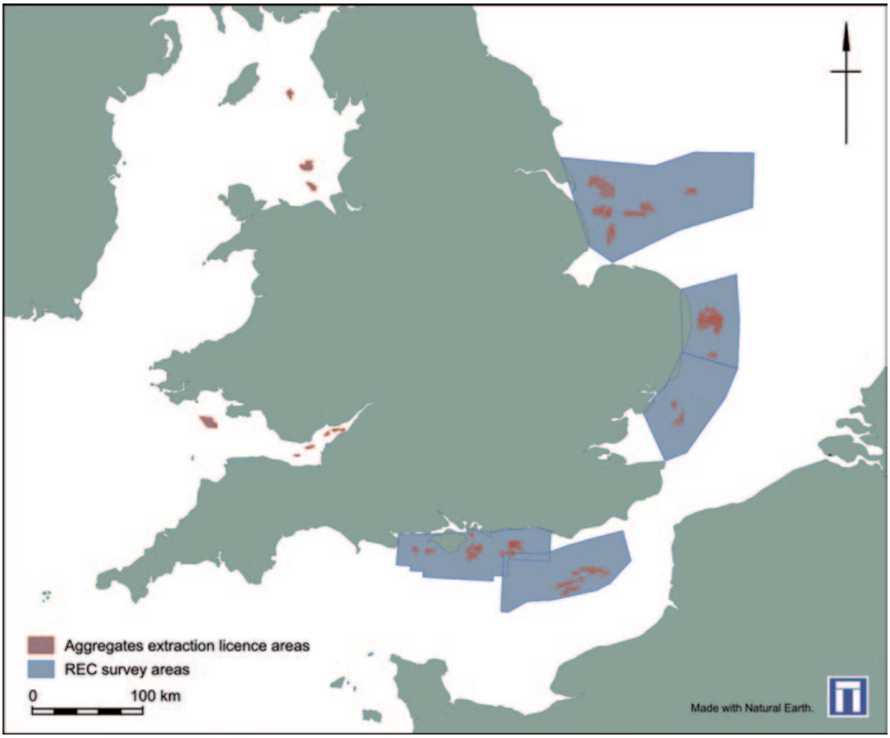

Fig. 12.1 Composite licence area, seabed prehistory and REC (Regional Environmental Characterisation) data. Much of the existing large-scale research on submerged prehistory has focused on areas near aggregate extraction in England and Wales

focused on areas near aggregate extraction in England and Wales (Fig. 12.1). By the end of the MALSF early in 2011, around £3 million had been distributed for cultural heritage research to recipients across the UK including universities, charities and commercial companies. A significant proportion of the fund has supported the investigation of submerged prehistory and offshore paleolandscapes.

A principle finding of the MALSF research projects was that submerged paleolandscapes are preserved beneath the seabed and over considerable areas (Gaffney et al. 2007, 2009; Emu Ltd. 2009; James et al. 2010). Depending upon the severity of glacial scour and other processes of erosion and degradation during the Quaternary, the potential exists for Paleolithic (c. 900,000–10,000 BP) and Mesolithic (10,000–6,000 BP) archaeology to survive in marine contexts. This potential has been demonstrated by MALSF research projects, but as yet the widespread presence of prehistoric remains, in particularly, discrete sites have remained elusive. For example, several of the Regional Environmental Characterisation (REC) projects have highlighted the presence of submerged sedimentary facies across very large areas of seabed that were once dry land which have the potential to contain in situ Lower Paleolithic archaeological materials; from periods dating to around 720,000 BP in the Outer Thames (Emu Ltd. 2009), 500,000 BP in the South Coast region (James et al. 2010) and 700,000 BP in the central and southern North Sea (Limpenny et al. 2011; Tappin et al. 2011) (Fig. 12.1).

Geophysical survey and paleoenvironmental analyses enable researchers to create large-scale reconstructions of paleolandscapes. Nonetheless, the reconciliation of conceptualised paleolandscapes (as context) and physical sites has not yet been fully realised. There are few known submerged sites in UK waters but significant reports of chance finds of artefacts and Pleistocene megafaunal remains provide undeniable evidence of the potential for discrete deposits of prehistoric material, such as those examined within Area 240 (discussed in further detail below). The contribution that geoarchaeological investigation of landsurfaces and deposits can make to understanding 'conventional' archaeological material such as artefacts and structures is considerable, especially for earlier prehistoric periods when such artefacts and structures are relatively ephemeral, widely dispersed and often reworked into secondary contexts (Hosfield and Chambers 2004). Where artefacts or structures are present, it is likely that the surfaces and deposits in which they are embedded will provide integral context to their understanding and interest.

The integrated methodologies and primary data produced thus far have informed fundamentally our view of the archaeological potential of our coasts and offshore areas. Currently, research undertaken through development-led archaeology, collaborative research projects and consultation with a broad cross section of marine stakeholders is likely to produce further results and significant discoveries. This will result in a continued realisation and improved understanding of submerged archaeological material. In turn, this will also support the seamless approach to heritage management of prehistoric sites and landscapes, both above and beneath the sea.

The Paleogeography of the United Kingdom

Great Britain as an island is the paleogeographical exception rather than the rule (Fig. 12.2). A peninsula for most of the last 1 million years, Great Britain has only relatively briefly been separated from Eurasia during the recent geological time. Large areas of now submerged, potentially inhabitable land in the central and southern North Sea, Irish Sea and a significant coastal band around the majority of the rest of the British Isles coastline have, for example, been inundated since the last ice age as the global sea level rose by around 120 m to their present levels (Fairbanks 1989; Bailey and Flemming 2008).

These now submerged paleolandscapes may have provided ideal conditions for hominins, their prey species and exploitable fauna and flora. The ability to investigate these potential archaeological resources following the last ice age (or previous Pleistocene glacial–interglacial cycles) is complicated in the UK by the complex interplay of several global-, continental- and regional-scale variables, i.e. eustatic sea level change (Shennan and Horton 2002; Shennan et al. 2006), glacio-isostatic tectonic readjustment (Lambeck 1995; Bradley et al. 2009), and the development of coastal geomorphology driven partially by these larger-scale processes (e.g. Smith et al. 2010). Moreover, the preservation of submerged and intertidal archaeological

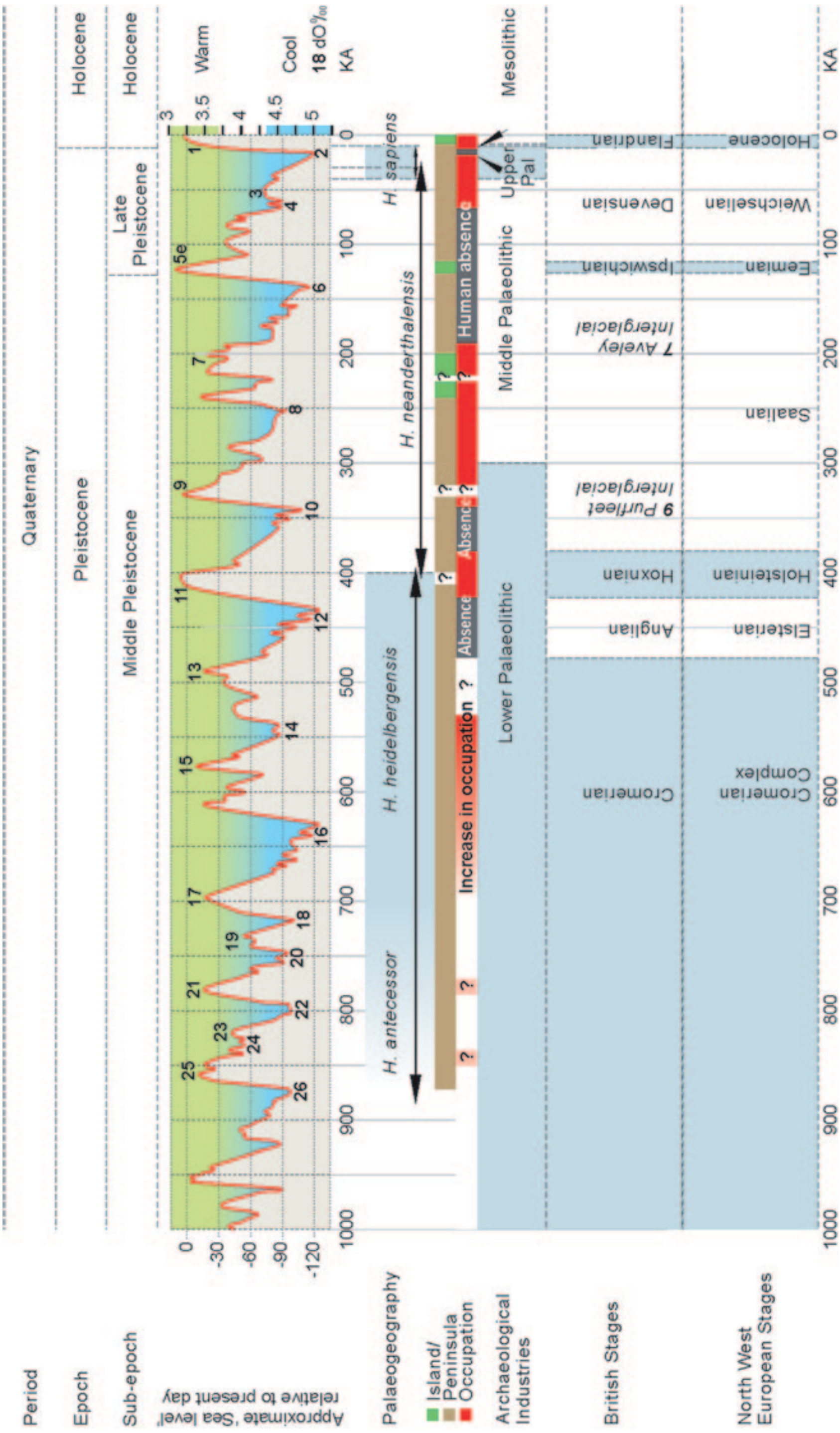

Fig. 12.2 Great Britain as an island is the palaeogeographical exception rather than the rule

material is influenced by high-energy processes such as glacial erosion (either directly by ice scour or subsequently by meltwater), tidal and wave action, and storms. It is also assumed that the high-energy Atlantic and North Sea coasts of the UK compared to more sheltered regions such as the south westBaltic (Fischer 1995; Lübke 2011) induce a further level of complexity for our investigations, suggesting that the preservation of archaeological material and sediments of paleoenvironmental interest is at worst removed, and at best fragmentary and problematic to investigate. Realistically, this may be so in many cases, but as it stands this assumption has not been proved. The corpus of submerged prehistory investigations is far from comprehensive around UK shores. The necessarily sparse spatial and temporal scale at which existing MALSF paleolandscapes projects like the North Sea Palaeolandscapes Project (Gaffney et al. 2007, 2009), RECs (Emu Ltd. 2009; James et al. 2010, 2011; Limpenny et al. 2011; Tappin et al. 2011) and The Relict Palaeolandscapes of the Thames Estuary Project (Dix and Sturt 2011) is also not sensitive to detecting discrete sites except by chance. Where large-scale research has taken place, a wealth of paleolandscape data has been retrieved but with very few sites being added to the catalogue. More focused investigations such as at Bouldner Cliff (Momber et al. 2011) and Area 240 (Tizzard et al. 2011) are clearly more suitable for examining a particular deposit of archaeological interest but not to a broader prospection for unknown sites across a region. Clearly, a balance must be struck between the regional identification of archaeological potential and the detection of smaller-scale sites to specifically define the archaeological significance and importance of in situ submerged offshore sedimentary deposits undisturbed by millennia of degradation by coastal-, glacial- and human-induced processes.

Directly through the MALSF, the commissioning of Regional Environmental Characterisation surveys (RECs) over large study areas surrounding the main clusters of aggregates extraction areas in the South Coast, East English Channel, East Coast, Outer Thames and Humber regions (Emu Ltd. 2009; James et al. 2010, 2011; Limpenny et al. 2011; Tappin et al. 2011) has led to a greater understanding of the level of preservation of submerged sediments of archaeological interest and the development of best-practice for identifying their traces from both geophysical and geotechnical survey datasets. The methods that underpin the examination of buried landscapes within the RECs were initially developed for the management of cultural heritage that may have been impacted by port dredging and aggregates extractions (Firth 2000). These integrated methods were then scaled up during earlier MALSF projects, particularly Seabed Prehistory, undertaken by Wessex Archaeology and others between 2004 and 2008 including investigations of the palaeo-Arun river (Gupta et al. 2004; Wessex Archaeology 2009).

Post-MALSF, this best-practice methodology continues to inform the examination of submerged prehistory through various offshore sectors including aggregates extraction and renewable energy schemes. Research such as that done under the auspices of the MALSF and RECs has produced high-quality deliverables that provide new insight for interpreting the terrestrial archaeological record in a continuum from land to sea (James et al. 2010). For example, during the South Coast REC survey, seamless 3D palaeogeography models of internationally important archaeological landscapes such as the south coast of England were developed and analysed for a period of 500,000 years through the integration of substantial spatial datasets such as the SRTM digital elevation model (James et al. 2010) and offshore geophysical survey data (James et al. 2010). This research reinforces the regional context of key Paleolithic sites such as Boxgrove within a scientifically based interpretation of the regional paleolandscape at various periods during the last 500,000 years (James et al. 2010). By understanding the configuration of the coastline, the land during a given period of time becomes a much more holistic and robust paleogeography in which to interpret the archaeological and paleoenvironmental records.

As has been shown by the Seabed Prehistory project, published in eight volumes (Wessex Archaeology 2009), the subsequent RECs and other significant MALSF-supported paleolandscape reconstruction projects, e.g. North Sea Palaeolandscapes Project (NSPP) (Gaffney et al. 2009), West Coast Palaeolandscapes Project (Fitch and Gaffney 2009), these offshore, buried landscapes are characterised by familiar features such as river systems (e.g. the paleo-Arun river investigated by Gupta et al. 2004), marshes, estuaries, hills and lakes that could have supported a rich and diverse array of species including early hominins when climatic conditions were suitable. There is, therefore, potential for these submerged landscapes to preserve archaeologically significant Paleolithic and Mesolithic archaeology (Wenban-Smith 2002; Westley et al. 2004). In addition, tantalising potential for as-yet unpopulated phases of the Pleistocene, predominantly the Ipswichian interglacial (MIS 5e, 130–110,000 BP), have also been suggested by palaeogeographic reconstructions of the English South Coast and East English Channel (James et al. 2010; Arnott et al. 2011). If colonised by humans, a significant reassessment of this period would be required hinting at the potential for offshore locations to provide insights that have so far eluded terrestrial-based investigation.

With sufficient resources in time, data and industry collaboration, this kind of enlightening and progressive paleolandscape research provides real context for making informed and effective decisions when managing cultural heritage offshore over large areas of the seabed.

Developing the Management of Submerged Prehistoric Archaeology

The MALSF had a major and positive impact on the ability of the marine aggregate industry to deliver sustainable development for the historic environment, in line with the high-level marine objectives of the UK[1]. Before the MALSF, which first came on-stream in 2002, the aggregates industry was making major strides in assessing the possible impacts on the archaeological heritage of individual licence proposals, through licence-specific Environmental Impact Assessment (EIA) and small strategic projects. The process of applying for individual aggregate dredging licences, accompanied by EIA, provided the basic structure for the sorts of archaeological work that were being carried out. From the mid-1990s onwards, EIAs were typically

[1] http://archive.defra.gov.uk/environment/marine/documents/ourseas-2009update.pdf.

accompanied by detailed desk-based studies of what archaeological resources were known—or might be expected—to be present in the vicinity of the proposed licence area. Geophysical data, acquired for assessing the aggregate resource, were being made available to archaeologists to help identify possible sites (Firth 2011). Provision was starting to be made for fieldwork to test conclusions from desk-based or geophysical studies (e.g. RECs, NSPP). Where issues were identified, exclusion zones were being introduced and fieldwork undertaken (Wessex Archaeology 2006) to mitigate possible impacts to features of archaeological interest such as paleochannels (Wessex Archaeology 2002). The results of individual desk-based assessments/technical reports and EIAs were clearly of interest to archaeologists, because they presented some of the first development-led area-based investigations in UK waters (Firth 2000). The results were of interest to industry and government, because they gave practical meaning to a previously unfamiliar and nebulous requirement of EIA regulations stemming from EU directives. The results were of interest to the general public, which has a widespread fascination with underwater archaeology. The elements of the EIA process—desk-based studies, geophysics and evaluation to test conclusions, mitigation strategies and dissemination to a variety of audiences—have heavily influenced the types of projects funded through the MALSF. This is unsurprising, because the key advances that were being made were simultaneously highlighting major gaps in knowledge and capability that could not be addressed within the scope of investigating an individual licence application.

Given the results of research conducted from 2002 to 2011, it has to be recognised that sustainable development of marine aggregates has not been the only beneficiary. Other sectors of marine development have also gained from the progress made in investigating submerged prehistory through the MALSF, including capital dredging for ports and offshore renewables. Heritage agencies have also benefited in relation to their statutory obligations and powers, as knowledge created by the MALSF and methodologies that have been developed have been transferred sideways. The "business of archaeology" has benefited too, with a diverse range of organisations—charities, universities and commercial companies—engaging in MALSF projects, and marine archaeology having a much higher profile than previously, both within terrestrial archaeology and amongst other marine disciplines. The MALSF contributed in a significant way to submerged prehistory being both vibrant, more effective and helping to deliver sustainable development whilst safeguarding the UK's marine heritage through innovation and the definition of 'best-practice'.

Case Study: Area 240

Between December 2007 and February 2008, lithic artefacts, including handaxes, flakes and cores, as well as faunal remains were discovered by Mr. Jan Meulmeester in stockpiles of gravel at the SBV Flushing Wharf, near Antwerp, Belgium (Fig. 12.3).

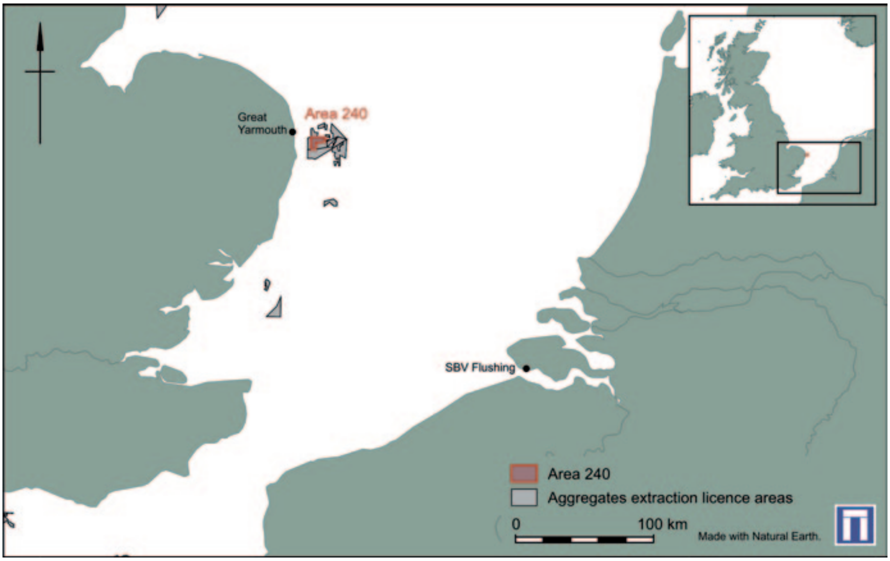

Fig. 12.3 Lithic artefacts, including handaxes, flakes and cores, as well as faunal remains were discovered by Mr. Jan Meulmeester in stockpiles of gravel at the SBV Flushing Wharf, near Antwerp, Belgium

They were recovered from a discrete locale within Area 240; a marine aggregate licence area situated approximately 11 km off the coast of East Anglia (south-east Britain) in water depths of between −16.7 and −33.5 m Chart datum (CD) (18.2 and 35.0 m below Ordnance Datum (OD)). The handaxes were dredged from a discrete 3.5 × 1.1 km area in water depths of −20 to −33.5 m CD (21.5 and 35 m below OD), which is situated within the active dredging area. Following the discovery, a voluntary exclusion zone was put in place by Hanson Aggregate Marine Limited (HAML), the licensee. The discovery has shown that significant and rare archaeological material can be present in deposits targeted for marine aggregate extraction in British waters; however, archaeologists have limited capacity to identify and localize such deposits in the marine environment. In light of the discovery at Area 240, a project concerning the application of geophysical, geotechnical and seabed sampling of those deposits was funded through the MALSF and administered by English Heritage (Wessex Archaeology 2011). Diving methodologies were considered during the project design; however, it was ultimately decided that this site in Area 240 was not conducive to diving; water depths approaching 30 m, the strong currents in the area and notoriously poor visibility all hindered potential diving operations. The prospect of locating flints, particularly in an area of 3 km^2 without a more precise location for the find-spot is remote and would require a major commitment of time and money. Due to cost effectiveness, it was decided that the chance of failure to find artefacts was too high and therefore, geophysical, geotechnical and seabed sampling was favoured over archaeological diver survey. The project was

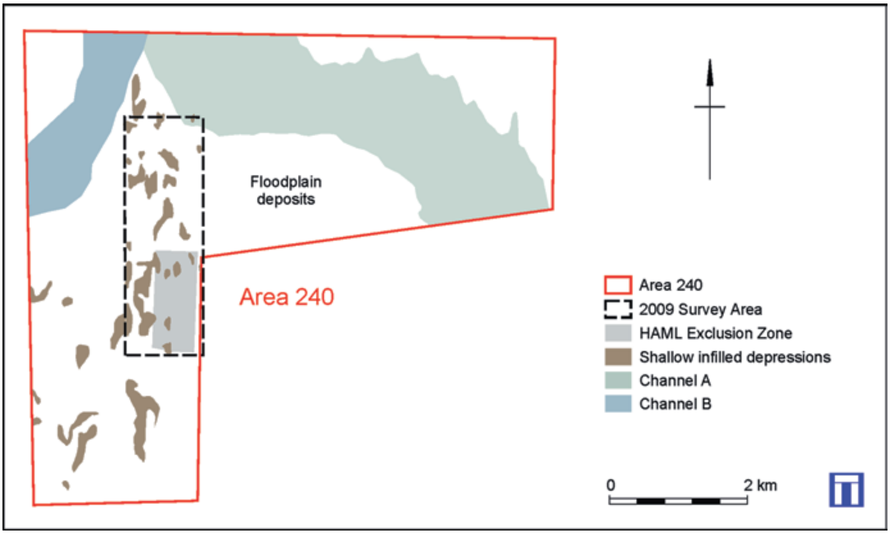

Fig. 12.4 A series of sediment units dating from >500 ka to the last marine transgression, c. 7200 BP/6100 cal. BC. Two channel features, Channel A and Channel B, dominate the area

divided into a series of stages allowing the work to be developed on an iterative, judgement-led basis. The investigations included:

- Detailed re-examination of geophysical data (multibeam echo-sounder and sub-bottom profiler) originally acquired in 2005 for the assessment of aggregate reserves across the whole of Area 240, and 158 geotechnical (vibrocore) logs acquired between 1999 and 2007
- Intensive geophysical survey of the 3.5 × 1.1 km area, acquiring a range of data including sub-bottom profiler data acquired using four different methods of sub-bottom profiling, undertaken in 2009
- Adaptation of ecological seabed sampling methods (photography, trawling and clamshell grabbing) to recover further worked flint and faunal remains from the seabed
- Targeted coring to obtain complete samples of the sedimentary sequence from ten locations in the vicinity of the site
- Paleoenvironmental assessment and analysis, and scientific dating using radiocarbon and Optically Stimulated Luminescence (OSL)

This process enabled the development of an overarching synthesis and interpretation. The results revealed a complex history of deposition and erosion in Area 240. Dredging operations over the last 20 years have further complicated the interpretation of this area. A series of sediment units dating from >500 ka to the last marine transgression c. 7200 BP/6100 cal. BC (Behre 2007) were interpreted, although not as a complete sequence. Two channel features, Channel A and Channel B, dominate the area (Fig. 12.4).

Channel A is observed to the north of where the artefacts were dredged, orientated north-west to south-east. The southern edge of the channel is prominent and is observed as a deep cut of 5 m. The northern edge of the channel is less obvious and is observed as gently shoaling, rather than being a steep cut. The sediment infilling this buried channel varies in composition and is indicative of a changing flow regime with periods of high-energy and low-energy sediment deposition. The high-energy depositional sediments comprise sands and gravels; fine-grained sediment units, indicative of lower-energy depositional environments are observed infilling broad shallow depressions or forming small bank structures up to 3 m high. The floodplain of Channel A is extensive, encompassing the majority of Area 240 and comprising sands and gravels. It is likely that the cut of the channel and the development of te floodplain occurred during the Anglian period, developing as the ice sheet retreated and glacial meltwater carved broad channels across the region as part of a braided plain system. It is possible that the system was more extensive both laterally and vertically and that much of the sediments deposited with this early development of the system were subsequently removed or reworked during the sea-level rise in the early Hoxnian.

The major development of the floodplain and the initial infilling of Channel A has been attributed to Saalian age, with OSL dates indicating deposition of outer estuarine sediments during MIS 8. Studies carried out to the north of Area 240 (Wessex Archaeology 2009) indicate that the coarse-grained fill may have been deposited during the Saalian (MIS 8, 7, 6) with overlying finer-grained sediments deposited at the onset of the Ipswichian Interglacial (c. 130,000–110,000 BP). Furthermore, sediments from a bank structure situated to the west of Area 240 were dated to MIS 7/6 (Limpenny et al. 2011). Within Channel A, the Saalian sediments were further cut, probably at the onset of the Devensian (MIS 5d), with fine-grained infill sediments deposited in a brackish or estuarine environment. These sediments returned OSL dates of 109±11 ka (GL 10037) and 96±11 ka (GL 10041), both correlating to the Early-Devensian. Further features observed in Area 240 include slight depressions cutting into the Saalian floodplain deposits. These depressions are predominantly situated in the central and southern areas and are infilled with sediments of variable composition. Vibrocores indicate generally finer-grained deposits (clays and fine-grained sands) and suggest an outer estuarine or near coastal depositional environment. To the south, a sand-gravel infill is observed and appears to be deposited in a fluvioglacial environment of mid-Devensian (MIS 3) age (36±3 ka, GL 10044). This age of sediment was unexpected in this area with no previously documented sediments of similar date in the offshore region. OSL dating of vibrocores in the wider East Coast region, however, indicate that the upper fill deposits of channels have dates of similar MIS 3 age (Limpenny et al. 2011). The channel and floodplain system are thought to be the remnants of an extension of the onshore Yare Valley.

Channel B is shallow and meandering, situated in the north-western corner of the survey area and orientated north-east to south-west. This forms part of a larger feature, which is observed in regional datasets to flow southwards through adjacent aggregate areas and beyond. Channel-fill deposits are observed on the sub-bottom profiler data and a topographic trace of the channel is also observed on the bathymetric data. The topographic trace indicates a broad feature, approximately 1 km wide and up to 4 m high. Sub-bottom profiler data indicate that the infill sediments are up to 6.5 m thick and the vibrocore data indicate a fill sequence including peats and other organic sediments, which are indicative of low-energy deposition in a fluvial or marshland environment. The intertidal mudflat/saltmarsh sediments are observed between 32.06 m below OD and 31.57 m below OD. Radiocarbon dating for the bottom and top of this unit returned dates of 7,710–7,560 cal. BC (8,595 ± 35 BP, SUERC-32234) and 6,730–6,590 cal. BC (7,820 ± 30 BP, SUERC-32233). These are comparable to previous dating undertaken within the area. Independent dating of four peat samples from a vibrocore situated within Channel B deposits dates the peat between 10,140 ± 35 BP (10,040–9,660 cal. BC, SUERC-11978) and 8,355 ± 35 (7,530–7,330 cal. BC, SUERC-11975) (Hazell, pers. comm. 2010).

Based on the Early Mesolithic date of these sediments, Channel B may also be an offshore extension of the River Yare and the peats comparable to those of the Breydon Formation (Arthurton et al. 1994; Bellamy 1998). Onshore, the basal peat of the Breydon Formation dated to c. 7,580 ± 90 BP and is observed at 23 m below OD. Around 6 km offshore Great Yarmouth, clays of the Breydon Formation are observed at a depth of 27 m below OD. These are comparable depths to the Early Mesolithic peats and clays between 30–32 m below OD in Channel B. The basal peat of the Breydon Formation is overlain by the Lower Clay composed of soft silty clay which becomes firmer with depth (Arthurton et al. 1994), and which may be comparable with the thin unit of sandy, shelly clay observed overlying the peats in the vibrocores from Channel B. Although not directly associated with the flint and faunal remains the preservation of Mesolithic sediments are important as relatively few have been documented off the East Coast.

Seabed sampling in the area from which the handaxes were dredged led to the recovery of further flints and faunal remains (Tizzard et al. 2011). The flint tools and bone already recovered by aggregate dredging in Area 240 and the flint flakes recovered during these investigations indicate that the area is significant in terms of its artefact content and preservation conditions. The methodologies used within this sampling survey, which included clamshell grab sampling, 2 m beam trawling and visual inspection have shown that debitage from the production of flint tools and hand axes exist at least within the localised area. Continued investigation of this material has led to an updated interpretation of the ages of this material (cf. Tizzard et al. 2011). The prehistoric characterisation indicated that the flint and faunal remains are likely associated with three particular units/ages. A proportion of the older (fossilised) faunal remains are likely to have been dredged from the older shallow marine unit dating to > 500 ka. The hand axes and some of the flints dredged in 2007/2008 and the flint flakes sampled during this project are most likely associated with the deposits dated to the early Middle Paleolithic (Wolstonian, 350–200 ka). Some artefacts may have been deposited in the mid-Devensian, in the fills of shallow depressions dating to c. 30,000–40,000 BP. In these two latter cases, Area 240 would have been a cold outer estuary environment.

The investigations demonstrate that it is possible to relate unstratified archaeological material to submerged and buried landsurfaces that, although complex, can be examined in detail using a variety of fieldwork and analytical methods. This work has also confirmed the likely provenance of the assemblage (discovered by Mr. Meulmeester in 2007–2008) and the entire assemblage can now be related to particular deposits. Furthermore, this work provided a detailed, factual basis for discussions of future management of the potential effects of aggregate dredging on the marine historic environment. The importance of linking artefacts to specific sedimentary contexts is a critical step for bolstering confidence in the regional assessments of submerged prehistory potential in submerged locations. The assessment of importance of prehistoric remains is based upon the specific qualities of a given deposit or remains; however, the rarity of Paleolithic (and Mesolithic) remains in the UK and the critical information they provide on the colonisation of early hominins in the UK during the Pleistocene and Holocene (even if degraded and limited at a given location) means that such materials are considered of national (and potentially international) importance (English Heritage 1998).

Archaeological, Geoarchaeological and Natural Deposits: Questions and Considerations for Heritage Management

Firth (2004) outlined three thematic issues regarding the submerged prehistory of the North Sea region: terrestrial versus marine; natural versus cultural; and sites versus context. Since the 2003 conference on the submarine prehistory of the North Sea (Flemming 2004), considerable advances and discoveries have been made in the field of submerged prehistory. In the same volume, Bailey (2004, p. 7) outlined the justification for researching submerged prehistoric coastlines. Furthermore, and importantly, greater focus has been paid by respected terrestrial archaeologists now willing to work collaboratively with marine sciences, and it seems that more and more terrestrial prehistorians are open to looking offshore (see various contributions in Benjamin et al. 2011). The question then shifts to that posed by Maarlevald and Peeters (2004), ‘Can we manage?’ Or perhaps put slightly more optimistically, ‘How can we manage?’ As suggested by Firth’s (2004) themes in submarine archaeology there is both cultural and purely environmental significance that paleolandscape and paleolandsurface research lends directly to prehistoric archaeology. Simply put: are preserved paleoenvironments or -landsurfaces found in today’s submarine environments significant to archaeology, heritage management, oceanography and the earth sciences? From the perspective of the archaeologist, it is easy to say that when there are obvious cultural deposits and features with identifiable material that these deposits are significant. It follows that the absence of such archaeological markers might lead to the suggestion that whilst preserved paleolandscapes or -landsurfaces may exist in situ, they may not be relevant to archaeologists if they do not contain what we would traditionally refer to as an archaeological *site*. Nonetheless, there are some cases when the paleoenvironmental data inform archaeological theory and questions in ways that prehistorians simply cannot ignore; distinguishing the culturally significant from the purely environmental remains challenging. There are perhaps geoarchaeological questions (or answers) stemming from the study of landscapes, context and paleoenvironments. We must, therefore, take the opportunity to describe the importance of natural deposits that provide context for individual sites and/or the wider paleoenvironment/landscape. We must also take a realistic approach that not *all* submerged landsurfaces are necessarily significant to archaeologists or heritage managers who may have real-world decisions to make based on limited financial resources and the on-going desire for socio-economic benefit and human progress. Therefore, a great deal of care should be taken to assess the cultural significance of these preserved natural deposits.

There are a number of reasons for prehistoric landsurfaces and deposits to be subject to special measures if they fall within development (or extraction) areas for not only 'archaeological' reasons. The following section summarises a previous ALSF report by Wessex Archaeology for English Heritage (2008) on the presence and importance of submarine paleolandsurfaces and deposits. For over a century, antiquarians and archaeologists have recognised that layers of peat are the remains of the previous surface of the land, in which prehistoric objects and structures can be found. These peaty layers are made up of earlier vegetation that has been preserved by being waterlogged; the same conditions that have preserved vegetation have also caused other organic material to survive which leads to their status as important paleoenvironmental archives. Although prehistoric landsurfaces and deposits can be characterised, for example, as layers of peat, sedimentary facies relating to coastal, estuarine and delta formations and paleoriver gravels, the range of circumstances in which special (archaeological) interest can arise is very wide. Also, our knowledge and understanding of the processes that are involved is still poor on the small scale (i.e. up to tens of metres). Paleolandscape reconstructions have thus far been on necessarily large spatial scales (i.e. hundreds of square kilometres). Reconciling this with the potential scale of prehistoric sites (sometimes only a few square metres in total size) is a conceptual and practical issue that must be overcome if we are to work at, and understand, the archaeological scale. Where diver (human-scale) investigation can be used this issue is overcome (cf. various chapters in Benjamin et al. 2011). In the increasingly challenging working environments of deeper water (>30 m), we are currently restricted to remote sensing, ROV/AUV, and extrapolation of geotechnical and paleoenvironmental analyses. Therefore, all generalisations about the presence or absence of interesting prehistoric landsurfaces or deposits have to be treated cautiously and with consideration of the spatial (and temporal) scale at which they can be interpreted and synthesised with other archaeological researches.

The term 'landsurface' is used here intentionally, and is distinct from 'landscape' in the sense of 'submerged landscapes' to which they are often referred. Landscapes exist in the perceptions of their inhabitants; they are as much a cultural construction as physical. Archaeologists might, at some point, be able to infer now-submerged landscapes in the way that our predecessors might have perceived them. However, there are currently too many difficult variables to address in delineating former

Table 12.1 Factors that make prehistoric landsurfaces of special interest to archaeologists and cultural heritage managers

Factor	Relevance
Narrative	A prehistoric landsurface or deposit will be of special interest where it makes a distinct contribution to understanding overall historical processes relating to a region (or country), to the early prehistory of a larger region or continent, or to the global understanding of humanity's origins
Associations	Generally, historic assets have special interest where they present a distinct, tangible link to a person or event, especially known, named historical people and events. Prehistoric deposits are unlikely to generate such interest as although there is no doubt that the lives of our predecessors were punctuated by significant characters and episodes, they are now lost in time
Respect	Some prehistoric landsurfaces and deposits have been found with human remains directly associated with them. In some cases, there are burials. In other cases, relatively small fragments of apparently isolated bone—including bits of skull—have been found, the meaning of which is uncertain. The presence of large quantities of human remains in a prehistoric landsurface or deposit may generate special interest by virtue of the need for respect
Aesthetic	The scope for a prehistoric landsurface or deposit to give rise to aesthetic special interest is probably limited to circumstances where early art—such as a cave painting—is preserved. Monumental structures such as Seahenge (Pryor 2001) might also be regarded as having special interest in aesthetic terms
Current relevance	A prehistoric landsurface or deposit will be of special interest on account of its current relevance if it presents a direct parallel with a topic of public debate today. Specifically, direct evidence of the relation between human activity and environmental change—including sea-level change—is likely to give rise to special interest on account of its current relevance. Special interest will arise not only where there is clear evidence of people responding to environmental change, but also where prehistoric people can be seen to have caused or modified environmental change

(currently low-resolution) topographies and adorning them with flora and fauna, and such slight understanding of the behaviours of the people that lived there, that attempts to discern 'landscapes' at anything but very regional scales are likely to remain highly speculative for some time to come. In the meantime, reference is made here to 'landsurfaces' as the physical evidence upon which landscape interpretations might subsequently be built. Not all prehistoric landsurfaces and deposits that have special interest will need to be managed in situ. Many important prehistoric landsurfaces and deposits have been found in the course of development, and have been managed (often through recording and analysis) in such a way that development has been able to proceed without restriction through the application of mitigation strategies. For a prehistoric landsurface or deposit to be of special interest, the remains must be capable of making such a distinctive contribution to our understanding or awareness of people's actions or environment in the past that the remains themselves should be protected from unmitigated damage. In these terms, prehistoric landsurfaces can be important because of what they can say about the environment that people lived in at the time they formed (e.g. factors outlined in Table 12.1), about the people themselves when they lived on and around these surfaces and deposits, and about the circumstances and processes that caused them to become uninhabitable. The scope for high levels of preservation within fine-grained deposits means that in some cases, material that gives a detailed and direct insight into the activities of a single individual or a small group, millennia ago, will survive (e.g. the factors informing prioritisation outlined in Table 12.2). In many cases, however, the study of early prehistory involves looking at far broader aggregations of evidence, to pick up patterns that hint at processes that affect whole populations of hominins, or overall human development.

Discussion

The consideration and analysis of submerged prehistoric archaeology, landsurfaces and their conceptual landscapes should be standard practice within development-led archaeology and heritage management. Like researchers in the fields of prehistoric and marine archaeology, organisations like Wessex Archaeology rely on baseline data from various interdisciplinary sources, and also create and interpret new data—primarily marine geophysics and geotechnical—with reference to marine archaeology of all types and ages. When possible, development-led archaeology aims to disseminate the reports generated into the public domain, to be accessed by students, researchers and the general public. Whilst heritage management and research communities may feel segregated at times, there is an important role each plays in the field of submerged prehistory. The importance of heritage management and cooperation is noted in Flemming's (2004) volume *Submerged Prehistoric Archaeology of the North Sea: Research Priorities and Collaboration with Industry*. The subtitle can be interpreted to mean research cooperation (cf. Gaffney et al. 2007), but also includes day-to-day work on marine development activities such as sub-sea cables, offshore renewable energy, pipelines, etc.[2] In the UK, where development projects in coastal and marine environments are a major growth industry, particular attention is now paid to the assessment of impacts on cultural heritage, including submerged prehistory. Discoveries and advances will continue to come not only from academic institutions but also from the developing field of highly specialised practitioners who have access to data and new techniques that are being developed by various sectors working offshore.

In order to be able to improve confidence in smaller-scale development-led submerged prehistory assessments, the regional picture must ideally be in place first. MALSF research was able to show the regional potential but was not able to assess the site—Area 240 being an exception, linking sedimentary units to artefacts. Regional projects such as the NSPP and Humber REC showed development towards a focused analysis and ground-truthing, producing a relatively coherent 8,000-year-

[2] For a discussion of development-led archaeology in the US see Faught, Chapter 3, and Pearson et al. Chapter 4.

Table 12.2 Prioritization and prehistoric landsurfaces

Factor	Rationale for prioritisation
Rarity	In principle, the absence of comparable landsurfaces or deposits will add to special interest on account of rarity. This will depend on the amount and quality of local knowledge in any given region or location. Thus, in the UK, as current knowledge of landsurfaces or deposits with direct artefactual evidence of prehistoric activity is currently limited; any such landsurface or deposit will be considered 'rare', at least for the time being. Equally, prehistoric structural remains are currently very rare, and will add considerably to the special interest of a landsurface or deposit
Representativity	The special interest of a landsurface or deposit is likely to be greater where it comprehensively represents the attributes from which the special interest arises, rather than a single facet. Representativity may be greater, for example, where a deposit covers an extensive stratigraphic sequence (i.e. potentially multiple phases 'landscape') rather than a single horizon, or where a surface encompasses a range of topographies
Diversity	Prehistoric landsurfaces and deposits have formed in a range of environmental circumstances. Even comparable, contemporary environments may have been inhabited in different ways depending on the cultural disposition of the people at the time
Potential	The special interest of a prehistoric landsurface or deposit will be enhanced where there is demonstrable potential for yet greater interest to develop. Potential may arise in respect of greater understanding through investigation and research, or for greater awareness and appreciation where the surface/deposit lends itself to wider access. Potential may arise from paleoenvironmental indicators, artefactual assemblages or even structural material that is exposed or can be reasonably assumed to be buried
Survival	The special interest of a prehistoric landsurface or deposit will be affected by the degree to which the physical remains have survived, gauged in terms of completeness. A surface or deposit is likely to be of greater special interest where its sequence or extent is complete, rather than fragmentary or interrupted
Documentation	The special interest of a prehistoric landsurface or deposit may be increased by the availability of documents, map, images, oral testimony or other evidence that enhances understanding or appreciation of the asset
Grouping	The special interest of a prehistoric landsurface or deposit may be greater where several surfaces/deposits are grouped together. Grouping is likely to add to special interest where the individual assets, taken collectively, enable greater understanding or appreciation of a range of environments, activities or types of inhabitation, or provide a chronological sequence, for example
Setting and context	The special interest of a prehistoric surface or deposit may be increased by its situation in a place that adds to its understanding or appreciation
Associated collections	The special interest of a prehistoric landsurface or deposit may be increased by the presence of an associated collection of artefacts in a museum or other archive. An associated collection may have been recovered from the surface/deposit in the course of previous investigations or activity, by trawling, or by antiquarian collecting at the coast, for example. Where the collection has accrued indirectly, care will be needed to establish the degree of association between the collection and the surface/deposit

old paleolandscape but the spatial limitations of offshore sampling strategies mean that the human smaller-scale is still obscure. Ideally, archaeologists would have greater control over sampling locations in order to produce feasible research questions which are not necessarily appropriate for development-led mitigation strategies. Indeed, collaboration is advisable when the particular juxtaposing goals of development-led archaeology and academic-led research are compared. Development-led mitigation is based around the tenet of reasonable and cost-effective mitigation where practicable, whilst academic studies are focussed around particular research questions and sets of objectives for the purpose of advancing scientific knowledge. Clearly the spatial distribution of development-led archaeology in licence areas across the UK territorial waters has considerable potential for advancing our knowledge of submerged prehistory. Important industry-led initiatives such as the Marine Aggregates Regional Environmental Assessments (MAREA) have provided detailed integrated baseline data gathering and environmental impact assessment for the aggregates dredging associations at a regional scale.[3] The ability of development-led mitigation strategies to fully examine particular questions is, however, tempered by important economic and practical factors.

Collaboration has an obvious role here. For example, COWRIE Guidance for offshore development now includes the recovery of duplicate geotechnical cores, with one set of cores purely for archaeological purposes (Gribble and Leather 2011). Various factors including time and cost limit the scope to which these cores can be analysed within development-led projects. The cost for academic research projects to recover the same offshore core samples would be prohibitive except for large, well-funded projects. Standardised or regular collaboration with universities or institutions such as the British Geological Survey on the analysis of these cores to extract detailed paleoenvironmental and paleogeographical datasets focused upon particular research goals (e.g. IPCC or national and/or regional research priorities and frameworks) would provide a considerable and cumulative resource that could be undertaken over the course of a PhD or research project as well as providing training and skills for the next generation of offshore specialists in geoarchaeology, paleoecology and geosciences. Further benefits include more cost-effective access to laboratory instruments and equipment, shared technical experience of technicians and researchers (in both commercial companies, universities and other institutions) and wider sources of additional funding in addition to the contributions from coastal and offshore developers required by curators.

An often-discussed factor that limits the dissemination of development-led research is moratorium periods, due to commercial sensitivity, on the release of project-specific information. The length of a collaborative research project would occupy much of a moratorium period (in addition to the analysis, compilation of research papers and relatively lengthy publication times of major journals). For all parties, including developers, this kind of collaboration would provide considerable *added value* at national and international levels whilst defining more clearly

[3] http://www.marine-aggregate-rea.info/.

the archaeological importance of offshore deposits and therefore the most suitable strategies for cultural heritage management and sustainable development.

Examining offshore paleolandsurfaces is challenging and can be expensive. Collaboration may have considerable benefits. A further challenge is the integration of terrestrial and intertidal prehistoric archaeology to the understanding of offshore-submerged prehistory in a continuum. In areas where submerged prehistory may be restricted to a relatively narrow coastal shelf (as is the case for much of Scotland), intertidal archaeology may be directly linked to submerged sites. In these cases, smaller-scale, near-shore surveys may be much more feasible for the prospection of submerged sites.

Conclusion

Reconstructing paleoenvironments through the identification of submerged terrestrial landsurfaces will enhance the archaeological record indirectly by providing context for existing sites—including those now coastal sites that were once hinterland locations. Such knowledge of existing paleolandsurfaces also provides direct information for the potential for archaeological material to be discovered—i.e. direct evidence of prehistoric human occupation on the now submerged continental shelf. However, management of submerged landsurfaces (or landscapes) will require greater understanding if we are to effectively establish archaeological significance. Until such a level of comprehension is established, a precautionary approach is advisable. Due to the increased financial and research resources that would have to be assigned to investigate the archaeological value/importance/significance of a given area of sub-seabed this may conflict with real-world issues of socio-economic benefit and offshore development. In such cases, offsetting mitigation, such as that provided to archaeologists through the MALSF, can be seen as an effective corpus of case studies whereby economic benefit is maximised and scientific progress is also made. Given the variety of techniques that can be used to explore continental shelves from around the world (cf. Benjamin et al. 2011), we should encourage our partners in industry to develop a similarly proactive approach to offshore development such as those presented through the Area 240 case study. This will not only provide a positive contribution for heritage and science, but can also be considered economically sensible from the perspective of developers who often seek to find added value through public relations and community engagement.

References

Arthurton, R. S., Booth, S. J., Morigi, A. N., Abbott, M. A. W., & Wood, C. J. (1994). *Geology of the country around Great Yarmouth*. London: HMSO.

Arnott, S. H. L., Leivers, M., Pascoe, D., Davidson, S., & Baggaley, P. A. (2011). EECMHM Archaeological Characterisation Use Many Times: Archaeological Interpretation of Eastern English Channel Datasets, MEPF 09/P118.

Bailey, G., 2004. The wider significance of submerged archaeological sites and their relevance to world prehistory. *In:* N.C. Flemming, ed. *Submarine prehistoric archaeology of the North Sea. Research Priorities and Collaboration with Industry.* CBA Research.

Bailey, G. N., & Flemming, N. C. (2008). Archaeology of the continental shelf: Marine resources, submerged landscapes and underwater archaeology. *Quaternary Science Reviews, 27,* 2153–2135.

Behre, K.-E. (2007). A new Holocene sea-level curve for the southern North Sea. *Boreas, 36,* 82–102.

Bellamy, A. G. (1998). The UK marine sand and gravel dredging industry: An application of quaternary geology. In J.-P. Latham (Ed.), *Advances in aggregates and armourstone evaluation* (pp. 33–45). London: Geological Society.

Benjamin, J., Bonsall, C., Pickard, C., & Fischer, A. (Eds.). (2011). *Submerged prehistory*. Oxford: Oxbow.

Bicket, A. (2011). Submerged prehistory: Marine ALSF research in context. In J. Gardiner (Ed.), *Marine ALSF Science Monograph Series No. 5*. MEPF 10/P150. Edinburgh: Wessex Archaeology.

Bradley, S. L., Milne, G. A., Teferle, F. N., Bingley, R. M., & Orliac, E. J. (2009). Glacial isostatic adjustment of the British Isles: New constraints from GPS measurements of crustal motion. *Geophysical Journal International, 178,* 14–22.

Dawkins, W. B. (1870). On the discovery of flint and chert under a submerged forest in west Somerset. *The Journal of Ethnological Society of London, 2*(2), 141–146.

Dix, J. K., & Sturt, F. (2011). *The relic palaeo-landscapes of the Thames estuary*. MALSF 09/P126. Lowestoft: The Marine Aggregate Levy Sustainability Fund.

Emu Ltd. (2009). *The outer Thames estuary regional environmental characterisation* (p. 129). Lowestoft: The Marine Aggregate Levy Sustainability Fund.

Fairbanks, R. G. (1989). A 17,000-year glacio-eustatic sea level record: Influence of glacial melting rates on the Younger Dryas Event and deep-ocean circulation. *Nature, 342,* 637–642.

Firth, A. (2000). Development-led archaeology in coastal environments: Investigations at Queenborough, Motney Hill and Gravesend in Kent, UK. In K. Pye & J. Allen (Eds.), *Coastal and estuarine environments: Sedimentology, geomorphology and geoarchaeology* (Vol. 175, pp. 403–417). London: Geological Society Special Publications.

Firth, A. (2004). Prehistory in the North Sea: Questions from development-led archaeology. In N. C. Flemming (Ed.), *Submarine prehistory of the North Sea* (pp. 89–94). York: CBA Research Report 141.

Firth, A. (2011). Marine geophysics: Integrated approaches to sensing the seabed. In D. Cowley (Ed.), *Remote sensing for archaeological heritage management* (pp. 129–140). EAC Occasional Paper No. 5. Brussels: Europae Archaeologia Consilium.

Fischer, A. (1995). An entrance to the Mesolithic world below the ocean: Status of ten years' work on the Danish sea floor. In A. Fischer (Ed.), *Man and sea in the Mesolithic: Coastal settlement above and below present sea level* (pp. 371–384). Oxford: Oxbow.

Fitch, S., & Gaffney, V. (2011). West coast palaeolandscapes project pilot study. Univeristy of Birmingham, Visual and Spatial Technology Centre. doi:10.5284/1000398 (last accessed 25/11/2013).

Flemming, N. C. (Ed.). (2004). *Submarine prehistoric archaeology of the North Sea: Research priorities and collaboration with industry*. York: CBA Research Report 141.

Gaffney, V., Fitch, S., & Smith, D. (2009). *Europe's lost world: the rediscovery of Doggerland*. York: CBA Research Report 160.

Gaffney, V., Thomson, K., & Fitch, S. (Eds.). (2007). *Mapping Doggerland: The mesolithic landscapes of the southern North Sea*. Oxford: Archaeopress.

Gribble, J., & Leather, S. (2011). *Offshore geotechnical investigations and historic environment analysis: Guidance for the renewable energy sector* (GEOARCH-09). London: COWRIE.

Gupta, S., Collier, J., Palmer-Felgate, A., Dickinson, J., Bushe, K., & Humber, S. (2004). *Submerged Palaeo-Arun river: Reconstruction of prehistoric landscapes and evaluation of archaeological resource potential. Integrated projects 1 and 2*. London: Final Project Report for English Heritage, ALSF Reports 3277 and 3543.

Hosfield, R. T., & Chambers, J. C. (2004). *The archaeological potential of secondary contexts*. London: English Heritage Project Report Project No. 3361.

James, J. W. C., Pearce, B., Coggan, R. A., Arnott, S. H. L., Clark, R., Plim, J. F., Pinnion, J., Barrio Frójan, C., Gardiner, J. P., Morando, A., Baggaley, P. A., Scott, G., & Bigourdan, N. (2010). *The south coast regional environmental characterisation*. London: British Geological Survey Open Report OR/09/51.

James, J. W. C., Pearce, B., Coggan, R. A., Leivers, M., Clark, R. W. E., Plim, J. F., Hill, J. M., Arnott, S. H. L., Bateson, L., De-Burgh Thomas, A., & Baggaley, P. A. (2011). *The MALSF synthesis study in the central and eastern English Channel* (p. 159). London: British Geological Survey Open Report OR/11/01.

Lambeck, K. (1995). Late Devensian and Holocene shorelines of the British Isles and North Sea from models of glacio-hydro-isostatic rebound. *Journal of the Geological Society, 152,* 437–448.

Limpenny, S. E., Barrio-Froján, C., Cotterill, C., Foster-Smith, R. L., Pearce, B., Tizzard, L., Limpenny, D. L., Long, D., Walmsley, S., Kirby, S., Baker, K., Meadows, W. J., Rees, J., Hill, J., Wilson, C., Leivers, M., Churchley, S., Russell, J., Pacitto, S., & Law, R. (2011). *The east coast regional environmental characterisation*. London: Cefas Open Report 08/04.

Lübke, H., Schmölcke, U., & Tauber, F. (2011). Mesolithic hunter-fishers in a changing world: A case study of submerged sites on the Jäckelberg, Wismar Bay, northeastern Germany. In J. Benjamin, et al. (Eds.), *Submerged prehistory* (pp. 21–37). Oxford: Oxbow.

Maarleveld, T., & Peeters, H. (2004). Can we manage? In N. C. Flemming (Ed.), *Submarine prehistory of the North Sea* (pp. 102–112). York: CBA Research Report 141.

Momber, G. (2011). Submerged landscape excavations in the Solent, southern Britain: Climate change and cultural development. In J. Benjamin, et al. (Eds.), *Submerged prehistory* (pp. 85–98). Oxford: Oxbow.

Pryor, F. (2001). *Seahenge: New discoveries in prehistoric Britain*. London: HarperCollins.

Shennan, I., & Horton, B. (2002). Holocene land- and sea-level changes in Great Britain. *Journal of Quaternary Science, 17,* 511–526.

Shennan, I., Bradley, S., Milne, G., Brooks, A., Bassett, S., & Hamilton, S. (2006). Relative sea-level changes, glacial isostatic modelling and ice-sheet reconstructions from the British Isles since the last glacial maximum. *Journal of Quaternary Science, 21,* 585–599.

Smith, D. E., Davies, M. H., Brooks, C. L., Mighall, T. M., Dawson, S., Rea, B. R., Jordan, J. T., & Holloway, L. K. (2010). Holocene relative sea levels and related prehistoric activity in the Forth lowland, Scotland, United Kingdom. *Quaternary Science Reviews, 29,* 2382–2410.

Tappin, D. R., Pearce, B., Fitch, S., Dove, D., Gearey, B., Hill, J. M., Chambers, C., Bates, R., Pinnion, J., Diaz Doce, D., Green, M., Gallyot, J., Georgiou, L., Brutto, D., Marzialetti, S., Hopla, E., Ramsay, E., & Fielding, H. (2011). *The Humber regional environmental characterisation* (p. 357). Keyworth: British Geological Survey Open Report OR/10/54.

Tizzard, L., Baggaley, P. A., & Firth, A. J. (2011). Seabed prehistory: Investigating palaeolandsurfaces with palaeolithic remains from the southern North Sea. In J. Benjamin, et al. (Eds.), *Submerged prehistory* (pp. 65–74). Oxford: Oxbow.

Wenban-Smith, F.F., 2002. *Marine Aggregate Dredging and the Historic Environment: Palaeolithic and Mesolithic archaeology on the seabed.* London: BMAPA and EH.

Wessex Archaeology. (2002). *Great Yarmouth: Area 254*. Salisbury: Wessex Archaeology Unpublished Report 50482.

Wessex Archaeology. (2006). *Area 451 grab sample assessment*. Salisbury: Wessex Archaeology Unpublished Report 63650.

Wessex Archaeology. (2009). *Seabed prehistory: Gauging the effects of marine aggregate dredging—Vols. I–VIII*. Salisbury: Wessex Archaeology Unpublished Report 57422.

Wessex Archaeology. (2011). *Seabed prehistory: Site evaluation techniques (Area 240)—Synthesis*. Salisbury: Wessex Archaeology Unpublished Report 70754.04.

Westley, K., Dix, J., & Quinn, R. (2004). *A re-assessment of the archaeological potential of continental shelves*. London: English Heritage Aggregates Levy Sustainability Fund Project 3362.