

East of England Archaeological Research Framework Review

Coastal Archaeology: Managing the Resource by Peter Murphy

Introduction

Archaeological work on the coasts of the East of England dates back to the 19th and early 20th centuries (e.g. Spurrell 1895, Warren 1911) but systematic modern archaeological investigation began in Essex in the early 1980s (Wilkinson and Murphy 1995). Desk-based assessment, field survey and post-excavation analysis is still continuing at the time of writing, as part of the English Heritage-funded *Rapid Coastal Zone Assessment Surveys* (RCZAS) and *National Mapping Programme* (NMP) (Suffolk County Council Archaeological Service 2003; Heppell, E., Everett, L. and Massey, S., this volume).

Alongside these survey projects other studies have been undertaken. The Natural History Museum's *Ancient Human Occupation of Britain Project* has detected sites pre-dating the Anglian glaciation on the Norfolk and Suffolk coasts, and inland. English Heritage has funded evaluation, survey and excavation of sites imminently threatened with destruction by erosion (e.g. 'Seahenge' at Holme-next the-sea, Norfolk (Bayliss *et al.* 1999; Brennand and Taylor 2003), Greyfriars, Dunwich, Suffolk, (Boulter 1999), and at a 16th century fort at Cudmore Grove, Mersea Island (Essex County Council 1900). Interventions related to coastal flood defence management and port developments, funded by the Environment Agency/DEFRA and commercial developers have provided additional archaeological data about specific locations. Alongside funded archaeological survey and excavation, investigation by Ron Hall in the Essex estuaries has led to the recognition of extensive Anglo-Saxon timber fish traps (Hall and Clarke 0000), whilst work by Tim Pestell at the medieval village of Eccles, Norfolk, lost due to dune recession, has produced a fine collection of organic medieval artefacts, besides clarifying aspects of site lay-out (Pestell 1993). A scoping paper by Flemming (2002) on the prehistoric archaeology of the North Sea (areas SEA3 and SEA2) provides a wider perspective, emphasising that the prehistoric land surface exposed inter-tidally, principally in Essex, is just the margin of the much more extensive submerged land surface of the North Sea basin (see also Oxley, this volume).

The Phase II Field Survey of the Norfolk RCZAS is scheduled to begin in 2004. Once this is completed, the East of England will be the first English region whose coastline has been completely surveyed. In addition, good quality information from modern excavations and detailed surveys at individual sites is available. This is not, of course, to say that all existing sites are now known. Many, buried beneath or within Holocene sediments, will be detected only where they are exposed during groundworks associated with coastal flood defence, habitat creation or commercial developments. Others, still in an intertidal location, are currently safely buried beneath recent sediments, and will only be exposed if natural coastal sedimentary and erosional processes change. However, sufficient is now known to focus attention on managing the resource in an informed way. It is possible in this region to rank sites in terms of rarity and/or significance, and to propose appropriate mitigation strategies in response to natural and human-induced threats.

In the first part of this paper, a broad overview of the archaeological resource will be presented, highlighting especially significant site categories. This will be followed by an account of the processes operating to threaten this resource, with suggested methodologies for

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mitigation, based on practical case-work experience. In a final section, research priorities will be presented.

Standing historic coastal buildings will not be considered here, for to do so would be a paper in itself. Fortunately, the majority of them are in modern settlements where, unless circumstances change radically, maintenance of existing sea defences will continue. There are, however, isolated standing structures which are potentially vulnerable to coastal change, including military structures, lighthouses, chapels, customs houses, mills and marsh farms. Some are immediately threatened (*e.g.* Martello Towers on the Suffolk coast near Bawdsey). They plainly pose special problems of mitigation, the implications of which are only now being considered.

Wrecks and hulks likewise represent a specialist area of study, not considered in detail here. Post-medieval hulks frequently occur in estuaries (*e.g.* the ‘*Tuesday of Rochester*’ at Orford Ness: Suffolk County Council 2003) and on the open coast (*e.g.* the barge ‘*Vicuna*’ at Holme-next-the-Sea: Norfolk Archaeological Unit 2003), and they can be detected from aerial photographs and ground survey. Submerged wrecks are detectable by bathymetric, sidescan sonar and magnetometer survey (BMAPA & English Heritage 2003). Vessels and remains of vessels stratified within the sediment prism are much more problematic: they can occur almost anywhere within channel and intertidal sediments, and they are quite unpredictable. Finds such as the Bronze Age paddle from Canewdon (Murphy and Wilkinson 1995, 152-7) or the Anglo-Saxon dug-out from Covehithe (*insert ref*) merely hint at the range of remains probably present.

The Resource

Lower-Middle Palaeolithic

The Pleistocene palaeogeography of the East of England obviously showed massive changes in response to glacial/interglacial relative sea-level changes. The East Anglian Crag Basin is infilled with a sequence of marine, estuarine and fluvial sediments of Pliocene and Pleistocene date. At present, and in the far corner of north-west Europe, most of the marine deposits would be considered too early to produce hominid remains. There are, however, some later Pleistocene marine sediments currently inland, the chronology of which is disputed (*e.g.* the Woodston Beds of the Peterborough area (Davey 1991) and the Nar Valley Beds in Norfolk (West 1970, 371). It is not impossible that evidence for Palaeolithic coastal activity comparable to that from the Sussex Raised Beaches (Wymer 1999, 147-153) will eventually be obtained, but the marine/estuarine sediments of the Peterborough area have not produced indisputably underived lithics, and only a few are known from the top of the Nar Valley Beds, which may in fact be fluvial freshwater deposits (Wymer 1999, 122 & 134).

Most of the interglacial sediments now visible in coastal exposures, or known from further inland, are freshwater or terrestrial and relate to periods of low sea-level stand. Exposures of fluvial sediments of the Cromer Forest Bed Formation, related to the now-extinct westward-flowing river systems of the pre-glacial Thames and Bytham, and dated to before 485 Ka (the Anglian glaciation, OIS 12), have recently produced stratified lithics in association with faunal remains during survey by the Natural History Museum. The locations of sites are at present being concealed in an attempt to avoid damage and loss of material due to the activities of collectors, and information on them is available only in internal confidential

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papers (e.g. Parfitt & Ashton 2003), but outline information has been released to the press (Henderson 2002). On the evidence of small mammal remains, a date of 700 Ka or earlier is possible, making these the earliest hominid sites in the UK. Their national and international significance is obvious. Although it is not prudent at present to discuss these sites in detail, it is at least plain that the Cromer Forest Bed Formation must now be considered a potential archaeological context, wherever it occurs. Any construction works that might intrude into it demand a programme of archaeological assessment and mitigation.

Later fluvial sediments of the early Thames are exposed at Clacton-on-Sea, Essex. Foreshore, cliff and inland exposures of the sediments infilling the Clacton Channel, dated to the Hoxnian (OIS 11, 423-380 Ka), have produced abundant lithics, mainly of the flake- and core-based 'Clactonian' industry, with faunal remains. The site has also produced the only Palaeolithic wooden artefact from the UK – the tip of a yew spear (Wymer 1999, 99-103). There have been several phases of controlled excavation at this site, but extensive intact deposits still survive, mainly protected by coastal defences.

Late Glacial to Holocene landscapes: Upper Palaeolithic to Beaker

Rising relative sea-level since the end of the Devensian glacial stage has resulted in submergence of the prehistoric landscape of the southern North Sea basin (Flemming 2002). Sites lying at elevations within the modern tidal range were submerged during the latest phases of this process. Here, we are concerned primarily with pre-transgression landscapes and land surfaces (and sites on them) now exposed in the modern intertidal zone, and sites buried by thin sediment cover, which may be impacted by groundworks associated with coastal management and realignment schemes.

These sites are significant primarily because they have been sealed by sediment cover. Consequently, there has been little or no subsequent bioturbation of land surfaces, and no physical disturbance by later cultivation or other human activities. Intact palaeosols survive, offering potential for soil micromorphological and palynological analysis and for spatial sampling for charred macrofossils and bone. Patterns of artefact distribution are largely intact and undisturbed, and very shallow cut features survive. This applies especially in the Essex estuaries, at sites where the interval between Neolithic occupation and emplacement of overlying sediments was brief. Earlier sites would have been subject to sub-aerial weathering for some considerable period before burial.

The earliest reported intertidal prehistoric site on the pre-transgression landscape is at Titchwell, Norfolk, where a Late Upper Palaeolithic long blade industry on a surface (presumably a palaeosol) developed on the Hunstanton Till has been recorded (Wymer and Robins 1994). This site was well inland, in no sense coastal, when occupied. Palaeoecological studies of the overlying sediment sequence, the base of which has yielded a ^{14}C date of 8950 ± 120 BP (Switsur in Wymer and Robins 1994) were undertaken, but no palaeoecological data relating to the occupation have yet been obtained. This site was not sealed by sediments until millennia after its occupation, and subsequent taphonomic processes plainly modified the surface from which the lithics came, together with any associated palaeosol. There may, therefore, be only limited scope for palaeoecological analysis.

Much the same problem applies to former terrestrial surfaces associated with Mesolithic sites in the Crouch and Blackwater estuaries in Essex, notably at Hullbridge and Maylandsea. Both sites have produced very large lithic assemblages, but the overlying deposits are much

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later, and so no unmodified land surface of Mesolithic date survives. However, at Hullbridge there is clear evidence for a palaeochannel of the Crouch, to the north of the site and the modern river channel. This is thought to have been an active channel during the Mesolithic, and there is a likelihood that waterlogged sediments contemporary with occupation are present. The research potential of this palaeochannel is considerable.

Neolithic to Beaker intertidal sites on the Essex coast have been described in Wilkinson and Murphy (1995, 71-131). Most of these sites are on the pre-transgression land surface, though in the Thames estuary the Holocene sediment sequence is much thicker than in other Essex estuaries and, at Purfleet, Neolithic material is stratified within a palaeosol formed on emergent tidal flats, which became a sub-aerially weathered terrestrial surface during the Tilbury III regression (*c.* 4930-3850 BP). Sites on the open coast Jaywick, Clacton and Dovercourt were first fully described by Warren *et al.* (1936), on what was then termed the 'Lyonesse Surface'. Site categories include lithic and ceramic scatters, isolated cut features, extensive exposures of the Neolithic palaeosol and cut features, charcoal spreads of Late Neolithic date, 'burnt flint mounds' and 'submerged forests'. By far the most prolific and best-preserved site is Blackwater Site 28, on a mudflat known as The Stumble, north of Osea Island in the Blackwater Estuary. This is believed to be a settlement site. Elsewhere, Neolithic deposits and sites are not well exposed, though at Blakeney Eye, North Norfolk, a group of Neolithic pits has been recorded, on a low hummock of Pleistocene deposits, partly overlapped by Holocene coastal sediments (Birks 2003). The relationship of these sites to their contemporary coastline varies with location. The Essex sites were not truly coastal, but were within 1km of contemporary HWM; the location of the Neolithic coast in North Norfolk is unknown, but must have been considerably to the north.

The results from survey of the Essex estuaries and coast led to the initial assumption that extensive horizontal intertidal exposures of prehistoric land surfaces, and other sites comparable to The Stumble, would be found just as often during survey elsewhere. In fact this assumption proved to be wrong: more recent surveys in Essex, Suffolk, Norfolk and North Kent has not so far produced estuarine exposures and sites of this scale and type (Heppell, Everett and Massey, this volume). In Norfolk, intertidal exposures of pre-transgression land surfaces have been recorded (*e.g.* at Titchwell), but they are rare. It is worth exploring why this should be so.

First, there is a problem of visibility, especially in estuaries. Where accretion of recent intertidal muds predominates over erosion, sites will obviously be masked. At present, in the Blackwater, erosion predominates, and in many places only a thin veneer of recent sediment, or none at all, overlies submerged prehistoric land surfaces and sites. By contrast, many of the Suffolk estuaries include deep obscuring deposits of recent sediment. On open high-energy coasts, such as in the Clacton/Jaywick and Dovercourt areas and parts of North Norfolk, sediment (usually sand) cover is extremely mobile, but sites are at least intermittently exposed following storm-scour. The degree to which estuaries have been embanked is obviously also relevant. A prehistoric land surface will be present almost everywhere, but at many locations it now lies under grazing marsh or arable behind embankments with rock-rubble or concrete-block armour, so exposures are few.

Secondly, to be visible in intertidal exposures, surfaces and sites must obviously lie at an elevation within the modern tidal range. Coastal sites in the East of England are all subject to the same 'eustatic' effects, and there do not seem to be very marked differences in rates of

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crustal subsidence within the region: in the Thames Estuary subsidence is around -1.5mm/yr (up to -1.9mm), and values of around -0.7 to -2.0mm/yr have been calculated for East Norfolk (Long and Roberts 1997). For this reason, differential crustal subsidence does not seem to explain the apparent absence of sites in some areas. However, differences in tidal range between locations will obviously be relevant: in the Blackwater this is up to almost $\pm 3\text{m OD}$, whereas in upper estuarine reaches, tidal range is much less.

Additionally, there are marked sub-regional differences in the topography of the pre-transgression land surface. Generally speaking, relief is very subdued along the Essex coastal plain, and the pre-transgression land surface is almost flat in many areas. Consequently, where the prehistoric land surface is at an elevation within the modern tidal range, extensive horizontal intertidal exposures will occur. In areas with steeper slopes, such as many Suffolk estuaries, there can be only a narrow exposure of prehistoric land surface, at the intersection between the slope and modern tidal range. These limited exposures are obviously easily concealed by recent sediment cover, substantially reducing the effectiveness of site detection during survey.

It is now plain that far from being ‘typical’ of the East of England, the extensive near-horizontal exposures of prehistoric land surface and sites at several locations on the Essex coast result from the fortunate coincidence of a very specific set of variables: subdued topography of the pre-transgression land surface, wide tidal ranges, extensive erosion and generally thin recent sediment cover. This means that the Essex Mesolithic- Late Neolithic sites are of a much rarer accessible site category than has generally been appreciated. They are eroding and require further recording.

Elsewhere, for example in the Suffolk estuaries, there is every reason to think that comparable prehistoric surfaces and sites exist in the modern intertidal zone, but that exposures are much narrower and concealed by modern sediments. Any sites present are currently buried and stable. However, changes in current velocities, erosion rates, and sediment loads, caused by natural processes or, more probably, by coastal management schemes and/or coastal developments, could change this. It follows that careful consideration should be given to the indirect, wider, effects of coastal schemes and developments on erosion elsewhere in any given estuary.

Intertidal submerged prehistoric land surfaces extend inland from the intertidal exposures, where they are buried under later sediments. Although these surfaces, and any sites on them, are stable and protected at present they are vulnerable to damage from groundworks associated with coastal management schemes and coastal developments. Appropriate mitigation measures must be put in place (English Heritage 2003).

The archaeology of the Holocene sediment sequence

The later stages of transgressive overlap led to formerly terrestrial sites at the margins of the North Sea basin becoming submerged. Neolithic and earlier sites and landscapes so far considered were fully terrestrial when occupied. From the Bronze Age up until Early Modern times sites exposed in the modern intertidal zone were coastal when occupied. They are of several main types:

sites at the upland margin, related to coastal economic activities (*e.g.* salt production, shellfishing, wildfowling, saltmarsh grazing);

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intertidal structures (*e.g.* fish traps, landing stages, hards);
 sites on former saltmarsh surfaces, now exposed intertidally as a result of changes in coastal morphology (*e.g.* dune recession);
 sites on former islands; and
 freshwater wetland sites truncated by erosion and coastal recession.

These site categories cut across period sub-divisions, and are best considered thematically, rather than by period. Salterns are conspicuous sites, due to the associated red-earth deposits, or saltern mounds, and have been widely recorded. The earliest known is at Fenn Creek, South Woodham Ferrers, with a radiocarbon date of 1412 – 1130 cal BC (3020 ± 90 BP; HAR-5733: Wilkinson and Murphy 1995, 157). Late Iron Age to Roman Red Hills are extremely common in the estuaries of the Blackwater and Colne (Murphy and Brown 1999, 16), with some sites in the Crouch and, in Suffolk, in the Alde and Blyth (Suffolk County Council 2003). The main focus of medieval salt production appears to have been around the Wash: particularly well-preserved saltern mounds are known from North Wootton.

Most prehistoric shell middens must now lie under the North Sea. Later middens are surprisingly rare, although Roman and medieval midden deposits have been recorded at Canvey Island (Wilkinson and Murphy 1995, 183). Oyster pits, relating to post-medieval to recent shellfish exploitation, are virtually ubiquitous in salt marsh. Decoy ponds for wildfowling are likewise widespread (Murphy and Brown 1999, Fig. 15). Use of saltmarsh for grazing is known to have been of economic importance at Domesday, and presumably was as far back as prehistory, but it leaves little indisputable archaeological trace. Perhaps the clearest evidence comes from droveways, used up until recently, and still visible on aerial photographs of the North Norfolk marshes ([ref](#)). Medieval domestic deposits on some Red Hills could represent occupation by shepherds (Rodwell 1965); as could timber and hurdle structures from The Stumble (Murphy and Wilkinson 1995, 150 and forthcoming).

Intertidal timber structures are often uninterpretable, but the massive V-shaped fish traps known from Collins Creek, Sales Point and The Naze, Essex are highly characteristic (Murphy and Brown 1999, 17; Hall and Clarke 0000). The scale of these structures may imply royal or monastic direction. The Essex structures have given Middle Saxon radiocarbon dates, but the recently-discovered trap in Holbrook Bay, Suffolk (Suffolk County Council 2003) is as yet undated. Fish-traps, including a possible Saxon example, have also been recorded at Holme-next-the-Sea (Norfolk Archaeological Unit 2003). Wood and timber structures representing trackways, causeways, landing stages, wharves and hards range in date from later prehistory and the Roman period (Murphy and Wilkinson 132 – 152); the causeway linking Mersea Island to the mainland is of Middle Saxon date (Crummy *et al.* 1982); a timber jetty at Abbot's Hall, Great Wigborough is dated to 890-1160 AD (95% probability: 1030 ± 50BP; GU-10644); part of a timber wharf associated with the Henrician fort at Cudmore Grove, Mersea Island has recently been excavated (Heppell 0000); and during the RCZAS of Suffolk, several later medieval to 19th century hards and wharves have been recorded. These are just a few examples. Other major timber structures remain uninvestigated and undated: for example the 'bridges' of the Crouch estuary (*e.g.* Hullbridge).

Dune recession has not only resulted in loss of terrestrial sites (*e.g.* the village of Eccles, Norfolk: Lyell 1867; Pestell 1993: see below), but also intertidal exposure of sites originally constructed on salt marsh. A location currently under investigation is at Holme-next-the-Sea, Norfolk, where an extensive prehistoric salt marsh surface, partly overlain by later peat, is

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exposed on the beach. This represents a exposure of prehistoric surface comparable in scale to the fully terrestrial Neolithic surface at The Stumble. It was the was the site of the Early Bronze Age structure comprising 55 vertical oak timbers surrounding an inverted oak tree stump known as ‘Seahenge’ (Bayliss 1999; Brennand and Taylor 2003). Continued survey by David Robertson, indicates that there is at least one other circular structure, besides pits and other less well defined wooden structures.

Islands on the coast of the East of England fall into two main categories: extant salt-marsh islands, especially on the highly-dissected coast of Essex; and islands composed of more consolidated Pleistocene sediments. Salt marsh islands must post-date the local marine transgression, in their present form, and many were not embanked until the middle ages or later. Their archaeology generally relates to agriculture, salt production and shell-fisheries.

Islands formed of Pleistocene deposits have a much longer and more complex history. During the earlier Holocene, they would have lain inland, and would have been low hummocks or hills – potentially favoured locations for settlement or ritual activity. Subsequently, rising relative sea level would have resulted in their isolation by freshwater marsh, saltmarsh, mudflats or open water, and they would have presented new opportunities for settlement as defensible locations, isolated yet accessible by causeway or boat. As transgressive overlap proceeded they would have become smaller, and deposits and features at low elevations would have been sealed beneath sediment cover. In extreme cases, they would have been entirely overwhelmed by sediments, or reduced to such a small extent that their significance as islands would no longer be appreciated. In that case, only modern techniques such as LiDAR reveal them. For example, the LiDAR survey recently commissioned by the Environment Agency as part of the consultation documentation related to the [Minsmere Sea Defences Study](#), the large island on which Leiston Abbey was first established in 1182 is obvious, but unexpectedly several other islands are now visible further south. In the fens, the significance of partly-overwhelmed islands as *foci* of activity is well understood (Evans 2003), but not that of islands in modern coastal wetlands.

Recent archaeological evaluation at Blakeney Eye demonstrates their potential (Birks 2003). At this site, on a sand and gravel island within salt marsh, there is evidence for pre-transgression Neolithic pit-digging. Beaker, Roman, and medieval ceramics, and a 6th century gold bracteate brooch indicate a continued human presence, followed by the construction of a late medieval flint-walled structure known as ‘Blakeney Chapel’, though the interpretation of this structure is now uncertain.

Finally, river valleys and their Holocene sediments may be truncated by barrier retreat and marine erosion, and then exposed on beaches. Freshwater peats intermittently exposed at extreme low tides, and after scour, at Weybourne and Benacre Broad are examples. There is nothing unusual, nor specifically coastal, about these exposures, since comparable sediment sequences are often exposed inland in various commercial excavations. However, they especially well exposed on coasts.

The archaeology of coastal transformation

The sea walls of the East of England are by far the largest archaeological earthwork structures in the region, dwarfing the military defensive dykes to the west. They are also the largest timber structures, for at many locations they include internal timber, for example at Tollesbury Creek, where a 400m length of timber posts with diagonal bracing is visible.

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Unlike most archaeological structures, they are still serving the function for which they were originally built, and that is why they are not perceived as being ancient. They are not, however, a single build. The earliest sea defence known – the Fenland Sea Bank – now lies well inland and is defunct. A recent investigation at Clenchwarton indicates construction no earlier than the 11th century, and other evidence implies a piecemeal construction, mainly in the Late Saxon period, (Crowson, Lane and Reeve 2000, 229). On Foulness, timber structures within a defunct early sea wall have been radiocarbon-dated to the late fifteenth century (Crump 1981). Until recently, there have been no opportunities to examine the structure of extent functioning sea walls, although documentary sources have provided some indication of phases of construction and repair. Managed Realignment (see below) will change this.

The sea walls, however, are merely the most conspicuous, and latest, phase in the exploitation, modification, (small-scale embankment), and transformation of coastal wetlands (Rippon, 2000). Transformation, as defined by Rippon, was a high-cost, high risk but potentially high-return strategy: by means of sea-wall construction, saltmarsh and even mudflat could be converted to grazing marsh and arable. The archaeological record of this process – for it is *that*, and not a single event – in the East of England is very poorly understood. cursory inspection of almost any reclaimed grazing marsh that has never been ploughed in the East of England shows that it is not flat. Some of the features visible no doubt are palaeochannels pre-dating land claim; others might be military excavations from the world wars. Others are likely to be more ancient, but very few topographic surveys have been undertaken. There certainly are some oddities, which appear to be unique, but may not be. One example is the ringwork-like earthwork and timber structure known as ‘The Shipslock’ at Abbot’s Hall, Great Wigborough (SMR 16702). It was used in the 19th century for penning sheep prior to shipment to London by barge, and also for storing the return cargo – London’s manure (Martin Winter, pers.comm.). This may explain its peculiar name – presumably meaning either the sheep’s lock or conceivably the shit-lock. It is, however, unclear why such a large structure was needed – when elsewhere hurdle fences sufficed. It has been interpreted as a ‘Danish Camp’ in the past, and certainly requires more investigation.

Threats and mitigation

The archaeological resource is under threat from three broad sets of processes:

- natural processes of coastal change;
- shoreline management (including flood and coastal defence, and habitat creation); and
- economic developments.

A ‘check-list’ of natural and humanly-induced coastal changes, their impacts on the historic environment, and approaches to mitigation (based on recent case-work experience) is given in Table 1.

Natural processes

Coastlines are inherently mobile, responding *inter alia* to changes in climate, prevailing wind and wave directions, sediment supply and relative sea-level. This is particularly true of the ‘soft’ coastlines of the East of England. There is nothing new about the loss of sites to natural erosion: Figure 00, an engraving dated 1786, which depicts the destruction of the Roman fort

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of Walton Castle, Suffolk, is probably the earliest record. However, this could be seen as merely part of the final stage in the loss of sites and submergence of an entire landscape due to the progressive expansion of the North Sea during the Holocene (Shennan *et al.* 2000). These processes are plainly not new, but current climate change models suggest that *rates* of change will increase over this century. The 2002 United Kingdom Climate Impacts Programme report (UKCIP 2002) indicates that, by the 2080s, relative sea-level in the London area might be between 26 and 86cm higher than during the period 1961-1990. Extreme sea-levels – as experienced during storm surges – are the cause of most damage at coasts, and these might be experienced between 10 and 20 times more frequently than at present, particularly in south-east England.

Hard-rock cliffs occur only at Hunstanton, and there are some cliffs of *relatively* hard rock - glacially-redeposited chalk rafts - at some other locations on the Norfolk coast, for example at Sidestrand and Trimingham. Elsewhere, cliffs mainly consist of glacially-deposited gravels, sands and clays (including diamicton or ‘boulder clay’). Cliffs composed of such unconsolidated sediments erode rapidly, albeit in a cyclical way (Pethick 1992, 49 – 64). Cliff erosion and longshore drift provides one sediment source for other types of coasts, especially gravel spits and beaches, sand dunes and beaches.

Cliff erosion results in truncation of archaeological sites in cliff-top locations, exposures of sections through archaeological features in cliff sections, scattering of artefacts on the shore and, ultimately, site destruction. The best-known example is the Anglo-Saxon and medieval town of Dunwich, Suffolk (Boulter 1999; West 1970) of which only part of the town defences and the Greyfriars Precinct now survive. Other sites, such as Covehithe, Suffolk and its vast, partly ruinous, medieval century church, will become vulnerable during this century: studies of historic maps undertaken by Ivan Ringwood (in prep.) as part of the Suffolk RCZAS indicate loss of about 0.7 km of land since 1817. Erosion of cliffs consisting of glacial deposits is also resulting in exposure of pre-Anglian sediments as foreshore platforms, and in section at cliff bases, where they progressively eroded. As noted above, Lower Palaeolithic artefacts have recently been reported from exposures of these types at several locations.

Migration of gravel spits also results in site destruction. A current example is Blakeney Eye, a gravel island within the salt marsh of North Norfolk. At this location, Blakeney Spit is moving southwards, constricting and blocking the channel of the River Glaven with consequent freshwater flooding of Cley village and an adjacent SPA (Environment Agency/Halcrow 2002). Ultimately, perhaps within 20-30 years, this will lead to direct tidal erosion of the Eye, and Blakeney Chapel SAM on it. A programme of archaeological evaluation has been completed (Birks 2003), and this will be followed by complete excavation of the SAM and a Neolithic pit group, with palaeoecological analysis and dating of the sediment sequence at the site.

Landwards movement of dune systems has comparable effects. Sand dune systems are effective natural coastal defences, behind which fully terrestrial (or at least salt-marsh) conditions exist; and this has permitted settlement and other types of human activity at locations that otherwise would have been intertidal. However, if dunes migrate inland, sites are first overwhelmed by dunes, and then exposed to erosion on beaches. The medieval village of Eccles, Norfolk is a well known example. Lyell (1867, Figure 43) includes an illustration showing the medieval church tower as it was in 1839, still standing within the

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dunes. Blocks of fallen masonry from the tower could be usually seen on the beach at Eccles before the 1990s, though the construction of offshore reefs has resulted in accretion of sand, so these are now rarely visible. Pestell (1993) has monitored and excavated transient beach exposures of associated medieval archaeological features (Figure 00). The Bronze Age timber structure dubbed ‘Seahenge’ at Holme-next-the-Sea, Norfolk was originally constructed on salt marsh behind a dune barrier but ultimately, due to dune recession, was exposed to direct tidal erosion on the beach (see above).

Salt marshes are particularly vulnerable to erosion and to the effects of rising relative sea level (Parry 2000, 16). Under natural circumstances they would re-form further inland at higher elevations, but the presence of fixed hard defences behind them makes this impossible, so that salt marsh is ‘squeezed’, eroded and ultimately lost. Sites of various types are stratified within salt marsh sediments (see above) and they are destroyed along with the marsh itself.

Mitigation of loss by natural processes

What forms of mitigation are possible, where ‘natural’ erosion is the main destructive process? Assuming that preservation *in situ* is not possible (see below), there are two realistic options:

complete excavation and recording in advance of destruction; or
monitoring.

Excavation and recording in advance of destruction is in some ways the simplest solution, relying in routine archaeological procedures; though it is also by far the most expensive option. Obviously, there is no ‘developer’ to fund recording, and so funding must be sought from other sources. English Heritage has funded such work at ‘Seahenge’ and also at Cudmore Grove, Mersea Island, Essex, where timber structures associated with the Henrician fort were exposed to erosion on the beach (Essex County Council 0000; Heppell, in prep). It is possible that future funding will be available for such work from English Heritage, but this cannot be guaranteed. Where there is a related shoreline management scheme, and the decision has been made by the Environment Agency not to protect a site of demonstrable significance, it is reasonable to seek funding from the EA (ultimately from DEFRA). Funding has already been obtained by this route to evaluate and then selectively excavate the Blakeney Chapel SAM and associated deposits. In Essex, funding has also been obtained via the EU Planarch process.

Monitoring is not necessarily an inferior option. It has proved to be very effective, for example, for the recording of eroding intertidal prehistoric and later sites on the Essex coast (Heppell and Brown 2002; Heppell 2003), when combined with detailed recording of specific locations thought to be of special significance. Erosion of such sites is a progressive process. Only part of the overall structure or site will be visible during any given site visit. Repeated monitoring progressively adds data to the overall understanding of the site, as it erodes. Now that GPS locational techniques are available a composite picture of a site, (never seen all at one time), can be assembled from repeat visits; and this can be used to guide targeted detailed investigation.

Shoreline management

The policy framework for shoreline management is considered in some detail in English Heritage (2003, 2-4), and will only be summarised briefly here. In England, coastal defence

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was formerly the responsibility of the Ministry of Agriculture, Fisheries and Food (MAFF) - now the Department for Environment, Farming and Rural Affairs (DEFRA). Coastal defence schemes are undertaken by Operating Authorities (often the relevant Local Authority), using grants provided by MAFF subject to each scheme meeting technical, environmental, and economic criteria. The Environment Agency has particular responsibilities in respect of flood protection for low-lying land and may, in some instances, be the relevant Operating Authority.

Considerations of sustainability and long-term viability have led to a shift away from traditional 'hard' defences, towards management approaches designed to produce more 'natural' coastlines.. Policy is also based on the fact that the coastline is a series of inter-linked physical systems, comprising onshore and offshore elements, known as sediment transport cells. Each cell contains a source of sediment (*e.g.* rivers or eroding cliffs): areas where sediment is moved by coastal processes; and sediment stores or sinks (*e.g.* beaches or estuaries). Within each cell, a series of "sub-cells" has been identified. Consequently, coastal defence works on one stretch of coastline may have a profound effect on the rate of erosion or likelihood of flooding elsewhere.

In 1995 MAFF first published guidance on the preparation of Shoreline Management Plans (SMPs) by Operating Authorities. SMPs are now a key element in DEFRA's flood and coastal defence strategy. The aim of an SMP is to provide the basis for sustainable shoreline management policies over the next 50 years within a particular length of coastline. They provide a large-scale assessment of the risks to people and to environmental assets associated with coastal processes (flooding, coastal erosion, cliff instability *etc.*) and present a policy framework to manage and reduce those risks in a sustainable manner. The 'first generation' of SMPs was completed during the 1990s. In three pilot areas in the UK, (including Kelling Hard to Lowestoft Ness in the East of England), work on "second generation" plans (SMP2s) has begun. Second generation plans will incorporate a wider range of data from supporting studies, including the Halcrow 'Futurecoast' study and Coastal Habitat Management Plans (ChAMPs). The DEFRA document '*Shoreline Management Plan: a guide for coastal defence authorities*' (DEFRA 2001) recognises five generic policies:

- Hold the line;
- Advance the line;
- Managed realignment;
- Limited intervention; and
- No active intervention

The new guidance also recognises that, over the 50 year period of the plan the preferred option may change.

Coastal defence now comprises a hierarchy of plans. *Large-scale plans* such as SMPs will typically cover a whole coastal cell or estuary system. *Strategy Plans* will normally be prepared for coherent sub-sets of the large-scale plan. Plans currently in preparation include the *Essex and Suffolk Estuaries Flood Management Strategies* and the *Wash Estuary Management Plan*. *Scheme design and appraisal* will be undertaken for particular time-limited capital or maintenance projects required to deliver the strategy plan. MAFF has issued detailed guidance on project appraisal procedures in the form of Flood and Coastal Defence Project Appraisal Guidance Notes (MAFF 1999 a-d and 2001, 2001a). These FCDPAGs

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include important references to the historic environment. Moreover, Section 7 of the Environment Act 1995 and sections 61A and 61B of the Land Drainage Act 1994 require the Environment Agency, Internal Drainage Boards (IDBs) and Local Authorities respectively to contribute to the conservation of nature and heritage when carrying out their flood defence functions under the relevant Acts. Other recent UK policy, strategy and consultative documents include *Safeguarding Our Seas* (DEFRA 2002), *Modern Ports* (DETR 2000), and *Seas of Change* (DEFRA 2002a).

Shoreline management policy is driven not just by requirements for flood and coastal defence, but also by ecological considerations. Over the UK as a whole, it is estimated that it will be necessary to realign 740 hectares of coast every year for the next fifteen years in order to compensate for loss of salt marsh and achieve Biodiversity Action Plan targets (English Nature 2000). The EU Habitats and Species Directive (EEC 1992) requires mitigation of damage to designated wildlife sites in terms of Habitat Creation. For example, if a managed realignment scheme results in loss of a freshwater wetland area, an equivalent area of habitat must be created: typically by excavation of lakes and lagoons, and management of drainage to encourage development of reed beds, further inland. Similarly, where a port development results in loss of salt marsh or mudflat habitat, that habitat must be re-created, usually by managed realignment and inundation of grazing marsh. Much of the coastline of the East of England has wildlife designation (as AONBs, SPAs, Ramsar sites *etc.*), so the EU Directive is widely applicable in our region. In a wider context, the Recommendation of the European Parliament and Council of 30th May 2002 on Integrated Coastal Zone Management (2002/413/EC) requires member states to take a strategic ecosystem-based approach to coastal management, in which the cultural heritage is an important consideration.

Mitigation of damage by shoreline management

The key to ensuring proper consideration of the historic environment within the shoreline management planning process is to ensure that adequate and properly interpreted information is integrated into all stages, as well as into operational procedures. Archaeological inputs are at the levels of the Shoreline Management Plan, Strategy Plan and Scheme Design. How is this working in practice?

Data from county HERs/SMRs and the RCZAS are currently being supplied to the Extended Steering Group producing the *Kelling Hard to Lowestoft Ness SMP2*. There are some problems of information exchange which require resolution, and it is not yet clear what level of detail about the Historic Environment should be included in SMP2s. The first generation SMPs referred only to Scheduled Ancient Monuments and Listed Buildings, and it is certainly hoped that it will be possible to improve on that. Similarly, contributions are being made to Consultation Group meetings for the *Essex and Suffolk Estuaries Flood Management Strategies* and the *Wash Estuary Management Plan*. The main aim is to establish a high profile for the Historic Environment, though inevitably that must be in broad terms at the SMP and Strategy level.

It is, however, at the individual scheme level that consultation becomes more specific. The first consideration may be scheme location. For example, related to the Roach & Crouch Flood Management Strategy is a requirement for compensatory habitat creation. DEFRA has produced consultation leaflets on two possible alternative schemes: Weymarks Wetlands Restoration (February 2003) and Wallasea Wetlands Creation Project (September 2003). English Heritage and Essex County Council were consulted about both and visited the sites

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with the Environment Agency Project Manager, Mark Dixon. The proposed Weymarks scheme is adjacent to the Roman Saxon Shore fort at Bradwell-on-Sea, and would involve groundworks in an area with a relict creek system, which may have been usable as a haven in the Roman period (Wilkinson and Murphy 1995, 00). Wallasea Island was badly flooded in 1953, and several farmhouses were destroyed; in the 1970s virtually the whole island was scraped and levelled by a team of bulldozers over a six year period to convert it to arable (Heppell 2002). Plainly, the Historic Environment of Wallasea Island is so badly damaged that a habitat creation scheme there would be preferred to Weymarks. Given this, and other, environmental and economic factors, Wallasea was selected as the preferred location by DEFRA in March 2004.

More often, where flood defence is the main issue, scheme location is pre-determined. An outline archaeological protocol has been defined in English Heritage (2003), comprising:

- desk-based assessment;
- fieldwalking;
- earthwork survey;
- geoarchaeological prospection and deposit modelling;
- geophysical survey;
- archaeological evaluation trenching;
- mitigation – either preservation *in situ* by modification of scheme design, or full excavation and recording;
- watching brief on contractors' excavations; and
- post-completion monitoring to mitigate against scour.

Not all of these techniques will be applicable at every scheme, but all have now been applied at schemes in the East of England. A particularly successful example, now (February 2004) reaching the stage of full excavation of significant areas defined during evaluation and palaeoecological analysis of the associated sediment sequence is that at Blakeney Eye, North Norfolk (Environment Agency/Halcrow 2002; Birks 2003)

Commercial developments

The principal commercial developments that have effects on coastal sites are ports (and, on a similar but smaller scale) marinas, and the landfalls of cables and pipelines, with associated infrastructure. Offshore developments including windfarms and marine aggregate extraction lie outside the scope of this paper, though see BMAPA & English Heritage (2003). Methodologies for investigating offshore, fully submerged, landscapes and sites are currently being developed (Flemming *in press*).

Several major port developments are currently proposed in The East of England, at Shellhaven (London Gateway), Bathside Bay, Harwich, Felixstowe (South Extension) and the Ipswich West Bank Ro-Ro Ferry Terminal. At the time of writing, none of these proposals has gone to Public Enquiry, and results from archaeological work remain in confidential client reports. It is therefore not possible to discuss procedures and results in any detail, but, in general terms, port developments are likely to involve:

- capital dredging to enlarge or create approach channels;

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land claim, depositing dredgings and/or hard-core to claim intertidal flats, on which operational areas are constructed;
groundworks and piling through alluvial sequences and pre-transgression surfaces of former marsh; and
groundworks associated with services and infrastructure on adjacent gravel terraces.

Archaeological investigations are therefore likely to range from the fully terrestrial to submarine. Methodologies for fully submerged sites can be based on BMAPA & English Heritage (2003), but there is one key difference: mitigation of impacts by avoidance is unlikely to be possible, since there is little or no scope for re-routing approach channels for modern vessels. So far as wrecks are concerned, techniques will include marine geophysical survey, followed by diver inspection and recording to an appropriate level. In the intertidal zone, examination of successive aerial photographs is a useful evaluation technique, which not only gives an initial impression of the types of vessels represented, but also their dates of abandonment. This can be followed by detailed ground recording.

Bathymetric survey, sub-bottom profiling, borehole (vibrocore) and grab survey provide data on submerged land surfaces and Holocene sediment sequences. There is a well-established methodology for examining prehistoric land surfaces and sediment sequences exposed intertidally and buried deeply beneath the coastal Holocene sediment prism, employing archaeological, geotechnical, geophysical and palaeoecological techniques (*e.g.* Bates and Bates 2000; English Heritage 2003, 11-12). However, detection of buried or submerged sites, as opposed to topographic reconstruction from which site locations may be inferred with reasonable confidence, remains problematic. For this reason, archaeological monitoring of dredging and of groundwork construction is essential, with provision for detailed recording where appropriate and possible..

Three other points are worth emphasising. First, burial of intertidal surfaces during land-claim under dredgings and hard-core is not preservation *in situ*. Buried sediments and sites will be subject to damage from compaction, so mitigation (including palaeoecological study of the sediment sequence) is necessary. Secondly, dredgings are highly likely to include archaeological material, which will then be re-deposited (either by dumping offshore or during use for land-claim). To avoid confusing the archaeological record, locations of dump sites must be recorded. Finally, the techniques used to evaluate marine, intertidal and sub-alluvial surfaces should be as consistent and comparable as possible. The aim should be to produce seamless deposit models which extend across the land/ocean boundary.

The effects of pipeline and cable landfall are essentially the same as on land. However, it is important to remember that trenches and tunnels may be dug through Pleistocene sediments exposed in foreshore platforms and cliffs. The potential archaeological importance of these has to be determined on a case-by-case basis. An example was at the Bacton, Norfolk Gas Terminal, where a pipeline cut through beach and cliff exposures of the Cromer Forest Bed Formation.....

Will preservation *in situ* ever be possible

Coastal archaeological sites must be considered within a broad and long-term context. Where realignment, or non-intervention, is the preferred management option for a length of coastline, it is not feasible to protect an isolated site by means of hard defences. As erosion proceeds,

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the site would first become a peninsula, later an island, encased in concrete or rock-rubble armour. It would be largely inaccessible and separated from its original environment; and maintenance would involve a perpetual financial commitment. Where cliff erosion is inevitable, or is necessary to provide sediment supply elsewhere, cliff-top sites will be lost. It must be accepted that some coastal sites are unsustainable, and cannot be preserved *in situ*. However, where sites are subject to localised erosion within a generally stable or maintained coastline, hard defences are certainly appropriate. Even in this situation, however, to construct and maintain hard defences is a substantial commitment.

Soft options offer a more sustainable approach. Beach nourishment (emplacement of sand or gravel seawards of sites to absorb wave energy) is one, although this involves on-going costs. Other options involve schemes designed to trap sediment, usually by construction of polders, groynes or similar structures. In principal, these will require a one-off cost, with only intermittent maintenance costs, but expert advice on their probable long-term effectiveness would be needed.

However, physical destruction is only one aspect of coastal site preservation. Even where a site maintains its physical integrity, management schemes which result in de-watering, or re-watering with oxygenated water, are bound to modify the sedimentary environment. There is very little information on the hydrological, chemical and biological changes that may result, and the effects that these may have on organic and inorganic artefacts. There is an urgent need for monitoring in order to provide hard data, so as to inform future site management schemes.

Research Priorities

The enhancement of the HERs with data from the NMP and RCZAS, (when completed), combined with other investigations noted above means that the East of England has a uniquely complete record of coastal archaeology. Research priorities relate, in some cases, to especially well-preserved or well-exposed landscapes and sites. In fact several of these are already under investigation. They include:

- Thorough recording, and artefactual and palaeoecological analysis of Palaeolithic Cromerian Complex sites in Norfolk and Suffolk exposed intertidally. Some of these appear to be the earliest known hominid sites in the UK, and are therefore of national or international significance.
- Investigation and analysis of the Hullbridge, Essex palaeochannel. This is probably our best bet for an East Anglian Star Carr: the only known location where a dense lithic scatter, probably representing repeated activity in the Mesolithic, lies next to a palaeochannel which must include anoxic sediments. There is considerable potential for multiple coring and three-dimensional palynological analyses, to investigate the spatial extent of anthropogenic impacts on vegetation.
- Survey of new exposures at The Stumble, Essex and more extensive excavation and analysis. This is by far the most extensive, best preserved, and most productive Neolithic land area and site in the East of England. It is also the most vulnerable.

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- Further survey and recording at Holme-next-the-Sea. This is the best-preserved and exposed undisturbed Bronze Age ‘ritual landscape’ in the region; and, indeed, the only one known where the timber components of monuments survive.
- More extensive and detailed study of the Anglo-Saxon fish traps in Essex and Holbrook Bay, Suffolk. The largest wooden structures in the region, these have great scope for studying woodland management and chronological development.
- Investigating other major timber structures of unknown date, *e.g.* ‘Hullbridge’.
- Historic Landscape Characterisation and detailed earthwork surveys of selected locations. Earthworks on grazing marsh are very poorly recorded, and even less well understood, but they will increasingly come under threat from Managed Realignment. Their significance needs to be appreciated.
- Island survey. As noted above, islands of Pleistocene deposits within marshland are likely to have been favoured locations for settlement and other activities at all periods. Many are nowadays barely perceptible on the ground as islands, but they can be defined by high-resolution LiDAR surveys. Once detected and defined, applying other survey techniques (*e.g.* aerial photography, geophysics, fieldwalking), would yield information on former use.

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