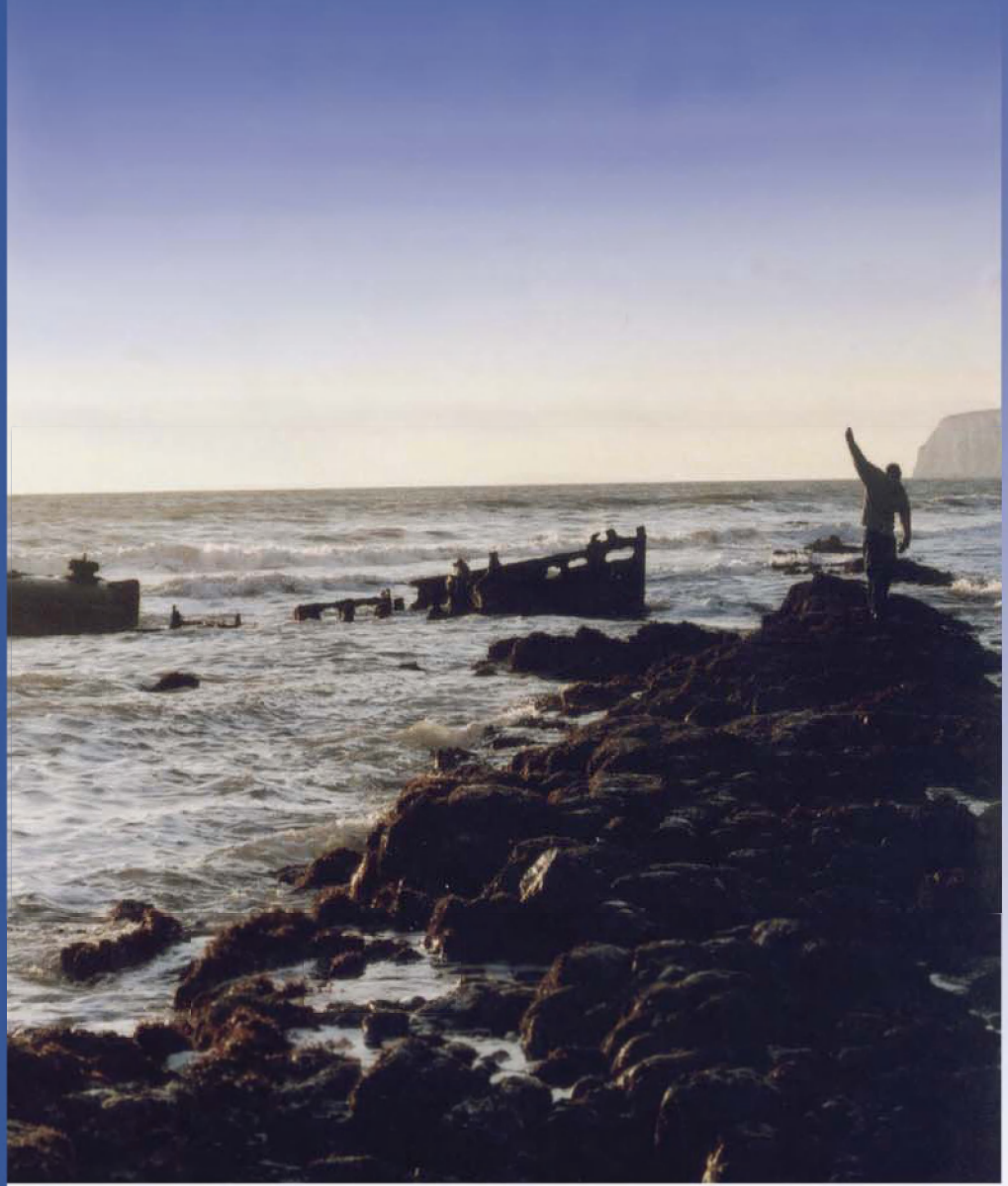
Hampshire & Wight Trust for MARITIME Archaeology

SCOPAC Archaeology & Coastal Change

Project Report

SCOPAC
STANDING CONFERENCE ON PROBLEMS ASSOCIATED WITH THE COASTLINE



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ii. Data licenses

Details of archaeological sites in the study areas were obtained from the Historic Environment Record (HER) and Sites and Monuments Records (SMR) maintained by West Sussex County Council, Isle of Wight County Council, Hampshire County Council, Southampton County Council, Portsmouth County Council and Dorset County Council. Copyright restrictions apply to all the HER and SMR data. See appendix 14.1 for specific details of license agreements.

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1. Non technical summary

This document has presented case studies where past planning regimes have suffered from a poor understanding of the ongoing processes and natural trends that are shaping our coastal zone. Consequently, many coastal settlements are becoming vulnerable as the relationship between the land and sea evolves. The following appraisal of archaeological and palaeo-environmental resources offers SCOPAC members a first step toward '*wisdom of hindsight*'. It leads to a position where coastal management decisions can be based on knowledge drawn from the long-term behavioural trends in the shifting boundaries of the sea.



Figure 1.1. Storms ravage the coastline along the south coast of the Isle of Wight. A better informed planning regime could have anticipated coastal vulnerability (LIFE Project)

The local communities of the SCOPAC coastline can rightly claim a long-standing wisdom drawn from a familiarity with the sea. The landslips of Lyme Regis and Ventnor; the shifting tiers of shingle in the Chesil Beach, the diminishing mud-flats and retreating strand-lines of the Solent; wave-attack and overtoppings at Selsey are known to all. The problem has always been securing a glimpse of a 'big picture' where a long-term timetable of coastal change may be revealed.

The problems that beset SCOPAC decision-makers are epitomised by the example set by the West Sussex village of Bosham. Here, it seems, cardinal principles concerning coastal protection and shoreline management were established in a particular field experiment made long ago. The result was an executive decision that has endured the acid test of time. The decision claimed at Bosham underlined three enduring principles governing all of our transactions and bargaining's with the sea.

- There is a need to respect the ungovernable and capricious power of the sea
- There is a need to observe and learn from the behaviour of the fluctuating shoreline
- There is a need to re-think, plan and adapt to the long term behaviour of the sea

Why Bosham? Those familiar with the drowned reaches of Chichester Harbour and the position of this historic village will be aware that the road, the car-park, vehicles and property still regularly succumb to advances of the sea. Clear and uncompromising warning signs have been erected yet incomprehension and unrealistic optimism are still remarkably persistent, especially amongst newcomers.

The difficulties of comprehension and unwarranted optimism are not specific to Bosham. They are part of an endemic problem that besets each region of the SCOPAC coast. Wherever drainage schemes and sea-defences and beach recharge projects have been implemented, there remains a permanent need to observe, learn and up-date our understanding of the changing shoreline.

It seems that the Bosham experiment was evoked at a time when the onset of a particular climatic episode was bringing perplexing changes to Britain's shores. Its course was not dissimilar from our present situation. This was heralded in the year 1014

> '*a great sea-flood, wide throughout the land, that ran so far as it had never done before, washing away many towns and countless number of people*'.

Drought and widespread heath fires betray climatic changes at this time. In the space of three centuries, people and land were to be lost in episodic coastal changes that were to claim villages in West Sussex and lands in parts of Hampshire, Dorset and the Isle of Wight. When a popular call arose for explanation and intervention, it fell to King *Canute* in his palace at Bosham to demonstrate that the agenda of the sea leaves little negotiable space for human bargaining.

This report reviews the Historic Environmental Records (HERs) held by the local authorities across the region and identifies their value as tools to inform shoreline management. Where possible it draws on local knowledge and research of coastal change to identify the potential of the resource. It has been recognised that sediment archives, and indeed, the recorded history of flooding events can indicate areas that will be at greatest risk as the climate changes. The need to understand the geomorphological evolution of a coastline has also been acknowledged as an aid to the interpretation of current and future trends. In some cases it can be demonstrated that the source material which created maritime barriers and spits has become exhausted, while in other areas, natural recharge may have been interrupted by more recent human activity. These concerns can only be comprehensively managed where the causes of any change are understood and risks identified.

Today our engineers and planners contemplate physical changes that have been witnessed in the eye's blink of a century or so. In this short time an assortment of maps, plans and photographs have given engineers, planners and decision-makers no more than a short-term view of Nature's agenda. We are now pressed to assign funds to options and strategies for coastal management and protection yet we have still been denied a clear view of Nature's 'big picture'. The historical record has demonstrated time and again that it is untenable to plan and build a future on such untested foundations.

The report contains essential raw data on those coastal sediments and cultural resources that will help all SCOPAC members to steer their communities away from the pit falls of incomprehension, unrealistic optimism and procrastination. A clock has been set and climate-change and the rising of sea-level now demand new and critical decisions. Some of these decisions may be difficult or unpopular to implement. Those concerning '*managed set-back*' and the option to '*do nothing*' may be particularly difficult to accept.

With the aid of this commissioned report, SCOPAC members can begin to identify specific sites where long-term indicators can be read. Each may reveal an anticipated timetable of natural change within a particular management unit of the coast. Now that these resources have been identified the next task is to ensure that appropriate information is extracted and interrogated. These are precautions that should be encompassed in the 'round 2' up-dates of each shoreline management plan. Here lies the essential evidence from which we may determine Nature's true agenda for the future configuration of the coastline.

2. Project framework

This project advances a valuable initiative taken by those SCOPAC members who participated in a study of *Coastal change, climate and instability*. This was funded by the LIFE programme of the European Commission (project LIFE-97ENV/UK 000510).

In 2000 the forum of European participants concluded that certain archaeological features and palaeoenvironmental deposits offered a vital source of chronological information pertaining to long-term behavioural trends in the natural change of the coastline. The technical forum of the LIFE Project further concluded that the system of shoreline management planning, employed in the United Kingdom, offered a particularly promising route to the sustainable management of the coast.

The LIFE Project concluded that a system of scoring and ranking could be applied to identify those sites that should be earmarked for their particular value to coastal-change studies and shoreline management planning. SCOPAC members have now acted on these conclusions by seeking a ranked database of appropriate sites that can be integrated into the ongoing development of each shoreline management plan.

The following objectives are contained in the project brief:-

- **To establish whether there is archaeological and/or palaeoenvironmental evidence in the region that can help inform on issues concerning coastal zone management and coastal change.**

The study has responded by assembling base-line data drawn from some 4508 entries within the Historic Environmental Records for Dorset, Hampshire, West Sussex and the Isle of Wight. These sites range from the Pleistocene period to the 20th century. All of this data has now been reconciled within a GIS system (Section 6).

- **To assess the quality of evidence that the archaeological and/or palaeoenvironmental archive can offer coastal managers.**

Data gathered in this desk-based investigation has been interrogated by means of an enhanced ranking system. This was developed from principles established in pilot studies in the LIFE Programme. The ranking criteria assessed each site with regard to its potential to inform on past coastal change (section 7). These criteria were applied to all sites falling within each of ten study areas situated across the SCOPAC region (section 8).

Analysis of the scored results has led to the selection of six key assessment sites suitable as exemplars for further study (section 9). A variety of periods, site types and environments are encompassed in this choice. The selection also demonstrates variety in the investigative techniques and the types of evidence that helpfully contribute to knowledge of coastal change.

- **To use the results of this study recommend the use of archaeological and palaeoenvironmental archives in good coastal management practice.**

The study has given separate attention to the assessment of sediment archives. It also gives special attention to the means by which archaeological information has been currently regarded in shoreline management plans (section 5). This leads to issues of 'best practice', considered in sections 11 and 12 of this report.

These issues embrace:

- Recommendations for the use of archaeological and palaeoenvironmental resources by coastal managers.
- Recommendations for further action on sites proffering an improved knowledge of coastal-change.
- Recommendations on the use of archaeological and palaeoenvironmental evidence in the SMP process.
- General recommendations for future work to pursue the findings of the study.

3. Archaeology and palaeoenvironmental studies in aid of coastal management

This project focuses on archaeological and palaeoenvironmental sites that offer a strategic contribution to good management and protection of the coastline. The two studies are closely related although palaeoenvironmental deposits are often lesser known. These sites have not always been included in *county sites and monuments records* (SMRs) or *historic environment records* (HERs).

3.1 Archaeology

For coastal managers and planners, archaeological studies can tell of past communities that once exploited the coast. They can reveal where people once lived in safety, the conditions they encountered and circumstances that could cause them to retreat from changing or unstable coastal conditions.

Some sites of human settlement are now deeply submerged. The Middle Stone Age site at Bouldnor is a particular example. Sites of this kind are an emphatic reminder that some of our present settled locations on the coast can never be secured from the long-term process of coastal change.



Figure 3.1 Diver inspects Mesolithic occupation site at –12m off North coast of Isle of Wight, now eroding from submerged cliff

The precise height and date of a submerged settlement may enable us to calibrate the scale and pace of the long-term coastal processes. Individual humanly formed objects (described as *artefacts*) can sometimes reveal much the same thing. A small artefact, such as the Middle Stone Age flint axe found during the excavation of Southampton's Graving Dock, is a good example. This has offered vital evidence of the date and height of past sea-level in one of our key estuaries. Such information may only be gained once the layer or 'context' of the artefact is fully investigated. It is in matters such as these that archaeologists, palaeoenvironmental scientists and coastal engineers must collaborate.

In this report the value of some particular types of artefact is emphasised. These include prehistoric dug-out canoes that have been recovered from the flood plain of the Arun. Such artefacts can offer tree-ring dates and a specific height for past river-levels.

3.2 Palaeoenvironmental studies

Palaeoenvironmental sites embrace natural deposits such as gravels, silts and peats. They may also include raised beaches, ancient soils and preserved root systems. They may even include trees contained within a submerged land surface. Where these deposits occur in long or unbroken sequences they are considered to be '*sediment archives*'. As the name implies, these deposits might be read like a book, once scientifically examined.

Many deposits contain ancient plant or animal remains (termed *ecofacts*). These can also reveal the nature of a changing coastal environment. The timespan of a sediment archive can be thousands of years. Within these long timespans specific events may be accurately fixed by such techniques as tree-ring dating and radiocarbon dating.

Some of the most valuable sediment archives are preserved in buried river courses or *palaeochannels*. These can be found at the mouths of harbours and creeks or on the floor of the English Channel. Coastal wetlands are a further source. Sediment archives offer some of the most reliable evidence for measuring long-term environmental change and sea-level rise on the SCOPAC coastline.

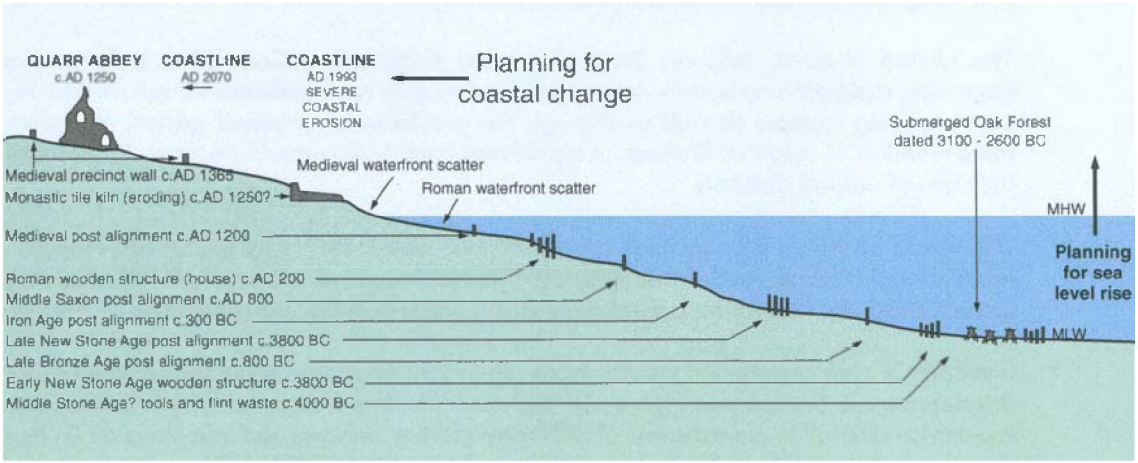


Figure 3.2 City and port development over a sediment archive in a riverine inlet (LIFE Project)

3.2.1 Environmental archaeology

Palaeoenvironment is a term used to define a past environment that has now become extinct in a particular region. Archaeologists commonly seek palaeoenvironmental information as a means of explaining past human activity. The *Association of Environmental Archaeologists* has provided a guide to the range of materials that should be sought and studied in archaeological or environmental evaluations (*www.envarch.net/publications/papers/evaluations.html#pt2*). Much of this material is of common value to botanists, soil scientists, geographers, planners, geomorphologists and those concerned with the past and present behaviour of the coast.

Palaeoenvironmental evidence pertinent to the history of coastal change can be found in geo-technical cores and vibra-cores. It can also be found in new exposures of sediment, in digger-cuts, cliff-falls and in navigational and capital dredging. In engineering works and in commercial dredging operations it is not uncommon for samples to be quickly

discarded. Much more can be gained by discussing and sharing common interests. This is an objective that can now be nurtured by SCOPAC.

We list here some of the principal lines of palaeoenvironmental investigation that may be shared in pursuit of a better understanding of the SCOPAC coastline.

- microfossils (phytoliths, pollen, diatoms, and fungal and fern spores)
- plant macrofossils (e.g. seeds, leaves, mosses—these may, variously, be waterlogged, charred or mineralised), large timbers and small roundwood
- the eggs of internal parasites
- arthropods, particularly insects, ostracods, cladocerans and mites
- terrestrial, freshwater and marine molluscs
- vertebrates, particularly large and small mammals, birds and fish as well as some other, minor, groups (such as annelid worms, larger crustaceans, and bryozoa). A range of biologically-derived residues, including humates, lipids, DNA and starches may also be present.

3.2.2 Geoarchaeology

Geoarchaeology is a relatively new area of specialisation and it is highly relevant to the study of coastal change. This discipline studies "the effects of earth surface processes on the evidence for human activity at various different scales" (English Heritage 2002). Geoarchaeological investigations aim to understand site-formation processes and landscape changes. The principal line of investigation lies in the study of soils and sediments. Members of SCOPAC have much to gain by prompting these new approaches in appropriate sectors of the coastal zone.

3.3 Using historic environment records

Historic Environment Records (HERs) within the SCOPAC region play a vital role in identifying those archaeological and palaeoenvironmental sites that are of special value to coastal planners and engineers. They include data previously known as *Sites and Monuments Records* or SMRs. These records show where archaeological and palaeoenvironmental resources have been found or noted in the past.

Across the SCOPAC region there are variations in the extent to which sites with palaeoenvironmental evidence have been included in these records. In general, these records will show where some palaeoenvironmental resources have been recognised or noted in the past but present databases may be biased in concentrating only on sites that show a combination of archaeological and palaeoenvironmental evidence.

It is particularly important to recognise that Sites and Monuments Records and Historic Environment Records can never offer more than a partial view of what is actually in the ground or beneath the sea. The content and scope of these records can be up-dated from week to week. This means that all researchers must be careful to avoid reliance on out-dated information.

The historic environmental record is a powerful tool in coastal management but it must be remembered that an absence of evidence in this record must never be taken as evidence of absence in the field.

In the past, lists taken from these databases have actually been used to argue ‘evidence of absence’. This is the worst case of bad practice and it should never be seen in a shoreline management plan or a planning proposal.

In the SCOPAC region Historic Environment Records are held by:

- Hampshire County Council

- Isle of Wight Council
- Dorset County Council
- West Sussex County Council
- Southampton City Council
- Portsmouth City Council

The nature of historic environmental records
The databases of most historic environment records document individual 'monuments', 'sites' or 'finds'. Further information about each site is often recorded as an 'event' (fieldwork such as excavation or survey), or a 'source/archive'. Information is usually held on an electronic database linked to a GIS system. The exact format of these databases and GIS varies between individual authorities which has been problematic in assembling evidence for this SCOPAC project.

In addition to electronically-stored records, local authorities also hold physical archives that can be consulted. These 'back-up' files often contain detailed information on archaeological sites and finds. Due to the large amounts of 'grey literature' derived from development-led investigations, HERs often hold a range of reports that are difficult to consult in any other public archive.

3.4 Relevant regional archaeological data-collection initiatives

It has long been recognised that, by comparison with records for the terrestrial environment, the gathering of data for the inter-tidal and off-shore zones of the SCOPAC region is weak. Within the Solent region a number of initiatives have sought to redress this balance. These are outlined below.

The Wootton-Quarr coastal study: an initiative by the Isle of Wight Council
The Wootton-Quarr coastal survey commenced in 1989 and was concluded in 1997. It was designed to investigate the course of past human activity on 4km of submerging coastline between Wootton and Ryde. This was a major research project funded by English Heritage. The chronological parameters of the project ran from the Middle Stone Age to the 20th century; a timespan of some 8,000 years. Much of the evidence is directly related to long-term coastal behaviour.

The Wootton-Quarr project identified wide-ranging human activity including camp-sites, fish-traps, fish weirs, salt kilns and anchorage strews. Submerged land-surfaces were investigated and a particularly informative series of tree-ring dates and radiocarbon dates was obtained. Many of these absolute dates could be related to rises in sea-level and the retreat of the shoreline.



Figure 3.3 Prehistoric tree eroding from the foreshore at Wootton-Quarr

Of particular interest is the long history of sedimentation in the Wootton-Quarr inter-tidal zone. This had preserved a submerged prehistoric landscape for some 5,000 years. The stability of the zone had then entered into a phase of marked reversals characterised by destructive wave-attack and sediment-loss in the later decades of the 20th century. A full published report by English Heritage is now awaited.

The Langstone Harbour study: an initiative by Hampshire County Council
The Langstone Harbour Project commenced in 1993. It was completed in 1998. It pursued an investigative agenda similar to that pioneered at Wootton-Quarr. The project was similarly multi-disciplinary and sought an understanding of natural change and the course of human activity on the Hampshire coast. This work was sited in and around one of the three inundated basins that lie on the Hampshire-West Sussex coastal plain between Gosport and Chichester. The project revealed intermittent human activity commencing in the Middle Stone Age and adapting, at various times, to a rising sea-level. These changes were accompanied by a retreat of the shore from mud-flats and salt-marsh.

Significant stages in the evolution of Langstone Harbour began with a transition from a down-cut ravine to a siltated river valley. This occurred during the Late Middle Stone Age. Dominant marine influences did not enter the channels within the harbour until after 800 BC. There then followed periods of stasis and episodes of both accelerated erosion and deposition. These dynamic episodes show a relationship with concurrent changes in relative sea-level and shifts in local currents and the tidal system (Allen and Gardiner, 2000, 186-198).

Like the Wootton–Quarr project, the Langstone Harbour survey has tested and reviewed a variety of methodologies for the survey and evaluation of sites in the inter-tidal and sub-tidal zones. By carrying these studies into the adjoining terrestrial zone the project has also become a valuable model for the 'seamless approach' to these resources.

The Langstone Harbour report contains many valuable recommendations for the management of the historic environment in the coastal zone. It helpfully considers where interaction and reconciliation can be achieved between conservation interests concerning both the natural and the historic environment.

The review of current survey and analytic methodologies at Langstone will naturally lead coastal managers and investigators to some new and rewarding sources of information pertinent to the study of shoreline change. The Langstone report, nevertheless, has not been framed to address the specific interests of shoreline management. It is unfortunate that the present shoreline management plan for the East Solent was issued before the publication of this report. This is a lacuna that must surely be redressed in round two of the SCOPAC shoreline management plans for this region.

Isle of Wight coastal audit
Unlike the Wootton-Quarr and Langstone Harbour surveys, this project has sought rapid assessment of previously unrecognised sites on the Isle of Wight coast. It has been specifically designed to enhance the coverage of the Historic Environmental Record so that it can helpfully address issues in the Shoreline Management Plan for this area.

Objectives:
- To identify sites and structures in the coastal zone (the intertidal zone, the coast edge and the coastal strip) using documentary records, maps and charts, air photographs and in the field.

- To assess the condition and vulnerability of archaeological sites in the coastal zone. To provide information for the Coastal Protection Authority and for the LIFE project '*Coastal Change, Climate and Instability* '.

The Isle of Wight audit has significantly increased the number of known archaeological sites on the Island's coast. It has also revealed a general timescale in which many of these sites will be lost to erosion. This audit is of particular value to SCOPAC members because it shifts the number of sites in a given coastal area from a perceived quantity to a confirmed one.

The 'Rapid Coastal Zone Assessment' in Dorset
English Heritage is currently commissioning a series of rapid coastal zone assessment surveys. These are intended to improve understanding, to enhance local authority Historic Environment Records (HERs) and to advance the conservation of historic remains in the coastal zone. A first phase of rapid assessment has been recently completed in Dorset. This has sought to:

- Provide an enhanced Sites and Monuments Record for the coast, and offshore waters;
- Provide an overview of coastal change from the Late Upper Palaeolithic onwards;
- Provide an assessment of the degree and nature of threat to coastal and historic assets based on current predictions of possible coastal change;
- Provide a broad assessment of the likely archaeological potential and vulnerability of all stretches of the coast;
- Provide a sound basis for developing management and research priorities in respect of specific sites and areas of potential;
- Enhance public understanding and enjoyment of the coastal zone.

The *'Dorset Coast Historic Environment Research Framework*' provides a thematic summary of this current work. Most notably it recognises that:-
'Poole Harbour, Christchurch Harbour and the Fleet are key areas for the study of past environmental change and its relationship with human activity' (Wessex Archaeology 2004: 6).

Coastal projects by Hampshire and Wight Trust for Maritime Archaeology
A number of fieldwork and research projects undertaken by the HWTMA have aimed to:

- Gather data on maritime archaeological sites to help enhance HER records
- Study areas and/ or sites which have the potential to add to our knowledge of the maritime archaeology of the Solent
- Develop techniques for the study and investigation of maritime sites

Several projects, of particular relevance for this study include:

- The Itchen River Project
- The Hamble River Project
- Eastern Solent Maritime Archaeology Project
- Submerged Landscapes of the Western Solent
- Investigations at Bouldnor Cliff

3.5 Sites and natural resources with particular links with the process of coastal change

Maritime archaeologists and palaeoenvironmental scientists have long recognised the impact of the sea on humanly-formed structures. Many of these have been severely

inundated. Wooden trackways and fish-weirs built along the coast at the end of the Middle Stone Age can now be found metres below current high water. Some are now only accessible when the tide is out. Medieval salt-making ponds, whose viability was dictated by their relationship with high water, are now inundated and would be useless today. Some Iron Age and Roman salt-making kilns are now submerged and, certain historic fortresses on the coast are now subject to progressive sea-attack.

The degradation of these sites is an unfortunate loss to our cultural heritage, but their study can be vital to our measurement of the nature, scale and pace of coastal change.

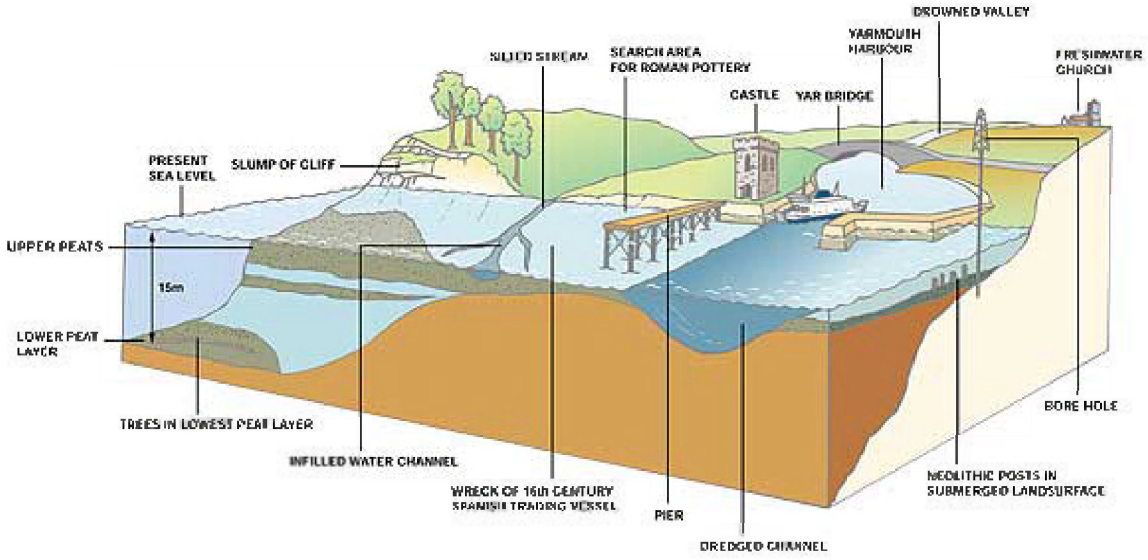


Figure 3.4 Schematic diagram of the coast near Yarmouth, Isle of Wight (LIFE Project)

Recent studies have recognised that the sea is not always destructive. As the waters rose after the close of the Ice Age, blankets of marine sediment were laid over the margins of river valleys and estuaries in the SCOPAC region. This has been clearly demonstrated and dated at Wootton-Quarr (Loader, Westmore & Tomalin, 1997: Tomalin, 2000) and Langstone Harbour (Allen & Gardiner, 2000, 203-205).

These alluvial silts often sealed and preserved the underlying landscapes. Analysis of these covering sediments can reveal information about past events in the evolution of the coastline. Like growth rings in a tree, the laminations within these 'sediment archives' can act as an index to the long-term changes in our coast. In the SCOPAC region we have yet to make a fully co-ordinated investigation of these sediment archives.

4. Overview of the course of natural events and past human settlement in the SCOPAC region

4.1 Summary of geomorphological and palaeoenvironmental time-scales and their relationship with archaeology

The present configuration of the SCOPAC coastline is a direct product of both abated and developing processes. The progressive drowning of the Portsmouth, Langstone and Chichester Harbour lagoons; the widening of the Western Solent; the retreat of cliff-lines in Bournemouth and Christchurch Bays; the empondment of the Fleet; the accretion and re-sorting of shingle in the Chesil Beach; the shifting configuration of the Solent spits; massive ground-slope failures on the coast at Ventnor and Lyme Regis: all are long-term processes that are still proceeding in accordance with their own individual time trajectories.

Some of these phenomena began within the relatively short course of the Holocene period; that is the last ten millennia that have followed the cessation of the Ice Age. Others claim more ancient origins during the glacial fluctuations of within the Pleistocene period. These earlier phenomena concern major fluctuations in climate and sea-level that triggered a number of erosional and depositional processes. Many of these events are still impacting on the present character of the SCOPAC coastline and will continue to do so.

The summary, presented here, places the principal changes on the SCOPAC coast in the conventional setting of human history. A more detailed consideration of the geology and geomorphology of each of the project 'study areas' is presented in section 8. These draw heavily on data already assembled by SCOPAC 'Coastal Sediment Transport Study'.

4.1.1 The core of the SCOPAC coastal region in the Middle and Late Pleistocene (c500, 000 – 13, 000BP)

During the interglacial episodes of the Middle and Upper Pleistocene, the climate was warm enough to accommodate early human settlement. (Stone implements or 'lithics' of this period, termed palaeoliths, are classified as Lower and Middle Palaeolithic).

'Lithic' evidence offers a valuable means of characterising and dating the early development of the river systems that now impact on the SCOPAC coast. Evidence of this kind can be recovered from various 'trains' or terraces of river and beach gravel but the chronological value is not always strong. This is because some items are suspected to be re-deposited or 'reworked' by later shifts in the course and depth of our rivers.

Where 'lithic' deposits have escaped re-working, palaeoenvironmental evidence may also be present. This can help to reconstruct the past character and configuration of the SCOPAC coastline. Sites of particular significance are Boxgrove (West Sussex) and Red Barns (Fareham, Hants). Other sites showing promising potential are those at Priory Bay and Pan Pit on the Isle of Wight.

The most helpful geo-archaeological studies in the SCOPAC region are those assembled for the Solent catchment by Allen (1990) and Allen and Gibbard (1993). These claim a Pleistocene origin for a '*Solent River*' that once drained much of the southern part of the Hampshire basin. A course from the chalk uplands of south Dorset to the coastal lowlands of West Sussex was first proposed in the 19th century (Fox, 1861).

Adherents to this original hypothesis have accepted that a ' great western arm' of the *Solent River* passed eastwards from the Poole Harbour area of Dorset to enter a

palaeovalley that now lies somewhere beneath the floor of the Western Solent (Nicholls 1987).



Figure 4.1 The original concept of the Solent River prior to Holocene inundation of the SCOPAC coast

In Southampton Water, and the beneath the floor of the Eastern Solent, the course of the lost *Solent River* is well attested (Dyer 1971), It then turns south to join the *Channel River* some 30km south of the Isle of Wight (Wenban-Smith 2001). The dating of the marine invasion and truncation of part or all of the *Solent River* is critical to our basic understanding of the nature pace and scale of erosion throughout the core area of the SCOPAC coast.

Recent research, employing a combination of seismic survey and coring, has examined the 17 km chalk monocline ridge that once connected Handfast Point with the Needles of the Isle of Wight. This ridge was once breached by three river-gaps during the low sea-level stage of the Devensian glacial phase. It is possible that there were two principal drainage routes out of the Hampshire basin. These would be served by separate river systems set east and west of the Isle of Wight (Velegrakis et al 1999, Velegrakis 2000).

While the east arm of the *Solent River* channel is now scientifically confirmed, the course of a western channel remains un-mapped and unproven. Tomalin (2000b) has postulated a 'last umbilical' or 'land bridge' in the Hamstead area of the Western Solent. This may have been be breached as late as the 45th millennium BC when tidal linkage could be achieved between the individually drowned basins of the Newtown River and the Western Yar.

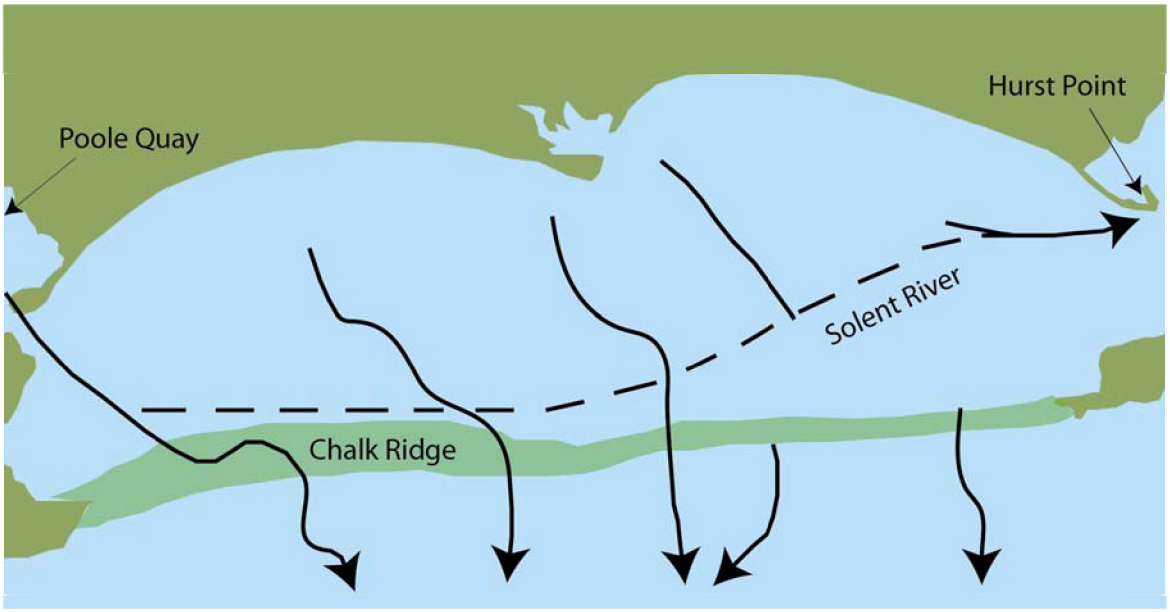


Figure 4.2 Pleistocene river channels now submerged in Christchurch and Bournemouth Bays

This proposal disallows the 'great western arm' of the *Solent River* and postulates a long-standing east-west watershed drawn between Hamstead and Pitts Deep. Until the exact nature and date of the severance is established, all timescales concerning the true pace of coastal erosion in this region will remain uncertain.

In West Sussex, detailed field mapping and borehole analysis of certain gravel terraces has investigated associations with the lines of 'fossil cliffs'. This has provided some of the best evidence for sea level change in the Pleistocene period (Roberts 1986, 1998; Bates, 2001).

There are particularly high numbers of palaeoliths in some of these gravels. These have offered a further means of obtaining relative dates for the levels of past rivers and shorelines. Wymer (1999) considers the total number of these find-spots in the Solent region to be the highest concentration in Britain. These promise closer refinement in the study of river development and the evolution of the SCOPAC coastline.

4.1.2 Fundamental changes to the SCOPAC coast during the Early Holocene

Before the close of the *Devensian* glacial maximum, an episode of intense cold drove all human occupation from Britain. It is not until around 13,000 BP (11,000BC) that re-occupation can be detected. The warming associated with this event leads to the onset of the *Holocene* and some marked changes in the SCOPAC coastline. The first of these changes is the advance of the Atlantic Ocean into the old *Channel River* system. This eventually drowns the terrain between Britain and Continental Europe.

During the early Holocene, the broad floodplain of the *Channel River* offered a vast hunting territory on land that is now submerged between Britain and France. The river valleys of the SCOPAC region are the headwaters of this ancient drainage system. The loss of this enormous territory is a reminder to all decision-makers that our plans for coastal protection must be tempered with a regard for those natural processes that are both on-going and un-negotiable.

The events of the Holocene period are dominated by a marked rise in sea level. In the SCOPAC region, the net result was particularly severe because the effective rise of the

sea was exacerbated by a particular bending or 'down-warping' of the land mass. The severity of these effects is evident in the 'drowning' of the coast and river mouths between Poole Harbour and Chichester Harbour. These processes are still continuing.

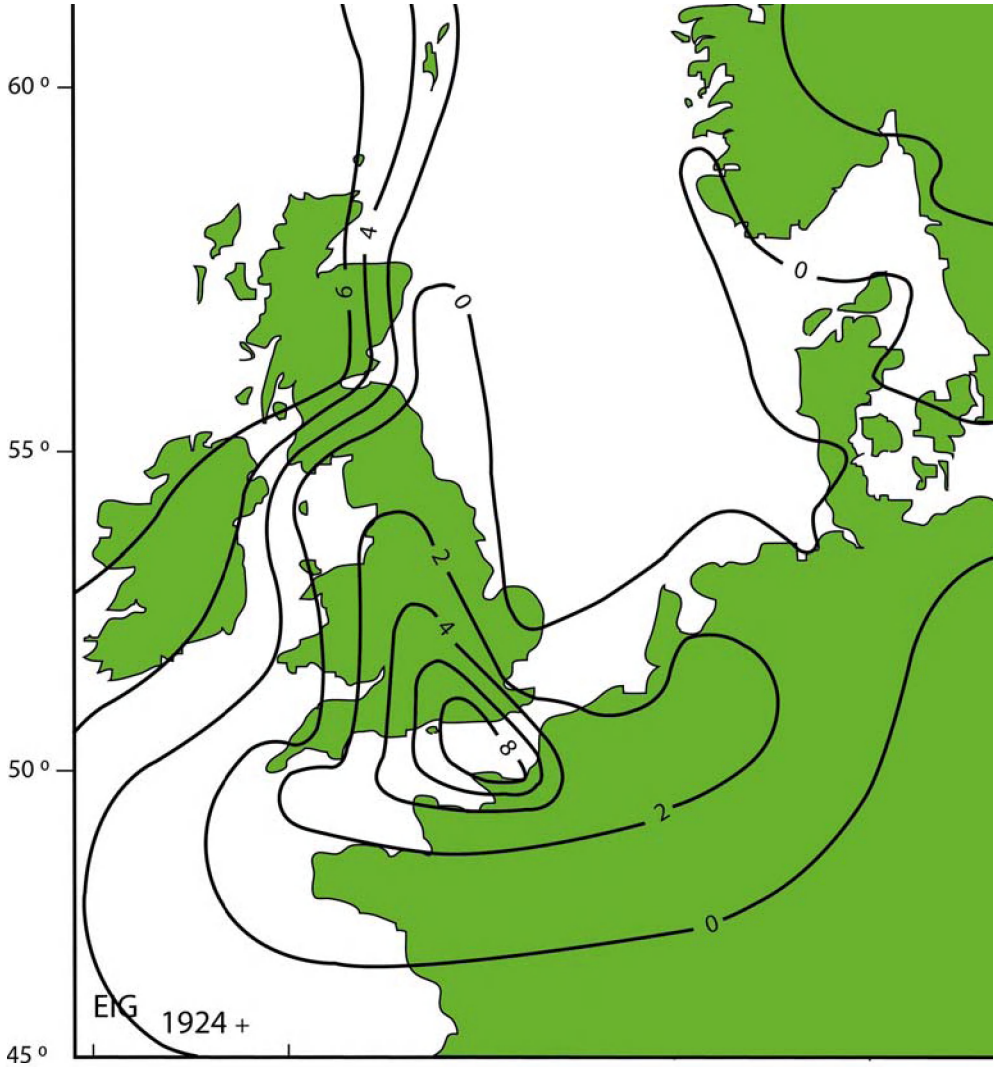


Figure 4.3 The focus of excessive downwarping in the Solent region

During the mid-Holocene many of the deeply incised river channels that had drained the periglacial landscape of Wessex began to fill with sediment. This change was driven by new estuarine conditions advanced by the rising sea. The risen sea also brought the development of coastal bars and subsequent effects of back-ponding. Brackish lagoons and new emponded coastal peat mires now appeared.

The waterlogged and anaerobic conditions in these environments were ideal for the nurturing of the *sediment archives* that SCOPAC investigators have since been able to identify. Particularly informative are the coastal and terrestrial peats with their integral pollen record and their plant macro-fossil evidence of environmental change. These have offered valuable records of long term change and sea-level rise in the Western Solent at Stansore Point (Long and Scaife 2001).

At Bouldnor, a submerged landscape containing a rich resource of stratified Mesolithic material and interbedded peats has been identified (Tomalin 1993; Momber 2000). These deposits now offer further opportunity to fix the date of the genesis of the Solent seaway.

Both of these sites have now produced radiocarbon dates that are vital to the calibration of sea level rise in the region.

Dix (2001) utilises data from a range of sources to summarise the current knowledge of Holocene sea levels in the Solent.

Date BP	Date BC	Sea level	Archaeological period	Epoch
18,000	c. 16,000	-130m O.D	Upper Palaeolithic	Pleistocene
10,000	c. 8,000	-30m O.D	Early Mesolithic	Early Holocene
8,500	c. 6,500	-15m O.D	Mesolithic	Mid Holocene
6,000	c. 4,000	-6m O.D	Late Meso/ early Neolithic	Late Holocene
2,500	c. 500	-2m O.D	Iron Age	Late Holocene

Table 1: Summary of current knowledge of sea-level in the Solent

4.1.3 The Late Holocene and the sequence of prehistoric and historic human activity on the SCOPAC coast

Table 1 shows a marked rise in sea-level during the early to mid Holocene. It also shows a reduced rate of progress as it enters the Later Holocene. This slowing coincides with the onset of the Neolithic or New Stone Age. This is a phase of human settlement when sea-level stands around -6 metres OD.

In the SCOPAC region considerable human activity was now focused on the coastal regions of the Solent including the eastern periphery of Langstone and Chichester harbours. The nature of human settlement and the configuration of the coast in Poole Harbour and the Dorset Fleet have yet to be established.

Between 6,500 BC and 4,000 BC the rise of Solent sea-level amounted to some 9m. It is suspected that changes within this period may have included the final achievement of tidal linkage through the Western Solent seaway. This would impose the severance of the Isle of Wight. Current archaeological, palaeoenvironmental and geophysical evidence demonstrates that the inundation of the Solent started at around 8,500BP (Dix 2001), continuing its rapid process for over 2,000 years (Velagrakis, 2000) before the Solent became a fully marine channel, perhaps around 6-7,000BP(Tomalin, 2000b).

The Late Holocene is characterised by a more gradual rise in sea level. There are noted climatic fluctuations during this period including the *Bronze Age Warm Phase*, the *Medieval Warm Period* and the '*Little Ice Age*' of the 17th and 18th century. The final warm trend is the so-called '*Hockystick*' in the global temperature chart. This coincides with the emission of 'greenhouse gases' after 1850.

While these perceptible climatic oscillations have been detected at a global scale, there remains a need understand the particular course of local behaviour on the SCOPAC coast where the effects of downwarping exacerbated the problem. With such new information should come an improvement in our ability to predict the nature and intensity of forthcoming change. There are hints that the Medieval Warm Period may have been accompanied by renewed erosion and coastal loss. Local coastal behaviour during the 'Little Ice Age' (AD *c.*1560 - *c.*1850) is also worthy of research.

Archaeological and palaeoenvironmental deposits of the middle and late Holocene have been identified in several key locations in the Solent region (Allen & Gardiner *ibid*). The edges of the Solent's tidal rivers and estuaries conceal buried peat deposits that have capped prehistoric land-surfaces. Through the identification and analysis of these deposits, valuable information on past climate and sea-level change may be revealed.

The Roman and medieval periods brought particular urban populations to settle at opportune locations on the SCOPAC coast. Here, docking and maritime trade might be promoted. The cities of Southampton and Portsmouth were preceded in this manner. With a rise in sea-level of less than 3m in the past 2,000 years, the balance between many shoreline settlements and marine advance in these areas has been just sustainable.

The 19th century brought a further wave of coastal settlement to the SCOPAC shoreline. This, too, lacked regard or understanding of the long-term agenda of the Holocene rise in sea-level. This new wave of coastal settlement sporned the south coast resort towns of which Bournemouth, Ryde, Sandown, Shanklin, Ventnor, Southsea, Bognor Regis, Littlehampton and Worthing are the principal examples in our region.

All of these towns sought to establish human habitation imprudently close to soft and mobile shorelines. Promenades and sea-walls are intrinsic features of these towns yet we must not forget that their sea-defences, like the towns themselves, were constructed in a boom of Victorian optimism when the term 'Holocene coastal-change' was no better known than the word Tsunami.

5. Review of Heritage within Current Shoreline Management Plans

The SCOPAC Archaeology and Coastal Change project is very timely in relation to the number and focus of a range of project ongoing within the marine and coastal zone. In the Round One SMP documents for the Solent heritage was not given prominence, however, since the formulation of these documents there have been significant advances in our knowledge of the extent and importance of the cultural heritage resource. Most importantly there has been recognition of the potential for archaeological and palaeoenvironmental material to be utilised within broader disciplines studying coastal change and impacts.

5.1 Over view of consideration of heritage within Round One Solent SMPs

5.1.1 Western Solent and Southampton Water Shoreline Management Plan

The Shoreline Management Plan for the Western Solent and Southampton Water was drawn up at a time when little advice on coastal and maritime archaeology was available from English Heritage. At this time, sites that were embraced within the term 'historic environment' were perceived to be little more than a conservation management 'problem'. They were certainly not seen as a resource for informing the measurement and prediction of coastal change.

The sites included in this shoreline management plan are mainly those that are protected under the *Ancient Monuments and Archaeological Areas Act 1979.* Some sites cited for particular protection in the planning process were also noted. These sites include Lepe House, Eling Tide Mill and Hurst Castle.

Some additional sites cited in this SMP offer particular archaeological potential. These include scatters of prehistoric flint artefacts in eroding cliffs and the find-spots of Palaeolithic hand-axes in the gravels of certain river terraces. Some submerged prehistoric landscapes are also cited.

In certain management units mention is made of potential shipwreck sites. In the management unit for the Hamble estuary specific mention is made regards archaeological foreshore deposits and hulks.

The present SMP for this region fails to give regard to archaeological and palaeoenvironmental sites that offer a capacity to inform and enhance strategic decisions throughout the life of the plan. Until this is amended there is a danger that the plan will proceed with insufficient wisdom drawn from long-term hind-sight. There is also a danger that sites appropriate for interrogation may be lost through oversight and omission.

A summary of this SMP is available online and copies of the entire report are available to read at the various civil offices in the area.

5.1.2 East Solent Shoreline Management Plan

The East Solent SMP contains a list of *Scheduled Ancient Monuments* and historic sites of notable importance. It also includes some additional heritage sites on several parts of the coast. The coverage of below-ground sites is generally weak yet some regard is given to sites lying in onshore, foreshore and offshore locations where there their future security might be affected by plans for coastal defence. Where the planning process has recognised sites to be vulnerable to shoreline management proposals, these too have been cited in the SMP.

The complete East Solent SMP document is available online at (http://www.havant.gov.uk/havant-2788) while a paper copy of the report is available at the planning offices of Havant Borough Council.

5.1.3 Isle of Wight Shoreline Management Plan

The Isle of Wight SMP embraces 51 management units around the Isle of Wight coast. The plan considers all relevant archaeological and palaeoenvironmental sites contained within the Isle of Wight Historic Environmental Record at the time of compilation of the 'Round One' Shoreline Management Plan. The plan is an exemplar giving particular consideration to sites proffering potential information on the nature and chronology of the past and present behaviour of the coastline.

The plan considers a need for over-arching chronological and environmental information on long-term behavioural trends within the six process units of the Isle of Wight coast. The plan demonstrates that sites with a high potential to contribute to behavioural studies of the process units may be located within individual management units where a 'do nothing' prescription has been adopted. This discord between the gathering of strategic field data and the implementation of unit-specific management prescriptions presents a dilemma for the Round Two phase of shoreline management plans.

5.1.4 Isle of Wight coastal defences

A very brief account of some of the Isle of Wight coastal protection works is available online. A report booklet on Isle of Wight Coastal Defences is only available for purchase from the Isle of Wight Centre for the Coastal Environment.

5.1.5 Conclusions

Where historic buildings, landscape features and archaeological sites of significance have been cited in the first generation of shoreline management plans for the SCOPAC region, their inclusion has generally been little more than nominal. With the exception of the Isle of Wight, these current plans are mostly concerned with those sites that are afforded particular legislative protection or those that might be directly affected by the implementation of a coastal defence scheme.

Government's advice for the management and protection of the broader array of sites embraced within the ambit of Historic Environment Records has evolved as both an explicit and an implicit instruction. The clearest directive concerning the importance of these sites is contained within '*Planning Policy Guidance 16 'archaeology and planning*' (PPG 16), (DoE 1990a) .In paraphrase, this instruction emphasises that *archaeological sites are a finite and non-renewable source requiring appropriate management. They contain irreplaceable information about our past and they require particular care to ensure that they are not needlessly or thoughtlessly destroyed.*

Section 14 of PPG16 goes on to emphasise '*the future of the great majority of archaeological sites and historic landscapes lies with local authorities, acting within the framework set by central government, in their various capacities as planning, education and recreational authorities*. It is within the role of coastal planning and protection that the local authorities of SCOPAC are expected to fulfil the over-arching objectives otherwise expressed in PPG16.

Further guidance on the management and appraisal of coastal archaeological and palaeoenvironmental sites is set out in *Government Planning Policy Guidance 20; Coastal Planning* (DoE 1990b). This guidance begins with by emphasising conservation responsibilities where '*certain natural and historic landscapes and habitats are particular to coastal areas'* and where '*policies for the safeguarding of the environment, including*

policies for nature conservation and for the protection of natural and historic landscapes and archaeological sites and monuments' are needed.

Helpfully, this guidance stresses that '*information may be needed on the current state of the environment and the nature, scale and pace of change due to natural processes and human intervention'*. These topics include*, 'earth science information, assessments of natural and historic landscapes and sites of archaeological and built heritage interest'* The need to gather '*information on recent and current rates of erosion and deposition of material within sedimentary cells along the coast'* is also emphasised (PPG 20, 4.6, DoE 1990).

In section 4.8, Government's coastal planning guidance returns to the need for gathering field data. Here it emphasises that '*Earth science and ecological information should provide a firm base for development plans which assess the potential risks; seek to limit the damage to the environment; and guard against the loss of significant coastal habitats and landscapes'*.

To date, MAFF/DEFRA guidance on the preparation and use of *Shoreline Management Plans* has proceeded in parallel with PPG20 yet has been less perceptive in regard to the historic environment. This weakness has been recognised by English Heritage whose supplementary advice has been issued in '*England's coastal Heritage; a statement on the management of coastal archaeology*'. More detailed advice and case-histories have also been published by Fulford, Champion & Long (1998). A valuable review of this aspect of shoreline management has been commissioned by English Heritage (EH-WA 1998).

Significant issues recognised by English Heritage are the partial nature and the inconsistent status of Historic Environment Records. The first problem arises where the primary function of these records has been to service good planning practice on land. Where the ambit of development control under the *Town and Country Planning Acts* has halted at mean low water mark, there has been a tendency for County and District HERs to overlook their strategic need to pursue and gather data from the sub-tidal zone.

A second impediment arises from weak and non-statutory status currently accorded to Historic Environment Records. At present, the spend patterns of those county, district and unitary authorities that maintain these records are unfairly compared with those local authorities that have been able to avert this responsibility. This acts to the disadvantage of the HER authorities when Government makes its yearly calculation of the *Standard Spending Assessment*.

The result has been a general disincentive to gather and interpret data in the coastal zone. This discouragement acts in direct opposition to the needs of sensitive and informed coastal planning. It also acts against the interests of coastal 'operating authorities' when fulfilling their role in up-dating and reviewing field information on the nature, scale and pace of coastal change.

The lack of statutory recognition for HERs has also discouraged the gathering of information on the inundation and submergence of historic environmental assets on the coast. The net effect is poor field observations on heritage-loss in the coastal zone and a low level of chronological information in the forum of strategic decision-making. The statistics generated in this current report confirm a general neglect of sites that offer a particular pertinence to the study of coastal change. This is hardly surprising because the case has never been clearly articulated. This study concludes that fields to record OD height, the relevant SMP and shoreline management unit should certainly be included in all entries for coastal sites in the databases of the County historic environment records.

5.2 Problems of physical, legislative and administrative recognition

Fragile and under-investigated sites that lack clear and visible structural integrity or mapped definition have rarely been included in SCOPAC shoreline management plans. This has largely excluded the very sites that offer the highest potential to inform on past and present trends of coastal behaviour.

The problem of omission has stemmed from poor strategic guidance at the inception of the Round One plans commissioned by MAFF/DEFRA during the 1990s. This is a recognised problem that has been closely examined in a strategic study of English and Welsh shoreline management plans, commissioned by English heritage in 1997 (EH-WA, 1998).

A principal impediment in Round One has been a lack of national guidance on specific briefing for consultant reports. This has been particularly weak on matters concerning the historic environment; or the 'built environment' as it was then termed. When consultants were engaged to compile plans during 'Round One', a skills-base in modern ecology was largely deemed to be the lead issue in dealing with environmental matters.

Where county archaeological curators were consulted in the 'round One process', a mixed response was received. This arose where most curators were merely asked to provide data rather than an interpretation of the data. Very few were asked to provide a view of potential issues (*ibid*, p53).

The purpose of acquiring such data does not seem to have been specified but it would appear that archaeological or 'built heritage' sites were then perceived to be an *'unquantifiable benefit'* worthy of inclusion in the plans but of uncertain status. It seems that sites of this type were then deemed incapable of generating a measurable score for the purpose of cost-benefit analysis (Penning-Rousell *et al*, 1992, 137; Tomalin, 2000c, 95). This left their value and potential hopelessly at sea.

With the exception of the Isle of Wight, the SCOPAC shoreline management plans reflect the national dilemma in handling the historic environment at the outset of Round One. In the shoreline management plan for the Isle of Wight, a 'first-cast' appraisal of archaeological and palaeoenvironmental sites was provided although it has since been out-dated by the coastal archaeological audit for the Island. This first-cast appraisal addressed sites pertinent to the issue coastal-change but it was unable to rank or prioritise those that were suitable for particular interrogation. At the approach of Round Two, SCOPAC members should be better prepared.

5.2.1 Heritage sites as an 'unquantifiable benefit' on the SCOPAC coast: a case example of current problems of perception

While an appreciation of the breadth of the historic environment continues to evolve, the process of national designation has remained ponderous and type-cast. The traditional concept of a cultural heritage site of 'national importance' has not found natural accord with the need of SCOPAC Authorities to recognise sites with a capacity to offer specific information on local or regional coastal change.



Figure 5.1 The nationally important protected historic wreck site of the Grace Dieu eroding from the banks of the Hamble River

In their practical and strategic roles, SCOPAC authorities require sound field evidence of past human experience of shifts in the natural configuration of the shoreline and the level of the sea. Lists of scheduled ancient monuments are unlikely to help coastal authorities in this quest.

This discord between the national portfolio and the interests of coastal planning and engineering has been exemplified in the first generation of SCOPAC Shoreline Management Plans. Particularly noticeable in the national portfolios of *scheduled ancient monuments* and *sites of special scientific interest* is a general omission of designations for the submerged cultural and palaeoenvironmental heritage. There can be little doubt that these omissions at national level have heavily influenced the current round of shoreline management plans within the SCOPAC region. This is exemplified in the example given below.

> *An examination of the Shoreline Management Plan for the Eastern Solent provides a clear example of difficulties that arise from weaknesses in legislative and administrative recognition. The plan defines its major objective to reduce risks to people and the developed and natural environment from flooding and coastal erosion by the provision of technically, environmentally and economically sound and sustainable defence measures.*
>
> *A secondary series of objectives includes a commitment to ensure that management operations comply with statutory obligations with respect to the natural environment, navigation and cultural heritage.*
>
> *In a subsequent section entitled 'Heritage and archaeology' the main types of archaeological site on the coast of the Eastern Solent are briefly described and those that are scheduled ancient monuments are listed in a short inventory. The text then goes on to describe the implications of scheduling and conditions under which development work might infringe the requirements of the Ancient Monuments and Archaeological Areas Act of 1979.*

> *The significant words in this document are 'natural environment', 'comply' and 'obligations'. The first words exclude the historic environment and, by implication, they remove any commitment to give regard to vulnerable and possibly unidentified archaeological sites that are not scheduled ancient monuments. The list of scheduled ancient monuments comprises 19 sites most of which are military buildings. None of these are likely to offer any significant evidence of coastal change.* (McInnes & Jakeways 2000)

5.3 Round One Response and DEFRA guidance for Round Two SMPs

Reacting to the inclusion of heritage within the Round One SMPs there were a number of responses from heritage organisations and agencies. One response from English Heritage was the publication 'Coastal Defence and the Historic Environment' (2003) which sets out how the protection of historic remains can be fully integrated within the shoreline management planning process'. Such documents have helped to promote heritage concerns and appear to have been taken on board in the development of guidance for Round Two SMPs.

In March 2006 DEFRA published their 'Shoreline Management Plan Guidance Volumes'. There is a higher profile for heritage within these documents than in the previous Round One guidance. Some specific examples include:

- The recommendations for assessing the consequences and effects of adopting particular coastal strategy's include specific reference to cultural heritage
- There is a need for SMPs to set out the threat of flooding and erosion on the historic environment
- Chapter 3 of Volume one 'Assessing Policies: the main issues' highlights five main issues for consideration, one of which is: "Historic and archaeological features recorded in historic environment records and areas of high archaeological potential, including maritime archaeological features, scheduled monuments (see the glossary), listed buildings and registered battlefields"
- Section 3.4a outlines in more detail the required data to be collected and the need for 'analysing' local authority HER data

There is still a focus on information from HER and NMR records in the recommendations for data gathering. Although worryingly there is no recognition of the nature, strengths and weaknesses of HER data which can be patchy and unrepresentative of the true archaeological potential of stretches of the coastline. The involvement of archaeologists familiar with the local area and resource, in addition to coastal geomorphology is essential to gain full understanding of the heritage resource, potential impacts and information it can provide on historic coastal change.

Although additions to the advice for SMP revision is more comprehensive that that from Round One it is yet to be seen how this will be implemented in terms of the interpretation of archaeological data to make full use of its potential to inform on coastal change. This is particularly as SMP reviews can be undertaken by consultancies which have little or no experience of dealing with the historic environment within the marine and coastal zones. The need for specialist input by suitably experienced archaeologists will be key to the consideration of cultural heritage within the Round Two SMPs.

5.4 Wider project relevance

The profile of the marine and inter tidal historic environment is growing. This has been helped through the change in legislation through the National Heritage Act (2002) which enabled English Heritage to play a full and active role in the marine environment.

Ensuring that heritage is included in the wide range of coastal and marine projects, consultations and initiatives that are currently ongoing is essential. The results of this project will directly contribute to this agenda, in addition to feeding into a number of ongoing local and national projects:

- ICZM strategy
- Solent Forum Coastal Indicators
- English Heritage Seascapes Characterisation
- Marine Spatial Planning
- FutureCoast
- Dynamic Coast

6. Project data collection and handling

Data-collection for this project has involved all repositories of historic environment records across the SCOPAC region. All staff concerned with these records have been extremely helpful although some have found their latitude restricted by current systems of data-storage and some paucities of data-collection in the coastal zone.

It was found that information concerning palaeoenvironmental sites varies in quantity and quality between the individual county records. This is because the original sites and monuments records did not necessarily include non-cultural assets within their remit. When preparing this report, this weakness has been overcome by considering any additional palaeoenvironmental sites or information pertinent to the study of coastal change.

6.1 Data collection

Data-collection for the project involved the assembly of baseline data from the Historic Environment Records (HERs). These have formerly been known as Sites and Monuments Records and County Environmental Records.

Data-collection was confined to all sites falling between contours drawn at +10 metre and -15 metre OD. This was further broken down into ten specific '*study areas*' in those parts of the SCOPAC coastline that were deemed to be subject to particular risk or change. This enabled the collection of a sample set of data covering the principal environmental variations of the SCOPAC coast. The ten study areas are outlined below.

No	Site name	Physical environment	Character
1	Lyme Regis	Landslip	Urban
2	The Fleet	Barrier beach	Rural
3	Poole Harbour	Ria basin	Urban/ rural
4	Christchurch Harbour	Ria inlet	Urban/ rural
5	Western Solent	Complex of ria features	Urban/ rural
6	Sandown Bay	Advancing embayment	
7	Hamble	Ria	Rural/ urban
8	Portsmouth Harbour	Ria basin	Urban
9	Chichester – Selsey	Ria and headland	Rural/ urban
10	Arun	River estuary & offshore palaeochannels	Urban/ rural

In each of the ten chosen areas information regarding the name, period, location and description of the sites falling within the criteria of +10 metre and -15 metre (OD) was requested. This information forms the basic record from the HERs although the height field was often devoid of information. This severely impeded the scoring of the sites.

The data received from the HERs came in a variety of formats. Each used slightly different software both in terms of the basic descriptive records as well as the location data. The records supplied for this study came in HTML, MS Excel, MS Access, and MS Word or in paper format. The locational data came supplied in ArcView shape files, MS Excel DBF format, MapInfo tables or in paper format. These variations proved very difficult when producing a single region-wide analysis for SCOPAC.

6.2 Data assimilation

Due to the variety of formats in which the basic descriptive datasets were received, a single and separate database had to be designed. This incorporated the various tables drawn from the raw sources. Due to the differences in the layout of data, both within the HERs and between different HERs, several tables for each had to be designed. These were then further amended to provide columns for the scoring exercise.

In order to represent chosen sites on a map, manipulation of the various GIS packages was required. In some cases a lack of GIS data had to be overcome. This was solved by applying a single GIS package. *MapInfo* was used to convert the locational data into a format that was compliant. Once this had been completed the sites were geo-referenced and mapped in a presentable format.

During this process significant complications were encountered. These arose from a wide array of data-storing software packages and GIS systems used by different local authorities. Where study areas fell across Local Government boundaries some degree of duplication arose. This was due to data-format inconsistencies between the different HER offices. These problems were overcome by a manual sorting of records. This process greatly impeded the timetable that had been set for the compilation of this report.

Within some of the HER records there was a lack of descriptive data from which informed decisions regarding the sites potential could be assessed. This was especially apparent in records concerning early discoveries and single find-spots. Many of these were bereft of precise descriptions or information regarding context or association.

The initial collection, assimilation and cleaning of the data was a task that took considerably longer than anticipated. Any future projects attempting to handle this data should be aware of the potential transformations required.

6.3 Data coverage; strengths and weaknesses

For some of the study areas in this report, the entries in the relevant historic environment records were generally weak. This was particularly the case for sites in the inter-tidal and sub-tidal zones. Such sites were similarly under-represented in the lists of those sites that had been awarded statutory protection.

An absence of recorded archaeological sites along some sections of the SCOPAC coastline is likely to be a reflection of under-investigation rather than a true absence of evidence. This caution must be applied to both the inter-tidal and the sub-tidal zones. This weakness in the recognition and designation of coastal sites currently pertains at both national and local levels.

Where new and targeted coastal survey have been carried out on the Wootton-Quarr coast and in Langstone Harbour, it has been demonstrated that changing sediment regimes will unmask some sites while masking others. Thus, by their very nature, these zones provide important evidence for determining coastal change but they are unable to reveal, at any one time, a measure of their full resource.

7. The scoring criteria

The scores assigned in this report do not place archaeological or cultural values on sites that have been listed on the coast. Neither do they provide a list of important sites that might, or should, be protected by future coastal defensive works.

The scoring system has been designed to lay a relative value on the potential of each site to provide scientific information that may be beneficial to practical decision-making in the long-term management and protection of the coastline. Particular importance has been attached to potential information concerning the past behaviour of the coastline and to chronological information concerning the nature, scale and pace of sea-level rise and coastal-change.

Scorings have also taken account of the fact that rates of change vary between different parts of the SCOPAC coast. Experience of a rise in sea-level will also vary at different locations. Such contrasts arise from differences in coastal geomorphology and from variations in 'down-warping' or crustal behaviour within the deep geology of the Channel coast.

In areas of coastal instability, archaeological and palaeoenvironmental sites have a particular role to play in establishing proven histories of localised ground movement. These are particularly valuable in sectors subject to landslide movement and other coastal changes. Thus the scoring criteria seek to identify those sites that might best offer evidence for measuring the magnitude and rate of coastal change. Scoring has also considered the value of sites where further research might strengthen current understanding of causation and periodicity.

7.1 Aims and objectives of scoring criteria

In the first round of shoreline management plans, it was often the case that a site would be overlooked if it was not recorded as a nationally important *'scheduled ancient monumen*t'.

The aims of the scoring criteria in the present report are to consider the attributes of all types of sites, finds and deposits, and to assess their ability to provide information relating to processes or causes of coastal change. The scoring and ranking system in this report has been used to highlight these sites so that their value can be readily assimilated in the revision and implementation of the shoreline management plans.

7.2 Implications in the use of scoring criteria

The need for a set of scoring criteria was emphasised in the project brief. The purpose of the scores was to assess the potential of certain archaeological and palaeoenvironmental sites to inform the decision-making of coastal managers. Experience in the European LIFE project demonstrated that a set of criteria could be used for the assessment of various aspects of the cultural and palaeoenvironmental record. While it might be considered contentious to attempt the 'grading' of sites in certain circumstances, it was deemed appropriate to test such a system for answering specific queries on what could be a measurable occurrence – coastal change.

Some key benefits of the use of scoring criteria are:

- Providing a standard against which all sites can be judged
- Securing an overview of the collection of archaeological and palaeoenvironmental sites

- Providing an accountable system for the assessment of sites in relation to coastal change
- Highlighting areas or sites that should be prioritised by coastal managers
- Identifying archaeological and palaeoenvironmental evidence that will clearly demonstrate the nature of long-term coastal-change to a range of audiences

Some limitations of the use of scoring criteria are:

- Achieving a universal consensus on the scoring system proposed can be difficult, particularly when dealing with a relatively large geographical area and a large number of potential 'end-users'
- It is not easy to devise a scoring system that allows for flexibility while avoiding potential misinterpretation
- The scoring system can only test present knowledge of the archaeological and palaeoenvironmental resource. The scoring, and possibly the system, will require review and change as knowledge develops
- Scoring systems are always reliant on the 'scorer'. Consequently, they are still prone to subjectivity

Despite these caveats, the project scoring criteria have provided a workable assessment of archaeological and palaeoenvironmental resources on the SCOPAC coast.

7.3 The criteria explained

The scoring criteria have been developed to quantify just one particular value of an archaeological or palaeoenvironmental site. This is its potential value to inform coastal managers of past changes to the coastline. The opportunity to recover such information will be affected by the current condition of each site and its prospect of short, medium or long-term survival. For this reason the scoring has received a weighting that recognises varying degrees of fragility or vulnerability.

The scores for criteria 1 to 5 (below) relate to a scale of 'low', 'medium' or 'high'. It also proved necessary to provide a field for 'not enough data to score'. The latter has highlighted many sites where insufficient data has so far been collected. It can also identify areas in the SCOPAC region where the information stored in the historic environment record is currently weak.

Criteria 6 – 9 are non-scoring observations used to place each site in a geographical and geological context. They also permit an assessment of current fragility or vulnerability.

7.3.1 Sea- level change

- *Does the site contain evidence that could indicate a relative change in sea-level?*

Sea level is continually fluctuating. During the period since the last Ice Age (the Holocene) there has been a marked rise in sea level. The potential for archaeological and palaeoenvironmental material to hold information about this change has been scored from 1 to 3. Indicators of this change can include, artefacts, sediments, diatoms, foraminifera, marine induced features and submerged structures and land-surfaces.

Score	Level	Example
1		Not enough data available to score
2	Low	A low score is given to items that have not been static long enough to demonstrate relative change. An example is a modern

		vessel, which, was built to float and would not be old enough to demonstrate change in water levels if recently abandoned.
3	Medium	A medium score would be given for a site that has the potential to provide an index point for sea level at a point in time. A stratified artefact or site dating from a period when sea level was lower can provide a reference point and help calibrate the sea level curve for a region.
4	High	A high score is given to material that can demonstrate a record of changing sea level. A good quality core through Holocene sediments may hold datable alluvial and colluvial material, deposited during a rising sea level as well as vegetation horizons. This can provide datable evidence to indicate a still stand or falling sea level.

7.3.2 Environmental change

- *Does the site contain material evidence that could enhance understanding of local environmental changes at an identifiable point in the past?*

Since the last Ice Age, local environmental conditions have been adapting to a fluctuating climate. The underlying trend has been global warming and this has brought changes in vegetation, water-table, river-flow and coastal behaviour. Assessment of environmental evidence can demonstrate the nature of a coastal landscape at a particular time. Indicators of this kind include soils, sediments, insects, pollen, flora, fauna and snails.

Score	Level	Example
1		Not enough data available to score
2	Low	A low score is given to sites with little datable material that will be able to tell us about past environments. An example is a relatively modern structure which might be of cultural importance but would not be old enough to contain material about past environmental change.
3	Medium	A medium score would be given for a site that has the potential to provide an indicator of the environment at certain period. Dates available for the material or artefacts would be broad rather than absolute.
4	High	A high score is given to material that can demonstrate a record of the changing environment through a long period of time. An example is a good quality core from submerged or buried terrestrial deposits having dated material, archaeological evidence and a well preserved range of environmental material associated with mineragenic deposits.

7.3.3 Climatic change

- *Does the site contain evidence giving insights into past climatic variation and/or their effects?*

Since the last glacial maximum, the climate has been fluctuating. The underlying trend has been global warming but there have also been some reversals like the so-called 'Little Ice Age'. Changing environmental conditions and the process of sea-level rise are consequences of climatic change. On the SCOPAC coast certain peat bogs and

waterlogged sediments can offer palaeoenvironmental evidence of both sea-level fluctuations and climate change.

Score	Level	Example
1		Not enough data available to score
2	Low	A low score is given to single or mobile artefacts, particularly those of limited antiquity that could not be related to a clear contemporary context. A 20th century shipwreck would tell us little about past climate change.
3	Medium	A medium score would be given to a site that has the potential to provide indications of climate change. Examples might be similar to those given a high score but where the material has yet to be assessed or analysed.
4	High	A high score is given to material that can demonstrate a change in the environmental conditions brought about by climate variation. Examples could be a change in vegetation or a well defined change in sea level. A site with a high score could be where analysis of pollen, macrofossils, or tree-rings offers good quality datable evidence that can be used to demonstrate temporal changes. Sites associated with clearly defined transgression events will also score highly. Examples include submerged or inter-tidal land-surfaces, palaeochannels with organic materials, peat deposits, diatom evidence from saltmarsh or brackish water deposits.

7.3.4 Running chronology

- *Does the site contain material that could provide evidence of temporal continuity?*

Where evidence of yearly or successive changes can be extracted from peat bogs and channel sediments, this can reveal how an area of the coast has responded to a changing climate or a rising sea level.

When assessing and scoring the scientific potential of these sites, added value has been given to those deposits that can offer an unbroken record over a substantial period of time. This has been described as temporal continuity. Deposits of this type have been described as 'sediment archives'. Special value has also been attached deposits that may offer 'absolute dates' through radiocarbon, tree-ring dating and other related methods.

Score	Level	Example
1		Not enough data available to score
2	Low	Sites, palaeo-environmental material or artefacts that contain evidence from single events or are datable to one period only.
3	Medium	Sites that could provide datable evidence of changing sea level, environmental, or climatic change but have yet to be analysed.
4	High	Sites with long datable sequences which have been analysed. Sites would provide evidence of changing sea level, environmental, or climatic change over a period of time that straddles a series of geomorphological events.

7.3.5 Fragility

- Wherever possible, the projected survival of a site or feature has been estimated. This desk-top assessment has been based upon the composition of the feature, its reported condition and its current position in relation to the active coastal processes.

Many sites along the coastline are threatened by erosion. This can be driven by climate change or sea-level rise. Both processes pose localised impacts that will need to be assessed. Of particular interest to SCOPAC are sites that have been long preserved by coastal deposition but are now subject to coastal erosion. Abrupt reversals of this kind are explicit indicators of profound change.

The switch from deposition to erosion can rapidly expose and destroy those sediment archives that can offer some of the best natural records of past coastal behaviour. This is particularly true of organic material that can be lost in a very short space of time. The need to sample and interrogate pertinent sediment records of this kind should be included in the round 2 review of the shoreline management plans and it should be applied regardless of individual management unit policies.

A further threat to the cultural and palaeoenvironmental archive is human intervention. This includes development, dredging and mineral extractive activities. Certain inter-tidal activities such as large-scale bait-digging and *ad hoc* reclamation must also be considered a potential threat.

The impact of some processes of development can be controlled and mitigated by planning regulation applied above mean low water mark. Unfortunately, activities in the sub-tidal zone can proceed with very little regard for concealed aspects of the historic environment. All of these potential threats have been taken into account within this desk-top assessment.

In the SCOPAC region there has already been much fruitful liaison between commercial interests, scientific interests, conservation interests, and recreational interests. This is a role in which SCOPAC has been able to play a central part. The dredging role of Port and Harbour Authorities can exert a particular pressure on the unseen archaeological and palaeoenvironmental resource.

Non-scoring criteria
The following criteria are descriptive terms that help provide a physical and managerial context for the scored material.

Score	Level	Example
0	Excavated or lost	Sites which have been recorded in the past and may appear on the SMR/HER but are now lost.
1	Not enough data available to score	
2	Stable	Sites which are not currently under threat from loss.
3	Progressive Erosion	Sites subject to ongoing degradation reducing the quantity and possibly quality of the material.
4	Imminent loss	Sites under direct and immediate threat from erosion or development.

7.3.6 Site Validation Code

- *What is known of the current status of the site?*

Code	Level
ER	Extant Remains
BGR	Below-ground remains
BGS	Below-ground sediments
D	Destroyed
I	Information needed
SR	Submerged remains
RF	Riverine Feature
R	Recovered

7.3.7 Coastal policy

- *What coastal policy is advanced in the current SMP prescription?*

Code	Level
DN	Do Nothing
HTL	Hold the line
ATL	Advance the line
MS	Managed re-alignment
RTL	Retreat the line

7.3.8 Coastal context

- *Where does the site lie in relation to the shoreline?*

Code	Level
1	Marine, below water
2	Inter tidal
3	Above HW
4	Saltmarsh
5	Cliffs
6	Other

7.3.9 Coastal type

- *What is the principal geomorphological character of this coastline?*

Code	Level
1	Dune Coast
2	Hard Coast
3	Soft Coast
4	Submerging coast
5	Accreting coast
6	Estuarine coast
7	Hard defended coast
8	Eroding coast
9	Riverine

8. The study areas - description and scoring

This section outlines the individual study areas and includes data on their scoring and assessment.

8.1 Selection and methodology

Ten study areas of the SCOPAC coast are shown in figure 8.1. The sites assessed within these areas all lie between the contours of +10 metres and – 15 metres Ordnance Datum.

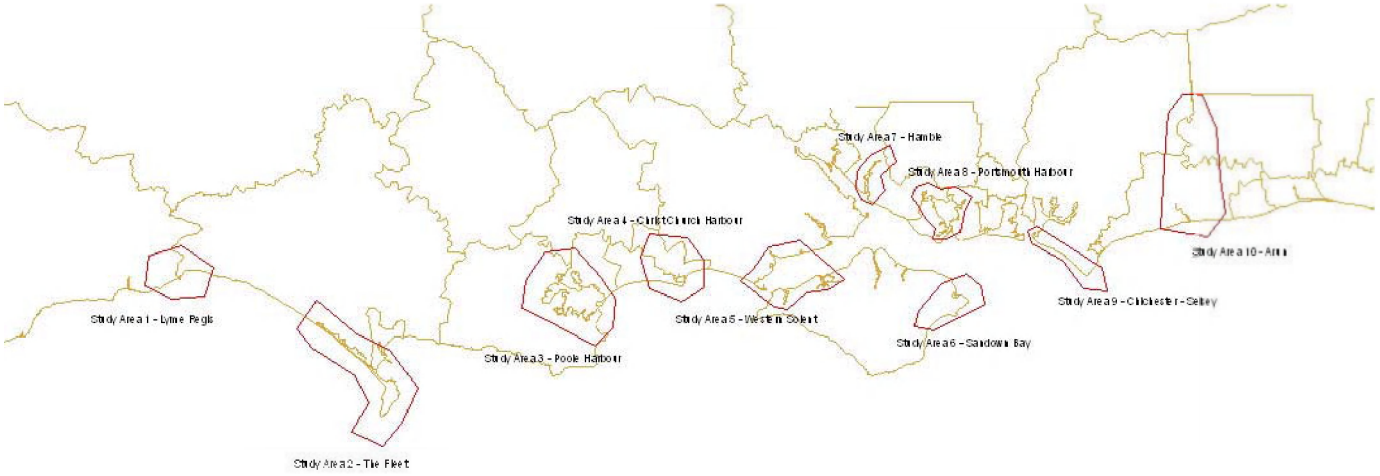


Figure 8.1 Map of the SCOPAC area showing the ten study areas

8.2 Summary of study sites

The ten study areas are summarised below.

No	Site Name	Physical Environment	Character
1	Lyme Regis	Landslip	Urban
2	The Fleet	Barrier beach	Rural
3	Poole Harbour	Ria basin	Urban/ rural
4	Christchurch Harbour	Ria inlet	Urban/ rural
5	Western Solent	Complex of ria features	Urban/ rural
6	Sandown Bay	Advancing embayment	Urban/ rural
7	Hamble	Ria	Rural/ urban
8	Portsmouth Harbour	Ria basin	Urban
9	Chichester – Selsey	Ria and headland	Rural/ urban
10	Arun	River estuary & offshore palaeochannels	Urban/ rural

Table 2: Principle characteristics of study areas

Scoring has been based on descriptive information that has been currently available from the historic environment records of the SCOPAC county and unitary authorities. Data-gathering for this project has also identified a number of sites, mostly of a palaeoenvironmental nature, that had not yet been listed in the local authority databases. These sites could not be included in the formal scoring procedure but they have nevertheless been ranked and discussed in the conclusion. Where their significance has been deemed to be high, steps have been taken to ensure their full discussion.

Consideration has been given to the geographic setting of each scored site. The entire scoring database was completed prior to analysis and interpretation of results. Due to the large body of scored data, pictorial summaries have been provided along with tables dealing with the highest scored sites within each area. The report details the following information for each study area:

- Area Introduction
- Summary of archaeology and history
- Summary of geology and geomorphology
- Coastal SMP units within the area
- Scoring results
    - Distribution map
    - Table of top twenty scoring sites
    - Distribution map of top scoring sites
    - Scoring of sea level change
    - Scoring of environmental change
    - Scoring for climatic change
    - Scoring for running chronology
    - Scoring for fragility
    - Combined scores (a summary of all scores given for the categories 'sea level', 'environmental', 'climatic' and 'chronology')
- Discussion of scoring results
- Implications for shoreline management in this area

Information gathered for the project has been included within a project database a summary of the results is included in appendix 15.3. Full project scoring information is contained within the database held on CD.

8.3 Lyme Regis

8.3.1 Introduction to the Lyme Regis study area

Lyme Regis is the most westerly of the project study areas; it lies on the coast of West Dorset close to the boundary with Devon. The town occupies a small bay between Church Cliffs to the east and Seven Rock Point to the west.

Historic records verify that ground movement and structural damage have long been a major problem in and around Lyme Regis. Large parts of the town are protected from marine erosion by seawalls; nevertheless, the on-shore hill-slopes are less readily managed and they continue to be affected by instability.

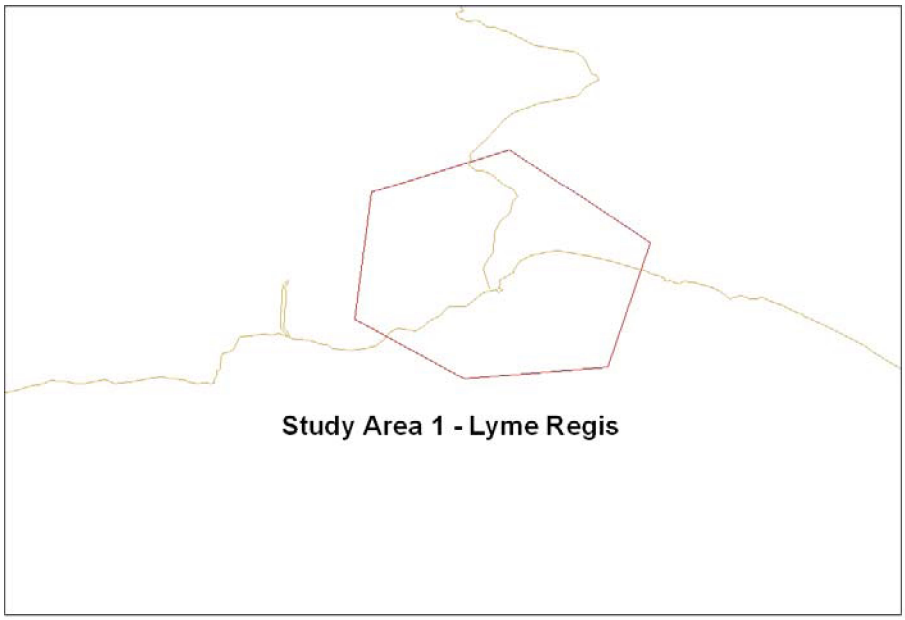


Figure 8.2 Map showing the Lyme Regis Study Area

8.3.2 Summary of human coastal experience in the Lyme Regis study area

The Lyme Regis coastal area in prehistory

Currently, there is little prehistoric evidence relating to the former character of this coastline but a recent Rapid Coastal Assessment (EH-WA 2004) recognises some notable potential. This has been especially noted in the offshore zone where traces of a submerged prehistoric landscape are suspected. Evidence from the sub-tidal zone could be particularly helpful in calculating the former height of sea-level and the rate of marine advance into the head of the bay.

On-shore, a small number of Bronze Age burial mounds offer an opportunity to examine buried land-surfaces where pollen and plant macro-fossil evidence might offer an opportunity to determine the character of this area during the Bronze Age Warm Period.

At present it is difficult to obtain evidence of the past behaviour and periodicity of land-slips at Lyme Regis. Submerged and buried land-surfaces of the prehistoric period may offer the best opportunities of resolving this problem if the right preservative environments can be identified and investigated. Buried soil-horizons in geo-technic cores offer particular promise. Fresh slips and crevasses should also be opportunely examined for

their palaeoenvironmental potential before remedial works, such as back-filling, are carried out.

The Lyme Regis coastal area in the Roman period
Within the town of Lyme Regis, remains of a Roman hypocaust have been reported. A small Roman villa is sited up-valley in the nearby village of Holcombe. It is generally thought that this Holcombe villa is too far from the sea to have served a maritime community. On the other hand, the report of the hypocaust suggests that additional evidence of past human activity may be available from Roman settlement closer to the shoreline.

The Lyme Regis coastal area in the medieval period
The Saxon and Norman features of the parish church and the nature of the street pattern suggest that the early centre of settlement was focussed on the area where the Lim valley meets the sea.

In 1284 the town was made a borough. This recognised growing prosperity centred on one of the few points on this coast where a safe landing might be attempted. In response to increased trade, the town now expanded. Improvements included the construction of the Cobb. This was a substantial stone breakwater offering a modest quay and harbour.

Between the harbour and the town, goods were transported across the beach at low tide on what was to become known as the Cart Road. It is possible that Cobb hamlet, which developed as a separate entity, dates back to construction of the Cobb.

The Lyme Regis coastal area in the Post-Medieval period
During the Elizabethan period, storm damage and landslips beset the town. Damage was particularly severe where the River Lim enters the sea. It was not until the wool and linen industry brought prosperity to the town that the harbour and its neighbouring houses were repaired.

The Lyme Regis coastal area in recent times
An economic down-turn hit the town early in the 18th century. It was the health and holiday industry of the Victorian period that finally restored its fortunes. An influx of visitors prompted enthusiastic development but little regard seems to have been given to the nature of the terrain, the confines of natural drainage and the stability of the hill-slopes.

After the first seafront promenade was established in the 19th century, the sea-defences soon grew to incorporate the Cobb and the old Cart Road. Other major events to affect the town include a storm that resulted in the rebuilding of the Cobb in 1824. A fire in 1844 caused considerable damage to the historic centre of the town.

In 1839 a major landslip occurred to the west of the town. This was in the area known as the Undercliff. Land that had once formed private gardens along the seafront became particularly vulnerable to ground slippage. This was area was acquired and utilised as public gardens. The 20th century saw the town expand into a hinterland that largely sought higher ground. The unstable coastal slopes were generally avoided.

Major coastal protection and slope stabilisation works are now proposed or are underway on the seafront, in Langmoor and Lister Gardens, and Cobb Road. This includes the building up of the Cart Road along its full length. These works offer a potential opportunity to observe and recover sediment records of the past behaviour of this coastal terrain.

8.3.3 Summary of geology and geomorphology within the study area

The physical nature of the study area

The Lyme Regis study area embraces the valley and mouth of the river Lim. The river provides an access point to the sea on a coastline that is otherwise largely lined with cliffs and ancient rock-falls. The mouth of the Lim has been truncated by marine erosion. This has confined the town to a narrow and cramped sea-frontage. Historically, the name *Lim* commonly refers to marshland (Rivet & Smith, 1979). This suggests that a protective apron of wetland may once have stood between the site of the town and the sea.

The coastline is composed of rocks of Jurassic and Cretaceous age. Both are actively eroding. Particular problems arise where inter-bedded limestones, siltstones, clays and mudstones of the Lower Lias are overlain by Cretaceous sands. The result has been mudslides and translational blockslides as well as rotational and compound failures. Ancient landslides are also evident on the slopes of the inland valley. Here, more recent failures have been triggered by the soft nature of the underlying geology.

At the shoreline, steep sea-cliffs are backed by sequences of scarps and benches. The latter have been formed by outcrops of the more resistant limestone strata. Marine undercutting and the removal of fallen debris at the toe of the cliffs have promoted instability. Many of these failures have been triggered by increases in groundwater introduced from upslope and accumulating within the landslide debris.

Coastal geomorphology

On the beach at Lyme Regis a northward change has occurred in the orientation of the shoreline. This has created significant potential for eastward drift along Town Beach and Marine Parade. The result is an accumulation of sediment against the western sides of the various jetties and groynes along this frontage.

The Cobb appears to be an effective barrier to the drift of shingle, as witnessed by the long-term accretion of Monmouth Beach. Beach shingle as witnessed by the long-term accretion of Monmouth Beach. There is severe depletion of beaches to the east (West Dorset District Council 2000). The Cobb has functioned as a large terminal groyne intercepting west to east drift and promoting the up-drift accretion of Monmouth Beach.

The general loss of sediment volume on Monmouth Beach is principally due to the substantial reduction of drift input from feeder beaches lying to the west in Pinhay Bay. This, in turn, is ascribed to impedance of the drift pathway imposed by post mid-eighteenth century landslides at, and close to, the Humble Point.

Sediment distribution in groyne compartments beneath Church Cliffs indicates net north-easterly directed drift (Hutchinson 1984, Bray 1996). The amounts actually transported are very small in relation to the depletion of the foreshore at Church Cliffs and East Cliff. These beaches were formerly quite substantial, but they have lost volume over the past 150 years. This has followed modifications made to the Cobb and the construction of defences at Lyme Regis that intercepted incoming drift.

Coastal management issues

The geological and geomorphological characteristics of this coastline have given it prime international, as well as national, importance. In 2001 it was granted UNESCO *World Landscape Heritage Status*. The coastlines at Chesil Beach and Golden Cap to Lyme Regis are also *Geological Conservation Review* sites. Their significance for coastal geomorphology has been cited by May and Hansom (2001).

Sea walls have been present at Lyme Regis since before 1789 (Posford Duvivier, 1990a; 1991), but protection has not been continuous. Different sections have been protected at various times. East Cliff and Church Cliffs were subject to continuous recession over the period 1841-1903 (Geotechnical Consulting Group 1987). In 1957 a new sea wall was constructed here.

During the 19th century there was quarrying of limestone ledges on the foreshore at Church Cliffs. This may have contributed to marine erosion by reducing protection from wave attack (Hutchinson 1984). Protection offered by the sea wall is now complete to the west of East Cliff. This wall now prevents coast erosion except on occasions when ancient landslides are reactivated and material surges across over the top e.g. Cliff House slide of 1962 (Arber 1973, Pitts 1979, Lee 1992).

The town has developed a system of coastal defence and drainage that is designed to resist marine erosion. Extensive study and assessment has resulted in a detailed understanding of the nature of principal threats to the area but the long-term behavioural record is still not clearly understood (www.swgfl.org.uk/jurassic/lymeng13.htm).

8.3.4 Coastal units within the study area

The Lyme Regis study area lies within the Lyme Bay and South Devon Shoreline Management Plan. It falls between the boundaries of coastal process units 3 and 4. It incorporates management units 5, 6 and 7 (Figure 8.3).

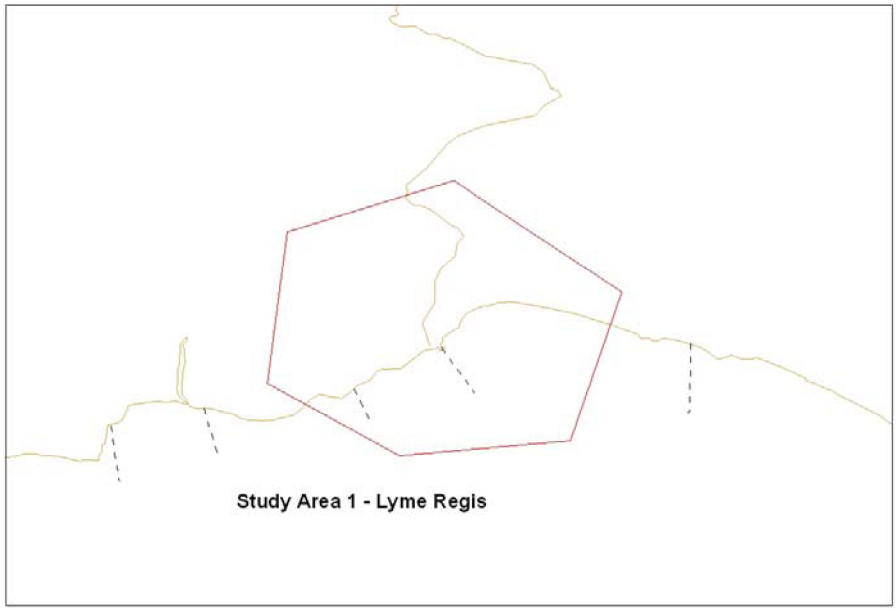


Figure 8.3 Map showing the Lyme Regis Study Area and its coastal cells

Coastal Process Unit 3 forms part of Lyme Bay and extends from a point west of West Bay to The Cobb at Lyme Regis. It encompasses the settlements of Eype, Chideock, Seatown, Charmouth and Lyme Regis.

Management Unit 5 between the west of West Bay and the east of Lyme Regis is predominantly rural and the preferred strategic option is to SELECTIVELY HOLD THE LINE. Management Unit 6 covers the Lyme Regis frontage and is mainly urban; the preferred strategic option is to HOLD THE LINE.

Coastal Process Unit 4 also forms part of Lyme Bay and extends from The Cobb at Lyme Regis in Dorset to Beer Head in Devon. It encompasses the settlements of Seaton and Beer.

The management unit encompassed in this study is Management Unit 7 between The Cobb at Lyme Regis and the mouth of the River Axe and is predominantly rural. The preferred strategic option is to DO NOTHING.

8.3.5 Results of scoring

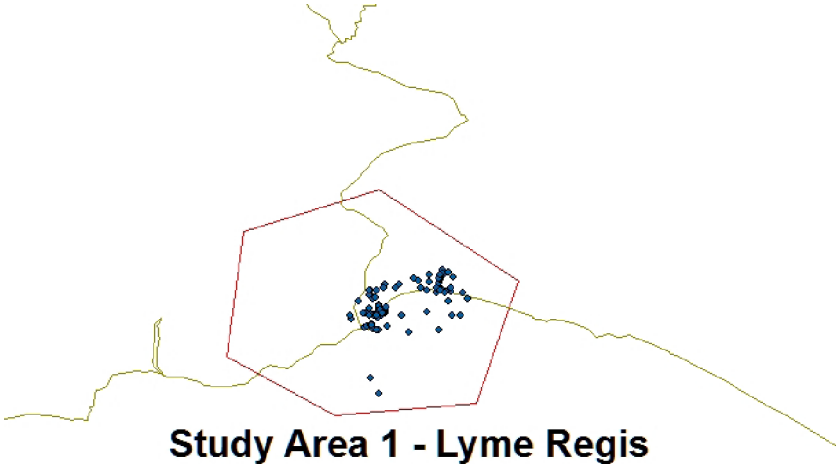


Figure 8.4 Map showing the distribution of sites within the Lyme Regis study area

It should be noted that the scoring for all sites within the Dorset area has been undertaken at a time when the historic environment record for this county has been undergoing a change in its computer management. This event has limited the level of detail currently available for each site and it has allowed only a limited number of sites to be scored. The results nevertheless provide a helpful reflection of site types and their potential value to coastal studies.

Twenty highest scoring sites

MONUID	NAME	TYPE	PERIOD	Sea Level Change	Environ Change	Climatic Change	Chronology	Fragility	Total Score
WX100*	St Michael's Church, Lyme Regis	CHURCH	Medieval	1	2	1	2	1	7
WX85	The Cobb, Lyme Regis	HARBOUR	Medieval	1	2	1	1	3	8
WX96	Lyme Regis: Guildhall	GUILDHALL	Medieval	1	2	1	1	2	7
WX99	Bridge Street, Lyme Regis: 14th century bridge	BRIDGE	Medieval	1	2	1	1	2	7
WX1532	Speak	WRECK	Post Medieval	1	2	1	1	1	6
WX1522	Adele	WRECK	Post Medieval	1	2	1	1	1	6

WX1523	Genereuse	WRECK	Post Medieval	1	2	1	1	1	6
WX1524	Elizabeth Ann	WRECK	Post Medieval	1	2	1	1	1	6
WX1525	Pauda	WRECK	Post Medieval	1	2	1	1	1	6
WX1526	Ann and Emily	WRECK	Post Medieval	1	2	1	1	1	6
WX1527	Elizabeth and Ann	WRECK	Post Medieval	1	2	1	1	1	6
WX1528	Collingwood	WRECK	Post Medieval	1	2	1	1	1	6
WX1529	Edward and Mary	WRECK	Post Medieval	1	2	1	1	1	6
WX1531	Emma	WRECK	Post Medieval	1	2	1	1	1	6
WX1519	Daphne	WRECK	Post Medieval	1	2	1	1	1	6
WX1533	Lily	WRECK	Post Medieval	1	2	1	1	1	6
WX1534	Flying Fish	WRECK	Post Medieval	1	2	1	1	1	6
WX1535	English Cargo Vessel	WRECK	Post Medieval	1	2	1	1	1	6
WX1536	Cargo Vessel, 17th Century	WRECK	Post Medieval	1	2	1	1	1	6
WX1537	George	WRECK	Post Medieval	1	2	1	1	1	6

Table 3 Scoring results from the top twenty sites within the Lyme Regis study area

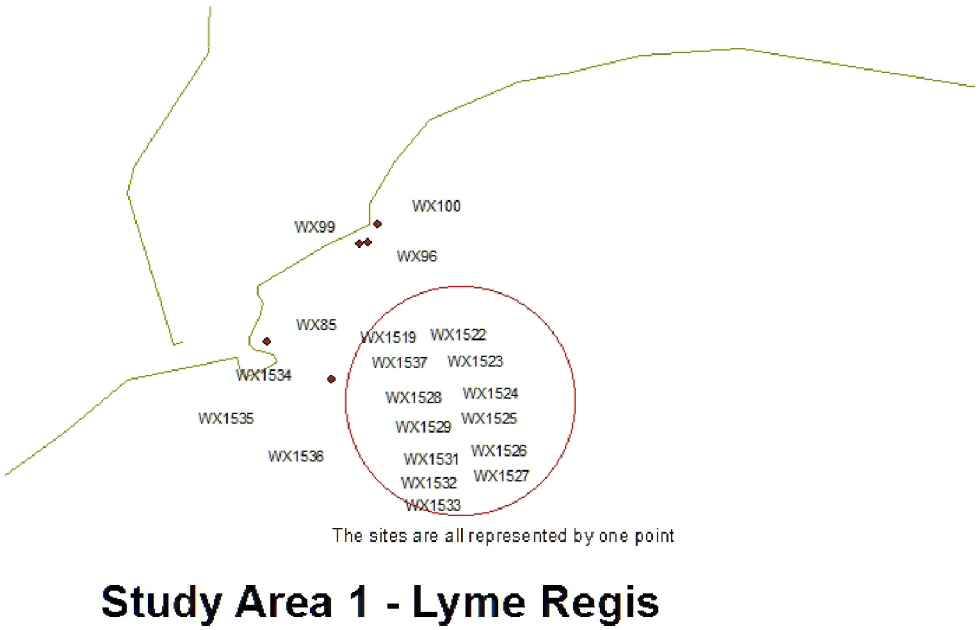
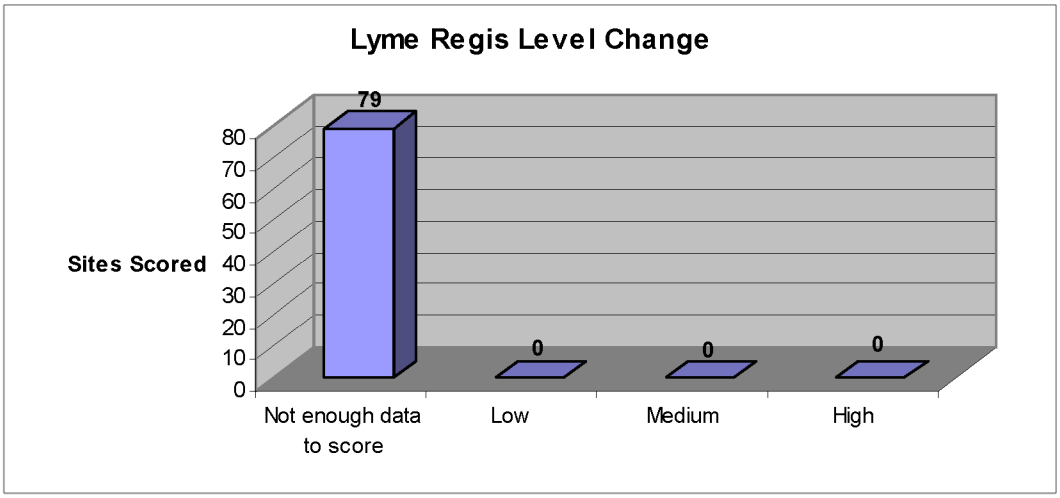


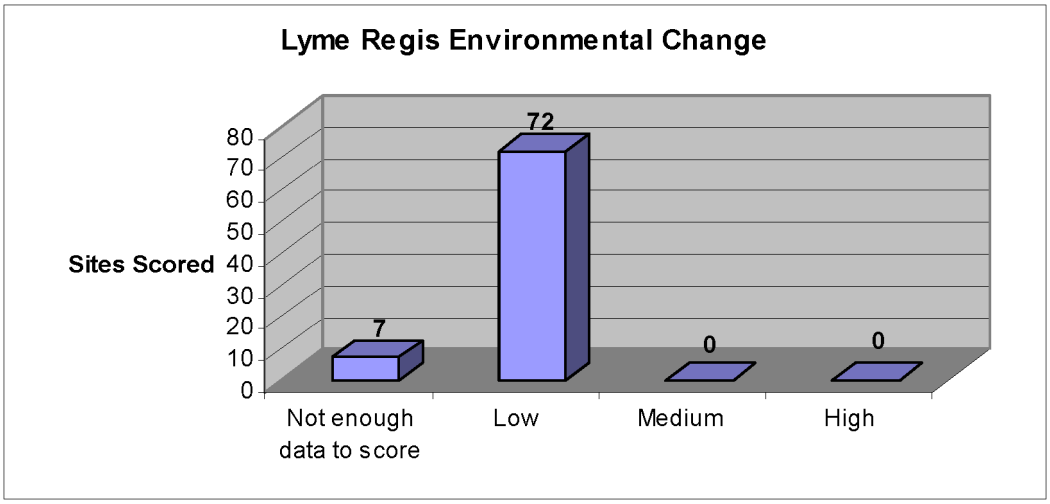
Figure 8.5 Distribution of highest scoring sites within the Lyme Regis study area

Scores for sea level change



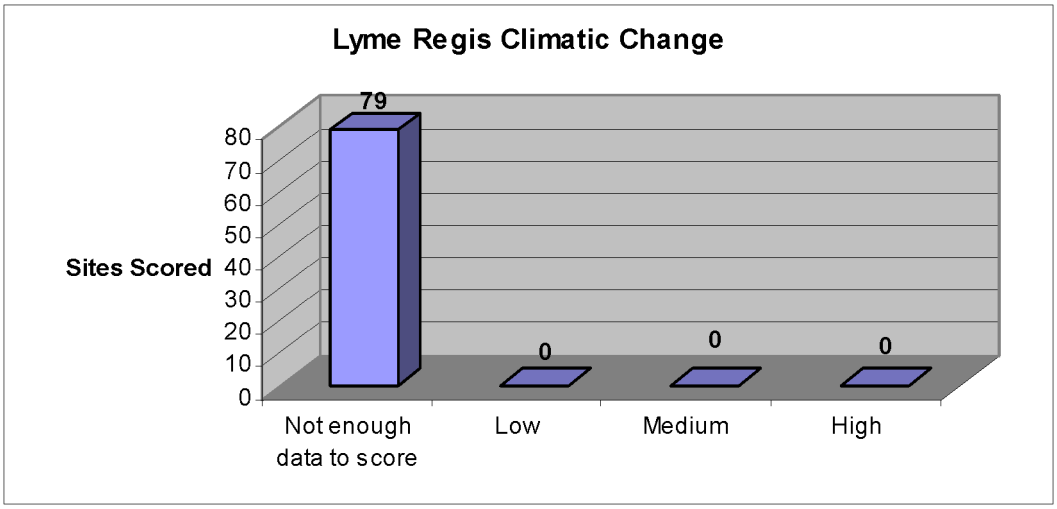
There was not enough data available to be able to attribute any scores for these criteria.

Scores for environmental change



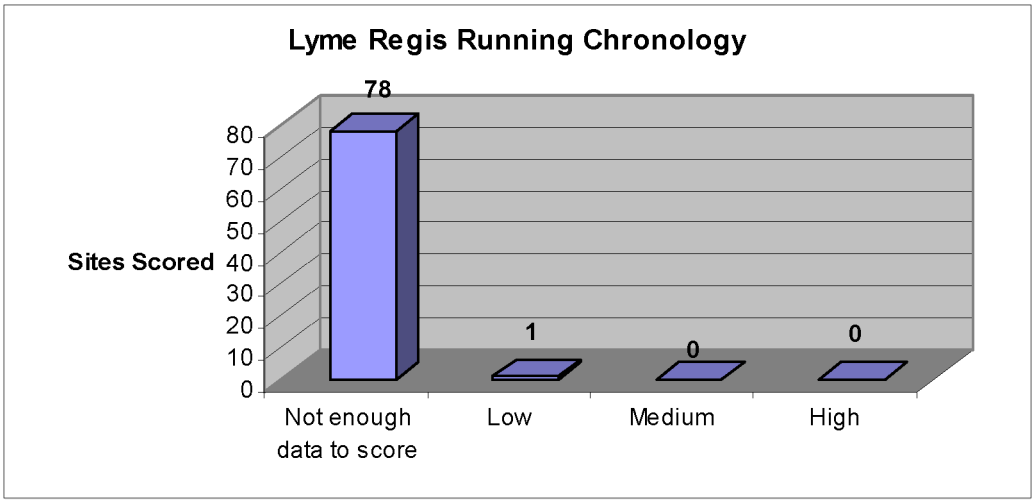
All of the higher scored sites within the study area have a 'low' score in relation to environmental change. This reflects the relatively recent nature of many of the shipwreck sites that have gained higher scores.

Scores for climatic change



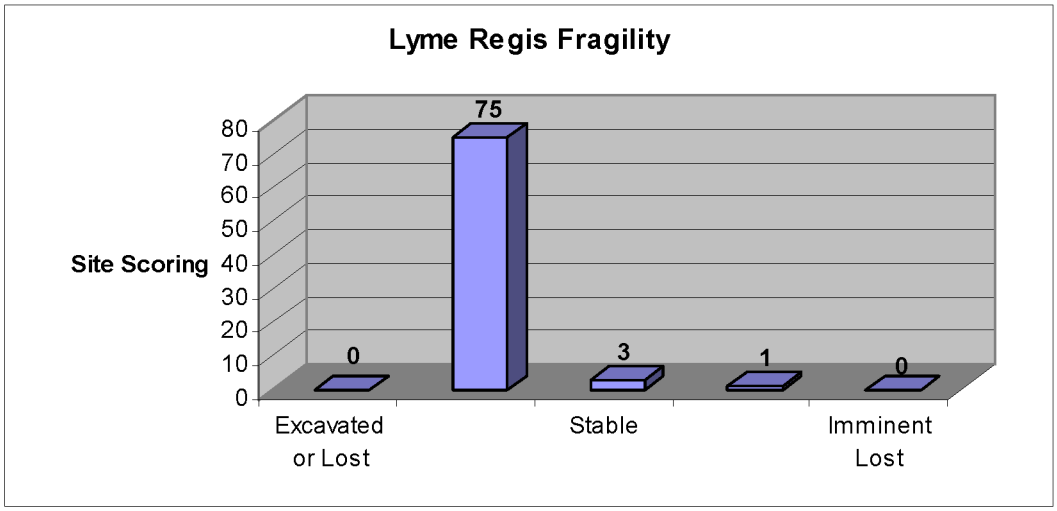
There was not enough data available to be able to attribute any scores for this criterion.

Scores for running chronology



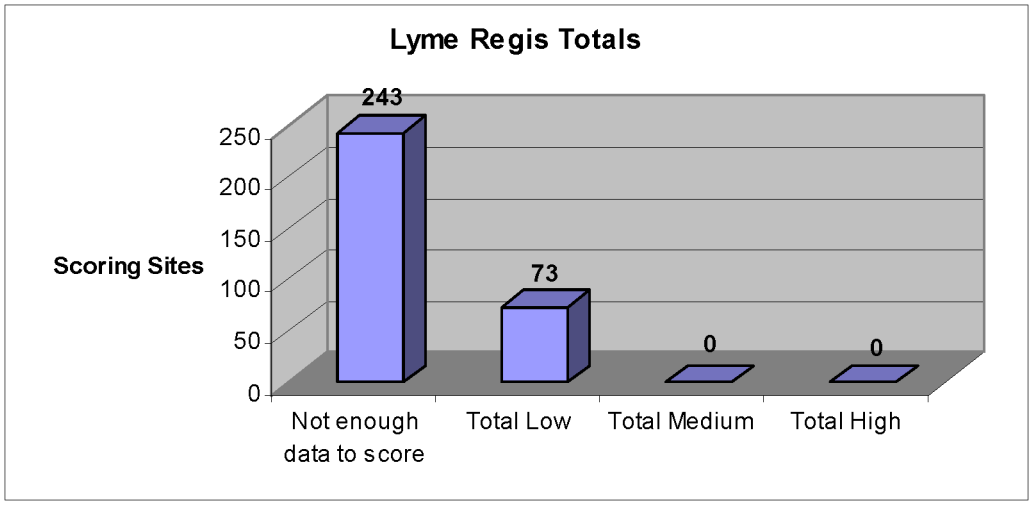
There was not enough data available to enable most sites to be attributed a score for this criterion.

Scores for fragility



A number of sites were scored within the fragility criterion. Most notably, the Cobb and a 14th century bridge attained high scores. These two features are directly affected by coastal changes and this has prompted a number of changes to their structure during their long history.

Combined total scores



In this study area the number of sites receiving scores is notably low. This is an indication of a low level of available descriptive data rather than a lack of sites that may inform on coastal change.

8.3.6 Discussion of scoring results

The highest score of any site within this study area was 8. This is a relatively low score. The range of site types represented in the list of highest scoring sites is limited to buildings, shore-side features and wrecks. This reflects the open nature of the coastline in this area.

All of the wrecks cited in this study area are of a post-medieval date. They may offer some potential to assess the history of seabed processes since the date of wrecking.

The shore-side buildings and features are all medieval in date. These offer the potential to reflect on the nature of coastal change since these buildings were erected. It is perhaps not surprising that the 'Cobb' is the highest scored site in this study area. This has been a dominant feature of the town and the shoreline for many centuries. Additionally, the Cobb has created its own local effects on coastal change.

This analysis has produced a relatively low number of sites with potential to inform on coastal change. This should not be taken as an indication of low potential within the study area. It is unfortunate that the HER for Dorset was undergoing changes during the data-gathering stage of this project. There is certainly further information contained within this important source.

8.3.7 Implications for shoreline management in this area

The steep valley profile of the Lim and the cliff-truncation of its adjacent upland suggest that the course of a palaeovalley may lie beneath Lyme Regis beach and Lyme Bay. An archive of sediments contained within such a concealed channel may offer one of the

best means of ascertaining the nature, scale and pace of Holocene sea-advance towards the area now occupied by the town.

Colluvial deposits and buried land-surfaces within the town's deep valley complex may offer evidence of past slope behaviour and episodes of stability and instability. Opportune exposures through boreholes and engineering activities should be anticipated and closely monitored. The revised shoreline management plan should allow for these eventualities and for the procedures of monitoring, analysis, dating and interpretation.

A revision of scoring for this area should be considered when the available dataset has been up-dated.

8.4 The Fleet

8.4.1 Introduction to the Fleet study area

The Fleet study area includes the area encompassed by the geological features of Chesil Bank, the Fleet lagoon and the Isle of Portland. This coastline has both national and international conservation designations for its geomorphology, habitats and fauna. It now forms part of a *World Heritage Site*.

Chesil Bank stretches for 29 km from Bridport Harbour to Chesil Bay on the Isle of Portland. The bank is linked to Portland at Chesil. Northwards, it is bordered by Portland Harbour. West of this point it is separated from the land by 13km of the Fleet lagoon. The Fleet is Britain's largest lagoon and has been subject to intensive biological and geomorphological study.

Within this study area lies the Isle of Portland. Due to its prominence and suitability for long-term occupation the isle holds a notable density of archaeological remains but few of these sites have received high scorings for their coastal environmental potential. Along the length of Chesil Bank the principal archaeological sites to be scored are those of shipwrecks that have been wrecked on this open stretch of coast.

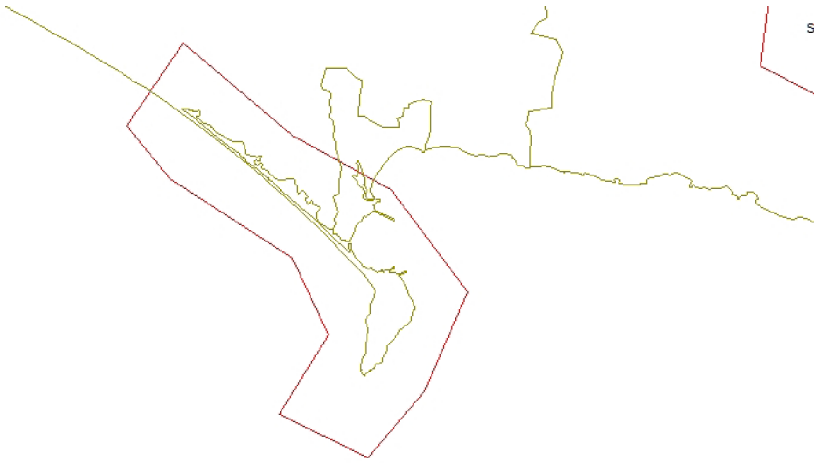


Figure 8.6 Map showing the Fleet Study Area

8.4.2 Summary of issues and sites concerning the Fleet study area and the behaviour of the Chesil Beach

Few of the archaeological sites that have been currently identified and scored within the Fleet study area are particularly informative coastal studies.

For the purpose of coastal management, the outstanding question in this study area concerns the long-term behaviour of the Chesil Beach. This barrier beach is currently 29km in length. Its natural function, as a barrier, has been to offer long-term protection to the West Dorset cliff-line and Britain's largest lagoon, the Fleet.

Past research into the nature and origins of the Chesil Beach have raised several issues that are critical to shoreline management.

- It is clear that the material contained within the Chesil Beach has been transported from the west. A long held view is that much of this shingle comes from Tertiary gravels once contained within a lost headland lying in West Bay and seaward of Beer cliffs (Arkell, 1947). A more recent view considers at least some of the Chesil shingle to be derived from ancient Atlantic marine gravels. These were formerly deposited down-Channel during the Late Pleistocene (Bray 1999). This source of beach material appears to have been an earlier bank formed during the Devensian, some 120,000 years ago. West (2005) summarises the extent of current knowledge while refining discussion of the sources and significance of the more exotic pebbles on Chesil Beach.

- The accretion of the present beach appears to belong to the early to mid Holocene. Its barrier functions had certainly become effective by Neolithic times, if not before. Some evidence as to the date of the genesis of the present beach has been sought from deposits in the pocket beaches that are closed by the western portion of the Chesil Beach.

- East of Abbotsbury the beach is held off-shore by the Fleet lagoon. Cored deposits within the Fleet confirm the presence of lagoonal conditions, and hence the Chesil Beach, around 7000BP. It appears that the full sediment archive on the floor of the Fleet has yet to be thoroughly investigated. This is clearly a priority if the past behaviour of the beach during breachings and overtoppings is to be understood.

- It is generally considered that the coastal processes responsible for the creation of the Chesil Beach are now defunct. A past state of stasis might be assumed during, and since, which various processes of long-shore drift and re-sorting have continued. With a finite quantity of material now contained within the beach, the possibilities of degeneration and future breaching must now be taken into account.

- There are historic accounts of breaching of the beach. A notable event occurred in 1824 when disastrous flooding of property occurred. More common are accounts of over-toppings (Le Pard 1999, West 2005). The capacity of the beach to re-seal itself in future breachings must be considered. The potential effects of breaching may be sought in the sediment archives that are now contained within the bed of the Fleet and along its shore. A quantification of off-shore gravel and sediment supplies would be helpful. This might be aided by an assessment of the sediment history of some of the dated wrecks lying off-shore of the beach.

Despite the potential of the Fleet to inform our understanding of coastal change, few of the archaeological sites that have been currently identified and scored within the Fleet study area are particularly informative to coastal studies.

Historic accounts of breaching and overtopping of the Chesil Beach

Historic accounts of an episodic storm event on 24 November 1824 provide a striking example of predictable flood effects in the event of a future breaching of the Chesil Beach. On this occasion huge storm waves were whipped along this part of the south coast in an event known as '*the Great Gale*'. Many places along the SCOPAC coast suffered severe flooding and damage to property yet it is the effects behind Chesil Beach that are most dramatically reported.



Figure 8.7 Library picture of storm surge overtopping Chesil Beach

It would seem that once breached, the beach, on this occasion acted as an impediment to the retreat and release of flood-water. The depth of inundation is both astonishing and alarming. A marker pole erected at Abbotsbury still records a depth of 24ft 8 inches (7.40m). It seems highly significant that the current pattern of human settlement throughout this entire coast still shows a judiciously avoidance of the margins of the Fleet.

8.4.3 Summary of geology and geomorphology within the study area

The physical nature of the study area

The dominant feature of the study area is Chesil Beach. This is one of three major coarse clastic (shingle/gravel) structures on the British coast that has been distinguished by the definition of a linear barrier beach. The shingle of the Chesil Beach represents accumulation over at least the past 7,000 years (Carr and Blackley, 1973; 1974). Current opinion considers the shingle to be a relict accumulation that has now reached a late stage of its evolution (Carr 1980a; Bray 1996).

Investigations indicate that the beach receives no significant contemporary supply and is now a closed sediment circulation system. The beach displays relatively stable form, although subject to occasional overtopping and slow recession (Carr and Blackley 1974; Carr and Seaward 1991).

Now that shingle supply to the beach seems to be terminated, the possibilities or further overtoppings and breachings need to be considered. This must be weighed against expectations of global changes driving a rising sea and an increase in the incidence of storms.

The origin and evolution of the Chesil Beach and the Fleet lagoon is still not fully understood. The current view on its development has been outlined by West (2005). This view follows that of Arkwell (1947) who postulated that the existing beach began its life during an earlier stage of the Holocene. The first beach is claimed to be a bay-mouth bar stretching eastwards from some lost headland of Cretaceous and Tertiary rocks seaward

of Beer Head and Dowlands Cliff. From here it supposed that the bar extended across what is now West Bay (Lyme Bay) to join an extended element of Portland Bill.

As sea-level rose the old headland coast in the Beer region was modified and worn back. Destruction of its outcrops and headlands combined with longshore drift to mix Tertiary gravels and move them east.

The coastal geomorphology of the beach and lagoon

The area of coastline in the study area comprises a discontinuous belt of shingle beaches. Chesil Beach is the most extensive; a linear storm beach extending 29 km eastwards from West Bay to the 'Isle' of Portland. The huge volume of Chesil Beach almost completely protects the land behind. Cliffs only exist close to West Bay where the beach is lower. To the west, there are pocket beaches which offer only partial protection to the cliff-line. Some major landslide systems have developed on this rapidly eroding soft-rock coast.

It now seems that the present shingle accumulation of Chesil Beach rests upon a predominantly sandy and shelly foundation. This has been proposed from a re-evaluation of borehole data documented by Carr and Blackley (1973). New cored data has also been contributed from the Fleet lagoon (Coombe, 1997). The chronological sequence, first proposed by Carr and Blackley (1973), has since been modified by Bray (1996), High-Point Rendel (1997) and Brunsden (1999). This proposes that the initial forerunner of Chesil probably a bank well offshore of the present beach. A date of some 120,000 years BP has been proposed for this feature.

The formation of the present Chesil Beach began at the end of the Devensian when rapidly rising sea-level caused erosion of these deposits and wave action drove the sands and gravels shoreward to form a barrier beach. Close to the land, the beach overrode existing sediments. As a result, the Fleet lagoon was rapidly filled with silt, sand, peat and pebbles.

Dating of peat samples retrieved from boreholes suggest that infilling of the Fleet began about 7,000 BP and was virtually complete by 5,000 BP. Such deposition requires shelter, so a significant barrier must have existed at this time. This suggests that Chesil Beach had formed slightly seaward of its present position by 4000-5000 BP when sea level approached its present elevation. Cores described by Coombe (1997) suggest that the initial Chesil Beach was predominantly sandy rather than gravel-rich, with layers of shells. Coarser materials may possibly indicate intervals of overwashing.

Coastal management issues

World Landscape Heritage status was awarded to this coast by UNESCO in 2001. This designation recognises its geological and geomorphological significance. The World Heritage Site is promoted and managed by the Jurassic Coast Project (see website: http//www.swgfl.org.uk/jurassic/). Chesil Beach and Golden Cap to Lyme Regis are also Geological Conservation Review sites for coastal geomorphology.

As part of the overall management plan for the World Heritage site (Jurassic Coast, 2005) the Jurassic Coast Project is promoting a mechanism for consultations between coastal engineers and the earth science community. This has been set up to provide a consultative scientific network so that potential conflicts and issues can be addressed (http//www.swgfl.org.uk/jurassic/consult.htm).

The main habitats of interest comprise the coastal vegetated shingle of Chesil Beach and the saline lagoon of the Fleet. This beach is one of the most important shingle sites in Britain and the lagoon is the largest and most important sites of its type in Britain.

8.4.4 Coastal units within the study area

The Fleet study area falls within the Lyme Bay and South Devon Shoreline Management Plan. It incorporates Coastal Process Unit Boundaries 1 and 2, incorporating Management Units 1, 2, 3 and 4.

Coastal Process Unit 1 incorporates the entire west side of the Isle of Portland in Dorset and extends from Portland Bill to the eastern end of Chesil Beach at West Weare. The coastal process unit contains only one management unit, Management Unit 1. This extends over the entire length of the management unit and embraces a variety of industrial, residential and rural uses. Sea-use comprises fishing and mussel beds. The preferred strategic option here is to DO NOTHING.

The Coastal Process Unit 2 extends from West Weare on the Isle of Portland through West Bay and includes Chesil Beach and the Fleet lagoon. It encompasses the settlements of Chiswell, Abbotsbury, Burton Bradstock and West Bay.

This coastal process unit comprises three management units. Management unit 2 covers Chiswell, with the adjacent industrial area, and is predominantly urban. Management unit 3 between Portland Harbour and West Bay is mainly rural. Management unit 4 at West Bay is urban.

The preferred strategic option for Unit 2 is SELECTIVELY HOLD THE LINE. For Unit 3 the option is DO NOTHING. For Unit 4 the option is HOLD THE LINE.

8.4.5 Results of scoring

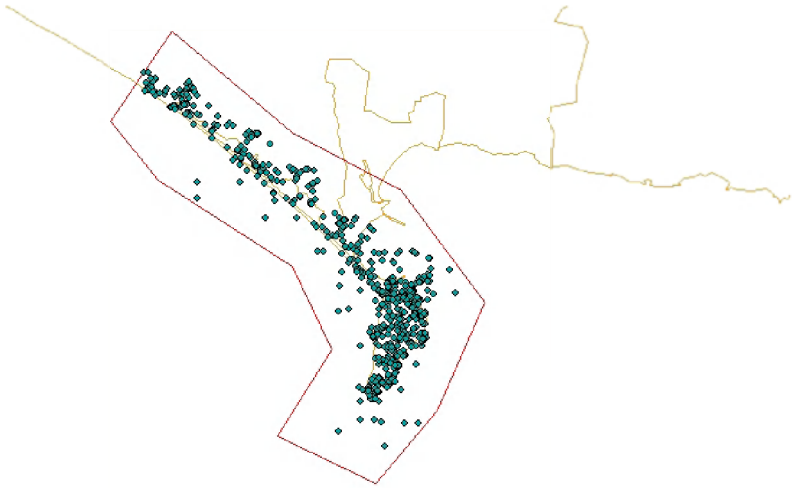


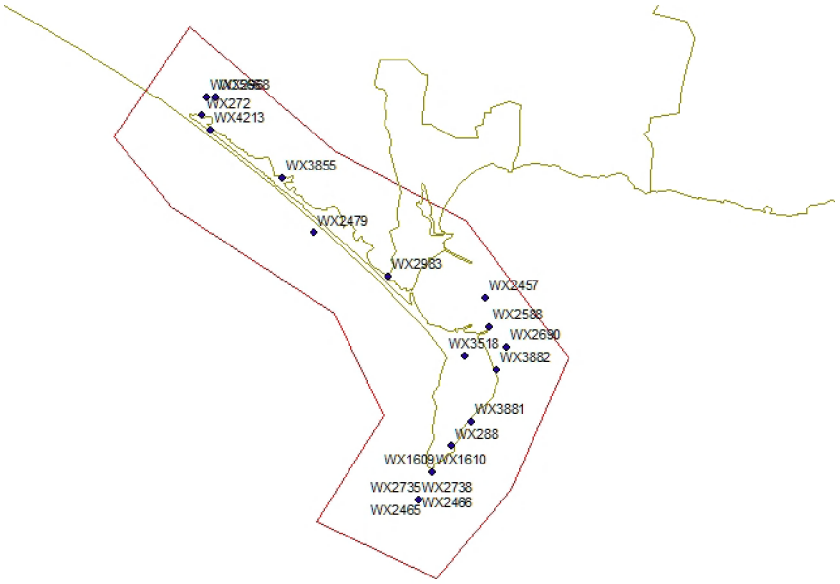
Figure 8.8 Map showing distribution of sites within the Fleet study area

A greater range of site types and periods are represented in the higher scoring sites within the Fleet study area. These reflect the range of physical environments.

Twenty highest scoring sites

MONUID	NAME	TYPE	PERIOD	Sea Level Change	Environ Change	Climatic Change	Chronology	Fragility	Total Score
WX288	Culver Well: Shell midden	SITE	Mesolithic	1	3	2	2	1	9
WX2465	Aletta	WRECK		1	2	1	2	3	9
WX2588	Bottle Bank Wreck	WRECK	Modern	1	2	1	2	3	9
WX2690	Grove Point: marine artefacts	FINDSPOT	Post Medieval	1	2	1	2	3	9
WX2466	Algarve	WRECK	Modern	1	2	1	2	3	9
WX2457	Sea off Portland: naval ceramics finds	FINDSPOT	Post Medieval	1	2	1	2	3	9
WX3882	Portland: Folly Pier	PIER	Post Medieval	1	2	1	2	3	9
WX2479	De Hoop (Hope)	WRECK	Post Medieval	1	2	1	2	3	9
WX2738	Marine artefacts	FINDSPOT		1	2	1	2	3	9
WX2735	Off Portland: Assorted artefacts	FINDSPOT	Post Medieval	1	2	1	2	3	9
WX3881	Portland: Chene Pier	PIER	Post Medieval	1	2	1	2	3	9
WX2983	Fleet, Wyke Regis: Iron Age saltworking.	SALTERN	Early Iron Age	2	2	1	2	1	8
WX272	Abbotsbury Swannery	SWANNERY	Medieval	2	2	1	2	1	8
WX4213	Fleet Wadeway	CAUSEWAY		1	3	1	2	1	8
WX3518	Shell midden below SW Glacis of the Verne, Portland	MIDDEN		1	3	1	2	1	8
WX3855	Works Wall, Langton Herring	MOLE	Post Medieval	1	2	1	2	2	8
WX3566	Chapel Hill	FISHPOND	Medieval	1	2	1	2	2	8
WX2968	Odden's Wood	FISHPOND	Medieval	1	2	1	2	2	8
WX1609	Peca Nova	WRECK	Post Medieval	1	2	1	2	1	7
WX1610	Jason	WRECK	Post Medieval	1	2	1	2	1	7

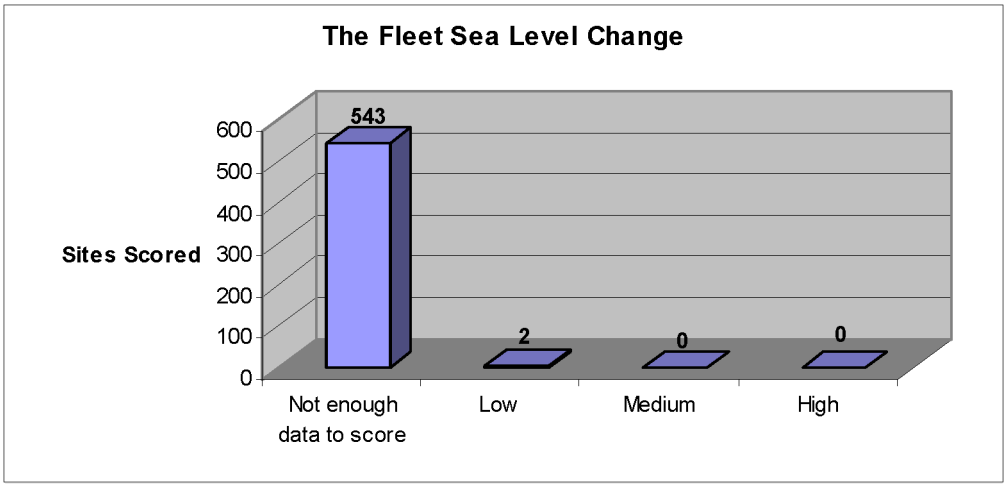
Table 4 Scoring results from the top twenty sites within the Fleet study area



Study Area 2 - The Fleet

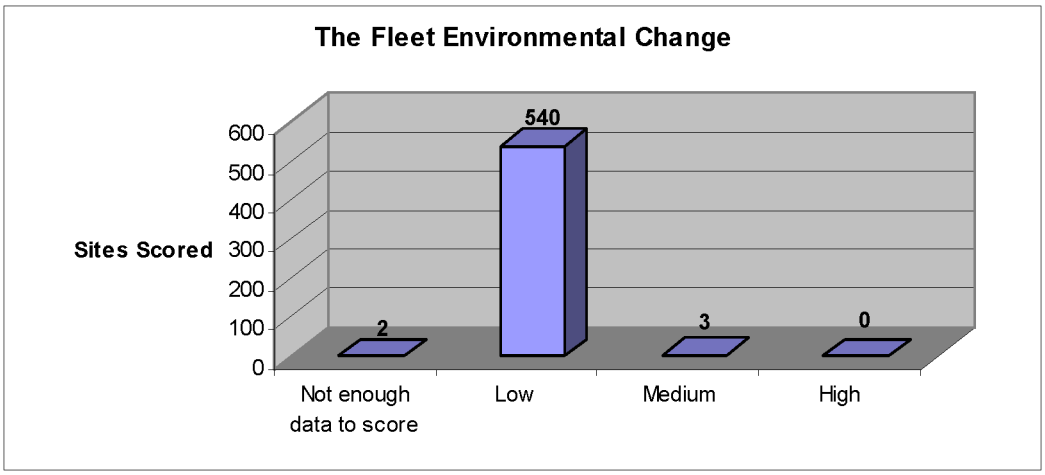
Figure 8.9 Distribution of highest scoring sites within the Fleet study area

Scores for sea-level change



Only two sites offered enough data to be able to score in this category. These are an Iron Age salt working site and a medieval swannery. Each of these sites has been given a 'low' score for their potential to inform on sea level change. However, the sediment archives below the Chesil Beach and the Fleet lagoon were not included in this calculation.

Scores for environmental change



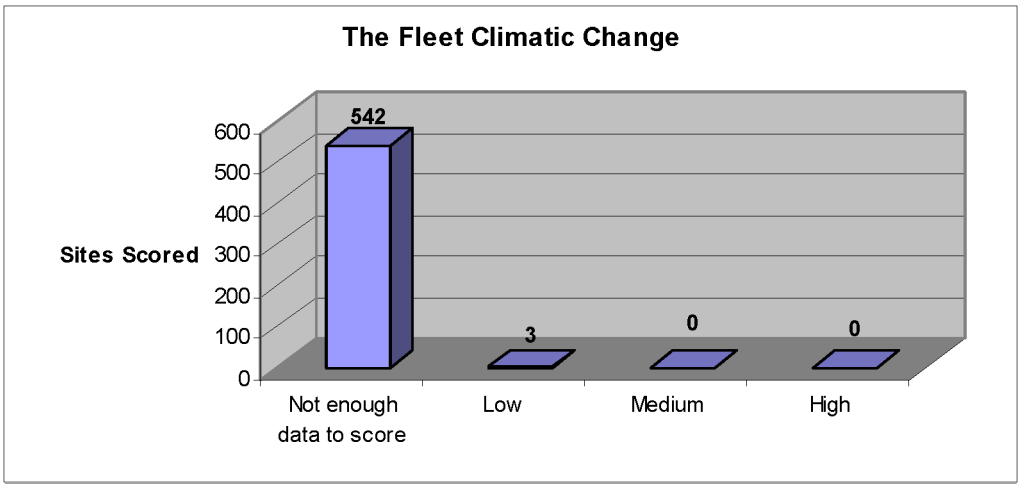
A number of sites within the area have been scored for their potential to inform on environmental change. Although most have received low scores, a few have scored at medium level. These sites include:

Fleet Wadeway
This is an ancient wooden trackway exposed at low tide. It is currently undated. Should a date be obtained, this feature could provide an index point for sea-level at a certain period.

Two shell middens
One of these middens has been dated to the Mesolithic period. Its contents of fish and crustaceans could characterise the nature of its contemporary coastline. Such features are relatively rare around the UK.

The floor of the Fleet was not listed in the current dataset provided by the Historic Environmental Record for Dorset. This may arise from an absence of specifically named sampling site. The potential of the Fleet to produce a first order sediment archive relating to the long-term behaviour of Chesil Beach is of the greatest importance to the long-term management of this coast.

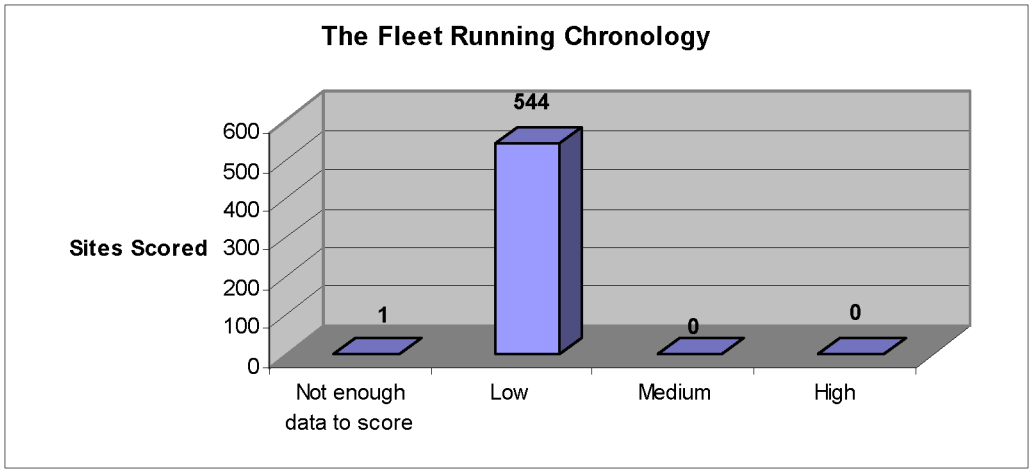
Scores for climatic-change



It was only possible to provide a score for one site meeting this criterion. This was the Mesolithic shell midden mentioned above. However, the potential palaeoenvironmental

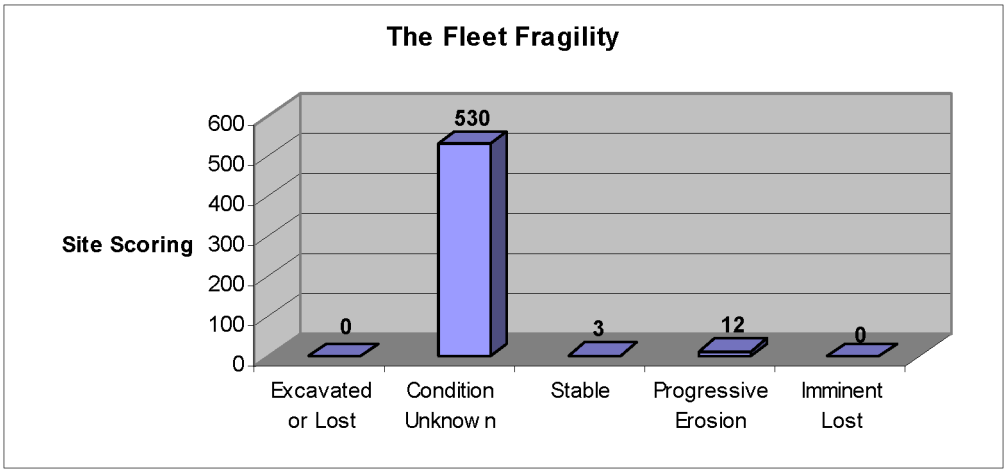
archives beneath Chesil Beach and the Fleet lagoon were not included in this calculation. Further lagoonal deposits and beach-barred wetlands at Burton Freshwater, Cogden Beach, and West Bexington should also be considered under this heading.

Scores for running chronology



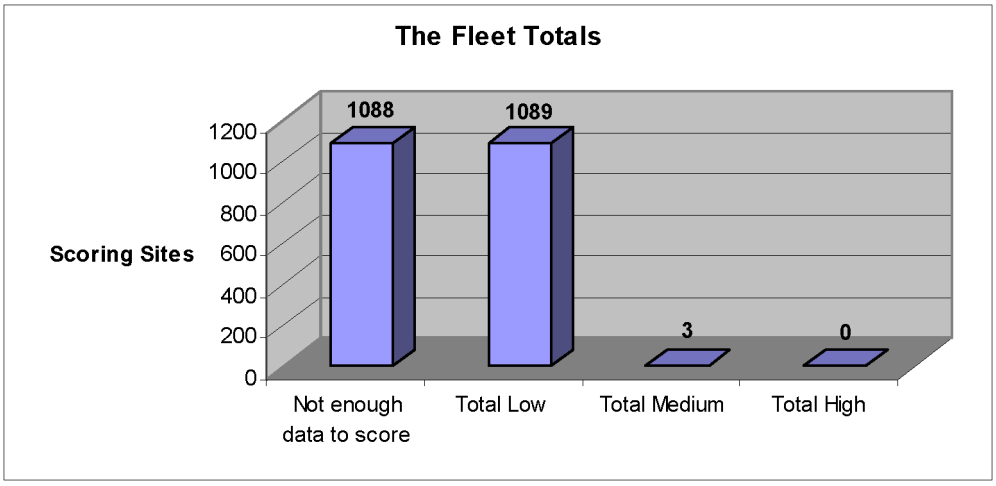
All sites within the top twenty scores were assigned a 'low' score for their potential to inform on temporal continuity. However, the sediment archives contained within the bed of the Fleet and beneath the footprint of Chesil Beach were not included in the current dataset from the Historic Environment Record for Dorset. While these were omitted from the formal scoring procedure they undoubtedly claim outstanding importance in the reconstruction of climate-change and coastal-change in this region. Similar potential should be considered for the beach-barred lagoons or wetlands at Burton Freshwater, Cogden beach and West Bexington.

Scores for fragility



There was not enough data available to be able to assign a fragility score to most of the sites; however, 12 were identified as being at risk from progressive erosion. This was due to the nature of the coastline and their exposed position.

Combined total scores



The combined scores appear to reflect a relatively low potential for the recognised sites in this region. This impression may certainly be misleading. It should be noted that due to temporary problems of data acquisition from the Historic Environment Record for Dorset, the present assessment is no more than a reflection of the level of information available at the particular time of this study.

8.4.6 Discussion of scoring results

The highest score gained within this study area is 9. This is a relatively low score. It must be viewed against a general lack of detailed site-descriptions that has bedevilled a full assessment of sites embraced by the Dorset Historic Environment Record. The scores for many of these sites have been prompted by their imprecise nature but there remains the likelihood that scores may change and become significantly higher when fuller information is available from the County database.

It has already been noted that the palaeoenvironmental deposits beneath the Chesil Beach and the Fleet lagoon offer the highest potential for securing an informed view of past present and future trends in the behaviour of this coast. Similar importance has also been accorded to beach-barred environments at Burton Freshwater, Cogden Beach and West Bexington. None of these sites were included in the formal ranking calculation.

8.4.7 Implications for shoreline management in this area

The present scoring draws attention to wrecks lying off-shore of Chesil Beach. These may offer some opportunity to assess the rate and nature of any persisting shingle movement that may affect the beach. A scatter of seabed artefacts along this same shoreline also offers some similar potential as well as some significant off-shore deposits of peat that have yet to be accurately located and scored.

The embedded legs of two historic piers may offer some opportunity to assess beach movement and accretion since the date of their construction. The potential of these sites is, nevertheless, low. An ancient causeway across the Fleet, known as the Wadeway, offers some notable potential in establishing the longevity of the Fleet exit channel. Within the lee of the Chesil Bank, a medieval swannery at Abbotsbury offers a potential opportunity to locate sediment archives and buried land-surfaces dating from the time of its construction. Similar opportunities apply to two medieval fishponds with scores of 9. A post-medieval mole described as ‘works wall’ offers another opportunity to examine a

buried land-surface that may tell of past breachings and floodings associated with Chesil Beach.

There can be no doubt that the sites of principal potential for the study of coastal-change in this area are those that lie in submerged or waterlogged locations within the shelter of the Chesil Beach. To these must be added the off-shore peats that have yet to be fully identified and plotted. A programme of geophysics and coring is now needed within the Fleet and off-shore of the Chesil Beach. This should be designed to establish the full behavioural profile of this natural protective barrier. This is an appropriate task that should be included in the revision of the of the shoreline management plan.

8.5 Poole Harbour

8.5.1 Introduction to the Poole Harbour study area

Poole Harbour is a shallow estuarine basin with an irregular indented coastline of just over 100kms. The shape and form of the harbour is a result of Holocene sea-level rise that has inundated the original topography of the Frome and Piddle river valleys. There have since occurred on-going modifications made by marginal erosion and accretion.

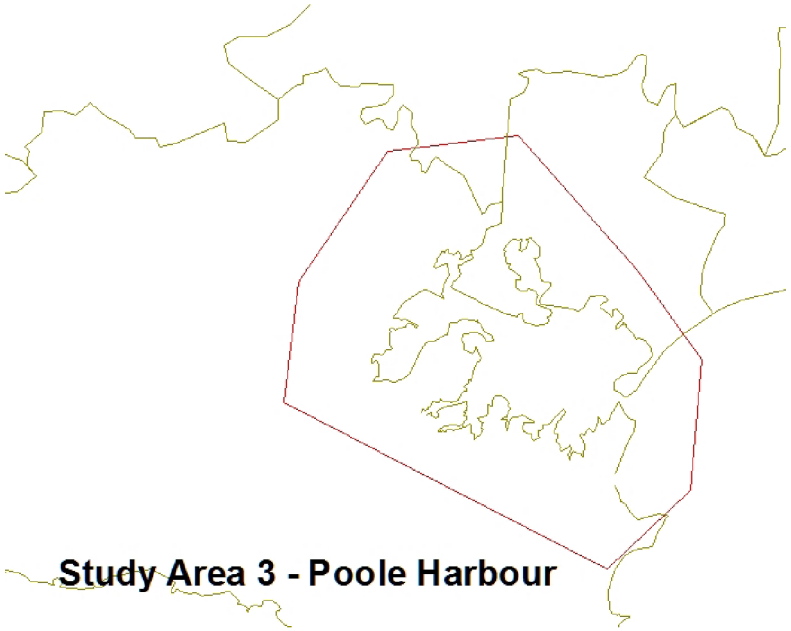


Figure 8.10 Map showing the Poole Harbour Study Area

8.5.2 Summary of the archaeology and history of the Poole Harbour study area

The Poole area in early prehistory

Evidence for the Pleistocene period comprises individual finds of Palaeolithic flint implements including several hand axes as well as a possible Clactonian flint flake found near Cleavel Point. The terrace gravels of the river Stour contain notable numbers of Palaeolithic tools (Wymer 1999), but the quantity of these implements becomes small and difficult to interpret in the vicinity of the harbour.

The Mesolithic period is characterised by a flint-working site, pits and individual flint finds. Peat deposits at Brownsea Island, Back Water Channel, Bridge Approach and Holes Bay provide evidence of other prehistoric environments sensitive to past coastal change.

Poole coastal area in later prehistory

Recorded items of the Neolithic period are limited to just three polished axes. These are reported from South-Western Crescent, Blandford Road and Creekmoor. Submerged peat horizons dated to the Neolithic have been found in Poole Harbour (Edwards 2001). A number of Early Bronze Age burial mounds are reported in the vicinity of the harbour and a pottery manufacturing site, ditches and pits are also known. The Bestwall Quarry Archaeological Project has identified a substantial settlement of Later Bronze Age date in the Poole area but at present little is known of human associations with the contemporary shoreline.

By Iron Age times the maritime importance of Poole Harbour was well established. The population of this period was able to exploit a landscape that extended to somewhere between 2.2m and 1m below Ordnance datum At this time the confines of the harbour were notably smaller. Green and Furzey Islands were then still connected to each other although by now they were separated from the mainland (Cox & Hearne 1991: 227, Markey, Wilkes & Darvill 2002).

Iron Age industrial activity in the vicinity of Poole Harbour area included salt production; pottery production; iron smelting; agriculture. Evidence from Furzey Island, Green Island, Ower and Hamworthy suggests that some of these activities were undoubtedly linked to cross-Channel trade.



Figure 8.11 Iron Age logboat find from Poole Harbour providing evidence of coastal occupation and transport

Salt production sites have been identified all around the harbour, at Poole, Hamworthy, Furzey Island and the Fitzworth peninsular. The heights of marginal salt-working sites in relation to contemporary sea-level can be particularly revealing. A search for inter-tidal and submerged examples would certainly be most helpful to the study of sea-level rise and shoreline behaviour. A log-boat discovered off Brownsea Island (Figure 8.11) has been radiocarbon dated to 295+50 BC (Cullingford 2003). This offers a further means of calibrating these local changes.

The Poole coastal area the Roman period

During the Roman period the activities of salt-making and pottery production were pursued around the contemporary shoreline of the harbour. This brought human access to areas that have since submerged or have become waterlogged.

It is evident that the Hamworthy peninsular now became the focus of maritime activity within the harbour. This area was linked to the main Roman road network by a coastal spur road leading northward to a Roman fort at Lake Gates (Cullingford 2003: 8-9). The road ensured the development of Roman activities on the shoreline at Hamworthy. This has made this location a particularly valuable target for further fieldwork and research into the nature of the contemporary tidal margin.

The Poole coastal area in the medieval period
By the 14th century AD the port and town of Poole was growing in importance. Some medieval buildings and structures still survive today. Archaeological evidence drawn from shoreline middens and salt-making activities can be particularly instructive as to the nature of the contemporary coastal environment. Other evidence, relating to the maritime environment, includes the remains of a jetty and deposits in the Ower Passage and the medieval port. In the off-shore zone, the nationally designated 'Studland Bay wreck' is a reminder that an array of historic shipwrecks has formed significant datable footprints on the neighbouring sea-floor (Velegrakis, Collins and Tomalin, 1992).

The Poole coastal area in the post-medieval period
The development of transatlantic trade and travel in the 17th century eventually brought prosperity to Poole at the start of the 18th century. By this time Poole was rivalling Bristol as the busiest port in England. The town now grew rapidly during an episode of industrial and urban expansion. The merchants of this period erected many tenement buildings which have since become a significant part of the 'listed building' townscape.

During this period several forts were built to protect the harbour from French and Spanish attack. Remnants of some of these fortifications still survive at Brownsea Island and Hamworthy. The pottery and building trade still played an important role in Poole as can be seen through gravel pits and clay pits. The extraction of clay for the supply of London pipe-makers was an important trade. This was eventually eclipsed by the Poole pottery industry. Poole's importance as a port is further demonstrated through a notable array of wrecks, quays and timber yards.

The Poole coastal area in recent times
During World War II Poole Harbour was considered a prime area for potential invasion by the enemy. Heavy fortification was installed. Evidence still abounds in numerous pillboxes, searchlight batteries and gun emplacements. A number of wrecks, both civilian and military, still survive together with some remains of aircraft. Studies on the French coast, under the European LIFE programme, have shown that military installations, such as the Mulberry Harbour shown in Figure 8.12 can be valuable indicators of the rate and scale of coastal change during the past half century.



Figure 8.12 Mulberry Harbour units with high potential for measuring coastal change

8.5.3 Summary of geology and geomorphology within the Poole Harbour study area

The physical nature of the study area

The physical characteristics in the study area show distinct west to east environmental gradients reflecting increasing marine influence and energy levels.

Poole Harbour has been substantially modified by both erosional and depositional processes. Erosional back-wearing of low cliffs has taken place at a number of localities within the harbour where wave-attack is evident. A process of spit-growth has generated both the Sandbanks and South Haven peninsulas. This continuing process of accretion is a cause of narrowing at the harbour-mouth. Artificial reclamation and shoreline protection has modified much of the north-eastern sector of the harbour. Elsewhere, natural processes and habitats continue to function.

The harbour now comprises a gently subsiding basin bounded by extensive mudflats. This environment reflects a long-term trend towards the deposition of fine sediments. These sediments are derived from rivers draining into the harbour. Their stability is assisted by the primary production of organic material on the mudflats and salt-marshes. Stability is also affected by erosion of the harbour margins by tidal and wave actions. It appears that overall sediment inputs are relatively slow. For this reason it has been proposed that the harbour operates naturally as a relatively closed circulation system giving encouragement to the redistribution of the existing accumulation of sediments.

Coastal geomorphology

The reclamation and dredging in the harbour has either impounded or directly removed large quantities of sediments from the active system. Reclamation has reduced the harbour area, diminishing its tidal prism and potentially affecting tidal currents. The longer-term effects of these alterations and outputs to the sediment budget have yet to be determined but the exposure of formerly stable archaeological features in the inter-tidal zone can be a revealing sign of unwelcome changes.

The most significant event to affect the harbour has been the expansion and subsequent dieback of *Spartina anglica*. This cord grass formerly dominated the mid and lower salt-marsh between the 1880s and the 1920s. Colonisation of these areas induced rapid

accretion raising the marsh surface by up to 1.75m. By 1934 a maximum area of 800 hectares had been covered. The subsequent dieback since the 1930s has resulted in the erosion of these marshes and a reduction in the level of the mudflats. The release of these accreted sediments has left rather less than 400 hectares of this depleted environment.

During the expansion of *Spartina anglica* the shorelines of Poole Harbour were first protected from wave action. In the event of the subsequent dieback they have been increasingly exposed. The result has been a reactivation of inactive cliff-lines and the growth of marginal beaches and spits. These changes have been fed by the movement of sands and gravels released from cliffs. The low-gradient inter-tidal shorelines and hinterland of the south and western margins of the harbour are now identified as being especially sensitive to the effects of future climate-change and sea-level rise. Defended portions face the prospect of increasing coastal squeeze and a diminution of the inter-tidal foreshore and its habitats (Halcrow Maritime et al, 2001).

Coastal management issues
Poole Harbour displays a rich variety of habitats. It is subject to many national and European designations that afford protected status. These include: SSSI, SAC (Dorset Heaths and Studland Dunes) SPA and Ramsar designations. Major landholdings dedicated to nature conservation are maintained at Arne (RSPB), South Haven Peninsula (National Trust and English Nature), Holton Heath (English Nature) and Brownsea Island (National Trust and Dorset Wildlife Trust).

At several locations, coastal ‘squeeze’ has, or will, accentuate losses of habitat. This will affect issues of both ‘extent’ and ‘quality’ and it will be induced by the continuing 'die back' of *Spartina anglica*. Opportunities for the improved management of European Designated Habitats within the harbour will need to be considered. Particular care must be taken to ensure that the forthcoming revisions of the SMP do not adversely affect these designated habitats. The monitoring of exposures of datable archaeological and palaeoenvironmental features beneath the mudflats will be a practical means of assessing the current and developing rate of change.

8.5.4 Coastal units within the study area

Poole Harbour falls within the Poole Bay and Christchurch Bay Shoreline Management Plan, with Poole Harbour having its own harbour Management Plan.

8.5.5 Results of scoring

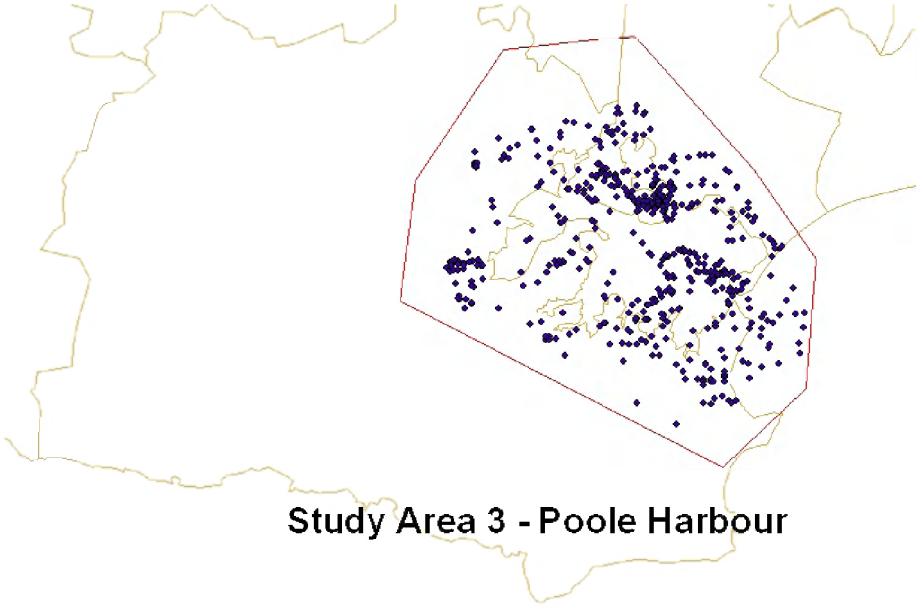


Figure 8.13 Map showing distribution of sites within the Poole Harbour study area

The rich archaeological and palaeoenvironmental resources of Poole Harbour are shown in Figure 8.13, they are also represented in the sites that have gained the highest scores within this study area (Figure 8.14). There is evidence of prehistoric environmental deposits including the presence of peat.

MONUID	NAME	TYPE	PERIOD	Sea Level Change	Environ Change	Climatic Change	Chronolol gy	Fragility	Total Score
WX3078	Brownsea Island: Peat Pits	PEAT WORKINGS	Post Medieval	3	4	3	2	1	13
WX3728	Submerged causeway at Green Island, Poole harbour.	CAUSEWAY		3	3	2	2	1	11
WX722	Poole Harbour: Mesolithic microlith	FINDSPOT	Mesolithic	3	3	1	2	1	10
WX4713	Fish trap	FISH TRAP		3	2	1	2	1	9
WX2772	Logboat, Poole Harbour	WRECK		3	2	1	2	1	9
WX4675	Bridge Approach: Peat deposit	SITE	Prehistoric	2	4	2	2	1	11
WX4676	Back Water Channel: Peat deposit	SITE	Prehistoric	2	4	2	2	1	11
WX4679	Brownsea Island: Peat deposit	SITE	Prehistoric	2	4	2	2	1	11
WX4465	Holes Bay: Possible peat beds	FINDSPOT	Prehistoric	2	4	2	2	1	11
WX2857	Cleavel Point, Ower Peninsula: Findspot	FINDSPOT	Late Prehistoric	2	3	2	2	1	10
WX3914	Salterns Copse: Medieval saltworking	SALT WORKS	Medieval	2	3	2	1	1	9
WX668	Ower Passage, Medieval port	PORT	Medieval	2	3	1	2	1	9
WX3646	Upton Country Park: Salt Works	SALT WORKS	Roman	2	3	1	1	1	8
WX836	Poole Harbour: Handaxe	FINDSPOT	Lower Palaeolithic	2	2	2	2	1	9
WX669	Medieval saltworking sites at Ower, Wytch and	SALT WORKS	Medieval	2	2	2	2	1	9

	Fitzworth								
WX663	Saltworks, Arne	SALT WORKS	Roman	2	2	2	2	1	9
WX835	Furzey Island: Handaxe	FINDSPOT	Lower Palaeolithic	2	2	2	2	1	9
WX864	Medieval saltworks, Studland	SALT WORKS	Medieval	2	2	2	2	1	9
WX3726	Possible Clactonian flint flake near Cleavel Point, Ower Peninsula, Corfe Castle	FINDSPOT	Palaeolithic	2	2	2	2	1	9
WX658	Salt working site, Fitzworth Peninsula	SALT WORKS	Iron Age	2	2	2	2	1	9

Table 5 Scoring results from the top twenty sites within the Poole Harbour study area

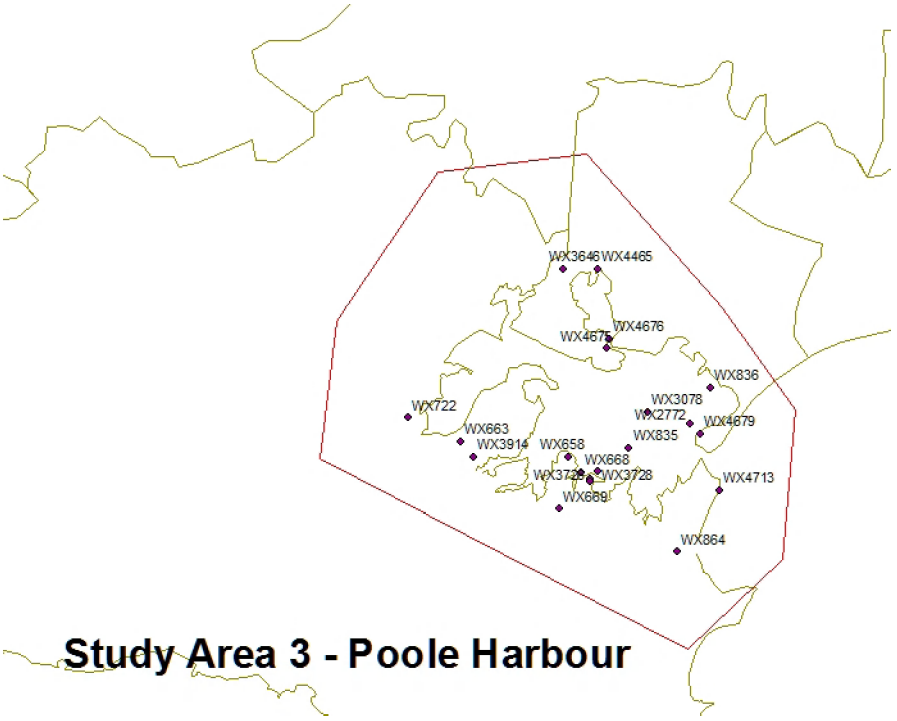
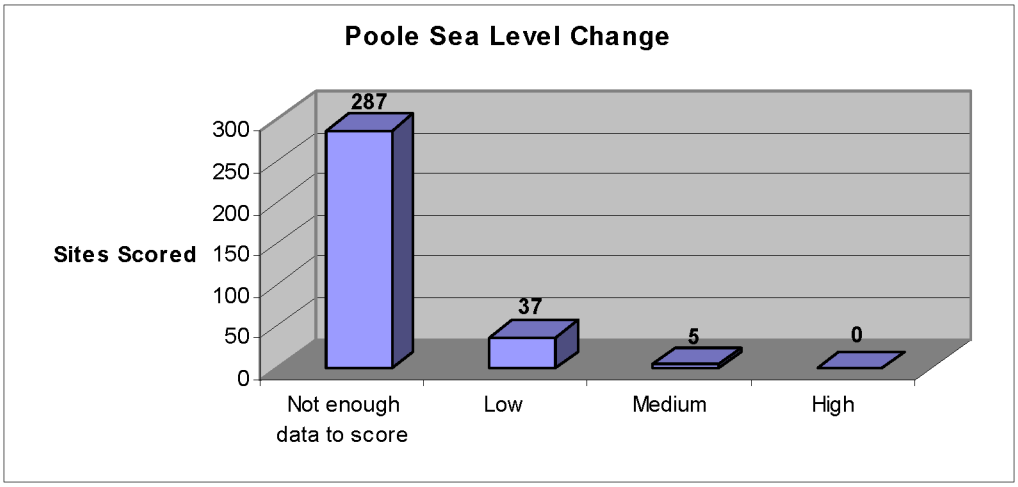


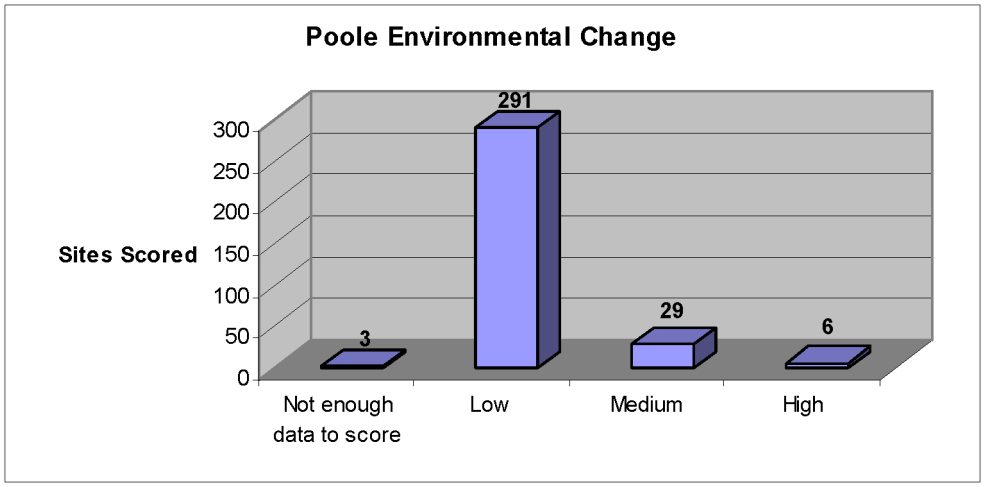
Figure 8.14 Map showing distribution of sites highest scoring sites within the Poole Harbour study area

Scores for sea-level change



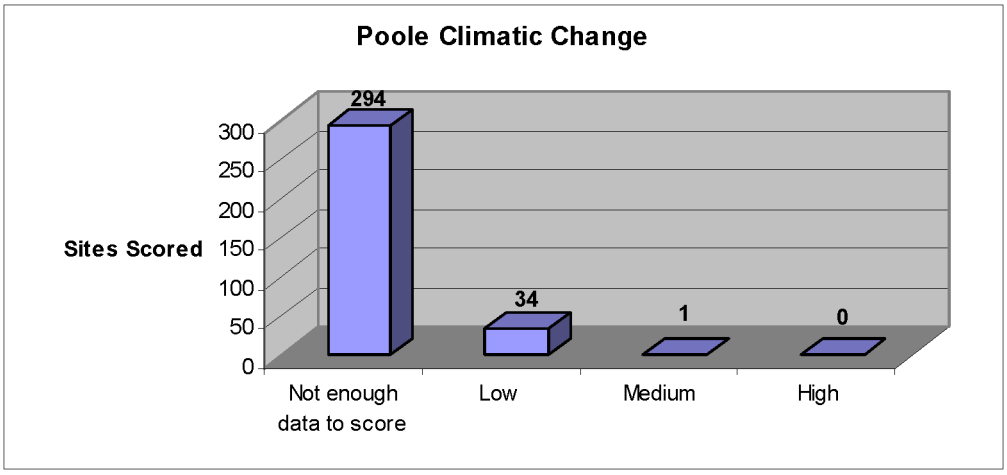
Five sites within the study area won a 'medium' score for their ability to inform on sea level change. These encompass a range of site types including peat-digging pits, a causeway and prehistoric artefacts.

Scores for environmental-change



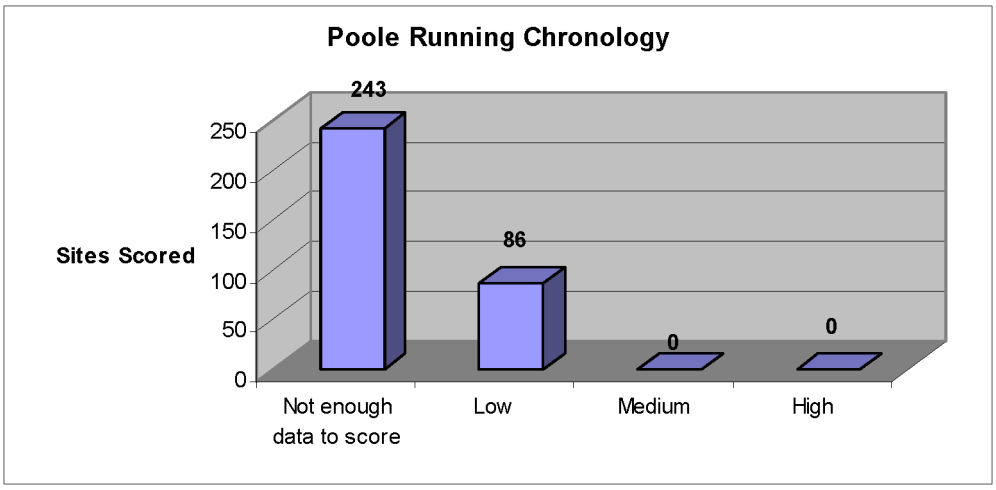
It is in this category that a number of sites are given a scoring 'high' score for the potential to provide evidence of environmental change. It is interesting to see that all these sites are related to peat deposits. Most of these are known to be stratified and have been investigated by core sampling.

Scores for climatic-change



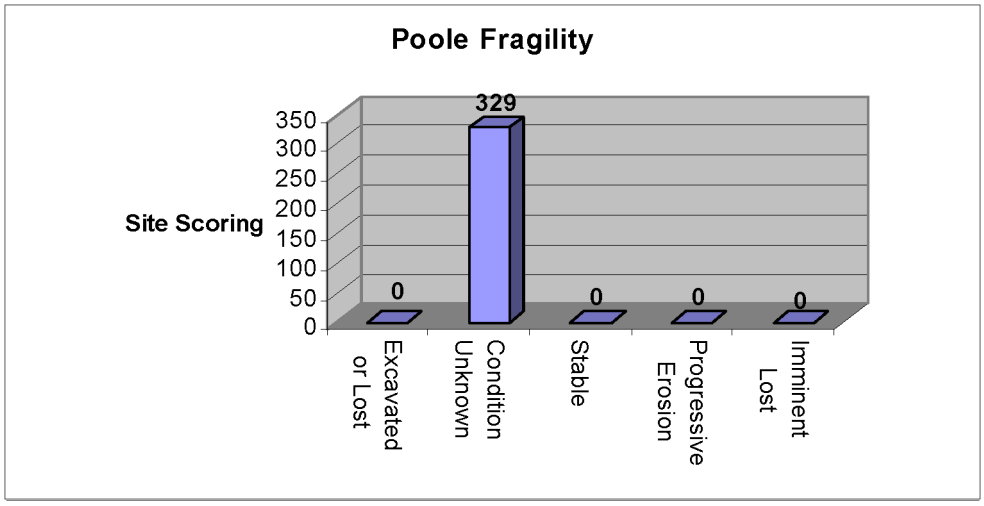
The highest scoring site in this category is related to peat deposits. The Brownsea Island peat-digging pits offer a potential to provide evidence related to sea level at a time that might be fixed by radiocarbon dating.

Scores for running chronology



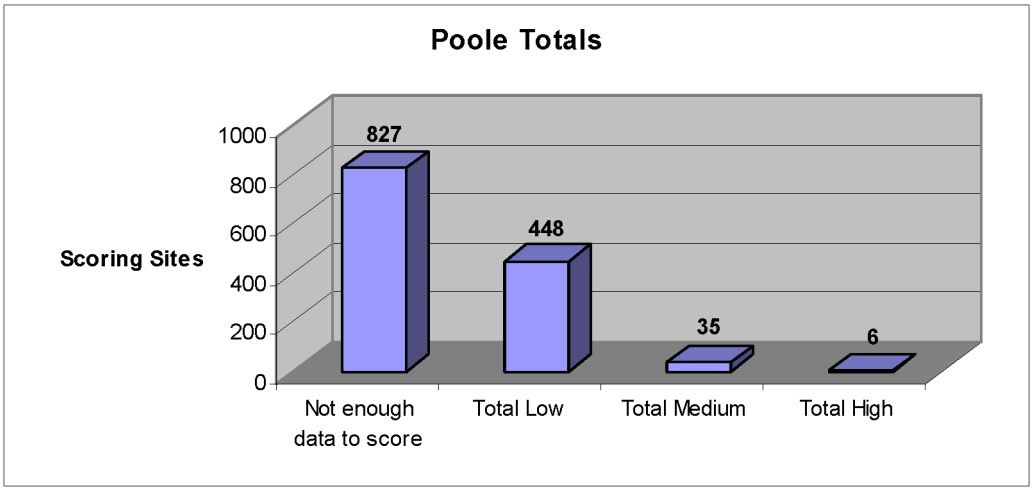
There are no sites identified as scoring 'medium' or 'high' in respect to running chronology.

Scores for fragility



There is not enough data available to make a judgement on the fragility of individual sites.

Combined total scores



The Poole results show that 62% of the sample was incapable of producing a score.

8.5.6 Discussion of scoring results

The potential to produce palaeoenvironmental evidence of past coastal change is clearly demonstrated within this study area. A number of peat deposits have been recorded around the harbour and these offer particular opportunities to reconstruct the past behavioural history of the changing coastland. The entries currently available from the Historic Environment Record for Dorset suggest that knowledge of sites pertinent to the study of coastal-change is not strong in this study area.

8.5.7 Implications for shoreline management in this area

There is a range of site-types and periods that could help inform on the development of the harbour and the nature and rate of coastal change. Little is known of sediment archives within palaeochannels in the harbour yet a programme of geophysical prospecting and coring could resolve this. These measures, together with new survey of the inter-tidal zone and the dating, interpretation and monitoring of exposed archaeological and palaeoenvironmental features, should be integrated into the revision of the shoreline management plan.

8.6 Christchurch Harbour

8.6.1 Introduction to the Christchurch Harbour study area

It has been claimed that the first elements of Christchurch Harbour were formed approximately 7,000 years ago when sea-level rose during the early to mid Holocene. By this time an earlier breaching of the Wight-Purbeck Chalk ridge had allowed the sea to cover much of the land that now lies beneath Christchurch and Bournemouth Bays (West 1980, Wright 1982, Nicholls 1985, Velegrakis 1994).

The study area includes Christchurch Quay and Quomps (see figure 8.15). These lie in the upper reaches of the harbour and on the northern bank of the river Stour. The entrance to the Christchurch harbour, known as 'the Run', is flanked by Mudeford Quay to the north and Mudeford Sandbank to the south.

Hengistbury Head is a large natural promontory obstructing the mouth of the Stour. The Head accommodates an array of archaeological sites offering evidence of past coastal habitats and changes in sea-level and coastal configuration.

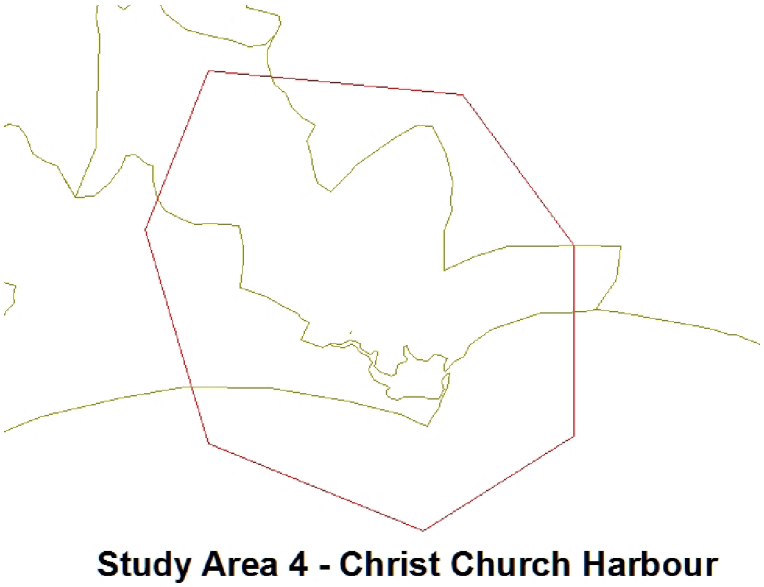


Figure 8.15 Map showing the Christchurch Harbour Study Area

8.6.2 Summary of the archaeology and history of the Christchurch Harbour study area

The Christchurch coastal area in early prehistory

Human activity on the margins of the river Stour is first attested in the Late Pleistocene. At this time an open settlement was established by an Upper Palaeolithic community on Hengistbury Head (Barton, 1992). Further occupation is evident during the Early Holocene, when Mesolithic flint-working took place on the Head (Barton, *ibid*).

The Christchurch coastal area in later prehistory

During the Neolithic period, human habitation persisted in the vicinity of the natural harbour. This is attested by the presence of a long barrow and the reported locations of Neolithic pits and flint and pottery artefacts. A notable number of burial mounds on

Hengistbury Head attest the presence of a well-established Early Bronze Age community. During the Later Bronze Age there is a hint of possible expansion or a settlement-shift slightly further up-stream (Calkin, 1964). A shift may be the result of environmental changes in the course of the river or the nature of the Hengistbury promontory.

During the Iron Age human settlement was emphatically established on the Hengistbury promontory. An increased population led to the defence of the headland by the cutting of massive earthworks, now known as the Double Dykes. An important function of this fortified community was maritime trade. These interests prompted an array of activities carried right down to a waterfront on the contemporary water margin of the harbour. These archaeological deposits now lie below present tidal limits and they offer valuable evidence of the past configuration of the harbour and its sea-level.

The Christchurch coastal area during the Roman period
In the aftermath of the Roman Conquest of 43 AD, settlement on Hengistbury Head entered into a notable decline. At present it is uncertain whether this was entirely due to the emergence of new trading centres on other parts of the Wessex coast or whether it was prompted by environmental changes in and around the harbour and its navigable approaches.

The Christchurch coastal area during the medieval period
The first written records of Christchurch appear in the *Anglo-Saxon Chronicle*. These refer to its capture by *Ethelwald* in AD 900. Excavations during the 1970s uncovered part of the Saxon defences. The town ditch sediments may offer an index of contemporary water-tables. Excavations by the Mill Stream in the town centre have also revealed a Saxon cemetery.

The *Domesday Book* of 1086 records Christchurch as a small market town. Mention is also made of a Saxon monastery in the Church of The Holy Trinity. This is embodied within the present Priory Church. The town was prosperous in the early medieval period but seems to have declined temporarily from about 1350, possibly due to the Black Death. The fluctuating fortunes of the town may be related to environmental changes in the nature of the navigable river and harbour.

The Christchurch coastal area during the post-medieval period
The history of Christchurch Harbour has often shown a shallow environment with drying conditions and difficult navigable access. During the post-medieval period attempts were made to alter this. In the mid 1600's Andrew Yarranton cut a deep-water channel from the harbour to the sea. This avoided the treacherous narrow entrance locally known as ‘the run’. The new channel was cut through the Mudeford spit approximately half way along its length. This was about 600 metres from the Head. The cut remained in use for some 30 years. It was still in use in 1698 although it had been blocked on several occasions. The most severe problems arose after the great storm of 1703. It was finally abandoned after it was blocked by yet another heavy storm.

After the demise of Yarranton’s scheme, the harbour reverted to being a small fishing port. However, in 1733 the Walpole Government passed the Excise and Customs Bill which severely restricted the import of a whole range of items into the country. This resulted in rampant smuggling for which Christchurch Harbour was ideally suited.

Later activities included the development of gravel pits and the exploitation of the iron doggers in the vicinity of Hengistbury Head. The doggers were recovered by repetitive dredging of the waters off the Head and by the removal of ironstone from the southern beach. This led to massive destabilisation of the beach processes that had maintained

the character of the shoreline. Soon the sea was able to attack the base of the cliff and carry away the sand and a notable portion of the Iron Age rampart known as the Double Dykes.

The Christchurch coastal area in recent times

Christchurch remained a modest town, expanding very little beyond its medieval suburbs until the 20th century. The western growth of Bournemouth then made it part of a much larger urban area. During the Second World, military installation, including pill-boxes and anti-tank structures were constructed on the coastal margin. There also occurred a number of contemporary wrecks. Between the production of the 1st and 2nd edition OS maps for the harbour area, a significant array of flood defences has been constructed. This has had an economic impact by on the protecting valuable grazing land.

8.6.3 Summary of geology and geomorphology within the Christchurch Harbour study area

The physical nature of the study area

Christchurch Harbour is a catchment area for fluvial sediment coming from the combined discharge of the Stour and Avon. It is uncertain how much of this material is transported through the harbour entrance. The entrance is confined by spits of unequal length. To the south, attached to Hengistbury Head, is Mudeford Sandbank. To the north is the smaller, but wider, Mudeford Quay spit which projects into the harbour.

The formation of Christchurch Harbour has been investigated by Velegrakis, *et al* (1999). This study identifies four infilled palaeovalleys in the off-shore zone. These lie within, and south of, Christchurch Bay. Each valley shows an abrupt transition in its sediment fill. This evidence could indicate that Christchurch Harbour was formed by a rapid or 'episodic' advance of the sea. Alternatively, it may have developed from a shallow estuarine embayment that had formerly enjoyed protection from an extension of Hengistbury Head. Although these possibilities are still un-resolved, the present evidence certainly suggests that Christchurch Bay is likely to have been submerged later than Poole Bay (Velegrakis *et al, ibid*).

Coastal geomorphology

Christchurch Harbour has a mean tidal basin area of 1.9 $km^{2.}$ Its mean water depth is 2.0m. The harbour sediments are mostly sandy gravels, sands, and muddy sands. Towards the inner margins there are changes to silty muds. The overall sediment budget of Christchurch Harbour is positive, as evidenced by net vertical accretion. In overall terms, the estuarine system of Christchurch Harbour is a sediment sink.

The shallow entrance channel of Christchurch Harbour shows a stable configuration. This is partly due to the protection offered by Mudeford Quay. The whole is indicative of a current state of equilibrium.

Coastal management issues

Christchurch Harbour is the site of both high and low salt-marsh. There are wet meadows and dry grassland. Reed-beds of both *Phragmites* and *Scirpus* are also present. By virtue of their diversity of species, the salt-marshes are unusual for South Coast estuaries. It is notable that *Spartina anglica* has failed to gain invasive dominance here. The present practice of maintaining a balance between different communities and habitats is crucially dependant upon shoreline protection against potential breaching at Double Dykes and Mudeford Spit.

The cultural importance of the Double Dykes area is confirmed by its status as a Scheduled Ancient Monument. This designation also recognises an array of above-ground and below-ground prehistoric monuments in the enclosed area east of the dykes.

8.6.4 Coastal units within the study area

The Christchurch coastline falls within the Poole Bay and Christchurch Bay Shoreline Management Plan. Christchurch Harbour is subject to its own Harbour Management Plan.

8.6.5 Results of scoring

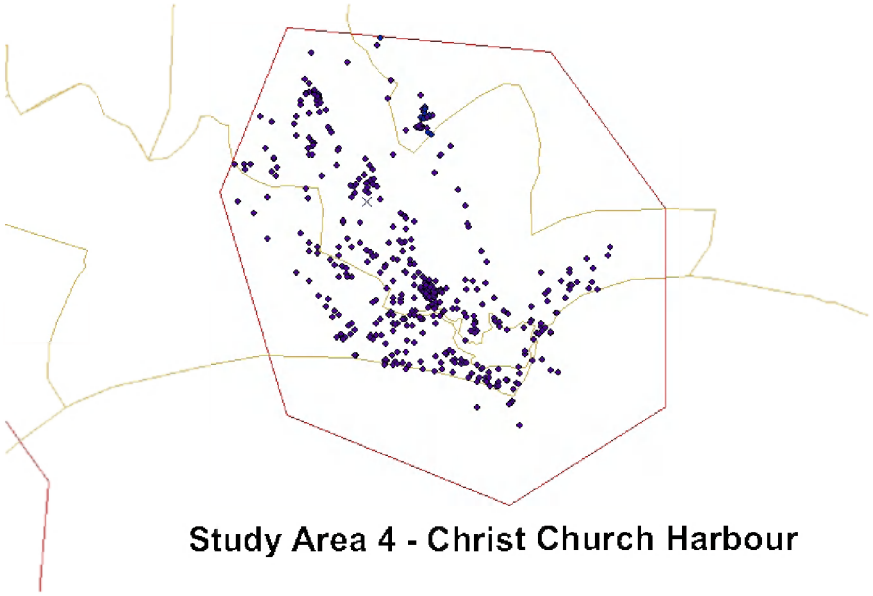


Figure 8.16 Map showing distribution of all sites within the Christchurch Harbour study area

Limits in the archaeological database currently available in Dorset have affected the numbers of sites that could be scored within this study area. Figure 8.16 shows the distribution of all sites within the study area, while figure 8.17 shows the distribution of the highest scoring sites.

MONUID	NAME	TYPE	PERIOD	Sea Level Change	Enviro mental Change	Climatic Change	Chronolo gy	Fragility	Total Score
28977		WATER MEADOW	MONUMENT	3	1	2	2	2	10
WX3532*	Grimmery Bank: Causeway	CAUSEWAY		2	3	2	2	1	10
WX3530*	North Marsh: Causeway	CAUSEWAY		2	3	2	2	1	10
WX1136*	Hengistbury Head	SITE	Upper Palaeolithic	2	2	2	1	3	10
54300	Ethel Maude	WRECK	MARITIME	2	1	2	2	3	10
54299	Marie Therese	WRECK	MARITIME	2	1	2	2	3	10
54298	Diver	WRECK	MARITIME	2	1	2	2	3	10
54297	Water Beetle	WRECK	MARITIME	2	1	2	2	3	10
54301	Elizabeth	WRECK	MARITIME	2	1	2	2	3	10

WX1092*	Hengistbury Head	OCCUPATION SITE	Prehistoric	2	2	1	2	3	10
WX3590*	Christchurch Priory	MONASTERY	Medieval	2	3	1	3	1	10
WX1260*	Tuckton Bridge: Hand-axe	FINDSPOT	Lower Palaeolithic	2	2	2	2	1	9
WX1261*	Tuckton Bridge: Hand-axe	FINDSPOT	Lower Palaeolithic	2	2	2	2	1	9
WX1175*	Sopers Lane: Lower Palaeolithic roughout	FINDSPOT	Lower Palaeolithic	2	2	2	2	1	9
WX1275*	Southbourne: Hand-axes	FINDSPOT	Lower Palaeolithic	2	2	2	2	1	9
WX1179*	Stour Road: Hand-axe	FINDSPOT	Lower Palaeolithic	2	2	2	2	1	9
WX897	St Catherine's Hill: Acheulian Hand-axe	FINDSPOT	Upper Palaeolithic	2	2	2	2	1	9
WX1181*	Friars Cliffs estate: Hand-axes	FINDSPOT	Lower Palaeolithic	2	2	2	2	1	9
WX1182*	Hengistbury Head: Hand-axes	FINDSPOT	Lower Palaeolithic	2	2	2	2	1	9
WX4817	Fishpond, Highcliff	FISHPOND	Post Medieval	1	3	1	3	1	9

Table 6 Scoring results from the top twenty sites within the Christchurch Harbour study area

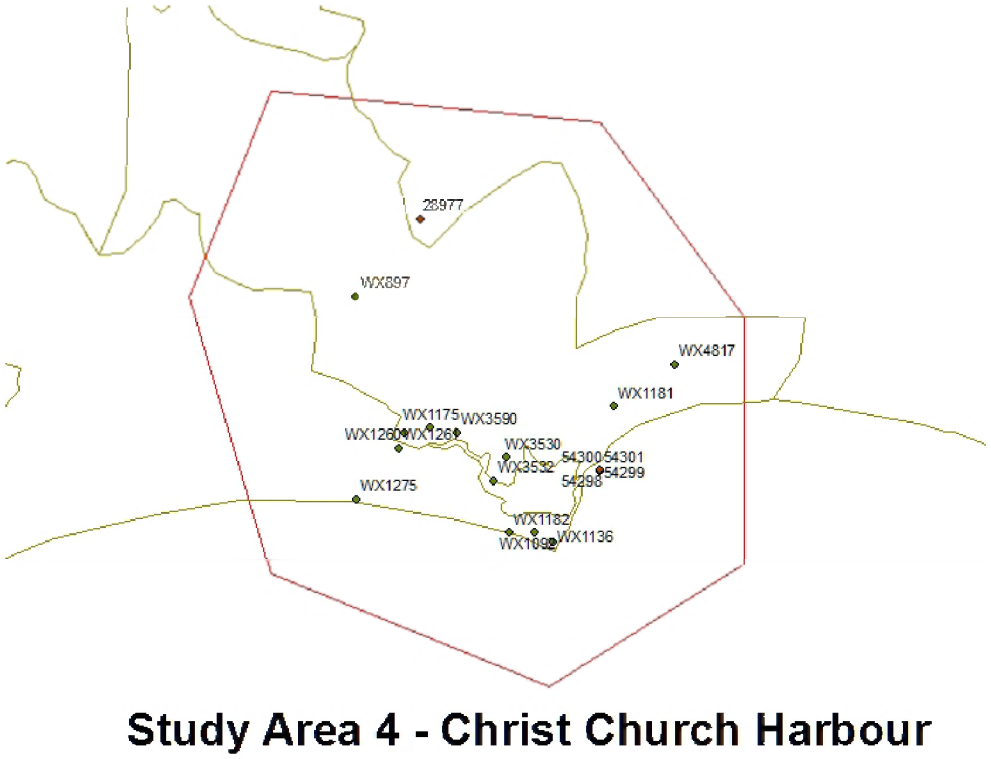
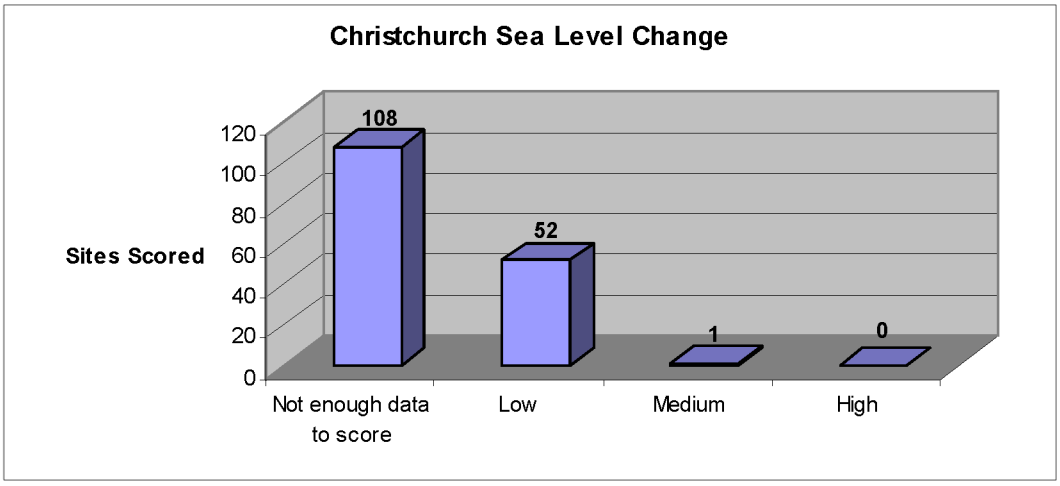


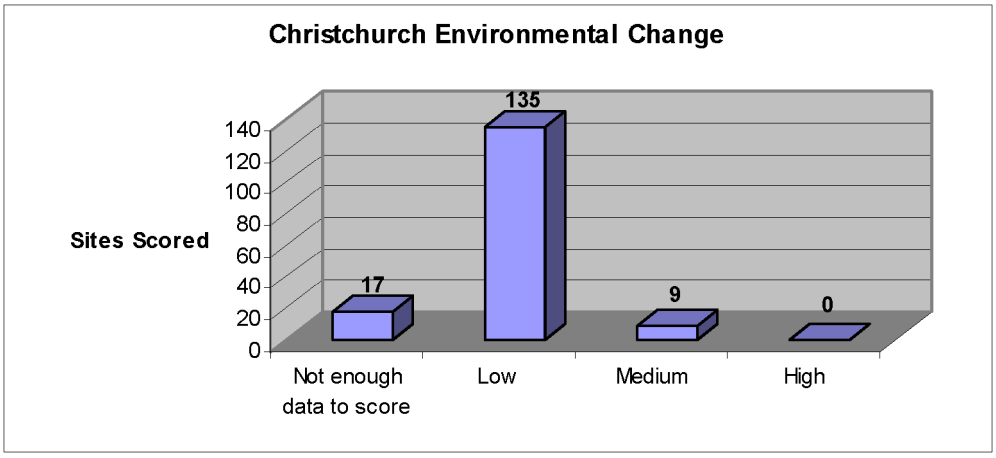
Figure 8.17 Map showing distribution of highest scoring sites within the Christchurch Harbour study area

Scores for sea level change criteria



Only one site within this area has scored at 'medium' level with regard for sea-level change. This is a site of water meadows. Although this site is undated the presence of water meadow can be an excellent indicator of sea-level because optimum conditions would be required to maintain productive pastoral land. This is a habitat that would be very sensitive to changes in sea-level.

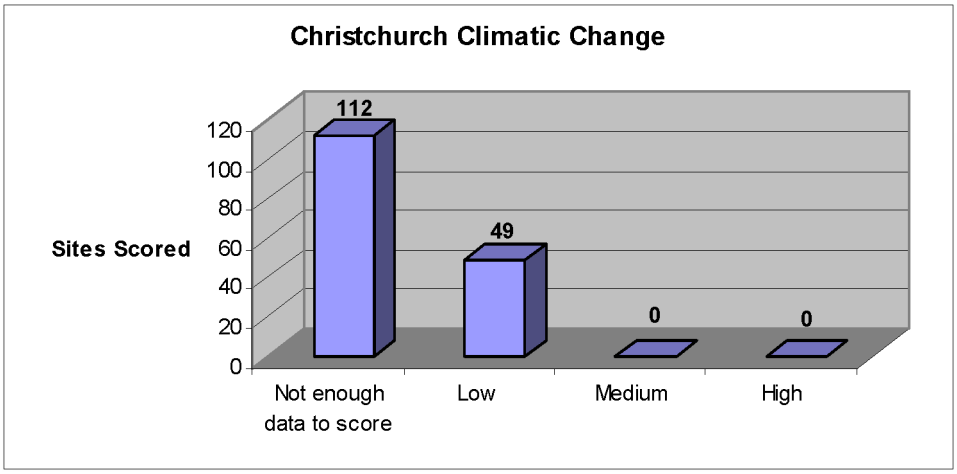
Scores for environmental change criteria



Nine sites have scored at medium level with regard to their potential to inform on environmental change. Only four of these sites are present in the list of the 20 highest scoring sites. These are two causeway features and a monastic building.

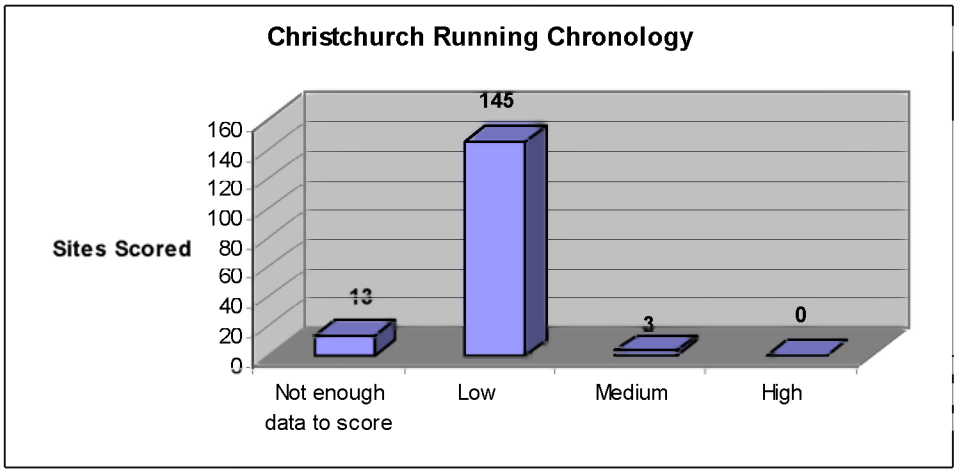
This result demonstrates the need to look holistically at the database when asking specific questions of sea-level change. The scoring information can be used for a variety of queries relating to issues of coastal-change. The 'total score' across the categories should not be used as the only indication of 'potential'.

Scores for climatic change criteria



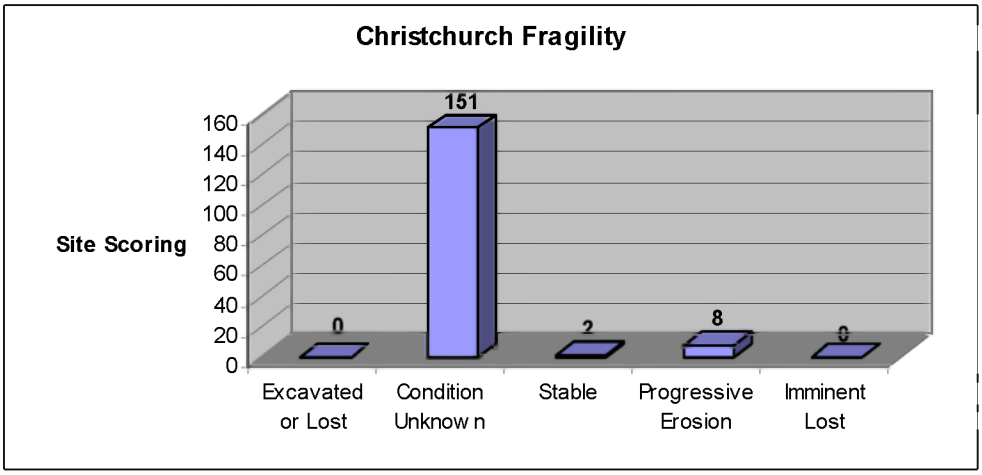
All scores fall within the 'low' potential or 'not enough data to score' categories.

Scores for running chronology



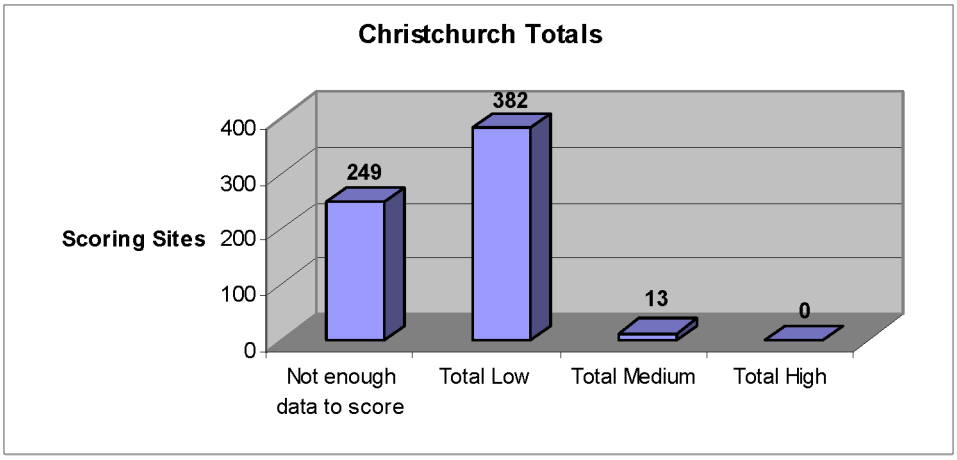
Three sites have drawn medium scores for their potential to provide information on temporal continuity. The only one to feature in the top twenty scored sites is the medieval monastery. Here, the possible survival of dendrochronological evidence has been taken into account. There are clearly un-grasped opportunities to gain information on the sediment history of the harbour and the former configuration of the lower Avon and the Stour. This includes concealed stratigraphy within the floor of the harbour and the sediment archive contained within the cross-section of the river valley.

Scores for fragility



Eight sites have been placed within the 'progressive erosion' score. Six of these sites are listed in the table of the top twenty scoring sites. These sites include the nationally important Hengistbury Head site and a number of wreck sites.

Combined total scores



The overall scoring for this area is comparatively low for this criterion. This reflects restrictions in the current level of available data.

8.6.6 Discussion of scoring results

This study area demonstrates the potential for fluvial gravel terraces to hold information on past habitation on the margins of the shallow valley of the Avon and the Stour. In this particular case the evidence comes from some of earliest human occupation of Britain. These gravel terraces have been formed and affected by changes due to the last glaciation in Britain. Their potential to inform on coastal evolution is underlined by their scoring.

The study area also shows the importance of viewing the scores in each category of the database rather than as a whole. A site may score very highly in one category but not in others. This can result in a low 'total score'.

Omitted from the scores are those sites or locations that can offer palaeoenvironmental information rather than archaeological information relating to the past configuration of this coast. This omission arises from the current nature of the County Historic Environment

Record. It also seems to reflect a lack of targeted fieldwork and a lack of gathered records from geo-technic and other exploratory cores in this particular area.

8.6.7 Implications for shoreline management in this area

A project design is needed to initiate a programme of fieldwork, sample-gathering; interpretation and monitoring that should address the problem of recognising the long-term agenda of coastal-change in this area. It should examine the open shoreline as well as the interior of the harbour and flood-plain in the vicinity of Christchurch town. Future work should also include research into the incidence and extent of past floodings and a review of stratigraphical information currently available from core records. Provisions to progress these issues should be encompassed within the revision of the shoreline management plan.

8.7 Western Solent

8.7.1 Introduction to the Western Solent study area

The Western Solent study area extends from Hurst Spit in the west to Park Shore on the Hampshire coast to the east. On the Isle of Wight the study area incorporates Newtown Harbour in the east and Yarmouth in the west.

The study area embraces the largest and best known of the two major spits in the Solent region, namely, Hurst Spit. The spit lies at the mouth of the Western Solent where it projects some 2.1 km towards the Isle of Wight. The study area also encompasses the distinctive chalkland coastal topography at Alum Bay and the Needles.

This study area was chosen as a 'cross boundary' example where two administrative entities, on the opposite sides of a relatively narrow stretch of water, share a common interest in coastal behaviour. It is here that an array of archaeological and palaeoenvironmental features may help to define the nature, scale and pace of coastal processes that are still actively widening and deepening the seaway channel.

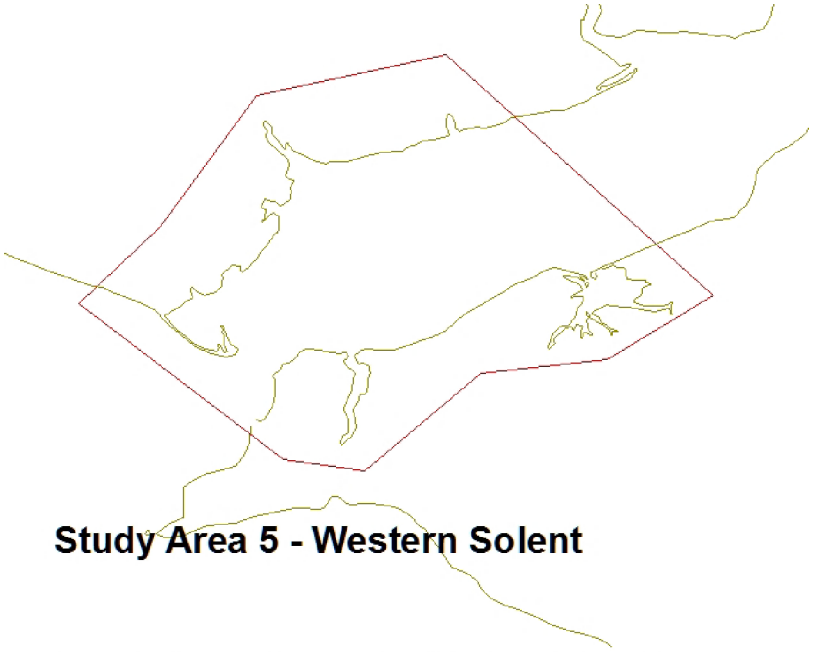


Figure 8.18 Map Showing the Western Solent Study Area

8.7.2 Summary of the archaeology and history of the Western Solent study area

The Western Solent study area has been significantly affected by changing sea-levels during and since the last glacial period. This has left a trail of gravel deposits along the shoulders of the Pleistocene river valleys of this region.

The outstanding question concerning SCOPAC authorities is the date of the sea-channel break-through and the severance of the Isle of Wight. Active forces of coastal erosion confront the interests of the coastal protection authorities on this coast and they all stem from this event. While the 'time trajectory' and the exponential energies of these forces remain uncertain, practical problems of coastal protection demand a clear view of nature's broader agenda for the future coast. The vulnerabilities of the spits at Hurst and Calshot exemplify this problem.

While headlands are retreating and protective spits are shifting, there is a fundamental need to understand the genesis of these processes and to secure a clear understanding of the 'timetable' of subsequent Holocene events. Early prehistoric flint tools in some of the gravel terraces offer a means of dating the formative events during the Pleistocene period. It is now the uncertainty of events during the middle and later Holocene that confounds our understanding of present processes of erosion and coastal-change.

It is particularly fortunate that recent archaeological investigations into submerged landscapes on the Solent coast are now offering some long-awaited answers. These include some specific times when earlier human populations could venture to a lower shoreline.

In the palaeoenvironmental field, new fieldwork and research is now revealing sediment archives that may tell of past impacts and natural changes along the retreating shoreline of the Western Solent. This includes pollen and diatom evidence from cores at Yarmouth, Bouldnor, Newtown and Stansore Point. These reveal past environmental changes that can be helpfully compared with the events being witnessed today.

The western Solent in earlier prehistory

The earliest pertinent evidence of human activity comes from Pleistocene terrace gravels deposited at various altitudes along and below the upland boundaries of the Western Solent lowland. Bridgland (2001, 16-19) cites four specific gravel terraces that may be dated by the presence of associated human artefacts. These deposits all rest on benches on the northern shoulder of the Western Solent valley. These are the gravels of Setley Plain (*c.*42m OD); Old Milton (*c.* 35m OD); Taddiford Farm (*c.* 28m OD) and Stanswood Bay (*c.*22m OD).

Maps provided by Allen & Gibbard (1993) and Bridgland (2001) show the course of these elevated terrace gravels shadowing the northern coastline of the Western Solent. Here they appear to conform to an ancient Pleistocene valley that long pre-dates the formation of the Solent seaway.

The highest and oldest of these gravels to yield datable human artefacts is the Setley Plain deposit. For this, Bridgland proffers a date of some 400,000 years BP (Oxygen isotope stage 11-10). This is based on implement typology and analogy. For implements in the Old Milton gravel, parity with oxygen isotope stage 8-7 is proposed. This would signify a date around 300,000BP. Implements within the Stanswood Bay gravel have yet to be assigned a conclusive date but a date within oxygen isotope stage 9/11 has been proposed (Bates, 2001).

It is unfortunate that research into Pleistocene gravels and finds of Palaeolithic implements has yet to be pursued with precision on the southern shoulder of the Western Solent valley. Basford (1980) provides a helpful summary of implement-finds within the Isle of Wight and this includes find-spots on the coastline at Alum Bay, Bouldnor, Cranmore, Hamstead, Rew Street and Gurnard.

At Cranmore a significant cliff-exposure of parent gravel has been observed where implements have been recovered from the beach. At Rew Street there are hints that a significant assemblage of datable implements may be contained within another coastal outcrop of gravel (Poole, 1936; Basford, 1980, 10 map 2, 94-5 sites 9 & 20). There now remains a need for the characterisation of these coastal deposits of gravels and for a detailed comparison to be drawn with their potential counterparts on the northern shoulder of the Western Solent valley. Bridgland (2001:16) comments on a general

paucity of biostratigraphic evidence in the Solent gravels. This problem may be partly due to the archaic nature of many discoveries and field investigations.

At lower levels within the Western Solent valley, some palaeoenvironmental evidence is available from submerged contexts in the coastal zone. These resources include some deposits off the Isle of Wight coast at Newtown where elephant and bison remains have been recorded (Munt and Burke 1986). Further palaeo-channel deposits yielding interglacial fauna have been identified on the New Forest shore at Stone Point, Lepe (Brown *et al*, 1975).



Figure 8.19 Modern day foreshore at Lepe, beneath which is a sediment archive demonstrating coastal change

It is the environmental changes of the early and mid Holocene that are of particular importance to the management and protection of the Solent coast. These events mark the genesis of the coastal processes that are still eroding and modifying this coastline. The presence of Mesolithic habitation sites in the inter-tidal and sub-tidal zones offers a particularly valuable opportunity to establish the long-term behavioural history of this shoreline. Current investigation into the submerged habitation site at Bouldnor has established a date of circa 8,000 BP for the existence of brackish conditions prior to the formation of the open sea-way. At this time habitation was still possible at a level of -11m OD.

Elsewhere on the floor of the Western Solent, further evidence of Mesolithic activity can be detected. This evidence has been produced by fishermen recovering flint tools from the seabed. The seabed near Pitts Deep and Pennington is particularly notable. These finds, and some associated deposits of peat, come from levels that are higher and arguably later than the dated occupation site identified at Bouldnor. This upward trail of submerged Mesolithic occupation sites now offers a valuable means of fixing and dating the retreat of the shoreline in the Western Solent.



Figure 8.20 Prehistoric flint tools dredged up by fishermen from the Western Solent

The Western Solent coastal area in later prehistory

There is no doubt that the coastal landscape of the Western Solent continued to submerge during the 3rd millennium BC. Explicit evidence comes from the mouth of Newtown harbour where a Neolithic wooden track-way was built across the coastal marshland at a time that has been fixed at 4160±70BP/ 2920-2500 *cal* BC (GU-5341) by radiocarbon dating. In the mouth of Western Yar, another Neolithic track-way, laid in a similar environment, has been dated at 4220±60 BP 2920-2620 *cal* BC.

Depths ranging from -2.9 to -1.6m OD place these structures well below current sea-level. The outstanding question now concerns to maximum depth at which these track-ways rest. At Yarmouth and Newtown it is strongly suspected that these structures to greater depths on the sea-floor. If established by further investigation and auguring, their maximum depth could provide a precise fix on the contemporary change in sea-level.

At Fawley, peat that had accumulated just above the tidal limit has been recorded at a level of -2.5mOD. This deposit has been dated approximately at 3600 BP. Other coastal Neolithic sites of potential value include the find-spots of flint artefacts at Newtown, Hamstead and Saltmead. At Colwell Bay, Bronze Age tools have been recovered from the inter-tidal zone but it is uncertain whether these were associated with a submerged landscape. The incidence of random discoveries such as these underlines the need for fresh investigative survey on both shores.

Toward the close of the 1st millennium BC, Iron Age activity developed within and around the hill-fort at Buckland Rings near Lymington. This site overlooks the Lymington River at a point where an entrenched enclosure has been constructed on the river bank at Ampress. At present little is known of the date and function of the Ampress enclosure although we must surely suspect a maritime association with Iron Age navigation of the river. Sediment archives occupying the margin between Iron Age occupation on the river bank and the accretion of river silts could offer particularly valuable information on past nature of this coastland and its contemporary sea-level. At Exbury, on the east bank of the Beaulieu River, another defended enclosure offers similar potential.

The Western Solent coastal area in the Roman period
At present, the nature of the Roman coastline of the Western Solent is very poorly understood. Inter-tidal survey to pursue salt-working sites of this period would be particularly helpful in establishing the sea-level of this period.

At Yarmouth Roads an anchorage of this period has been identified in a water depth of 9-16m (Tomalin 2006). A scatter of Roman pottery at this location suggests that very little change has taken place in the nature of this particular area of seabed during the past two millennia. Historic anchorages have also been identified at Lymington River and Hurst Roads. Here the opportunity has yet to be seized to use the condition of scattered anchorage goods as a means of assessing the nature of long–term erosion or deposition over these areas of the Solent floor.

The Western Solent coastal region in the medieval period
Since the Middle Ages the Isle of Wight has been important from both a commercial and military standpoint. There has always been a strategic need to protect this offshore domain from the unwelcome interests of potential invaders. As a result, the coastline of the Solent has seen the construction of a succession of military defensive structures.

The medieval town and port of Newtown (Francheville) was critically damaged by French attack in the 14th century. It is thought that the town had developed an anchorage and waterfront within the confines of Newtown Harbour but after the French raid of 1377 it never recovered its prosperity. The sacked town diminished to a shrunken medieval settlement and it eventually ended its days a 'rotten borough', it status dismissed during the Parliamentary reforms of the 19th century.

The inter-tidal and sub-tidal archaeology at Newtown is of interest because it offers a very rare opportunity to examine an unbroken record of sediment accretion in a Solent creek. This is a location that has escaped all effects of navigational dredging. It has also escaped development interests since the 14th century. If the record of riverine sediment-input into the Western Solent is to be assessed then Newtown Harbour is the primary site for research. This location has the potential to offer a sediment archive covering several millennia.

Like Newtown, both Yarmouth and Lymington are medieval port towns. Both owe their development to the maritime aspirations of Anglo-Norman entrepreneurs. At both towns the nature of the medieval waterfront is not clearly understood although it is likely that the remains of the quays and jetties of this period now lie within areas that can be subject to reclamation, development or the construction of sea-defences. Lymington also maintained a thriving medieval ship-building industry and this could bring a further array of helpful archaeological evidence to the low-water boundary of the contemporary shoreline.

Waterfront archaeology offers the potential of securing absolute dates for contemporary shorelines. It can also reveal a wealth of information on the past coastal environment. Timbers of waterfront structures may offer tree-ring evidence of contemporary climate. Navigational dredging is common at both Lymington and Yarmouth. Although destructive, these activities can offer opportunities to recover new evidence concerning the past environmental conditions that have accompanied the shoreline development of these historic towns.

The Western Solent in the post-medieval period

During the post-medieval period the coast of the Western Solent maintained its strategic importance. This is demonstrated by substantial fortifications at Hurst Castle, Yarmouth Castle, Fort Victoria and Fort Albert. The Tudor forts at Hurst and Calshot are sited on spits that are particularly vulnerable to changes brought on by coastal processes and sea-level rise. By their very nature, these massive spits are subject to shifts in their configuration. These changes pose threat to the cultural monuments on the spits and to a trail of leeward coastal habitats that depend on the spit's protection.

A significant feature of the 'built heritage' is salterns. These reflect the continued importance of the salt industry. Where rising seawater was allowed to enter these embanked enclosures, these features may offer a further opportunity to examine the limits of earlier tidal regimes. In Hampshire the salt industry was particularly intense in the vicinity of Lymington and Pennington where many abandoned salterns still survive. Other historic structures of the coastland are chapels, houses and tidal mills. The latter may offer some evidence of past tidal levels.

A further potential source of environmental information may lie within each seabed 'footprint' provided by a contemporary shipwreck. The discovery of a 16th century Iberian merchant ship on the floor of Yarmouth Roads has revealed a preservative environment associated with the benign accretion of a protective blanket of sediment since its loss in 1567. This wreck was randomly discovered as a result of a specific archaeological survey. Its presence is now a reminder that a very substantial archaeological and palaeoenvironmental potential is still concealed within the vast area of the Solent floor that has escaped any kind of scientific examination.

The coastland of the Western Solent in recent times

Some of the most visible archaeological sites and remains from this period are defensive military structures such as pillboxes, gun emplacements and decoy sites. Current changes in the coastline have been observed at Hurst Spit where storm events have exposed and revealed ancient wooden structures associated with an earlier configuration of the spit. At Yarmouth Castle the Tudor curtain wall has recently shown cracks on it seaward face and these appear to betray changes and new vulnerabilities on this defended coastline.

8.7.3 Summary of geology and geomorphology within the study area

The physical nature of the study area

The Western Solent tidal channel is the product of marine inundation and break-through in a western arm of the Solent River valley. The floor of this valley is composed of soft Tertiary and Pleistocene materials that are still being down-cut and removed by the tidal regime.

The shoreline of the Western Solent is soft, low-lying and inherently sensitive to inundation and erosion. The coastline remains vulnerable even when the driving forces are relatively weak. The behavioural history of this coast has changed since the inundation event of the mid to late Holocene. Prior to the tidal break-through, the marine environment was effectively depositional. Following the breakthrough, marked down-cutting began at Hurst Narrows and the present hydraulic regime was established. This now controls the nature of the coast between East Solent and Christchurch Bay and it is still exerting erosive forces that are deepening and widening the seaway.

It seems that it was between 8600 and 6800 BP that the land isthmus connecting north-west Wight with the Hampshire mainland was breached. The sea-level at this time would have reached -16 to -18m OD. With the introduction of through-currents, wave action

could deepen the tidal channel at Hurst Narrows. This enabled large quantities of gravel to be introduced into the West Solent.

Specific evidence offered by underwater archaeological investigations at Bouldnor
Studies of a sedimentary archive in the Western Solent were conducted during an investigation into climate-driven coastal change on the SCOPAC coast. This was part of a project funded by the European Community *L'Instrument Financière de L'Environnement* (LIFE). The project, entitled *Coastal Change, Climate and Instability*, was led by the Isle of Wight Centre for the Coastal Environment. The results have provided new insights into regional sea-level rise and the geomorphological evolution of the Western Solent. The site selected for examination was an underwater cliff cut through some 8m of submerged Holocene sediments. This deposit lay some 800m offshore from the Isle of Wight coast at Bouldnor, figure 8.21 provides a representation of this sediment archive.

Lacustrine sediments underlying the base of the cliff supported a well preserved matting of peat within a forest of large toppled oak trees. This was found at 11-11.5m below Ordnance Datum and dated to 8565 – 8345 cal BP (Beta-140104). Above the forest deposit lay soft alluvial silts. These, contained inclusions of branches and twigs deposited in a brackish water environment. Diatom analysis of the silts confirmed a low salinity (Scaife, 2000).

The alluvial material was over 5m thick leading to another laterally consistent peat layer dated to 6870 - 6485 cal BP (Beta-140103). Over this lay another metre of brackish water alluvium capped by peat at 4m below Ordnance Datum. This upper peat was dated to 6475 – 6280 cal BP (Beta-140102).

The formation of peat resulted from a stabilisation or relative drop in of sea level during periods long enough to allow vegetation to colonise the coastal margin. Trees inlaid in the upper peat suggested the land had become well established before it was overwhelmed by the sea and again protected by silt.

The evidence at Bouldnor suggests that the transition of the Solent to a fully marine environment began some time after 6,000BP (Dix, 2000, Momber, 2002; Tomalin, 2000b Long & Tooley, 1995). The results indicate that the onset of fully marine conditions may not have occurred until sea level was about 3-4m below that which we see today. Prior to this, the Western Solent seems to have supported estuarine conditions.

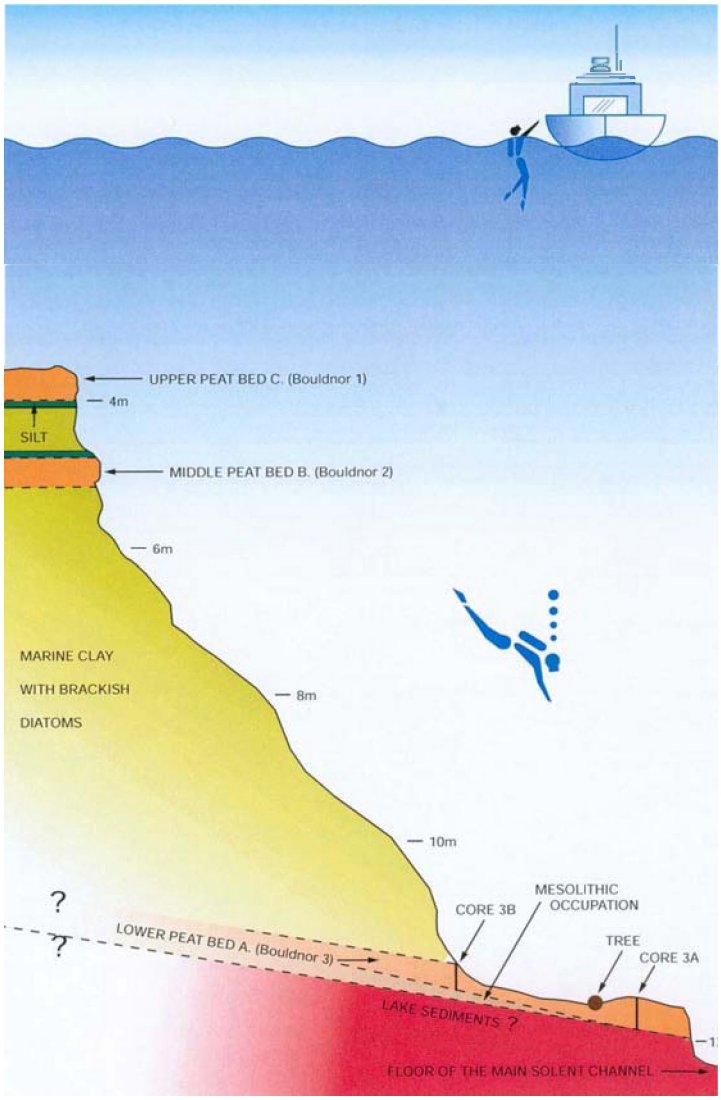


Figure 8.21 Block diagram of the submerged landscape at Bouldnor Cliff (LIFE Project)

When the sea eventually flowed over the final stretches of dry land that linked the Isle of Wight and the mainland, a 'proto Solent' would have been formed. As the water rose and the channel deepened, the new currents began to remove the alluvial infill that had been laid down over the previous 2-3,000. The vast majority of these sediments have now been lost but reservoirs of this valuable archive still remain along fringes of the seaway. As the covering silts are lost, the peat deposits that made up the Holocene valley floor continue to be exposed and eroded.

Following the breakthrough a marked down-cutting began until the present hydraulic regime was established. This now controls the nature of the coast between East Solent and Christchurch Bay and it is still exerting erosive forces that are deepening and widening the seaway.

It seems that a rapid widening and deepening of the old riverine system initially occurred in less than 2,000 years. Fortunately, however, a pre-severance environment is represented by the peat deposit and Mesolithic occupation at Bouldnor. A date of approximately 8000 yBP goes some way to confirm the onset of this critical event in the history of the Solent (Momber, 2000: 200).

Coastal geomorphology

Much of the bed of the Western Solent is mantled with Pleistocene river terrace deposits. Their nature is similar to those investigated on-shore at Hurst Spit, Pennington and Stone Point (Nicholls and Clark, 1986; Green and Keen, 1987; Allen and Gibbard, 1993). At Hurst Narrows, where tidal currents are rapid, a significant scouring action is taking place (Dyer, 1970; Webber, 1980). This involves the mobilisation of considerable volumes of sand and gravel as well as the removal of some fine materials gathered from the underlying Eocene bedrock.

The coarser sediments have been deposited in a series of banks within the Western Solent channel. In the central and northern parts of the main channel a general eastward movement of sand and gravel has been recognised (Dyer, 1971, 1980). These sediments extend eastwards from Hurst Spit and terminate at Solent Bank. It is here that much material has been removed by aggregate dredging (Hydraulics Research, 1977, 1981).

On the northern shore of the Western Solent, a substantial area of inter-tidal mudflat and salt-marsh has accrued along a front that is approximately 10km long. These habitats are seated on a substrate of Eocene rock that is commonly overlain by Pleistocene sediments. The most extensive areas lie between Keyhaven and the Lymington River. Less developed areas can be traced from Lymington ferry terminal to Pitts Deep.

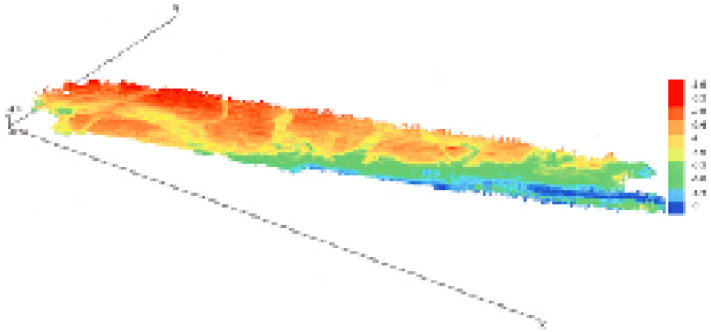


Figure 8.22 3D colour enhanced image of the underwater landscape east of the Lymington River. Two intercalated layers of peat which testify the existence of ancient land surfaces remain within the drowned landscape. One layer lies directly above pre-inundation, Pleistocene deposits in 6m of water and is coloured green. The second deposit sits on alluvial material laid down during the Holocene; these were deposited on top of the lower peat. They now lie in 4m of water and are coloured orange.

Most areas of mudflat and salt-marsh have eroded considerably during the 20th century. From Pitt's Deep east to the Beaulieu River, saltmarsh is absent. This has left a relatively narrow fringe of muddy lower foreshore. The diminution of this protective shoreline habit is an historic process that Tubbs (1999, 91, fig 7.2) has associated with a retreat of the drying-line since the early 19th century. The loss of this habitat has been accelerated by the invasion and spread of the hybrid cord grass, *Spartina anglica*.

Initially, the benign spread of *Spartina anglica* was responsible for a rapid growth in the size and elevation of the inter-tidal marshes. This was achieved by the action of the grass in trapping and stabilising a very substantial volume of fine silt and clay Tubbs (1980, 1999). With a genetic die-back of this hybrid species, there has followed a marked change to active erosion. These losses to the protective cordon of salt-marsh have been accompanied by a further reduction due to reclamation projects.

The discovery of peat deposits which were laid down in fresh water bogs over 6,000 years ago and now exposed below the salt-marsh, suggest long term stability that pre-dates the recent colonisation of *Spartina anglica.* The peat is exposed on the off-shore eroding edge of the salt marsh, 4m below OD. Once the organic matrix of the peat loses the protection of covering silts it is quickly degraded and lost. The presence of extensive mud flats before the development of salt-marsh is recorded on the charts of Murdoch McKenzie in 1781. At this time the mud flats were exposed until ¾ high tide and they extended to a marker at the mouth of the Lymington River. This was known as 'Jack-in-the-Basket'. This is now almost a kilometre from the current salt marsh.

The die back of *Spartina anglica* may well be playing a part in the reduction of the salt-marsh but this would appear to me more of a contributory factor when the process is viewed in the longer timescale.

Hurst Spit owes its origins to the behaviour of the bedload gravels on the Shingles bank. These gravels have been affected by sea-level rise. The shingle re-curves and ridges in the spit attest to past behavioural episodes. These features have been attributed earlier trends in wave action and wind direction. Recently, the spit has shown notable changes due to an increased rate of transgression. Tubbs (1999, 99, fig 7.6) has plotted a retreating trend in the configuration of Hurst Spit since 1868 but little is known of longer trends in the behaviour of the spit.

Coastal management issues

The study area embraces mudflats and saltmarsh. These are some of the principal inter-tidal habitats of the Solent. Other environments include coastal grazing-marsh at Pennington, saline lagoons and vegetated shingle. Several areas are covered by Ramsar and SSSI designations. Two National Nature Reserves have also been defined here. All of these designations emphasise the national and international importance of the natural assets of this area.

Due to 'coastal squeeze' almost complete loss of saltmarsh is predicted on the Hampshire shore of the Western Solent. Continued narrowing of the mudflats is predicted for the area between Keyhaven and Pitts Deep and at Inchmerry House at the mouth of the Beaulieu River (New Forest District Council, 1997).

Other natural and semi-natural habitats are associated with the gravel spits and the transitional margins of the higher (inner) saltmarsh and reed swamp areas. Some of these are essentially artificial, such as the saline lagoons within Pennington Marshes. These are the surviving relics of the Solent's historic salt-producing industry. Current rates of diminution are accelerating. This trend towards net loss almost certainly correlates with the commencement of erosion and the 'dieback' of *Spartina anglica*.

Within the Solent, dredging has been practised for the past century, but has only been since the early 1950s that large-scale extraction of aggregate has been undertaken. At Newtown Harbour marked and new erosion of the eastern spit has been observed. This has led to the exposure of prehistoric wooden structures that were formerly contained within a preservative environment. The switch between these two regimes is highly significant.

There has now arisen a danger that the loss of the East Spit at Newtown will severely impact upon the internal configuration of the harbour and its designated habitats. Studies have indicated that diminution of the East Spit has occurred since major commercial aggregate dredging has been licensed off-shore at Solent Bank. Such studies perceive a sediment path allowing material to pass from the bank to the spit. The archaeological

evidence at Newtown provides robust evidence that a long-established regime of coastal stability has been broken and a new process of active erosion is now in train.

Cause and effect relationships in this area are complex, and involve consideration of changes in sediment loading; wave climate and hydraulic regime, as well as sea-level rise (Ke and Collins, 1993). A further factor can be the impact of human remodelling of the foreshore. Uncertainty is compounded by incomplete understanding of the ecological energetics and succession of the area (Gray and Benham, 1990; Gray et al., 1991). Similarly, the genetics of the *Spartina* stock are yet to fully understood (Raybould et al., 2000).

Caution should always be exercised when proposing a solution to perceived problems of coastal migration when the origin of the any change is not fully understood.

8.7.4 Coastal units within the study area

The Western Solent Study Area encompasses the Western Solent and Southampton and Isle of Wight Shoreline Management Plans. Within in these are the Estuary management plans of Western Yar and Lymington.

8.7.5 Results of scoring

This cross-Solent area includes a wide range of archaeological and palaeoenvironmental site types. Of particular interest are the number of prehistoric finds, sites and peat deposits. The distribution of all sites and finds is shown in figure 8.23.

The higher scores are partly due to a high level of informative detail provided by the basic searches in relevant HERs. Scores have also been enhanced by a number of intensive archaeological and environmental studies that have been pursued in this area. Figure 8.24 shows the distribution of the twenty highest scoring sites.

MONUID	NAME	TYPE	PERIOD	Sea Level Change	Environmental Change	Climatic Change	Chronology	Fragility	Total Score
51253	Submerged peat deposits off Pitts Deep	PEAT DEPOSIT	Unknown	3	3	3	3	3	15
2175	Newtown East Spit	Trackway	Neolithic	3	3	3	3	3	15
30153	Mesolithic flint tool, Pitts Deep	FINDSPOT	Mesolithic	3	3	2	3	3	14
55127	Flint tools, off the coast	FINDSPOT	Unknown	3	3	2	3	2	13
140	Yar Bridge	Bridge	Post Medieval	3	4	2	3	1	13
187	Industrial site	Bouldnor	Medieval	3	3	2	2	3	13
5389	Newtown East Spit	Newtown East Spit	Unknown	3	2	2	2	3	12
189	Bouldnor	FINDSPOT	Mesolithic	3	3	1	2	3	12
186	Bouldnor, Mesolithic Tranchet Axes	FINDSPOT	Mesolithic	3	3	1	2	3	12
1338	Newtown Creek. Tusk of Straight Tusked Elephant.	FINDSPOT	Palaeolithic	3	2	1	3	2	11
1292	Bouldnor	FINDSPOT	Prehistoric	3	3	1	1	3	11
1343	Off Hamstead.	FINDSPOT	Mesolithic	3	2	1	2	3	11
2241	Yarmouth Spit	Natural Find spot	Prehistoric	3	2	1	3	2	11

MHM60	Hurst Spit wooden stakes	FINDSPOT	Prehistoric	2	2	2	2	3	11
42099	HARBOUR	Monument	Post Medieval	2	2	2	2	2	10
34554	Sowley Pond	Monument	Post Medieval	2	3	2	2	1	10
42082	HARBOUR	Monument	Post Medieval	2	2	2	2	2	10
42090	HARBOUR	Monument	Post Medieval	2	2	2	2	2	10
42091	HARBOUR	Monument	Post Medieval	2	2	2	2	2	10
22376	HURST CASTLE	ARTILLERY FORT	MONUMENT	2	3	3	1	1	10

Table 7 Scoring results from the top twenty sites within the Western Solent study area

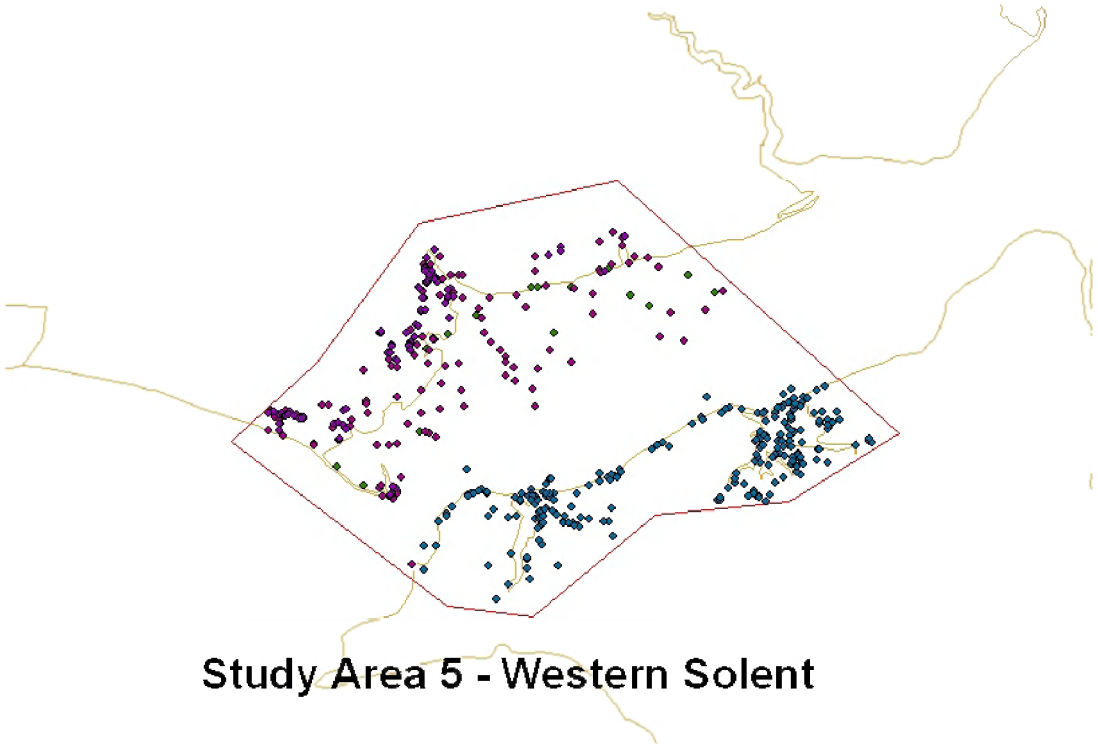


Figure 8.23 Map showing all sites within the Western Solent study area

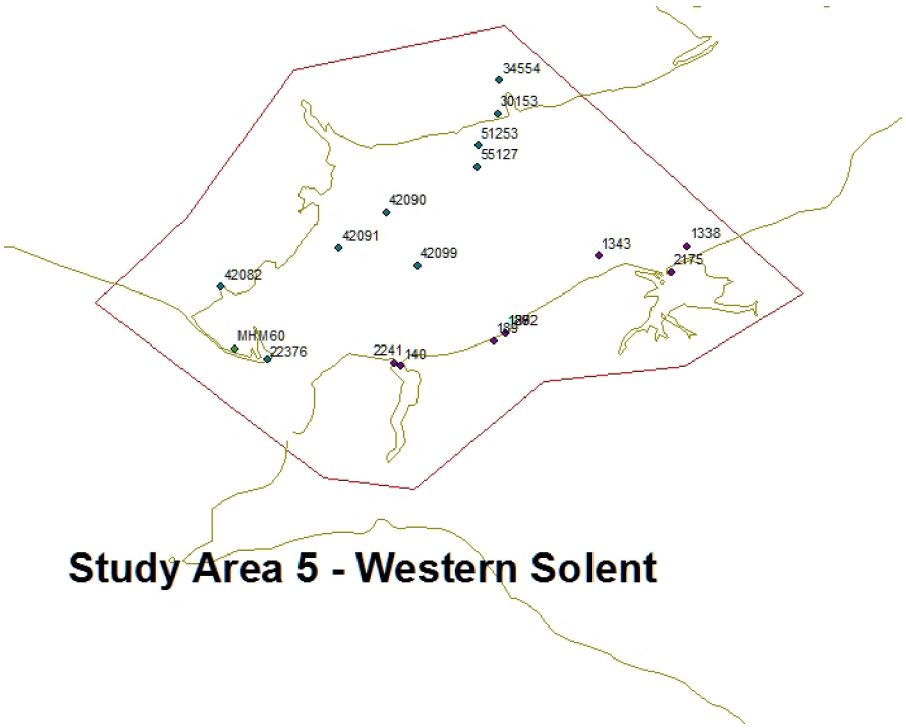
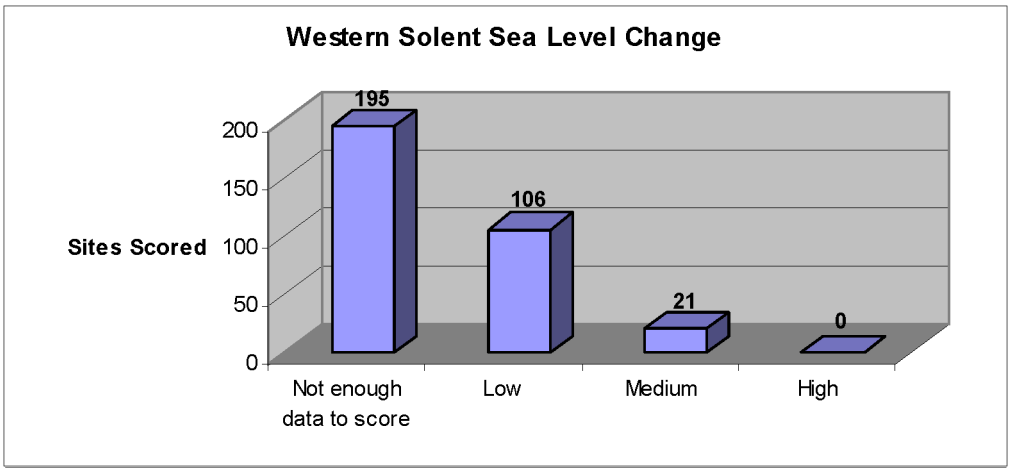


Figure 8.24 Map showing distribution of highest scoring sites within the Western Solent study area

Scores for sea level change

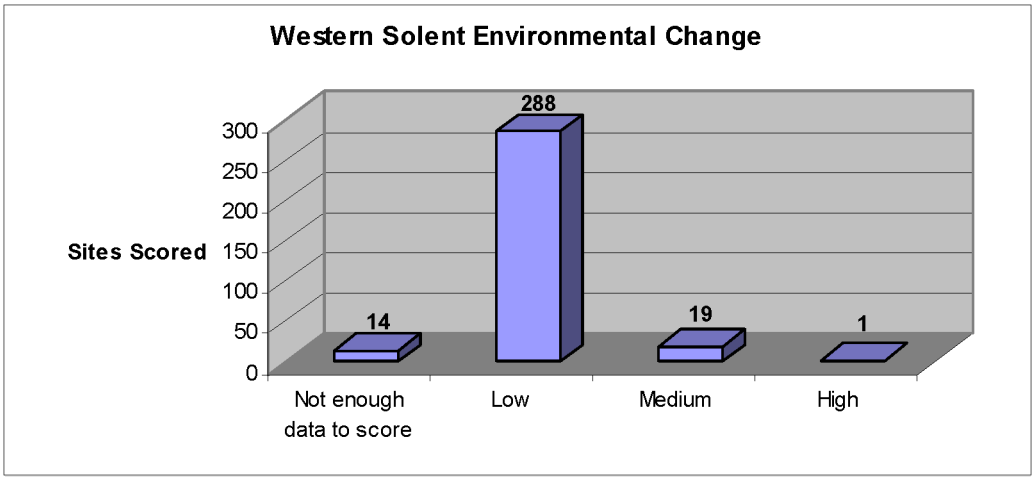


A relatively large number of sites have been recognised for their 'medium' potential for providing information on past sea-level. Of the 21 sites scored at 'medium' level, 13 lie within the table of top twenty scoring sites.

Prehistoric find-spots feature heavily in the higher scores. These include multiple finds from the Bouldnor area where stratified Mesolithic material has been found underwater at a height relevant to a contemporary sea-level. Stratified organic material can be used to date sea-level at particular periods. This is illustrated by the Neolithic wooden trackway at Newtown and dated peat deposits in a submerged landscape at Bouldnor.

Some features of later date also score highly. These include a post-medieval bridge and a medieval industrial site. The interpretation of these sites in relation to sea-level can provide information on the use and the development of the marine zone and on human responses to changes in sea-level or specific natural events.

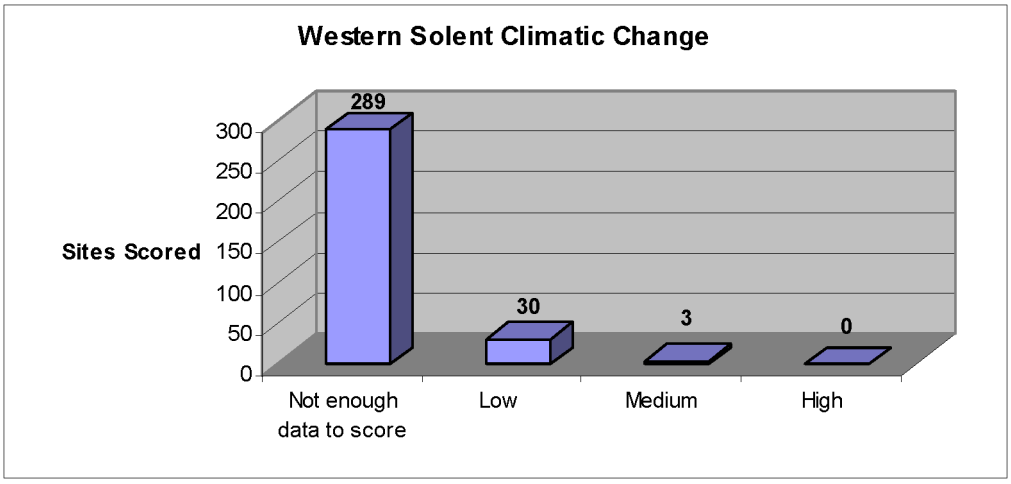
Scores for environmental change



Most sites have scored under this criterion. A significant number of these fall within the 'low potential' class. The analysis reveals a particular problem in locating and interrogating sites that can provide good levels of information. The low number of un-scored sites confirms that this is not a problem of weak information in the database but a true scarcity of high quality sites identified in the field. The one high score, awarded at Yar Bridge reflects the particularly long and helpful timescale offered by the sediment archive located at that spot. This issue is a significant one because many bridges in the SCOPAC region may be subject to ground-penetrating repairs or replacement works but unless the extant structure is of historic interest the palaeoenvironmental potential of such a site may escape entry in the HER.

Many of the sites with medium' potential to inform on environmental change are the same as those identified with a similar potential for the sea-level criterion. Important additions to this list of site types are Hurst Castle and Sowley Pond. These 16th century Hampshire sites are post-medieval in date and could contain datable palaeoenvironmental evidence.

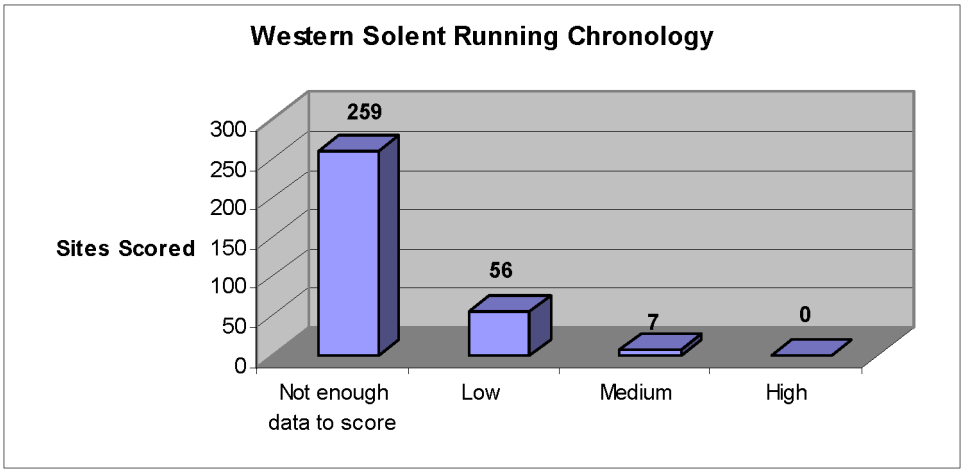
Scores for climatic change



For this criterion many of the sites showed 'not enough data to score'. Three sites were identified as being of 'medium' potential. These included submerged peat deposits on the Hampshire coast, the Neolithic trackway at Newtown and Hurst Castle. The predominance of prehistoric sites in these scores is significant. Identifying sites that can

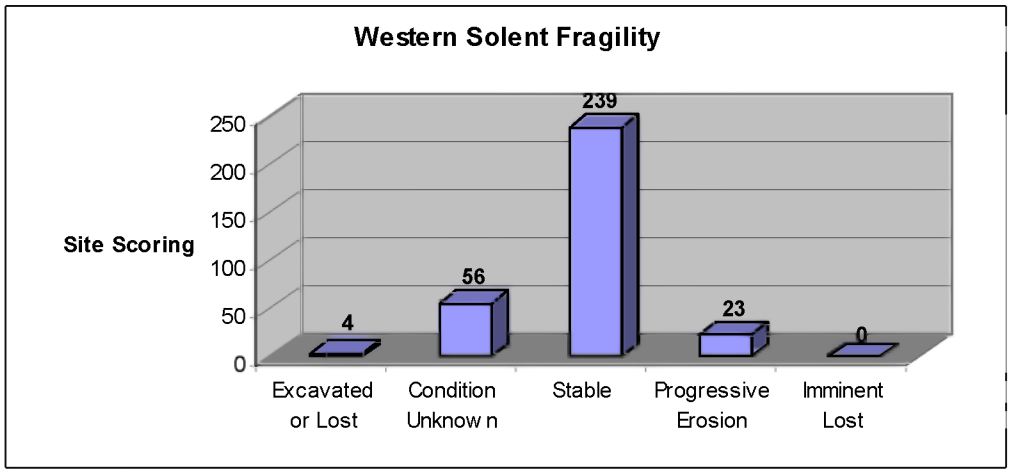
display long-term relationships with the coast is fundamental to the gathering of data that can inform our understanding of coastal-change.

Scores for running chronology



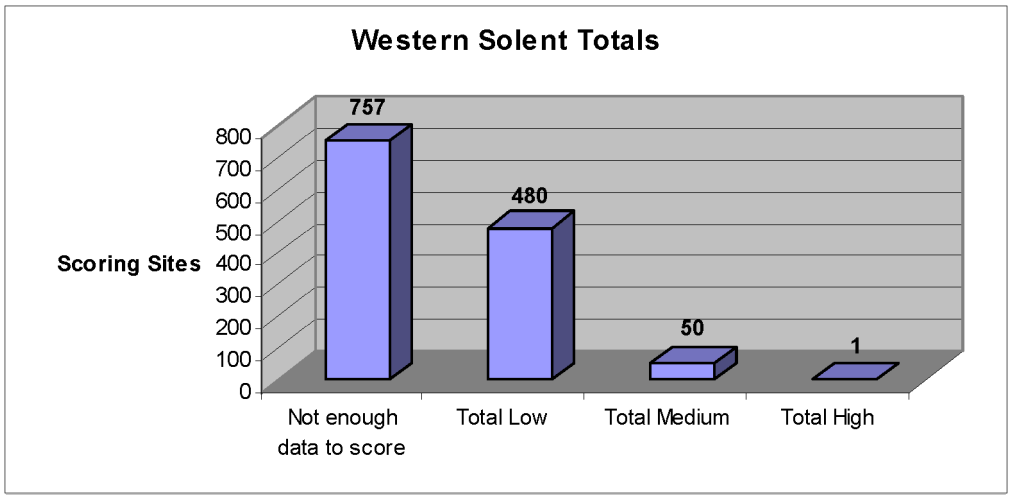
Seven sites have been scored for their 'medium' potential. At Yar Bridge the date of the structure is post-medieval yet the score has been awarded with respect to a sediment archive of earlier date lying beneath the bridge. The remaining sites are of prehistoric date.

Scores for fragility



In this study area it was possible to assign scores to a large number of the sites noted for their fragility. Most of these were in a stable condition but 23 were at threat from progressive erosion. Many of these threatened sites may offer archaeological and palaeoenvironmental information. If the recovery of coastal information is to be maximised, study of these sites should be pursued prior to their impending loss.

Combined total scores



Although there are still a relatively high number of criteria for which there is 'not enough data to score' this area has shown consistency amongst those sites that have been suitable for scoring.

8.7.6 Discussion of scoring results

The analysis shows that sites with overall high scores can be used to help pick out those that might improve their potential to provide data in a number of scoring categories. The high scores awarded to submerged landscapes and palaeoenvironmental deposits reflect their particular value in helping to inform on past sea-levels and coastal-change.

8.7.7 Implications for shoreline management in this area

This study area demonstrates that a complex number of factors can affect the shoreline. Accordingly, caution should always be exercised when proposing management strategies before a full understanding of coastal evolution is realised. The presence of submerged and inter-tidal prehistoric sites, landscapes and palaeoenvironmental material in this study area can provide data that will inform of past change. This should be highlighted in the next round of shoreline management plans.

8.8 Sandown Bay

8.8.1 Introduction to the Sandown Bay study area

The Sandown study area incorporates a sandy beach-head that is partially backed by drained marshland. The bay is partly a defended coast protecting an urban community and areas of agricultural land and natural wetland (Figure 8.25).



Figure 8.25 The vista across Sandown Bay as viewed from the south demonstrates the vulnerability of the low lying urban development to changes in the land-sea relationship. Coastal instability is not uncommon around the bay. The cliff from which this image was taken is under constant attack from the sea and has been subject to landfalls (R & G Long)

The coastal topography of the study area includes beaches and shore platforms of variable length, height and width. There are also active cliffs and some relict degraded coastal slopes of chalk and sandstone. These are partially stable. The area also includes an estuarine inlet at Bembridge Harbour. This is a former tributary to the Solent River. Its mouth is now partially in-filled with Holocene sediments (Figure 8.27).

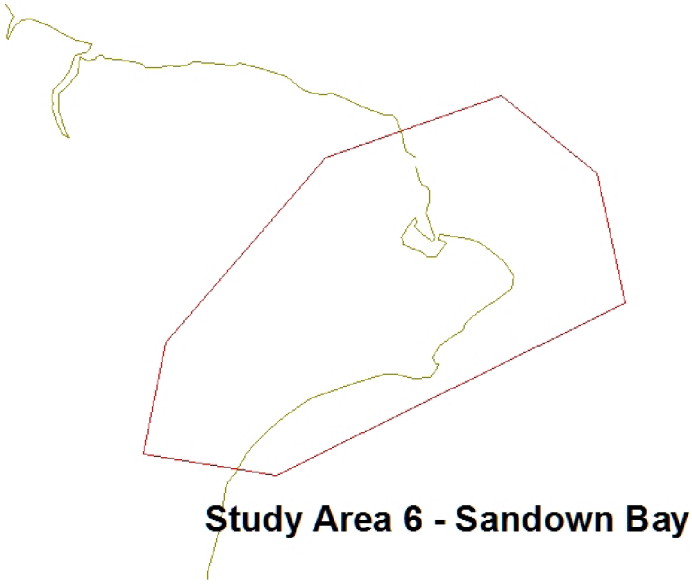


Figure 8.26 Map showing the Sandown Bay Study Area

8.8.2 Summary of the archaeology and history of the Sandown Bay study area

The Sandown coastal area in earlier prehistory

Evidence of the early geography of this coastal area is offered by Pleistocene raised beach deposits at Bembridge. These have been investigated by Preece *et al* (1990 and Bridgland (1999). At least two separate deposits have been recognised.

The earliest deposit at Bembridge is the Steyne Wood Clay. This has been attributed to the Hoxnian interglacial (Preece & Scourse, 1987). The altitude of this deposit begs comparison with further gravel deposits and an important assemblage of Palaeolithic implements recovered from the slumped cliffs at Priory Bay. The latter site has been recently investigated by Francis Wenban-Smith. Both deposits are associated with the early topography of the Solent River (Loader, 2001).

The biostratigraphy of the Bembridge raised beach deposits has included the remains of spruce and Artic buttercup. Exposed Pleistocene deposits in the Howgates-Foreland area of Bembridge have yielded further stratigraphic evidence and some disturbed Acheulian implements. These deposits skirt the defended shoreline where they require monitoring and investigation during the life of the shoreline management plan.

It seems that during the earlier Holocene a substantial tract of land was still accessible in the area now occupied by Sandown Bay. At that time it was naturally drained by a southern arm of the Eastern Yar. The marked rise of sea-level in mid-Holocene times accounts for the loss of this land and the advance of the shoreline towards the area now occupied by the town.

It appears that the drowning of the ‘bayland’ was followed by another important coastal development in the Sandown area. This was the entry of the sea into the lower valley of the Eastern Yar. The result eventually created a drowned estuarine basin formerly known as the Brading Haven.

The advance of the sea into the Sandown region also created back-ponding of the river flow and this seems to have triggered the development of marshlands and peat-forming conditions on the margins of the floodplain. This environment attracted Middle Stone Age

communities to locations like Lea Farm and Black Plan. These sites now lie in the vicinity the urban area of Lake.

Sediment archives of peat and river/estuarine silts on the floor and margins of the Yar Valley offer the best means of establishing the long-term behavioural history of sea and water-table rise in the area now encompassed by the limits of the town. These deposits can be traced from the margins of the town, through the Yar Gap and on to the floor of the, now drained, haven. On the floor of Sandown Bay, the course of a palaeochannel of the ancient the Yar has been detected during the construction of the Seaclean effluent pipe-line. The sediment archive contained within this channel offers a further opportunity to secure a clear overview of the changing coastal environments of this area.

The Sandown coastal area in later prehistory
It appears that it was during the Middle Bronze Age that a maritime community first began to develop its activities in the vicinity of Brading Haven. In the 19th century a hoard of imported bronze items of this period was found at a location that had since been 'drowned' by the natural configuration of the haven. It seems that Bronze Age and Iron Age communities were attracted to this area were obliged to respect the inundated margins of the valley. A clearer understanding of this relationship will undoubtedly improve the basis upon which planning and coastal defence is contemplated for the community that occupies the present borderline between land and sea.

The Sandown coastal area in the Roman period
A substantial Roman villa at Morton, near Brading, offers clear evidence of maritime interests in the 1st, 2nd and 3rd centuries AD. These interests are surely based upon contemporary navigational use of Brading Haven. On the opposite side of the haven, near Yaverland Manor Farm, further evidence of Roman maritime activity has been detected. The location of both of these sites points to specific Roman waterfront activity somewhere on the adjacent margins of the old haven. The margins of the chalk gap offer the most likely location. A single exploratory core at Yarbridge has confirmed the presence of a deep and continuous sediment archive but evidence has yet to found of identifiable Roman levels at this spot.

The possibility of Roman salt-working on the margin of the haven has yet to be explored. Such sites can be particularly instructive on contemporary sea-level. There is much to be gained from collaboration of archaeological and coastal study interests in this particular area.

The Sandown coastal area in the medieval period
A lost medieval settlement at *Tidelingham* (Kokeritz, 1940, 24) appears to denote a formerly deep penetration of tidal waters up the Eastern Yar. This location is presumed to lie in the vicinity of Arreton. It has often been presumed that the development of Brading as a market in the 13th century has signified particular maritime and port activities near the head of Brading Haven. A closer look at the archaeology and history of the town and its solitary quay provides no evidence to support this case.

In the Sandown area, the history of medieval land-use on the margins of the Eastern Yar deserves attention. Some of these low-lying areas have been subject to development yet the past nature of these drained wetlands is not clearly understood. The buffer between saline and freshwater conditions below water-table may deserve attention in this area.

The Sandown coastal area in the post-medieval period
Historic accounts attest notable and disturbing advances by the sea in the area now bounded and defended by Sandown sea-front. The first evidence appears in Tudor times

when a fort at was built at '*Sandham*' by order of King Henry VIII. An illustration of 1545 shows this to be a substantial stone structure standing in a shoreline position where it is abutted by the sea.

By the 17th century, coastal erosion had attacked the original fort and its replacement had been equally unsuccessful. With a growing awareness of the power of the sea another fort was designed with an appropriate set-back between its outer rampart and the shore-line.

During the early 19th century this fort was still in use. An engraving of 1800 shows a broad foreshore then opportunely in use as a parade ground. By then, the seaward ditch and rampart of the fort had been lost to the sea. At this time, a substantial gun-tower was also in use on the margin of the beach on the east side of the bay. This has since been lost to coastal erosion.

In the valley of the Eastern Yar, changes in land-use were prompted by land reclamations beginning in the Brading district in 1562. This eventually led to a serious attempt to reclaim Brading Haven in 1620. Initial success was followed by disaster in 1630 when a spring tide destroyed all that had been accomplished. Success was finally achieved in 1882 when the haven was drained as part of a railway scheme.

In the neighbourhood of Morton Common and Sandham Grounds, little is known of land-use history prior to the draining of the Brading Haven. The later field-names here are very revealing and betray the former presence of marshes and wetland pasture.

The Sandown coastal area in recent times

In Victorian times Sandham fort was replaced by a new 'granite fort' and the shoreline was defended by a seawall promenade. The old fort was then demolished. The history of fort construction and fort loss at Sandown demonstrates the ongoing advance of the sea over several centuries. Although the head of Sandown Bay is currently defended by the seawall promenade, the course of this structure is carried over soft Holocene sediments that fill an arm of the old Yar River. This is an area of floodplain that is naturally susceptible to flooding and erosion. The development envelope for Sandown has generally skirted the old drained wetlands of the Yar valley but some notable brinkmanship also occurs.

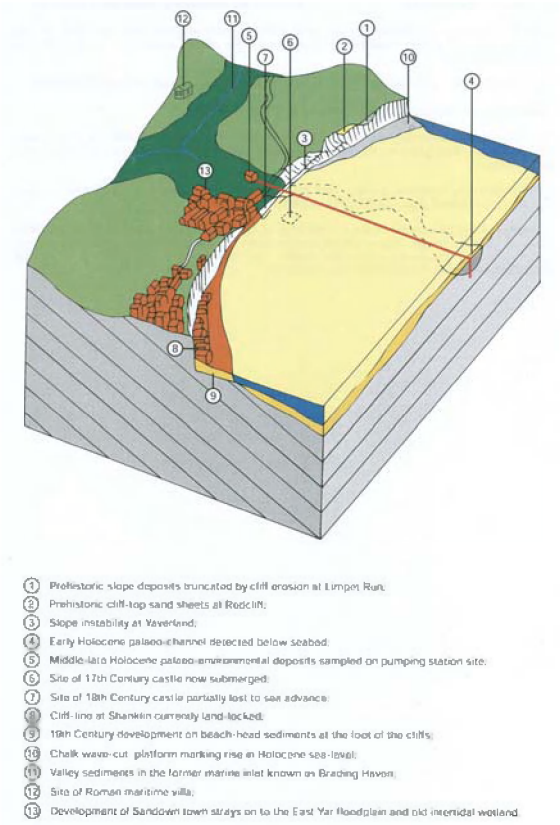


Figure 8.27 Block diagram of Sandown Bay (LIFE Project)

8.8.3 Summary of geology and geomorphology within the study area

The physical nature of the study area

The Cretaceous rocks at the eastern end of the Isle of Wight are responsible for marked contrasts in the nature of the coastline within this study area. The course of the chalk upland has produced a prominent headland at Culver Cliff. The secondary scarp of the Lower Greensand has produced another high cliff-line; Redlcliff.

South of the Chalk and Greensand scarps, the soft lithologies of the Atherfield Clay and Wealden Series have produced a low terrain that has been further levelled by the action of the river Yar in its tributaries. The southern coastline is distinguished by examples of long-established slope instability (Preece, 1980; 1987; Chandler and Hutchinson). Landslides occurring along this sector of the island's coast owe their character and scale to rock lithology and succession, hydrogeological controls (both above and below mean sea-level), structural form, and wave-climate (Halcrow, 1997; Hutchinson, 1991; Rendel Geotechnics, 1995). Variations in coastal orientation, wave exposure, relief and geological outcrops have also controlled the ways in which the coastline has behaved.

The major behavioural unit within the study area is Sandown Bay. Here there has been differential erosion of the soft clay, shales and sandstones of the Wealden and Lower Cretaceous formations. The result has been an embayment anchored to the north-east and south-west by headlands of hard resistant Chalk.

The presence of an extensive shore platform on this coast shows that long period of cliff-recession has taken place. The platform can extend well seawards of low water and it seems to imply that several kilometres of recession may have occurred. This coastal recession has truncated an arm of the Eastern Yar valley at Yaverland. Here, sediments migrating into this valley have formed a barrier beach that appears to have prevented fluvio-marine linkage with Sandown Bay.

The north-east Isle of Wight is less elevated than in any other part of the island where coastal cliffs and slopes are modest in height, nowhere exceeding 35m. Due to this factor the scale and frequency of slope-failure and the dynamics of mass movement have been suppressed. Mature woodland on much of the north-facing coastal slope also contributes to stability.

The erosion of the low cliffs on the Bembridge frontage provides an important source of beach shingle because the cliffs are capped by Pleistocene raised beach and fluvial deposits (Posford Duvivier, 1990b). Bembridge Limestone outcrops on the foreshore here where it has formed a series of ledges. This provides protection to the shallow cliffs against wave-attack at low water. Most of this coastline is occupied by either active cliffs subject to basal marine erosion and mass movement processes or by steep or moderately steep coastal slopes. The latter are currently removed from the influence of breaking waves.

Coastal geomorphology

The study area incorporates two major areas with differing sediment regimes. Sandown Bay is occupied by sandy beaches anchored between headlands. Evidence suggests that the sediments of the bay have been naturally transported to Ryde Sands. What is still uncertain is whether this link operates via a near-shore transport pathway, or whether it was accomplished by shoreline drift in earlier times prior to the emergence of Culver Cliff. The cliff is now viewed as a headland boundary to sediment-transport.

Sandown Bay was one of two of the locations selected for wave-modelling studies in the DEFRA Futurecoast Project (Halcrow, 2002). By virtue of its more sheltered position, the bay was not considered to be sensitive to future changes in sea-level and increased storminess.

At Bembridge, the old estuary of the Eastern Yar has been much reduced by successive stages of reclamation. These date back to the seventeenth century (Howard, Moore and Dixon, 1988). The last major phase of reclamation was concluded with the construction of the railway embankment in 1879. This finally limited the ingress of tidal waters.

At Bembridge dredging has been necessary to maintain a navigable approach channel subsequent to the major reclamation of the harbour completed in 1880-2.

Coastal management issues

The south-western coast of the Isle of Wight is of special geological and geomorphological value. A long segment of this coast has been designated a SSSI. Designation gives recognition to an area that is naturally eroding yet there can be potential conflicts between habitat, earth-science conservation and shoreline management objectives. While the development envelope for Sandown avoids some major areas of potentially floodable lowland it should not be overlooked that the principal sewage pumping station for the Isle of Wight is sited in a particularly low-lying area where field-names and historic records indicate a particular vulnerability to flooding.

Dredging of the approach and berthing channels to Bembridge Harbour is likely to impact on inter-tidal communities. Future sea-level rise is likely to cause "topographic squeeze" of saltmarsh habitats that lie against the steep valley sides. The behaviour of the Yar in severe storm events seems uncertain because no sediment archives of its past history have been fully examined. It is nevertheless evident that the Yar floodplain below Newchurch can readily flood in wet winters and that this can pose notable threat to

buildings and property. The defence and protection measures in the study area are limited to site-specific responses to local threats to property and infrastructure.

8.8.4 Coastal units within the study area

The Sandown study area falls within the Isle of Wight Shoreline Management Plan and encompasses two of the six process units namely, the North-East and South-East Coast. Within the study area there are several coastal defence options. Areas within the study area where a HOLD THE LINE policy has been implemented are at Sandown and Shanklin, while a MANAGED RETREAT prescription is in force for the coast west of Bembridge lifeboat station. For the remaining coastline within the study area a DO NOTHING approach has been adopted.



Figure 8.28 Map showing Sandown Study Area coastal management cells

8.8.5 Results of scoring

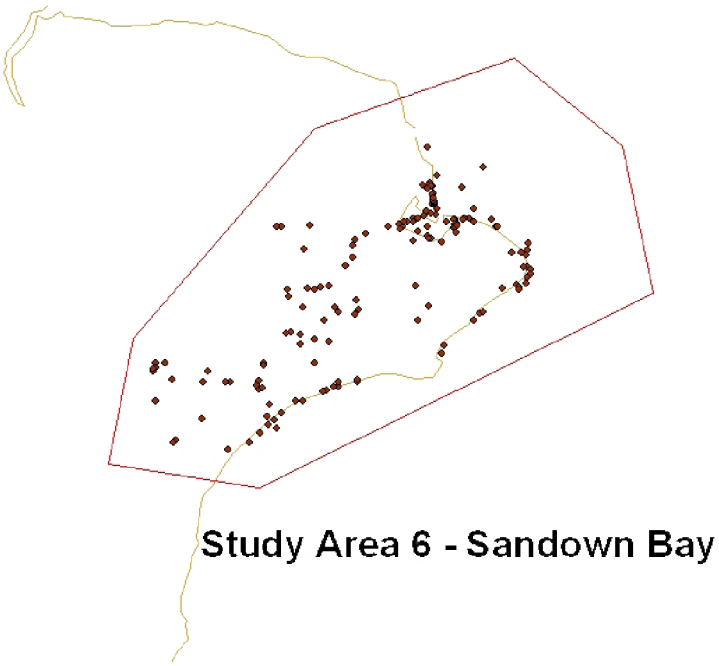


Figure 8.29 Map showing distribution of sites within the Sandown Bay study area

The data available for this area included a good level of detail, the distribution of all sites within the study area is shown in figure 8.29. Although there are relatively few sites in this area that attained 'total' high scores, there are a good range of different site types and periods. Interestingly of the twenty highest scoring sites (shown in figure 8.30) seven of these are of 'unknown' date.

Twenty highest scoring sites

SMR_NO	SITE_NAME	SITE_TYPE	PERIOD	Sea Level change	Climatic change	Environmental change	Running chronology	Fragility	Total Score
3488	Bembridge Foreland	Natural feature	Palaeolithic	2	2	2	2	3	11
3489	Bembridge Lane End	Natural feature	Prehistoric	2	2	2	2	3	11
1106	Side of Brading-Sandown road south of Morton. Site of causeway.	Causeway	Medieval	2	2	2	2	2	10
2596	Brading Haven / Bembridge Harbour	Bank (earthwork)	Post medieval	2	1	3	2	2	10
4939	Borthwood Bog	Natural feature	Prehistoric	1	2	3	2	2	10
1140	Bembridge Foreland. Ovate Acheulian Implement.	Find spot	Palaeolithic	2	2	2	2	2	10
1142	Bembridge. Thick pointed Acheulian implement and 2 ovates.	Find spot	Palaeolithic	2	2	2	2	2	10
2594	Brading Haven	Bank (earthwork)	Unknown	2	1	3	2	2	10
2593	Brading Haven	Bank (earthwork)	Unknown	2	1	3	2	2	10
2592	Brading Haven	Bank (earthwork)	Post medieval	2	1	3	2	2	10

3529	St Helens Millpond	Post built structure	Unknown	1	1	2	2	4	10
3530	Bembridge Harbour	Post built structure	Unknown	2	1	2	1	4	10
3552	Bembridge Harbour	Hulk	Unknown	1	1	2	1	4	9
3246	Bembridge Harbour pier	Pier	Post medieval	1	1	2	1	4	9
850	Sandown Castle (16th century Coastal Fort)	Fort	Post medieval	1	1	3	1	3	9
3551	Bembridge Harbour	Hulk	Unknown	1	1	2	1	4	9
3320	Priory Bay	Sea defences	Post medieval	1	1	2	2	3	9
3554	St Helens Duver	Bank (earthwork)	Unknown	1	1	3	1	3	9
1162	St.Helens Fort. (19th century.)	Fort	Post medieval	2	1	2	2	2	9
4005	Brading	Quay	Medieval	1	2	2	2	2	9

Table 8 Scoring results from the top twenty sites within the Sandown Bay study area

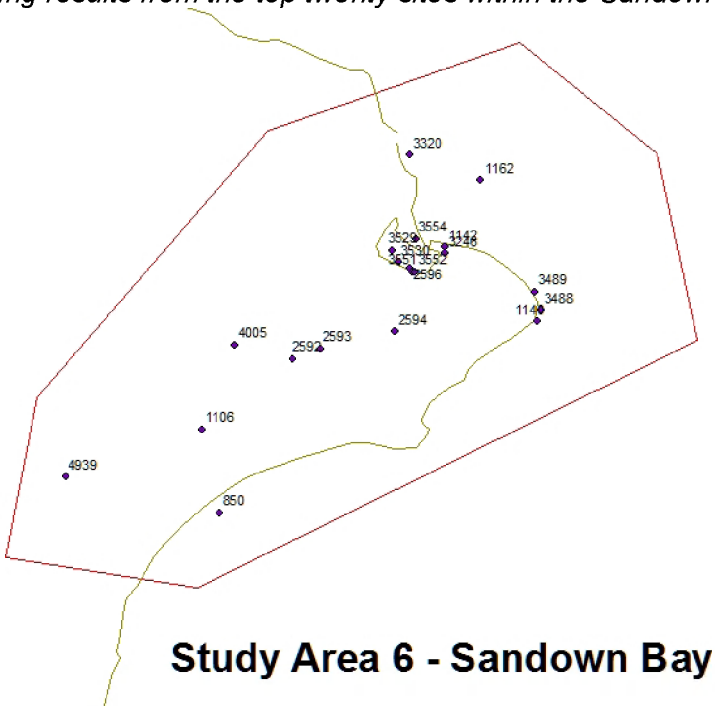
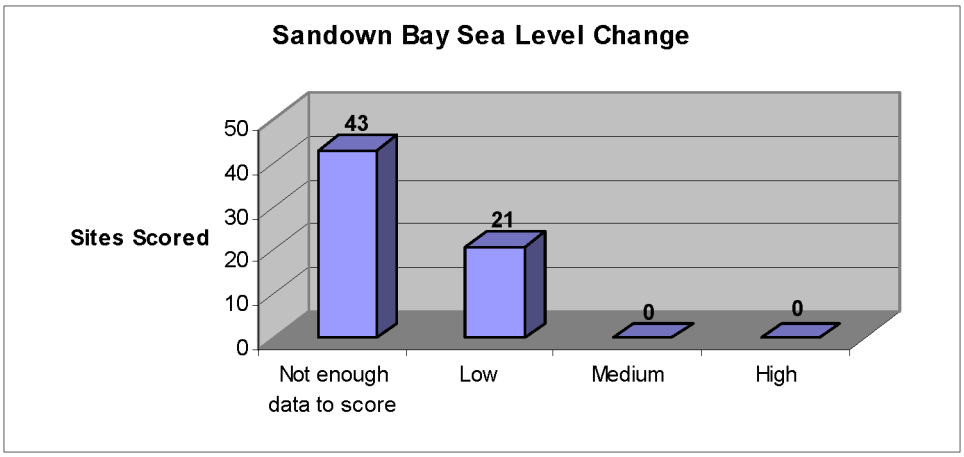


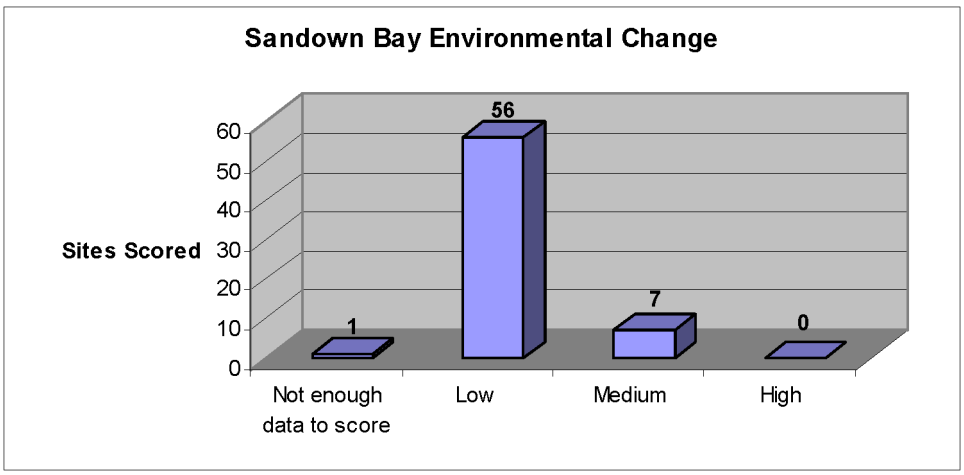
Figure 8.30 Map showing distribution of highest scoring sites within the Sandown Bay study area

Scores for sea-level change



All sites within this area fall into either the 'low' potential score or the 'not enough data to score'. This may be due to the unknown date of many of the sites, if their date is unknown then it is difficult to predict their potential to inform on issues of sea level change as we do not know when they were established.

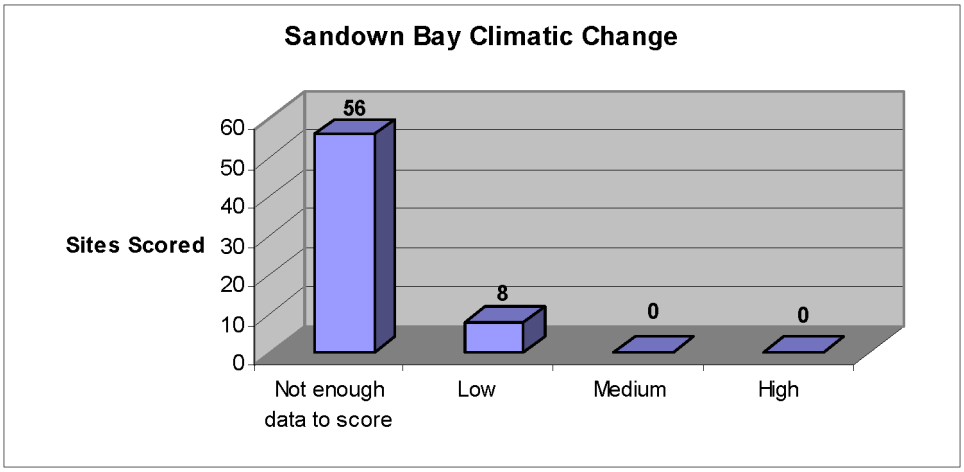
Scores for environmental change



It was possible to score all but one of the sites for this criteria. Although many of these fall within the 'low' potential for evidence of environmental change, there are seven which are of 'medium' potential.

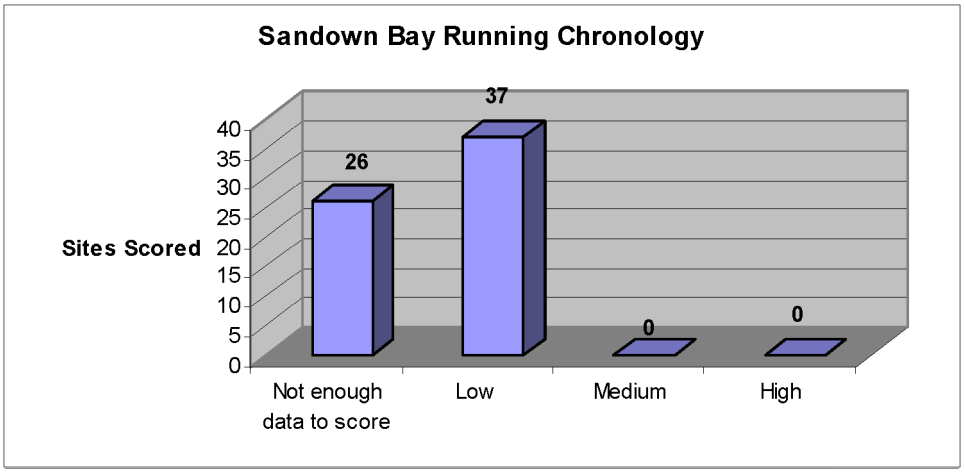
There are many sites of sea defences and banks that have been ascribed a medium score. These sites have an on-going relationship with the sea in terms of levels and conditions, when dated they can reveal important evidence in relation to coastal change.

Scores for climatic change



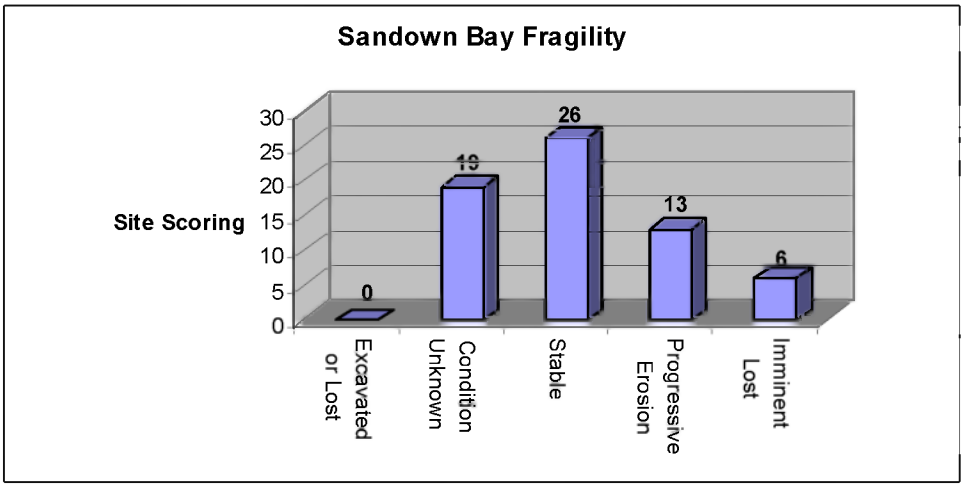
All sites are either of 'low' potential, or there is not enough data to be able to ascribe them a score within this criterion.

Scores for running chronology



All sites are either of 'low' potential, or there is not enough data to be able to ascribe them a score within this criterion.

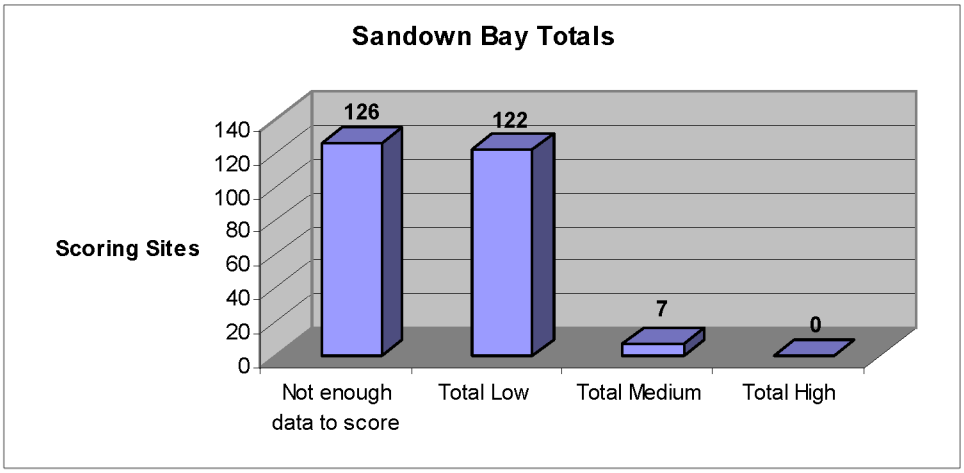
Scores for fragility



Many sites were ascribed a score within this category. Interesting there is a relatively high number of sites that are either at risk from 'imminent loss' or 'progressive erosion'. Types of sites represented in these categories include buildings directly on the coast, hulked vessel remains, banks and sea defences.

These high scores highlight that there may only be a short window of opportunity to exploit the data held within these sites and structures in relation to coastal change before they are lost to the very processes that they could help study.

Combined total scores



On initial inspection the combined totals do not appear to show sites that would be immediately selected as being of high potential. However, these combined scores do not include the 'fragility' criterion that should be considered in conjunction with these results.

8.8.6 Discussion of scoring results

This exercise has identified a potential in some sites that are of unknown date. Through inference offered by their context, these sites have still achieved a score. These scores recognise a need for scientific dating of sites and sediment archives that can offer greater levels of information pertinent to coastal behaviour.

It is within the categories of fragility and environmental change that the greatest range of scores has been ascribed. A site scoring 'medium' potential to inform on environmental change should be targeted for further investigation if it is observed to be at risk of imminent loss. The recognition that 50% of the identified sites are insufficiently understood to raise a score gives reason for new investigative survey.

8.8.7 Implications for shoreline management in this area

It is evident that the Yar floodplain below Newchurch can readily flood in wet winters. This can pose notable threat to buildings and property. The major sewage pumping station for the Island is sited on Sandham Levels. History and archaeology show this to be a reclaimed wetland within the Yar floodplain and it is demonstrably vulnerable to flooding. The ability of the station to pump when it is itself flooded should be considered.

There is a need to know the long-term behavioural history the Yar and the affects that the river has exerted over back-ponding and flooding in its lower course below Newchurch. Sediment archives associated with the river should be cored and examined to obtain a complete history of its past behaviour and to identify episodic or catastrophic events.

It has been observed that the natural beach-barring of a palaeochannel in the vicinity of Sandham Grounds may be the result of fluvial deposition by the Yar. If this should be the case then the natural protection that has been gained here may only rest on a fortuitous event in the past. It appears that the seawall-promenade at this point rests only upon the fill of the palaeochannel. There is a need to understand depositional history of this channel and its connection with the behavioural history of the Yar. These precautionary investigations should be encompassed in the revision of the shoreline management plan.

8.9 Hamble

8.9.1 Introduction to the Hamble study area

The lower Hamble is a *ria* inlet and tributary to Southampton Water. It has a tidal length of some 10 km and reaches as far as the village of Botley. The river drains a lowland area composed of the soft clays and sands of the Barton and Bracklesham Beds. The course of the river has been influenced by its underlying geology. This is apparent at Bursledon where an outcrop of hard sand and gravel has forced the river into a crescent shape, figure 8.31 shows modern activity at Bursledon.



Figure 8.31 The Hamble River at Bursledon, modern development sits alongside important archaeological and historical sites

Historically, the lower and more navigable section of the river has supported shipbuilding at Hamble, Warsash and Bursledon. A rich medieval and post-medieval legacy survives. Roman activity is evident at Curbridge and Badnam Creek and there is certainly a suspicion that this, too, is associated with maritime interests. A long maritime tradition has brought human settlement close to the river's edge. Settlement has largely been opportune and there is now a need to know what the long-term agenda of coastal behaviour is likely to be. Keys to this history lie in the sediment archives and concealed structures, within and bordering the river.

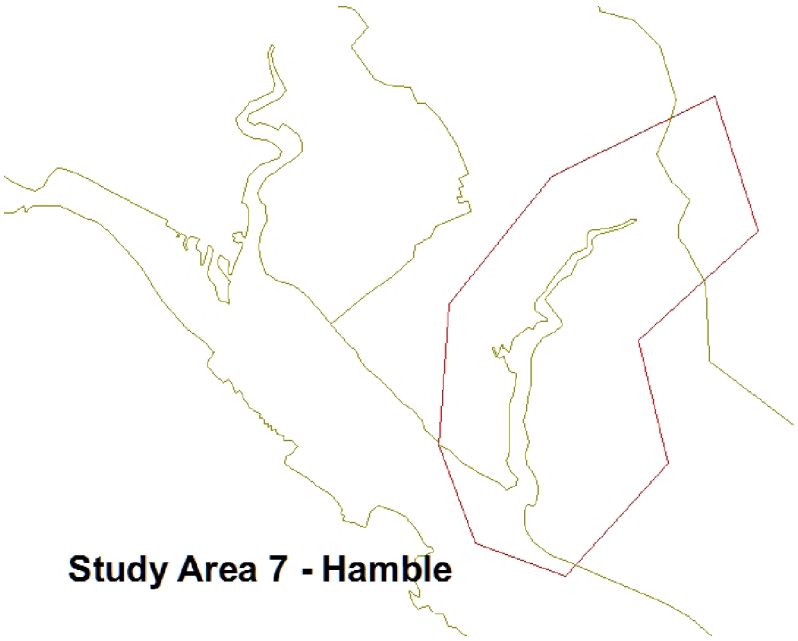


Figure 8.32 Map showing the Hamble study area

8.9.2 Summary of archaeology and history of the Hamble study area

The Hamble coastal area in earlier prehistory

Pleistocene gravels bordering the Hamble offer an opportunity of establishing the early history of the river when its course formed a tributary of the Solent River. Chance or opportune exposures of these gravels should not go unchecked. A modest incidence of finds of palaeolithic implements has been noted in the Historic Environment Record. These may offer a useful means of gaining a relative date for the gravel deposits. Elsewhere in south Hampshire, Bridgland (2001) has noted the difficulty of obtaining good biostratigraphical information and absolute dating for gravels of this type. This is a further reason for vigilance when gravel is disturbed by dredging or other activities in the environs of the Hamble.

A small marsh in the Hamble estuary has been cored and examined close to the bridge of the M27 (Long, Scaife & Edwards, 2000). The pollen content showed evidence of alder carr that had been overwhelmed by marine conditions just below -2m OD. The date of this event was 4410+70 BP (Beta-93197, 5289-4837cal.a BP). The cores at this site have also produced a pollen record of post-inundation events. This passes into a salt-marsh stage and eventually terminates with pollen attributable to the early 20th century. This long and informative record suggests that, after inundation, an open inter-tidal environment had been sustained for some four millennia in this part of the river.

Away from the river bank some small scatters of Middle Stone Age flint items have been noted. With further investigation, such sites could offer an opportunity to locate midden deposits that could reflect contemporary exploitation of marine resources in the river.

The Hamble coastal area in later prehistory

There is a distinct dearth of information for the later prehistoric period. A few items of Bronze Age metalwork have been noted and these seem to attest some later human activity near the shores of the Hamble. Some Iron Age artefacts are reported near the mouth of the river and these could signify early maritime interests here. There is also evidence of salt-working and possible settlement further up the river.

The Hamble coastal area during the Roman period
During the Roman period the Hamble seems to have gained some importance. A number of settlement sites have been identified in the vicinity of the river and these include a villa near its upper reaches. Occupation is also evident at Badnam Creek where a Roman inscription refers to the worship of a local water deity.

South of Fairthorne the Roman road to Bitterne crosses the river close to its head of navigation. An interesting find which may be linked to this period is an oak log-boat found by workmen at the side of Shawford Lake in 1888.

The Hamble coastal area during the medieval period
The earliest known mention of the Hamble river is in 720 AD when Saint Willibald set sail from here for the Middle East. At about this time the *Venerable Bede,* in his Ecclesiastical History wrote*…. 'the tides meet and oppose one another beyond the mouth of the River Homelea (Hamble) which runs into that narrow sea from the land of the Jutes'* ... This demonstrates that the Hamble river and its double high tides, were considered noteworthy during this period.

Some areas along the Hamble are cited in the *Domesday Book*. This includes the harbour of 'Hook'. During this period the Hamble river became a focus for settlement and trade. Eventually, a number of docks, jetties and timber yards began to flourish. The practice continues today.

During the 15th century, many Royal ships were laid up in the river for fitting out. Indeed the *Grace Dieu*, the largest ship ever built in England (at this time), was fitted out here and now lies in the river mud. This structure provides a footprint over the sediments pre-dating its abandonment. The deposits infilling and overlying the ship provide an index of the sedimentary environment in the river since the mid 15th century. A second medieval ship, the *Holy Ghost*, is believed to be entombed in sediments nearby. Both of these ships are accorded high cultural status and their preservation *in situ* and their safe monitoring should be an integral part of the shoreline management plan.

The Hamble coastal area during the post-medieval period
The growth of trade and industry continued in the post-medieval period when ship-building yards, docks, quays and similar structures continued to flourish. Frontages on the river now began to develop and these were accompanied and serviced by houses, farms and cottages in the immediate vicinity. Figure 8.33 shows the wooden remains of a hard which once supported riverside trades.



Figure 8.33 Archaeologists record the remains of a historic hard in the Upper reaches of the Hamble River

At Bunny Meadows there was an early sea defence. It dates from 1879 when a mud bank was built from Holly Hill Hard to Crableck Bank. This is described by F.W. Light (1939) as being built over the 'natural' bank. This 'natural' bank was, perhaps, an earlier sea-defence that can otherwise be seen on the 1610 map of Titchfield parish. A structure of groins and withy wattles is suspected.

The Hamble coastal area in recent times

During the 19th century an economic downturn occurred. Many ships were abandoned on the foreshore and some still rest here today. The first half of the 20th century brought a resurgence of activity including ship-building, timber yards and fishing. A new enterprise was the extraction and shipping of gravel.

During the Second World War, 'Pluto' (*Pipeline under the Ocean*) was laid through the Hamble depot. This supplied fuel to the Allied Forces at D-Day. Defensive structures on the river included a boom at the entrance and gun emplacements, slips, jetties and moorings for landing craft and flying-boats. In the latter part of the 20th century the village and the river developed into a principal centre for yachting activities.

8.9.3 Summary of geology and geomorphology within the study area

The physical nature of the study area

The coastline between the Hamble and Itchen rivers comprises low cliffs up to 9m in height. The cliffs cut through gravels of sandy and medium quality. These are Pleistocene deposits belonging to the course of the old Solent River. In the past they have been identified as ‘Plateau’ and ‘Terrace Gravel’ deposits but new terminologies and distinctions are now advocated (Bates 2001). The low cliff-line of this coast also cuts through an arenaceous bedrock composed of Eocene (Selsey) sands.

Map comparisons from 1870 to 1965 reveal a general retreat of the coastline. This has been countered by some coastal advance through land-claim at Hamble Point (Hooke and Riley, 1987). The highest recession rates are those noted at Hamble Common and the area between Netley Abbey and the Royal Victoria Country Park. Some of this recession has been attributed to the erosion of a cliff of gravel and clay. Another factor has been the deterioration of a sea wall.

Wave action along the shorefront of the Hamble study area is relatively weak. Waves are propagated across the 12km fetch of the western and central Solent. These may occasionally include local storm waves (HR Wallingford, 1995). Further up the Hamble a retreat of *Spartina* marsh and a consequent release of fine sediments has been widely reported (Nature Conservancy Council, 1984; Gray, et al, 1993). One cause appears to be the "dieback" of *Spartina anglica* around inter-creek 'pans'. This reduces the stability of accumulated salt-marsh sediments and makes them susceptible to wave action and tidal abrasion.

Coastal geomorphology

Hamble Spit contains a clay mineral suite that is characteristic of local Tertiary sediments (Hodson and West, 1972; Algan, et al, 1994). These minerals may be derived from the Solent or they may have eroded from either the north-east shore-face of Southampton Water or from the catchments of the Itchen, Test and Hamble (Algan et al, 1994). Marine input of suspended sediments has not been quantified, but significant net accumulation of fine-grained sediment has produced mudflats and marshes since at least 6,800 BP. This

evidence has been gained from radiocarbon-dated organic horizons recovered from boreholes (Hodson and West 1972, Long and Scaife, 1996).

Erosion along the River Hamble has been examined with the help of volumetric analysis of bathymetric charts, 1965-1993, (ABP Research and Consultancy, Ltd., 1994), These show an overall trend for erosional loss downstream but they also reveal a slight positive balance upstream. Most of the losses and gains seem related to changes in the position and depth of the main channel. However, Cundy and Croudace (1995) observe that while there is consistent sub-tidal erosion of mudflats adjacent to vertically accreting saltmarshes, there is no correlation between accumulation rates and site elevations. At present it is uncertain if changes in the sediment budget are primarily the result of channel-dredging and marina construction.

Coastal management issues

The Hamble has a diverse range of habitats and species many of which are protected by either national or European designations. The main habitats on the river are; salt-marsh, grazing marsh, mudflats, an inter-tidal lagoon and some ancient woodland on the fringes the Upper Hamble. These habitats are vulnerable to change from both natural process and human activity. There are also legal requirements required under the European Birds and Habitats Directive. The area is also covered by a Ramsar designation and a number of specific SSSI designations.

The Hamble is potentially one of the richest rivers in the region for archaeology. Sites of this nature are threatened by disturbance from dredging, construction, bait-digging, boat-wash and the direct impact of visitors. The potential of these sites to inform on nature, scale and pace of coastline change will not be fully understood until a targeted field survey and analysis is made of this un-tapped resource.

8.9.4 Coastal units within the study area

The Hamble river study area falls within the Western Solent and Southampton Water Shoreline Management Plan. The river is also subject to its own management plan for estuaries namely, the Hamble River Estuary Management Plan.

8.9.5 Results of scoring

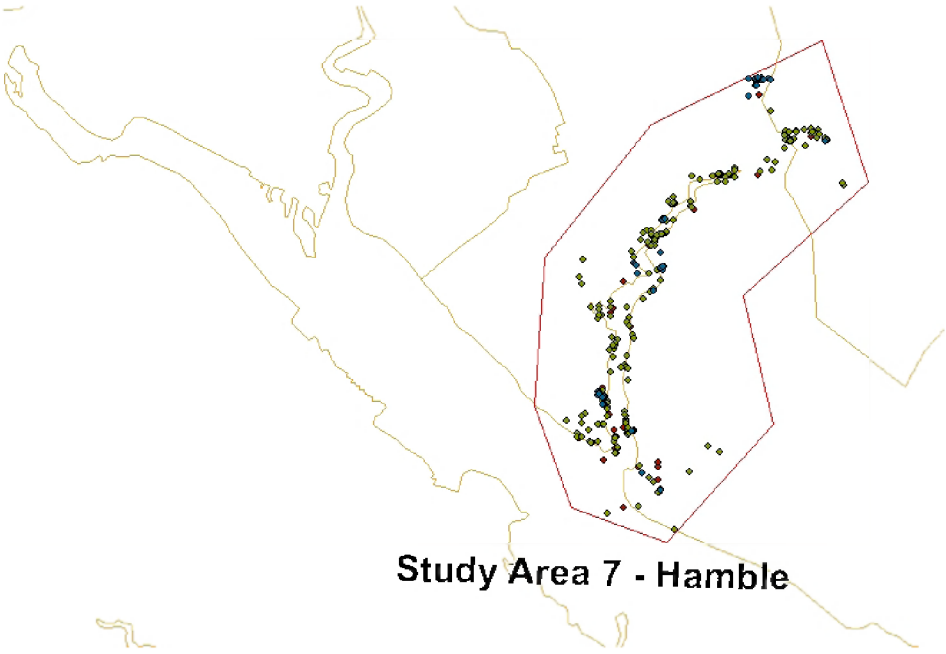


Figure 8.34 Map showing distribution of sites within the Hamble study area

The sites within the Hamble study area reflect a long association between human activity and the waterside, their distribution is shown in figure 8.34. Available data ensured that sites could be scored across the range of set criteria, figure 8.35 shows the distribution of the twenty highest scoring sites.

Highest scoring sites

Unique Number	Site	Event	Record Type	Sea level change	Climatic change	Environ' change	Running chronology	Fragility	Total scores
21992		SALTERN	MONUMENT	4	2	3	2	1	12
18094	Grace Dieu	WARSHIP	MARITIME	1	2	3	2	3	11
18095	Possible prehistoric canoe at Shawfords Lake	LOGBOAT	MARITIME	3	3	2	3	0	11
25762		SALTERN	MONUMENT	2	1	2	2	3	10
25801	Hamble Common earthworks	LINEAR EARTHWORK	MONUMENT	1	2	2	2	3	10
25763		SALTERN	MONUMENT	2	1	2	2	3	10
55663	Possible post-medieval jetty	JETTY	MONUMENT	2	1	2	2	3	10
19314		FINDSPOT	FINDSPOT	1	1	2	2	4	10
19308		FINDSPOT	FINDSPOT	1	1	2	2	4	10
18087		FINDSPOT	FINDSPOT	1	1	2	2	4	10
MHM283	Hamble River fish trap			3	2	2	2	4	13
MHM279	Dock Creek/Copse Installation - Possible timber-processinig site			2	2	2	2	3	11
MHM305	Warsash foreshore hulk			1	2	2	3	3	11
MHM281	Dock Creek dock installation			2	2	2	2	3	11
MHM277	Badnam Creek hulk			1	2	2	2	4	11
MHM289	Hamble River hopper barge hulk			1	2	2	1	4	10
MHM278	Badnam Creek houseboat? hulk			1	2	2	2	3	10
MHM286	Bursledon Point shipbuilding site			2	2	1	2	3	10
MHM276	Lincegrove Marshes pontoon/barge hulk			1	2	2	2	3	10

Table 9 Scoring results from the top twenty sites within the Hamble River study area

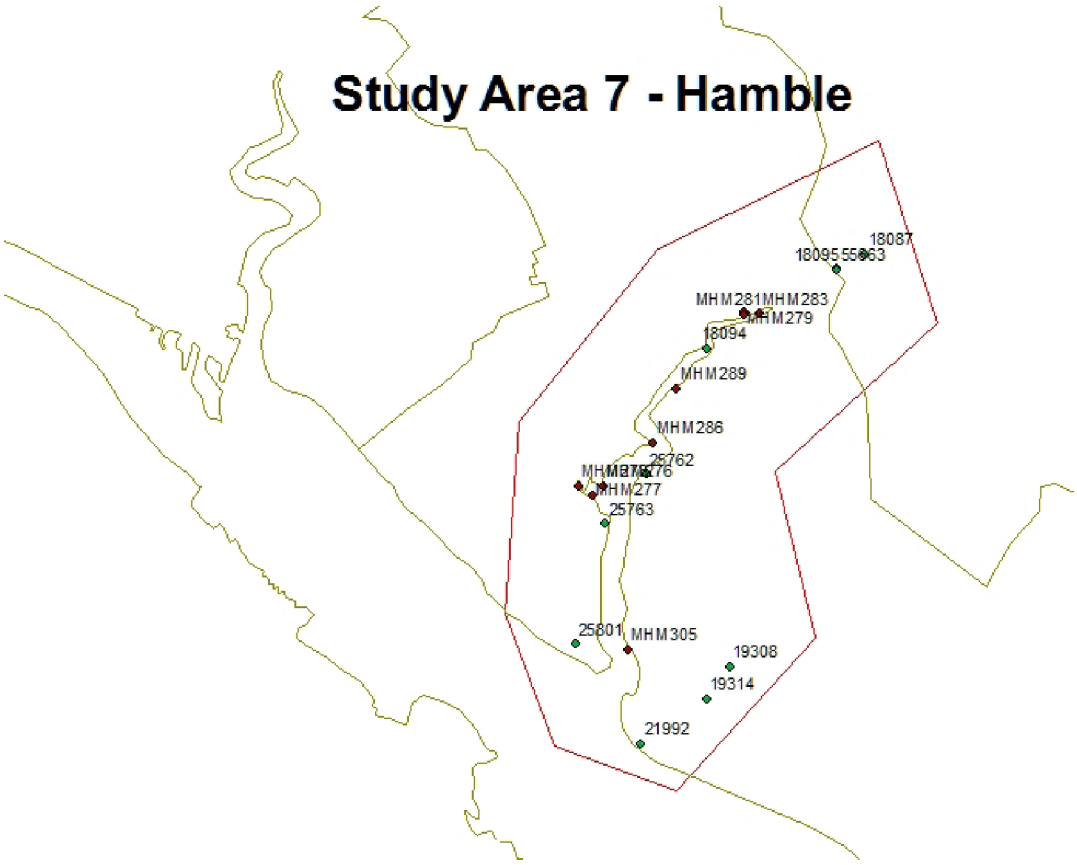
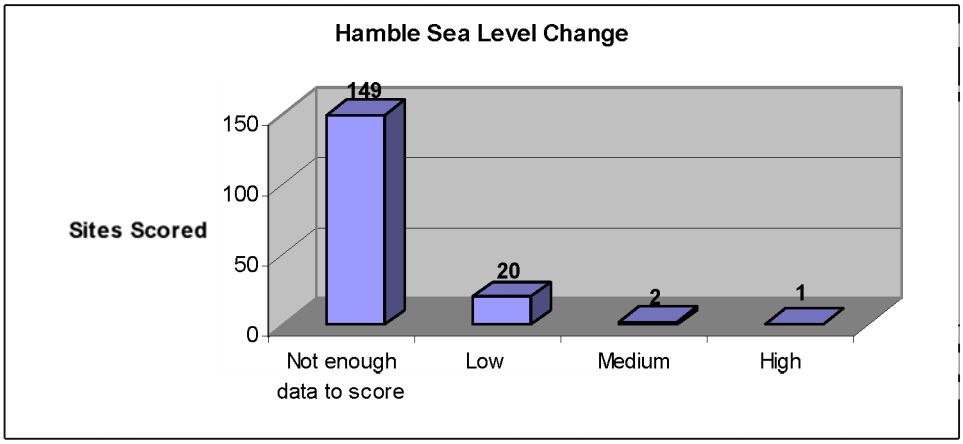


Figure 8.35 Distribution of highest scoring sites within the Hamble Study Area

Scores for sea level change criteria



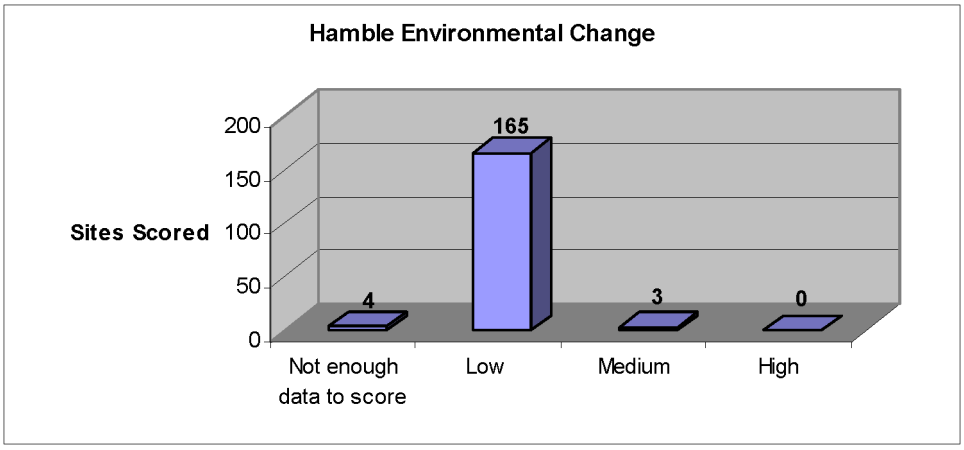
One site scored 'high' potential with regard for sea-level change. This was a saltern. The level at which tidal water was released from these artificial ponds can be a valuable indicator of contemporary low water mark.

A medium score has been awarded to an ancient log-boat find and an undated fish trap. Log-boats can offer a very high score but the usefulness of this example has been undermined by its early and poorly recorded recovery. However, there remains the possibility that a more could come to light.

The fish-trap is a more permanent feature that could potentially provide helpful information on contemporary sea-level if a height can be determined for the laying of the

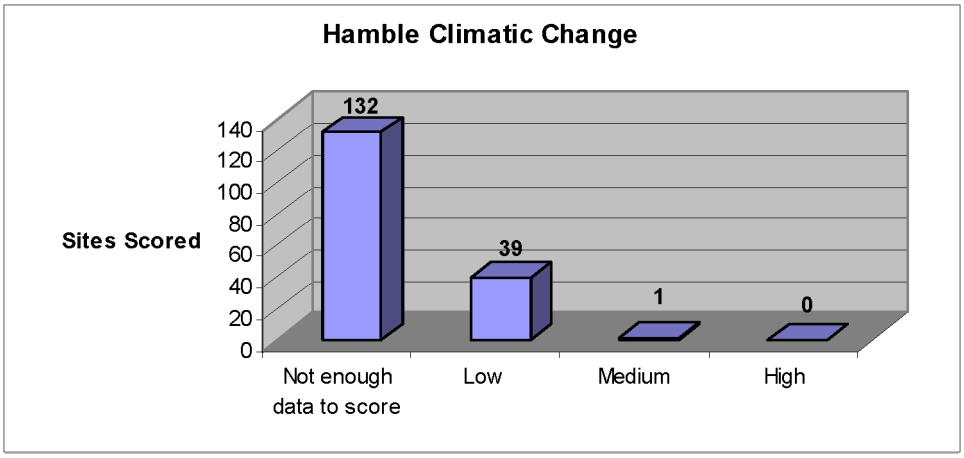
trap. Experience elsewhere has shown that traps were generally laid to allow access at low water springs. Both log-boat and trap would be suitable for radiocarbon dating.

Scores for environmental change criteria



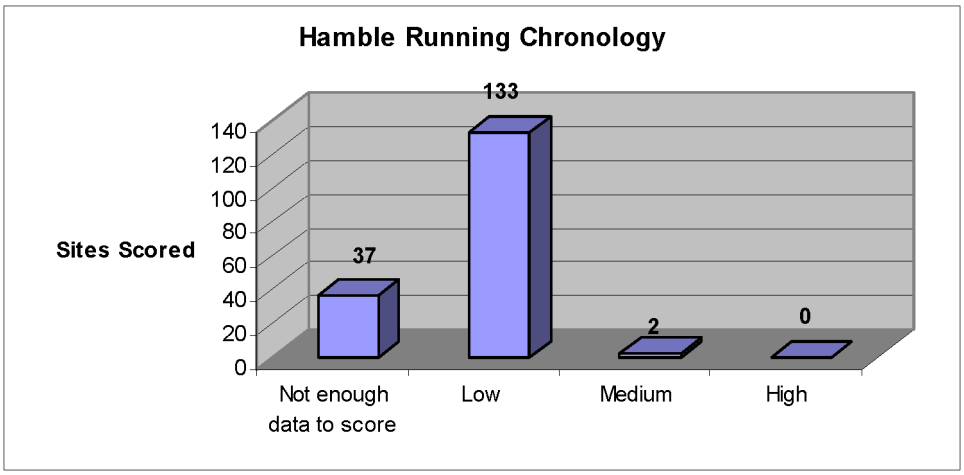
Three sites have received a 'medium' score in relation to their potential to inform on environmental change. These include the saltern (discussed above). The wreck of the *Grace Dieu* is one of the few designated historic wreck sites. It dates to the early 15th century. Analysis of environmental material related to this structure could help understand the environmental changes in the river since its deposition. Monitoring of the protruding timbers of the wreck can provide a valuable means of recognising immediate erosional or depositional changes in the river.

Scores for climatic-change



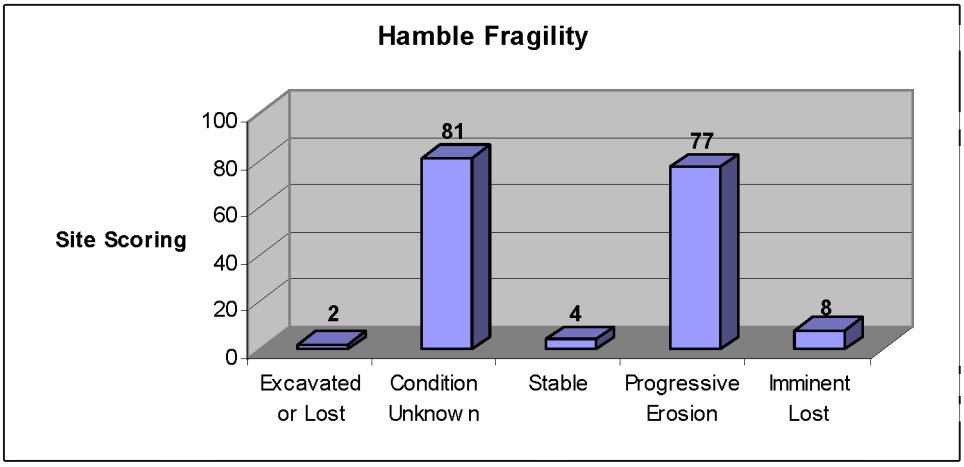
A 'medium' score has been awarded to the log-boat (discussed above). The tree-ring sequence contained within the log-boat offers a potential source of climatic information. A higher value would be won by the presence of *in-situ* tree trunks or tree boles.

Scores for running chronology criteria



The log-boat site again scores highly under this criterion. Its tree-ring chronology offers a valuable 'yard stick' by which to measure temporal continuity. The same is true of the other 'medium' scoring site, a hulk on the foreshore at Warsash. Both hold potential to provide chronological evidence linked to related sediments and environmental data.

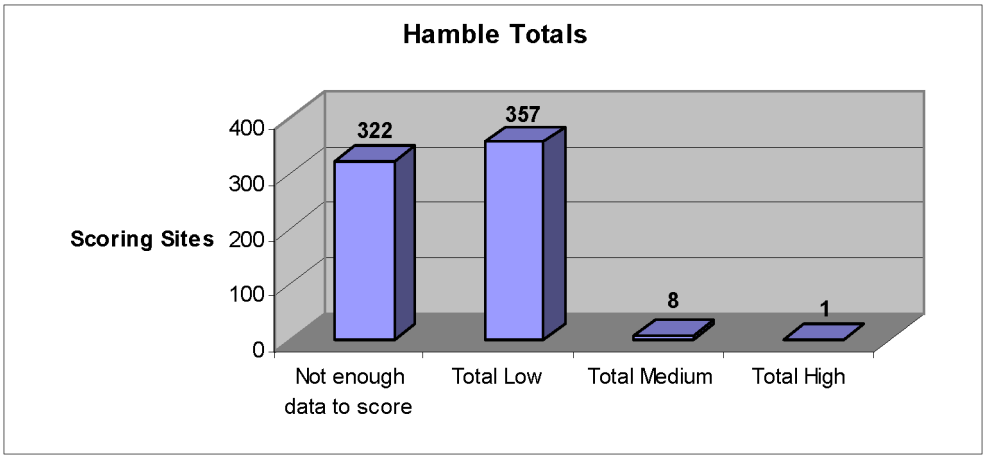
Scores for fragility



A relatively high number of sites in this study area are threatened by 'imminent loss', Of the eight sites in this category, six fall within the twenty highest scoring sites. These sites include find-spots, fish-traps and hulks.

A total of 77 sites were deemed to be at risk from progressive erosion. The range is wide and includes find-spots, earthworks, jetties, shipbuilding sites and hulks. The notable number of sites scored for this criterion is due to the high level of detail available from the Hampshire Historic Environment Record.

Combined total scores



8.9.6 Discussion of scoring results

The results for this study area have highlighted the fragile nature of many sites for which only a limited amount of archaeological data is available. The fact that 47% of the sites were insufficiently understood to score, shows that new field data is required. The notably weak scores in the medium and high categories of the 'combined totals' provides a further suggestion that too few sites have been pursued to the limits of their potential to inform on coastal behaviour.

8.9.7 Implications for shoreline management in this area

The amount of desk-top data available from this study area has proved a helpful overview of the archaeological and palaeoenvironmental resources of the Hamble river but it is notably weakened by the high number of sites that are clearly under-investigated. This assessment identifies gravel deposits within and adjoining the river as a paleoenvironmental resource worthy of monitoring and recording (this includes the products navigational dredging).

Wooden structures such as fish-traps and wrecks in the inter-tidal and sub-tidal require observation and monitoring and some should be viewed as specific indices for measuring environmental change. A site currently omitted from the HER is the salt-marsh and peat deposit investigated by Long, Scaife & Edwards (2000). Although this was not included in the scoring exercise it is accorded a high value in this report and it underlines the need to identify and interrogate other such deposits in the river. Provision for survey, regular monitoring and targeted investigation should be included within the body of the revised shoreline management plan and should redress the current weaknesses.

8.10 Portsmouth Harbour

8.10.1 Introduction to the Portsmouth Harbour study area

Portsmouth Harbour is a drowned river basin occupying a narrow coastal plain set at the foot of a chalk scarp in south-east Hampshire. The harbour includes one of the four largest expanses of mudflats and tidal creeks on the south coast of Britain. The natural and progressive drowning of the harbour has not been recognised by past human communities who have carried their activities and settlements close to many parts the harbour shore. Large areas of land adjacent to the harbour accommodate urban and industrial buildings and are particularly susceptible to future flooding.



Figure 8.36 Portsmouth Harbour from the Spinnaker Tower showing relationship of urban areas with the coastal environment

Portsmouth Harbour is a major military and civil port claiming a maritime history that is at least as old as the Roman period. Its margins are heavily committed to industrial and urban use. Its seabed is subject to many navigation requirements and its natural environment is highly stressed.

The harbour is also a major archaeological resource pertinent to the history of maritime Britain. The northern bank of the harbour accommodates the Roman coastal fort of Portchester. Around the opening of the 2nd millennium AD, human settlement shifted from Portchester to the east bank of the harbour. It was here that the medieval town and naval port of Portsmouth began to grow.

Portsmouth was destined to become a principal post-medieval military port and dockyard. The northern half of the harbour is an SSSI, an SPA and a Ramsar site. These designations recognise a range of inter-tidal, brackish, lagoonal and terrestrial habitats.

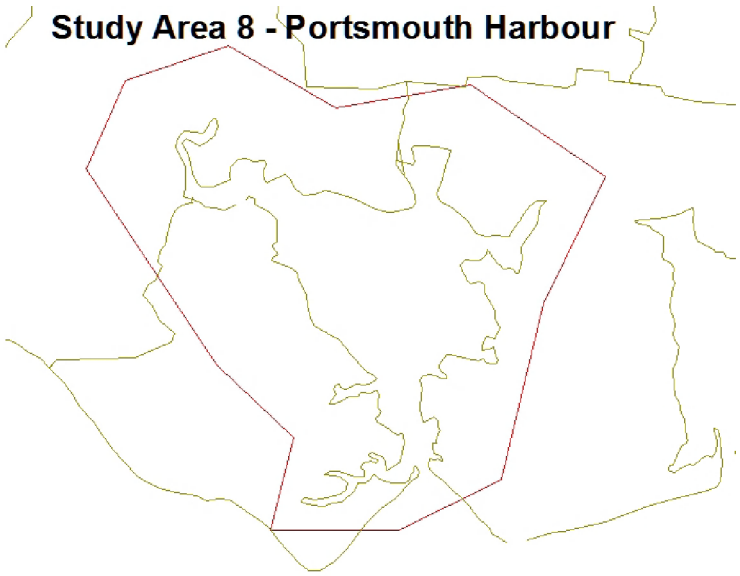


Figure 8.37 Map Showing the Portsmouth Harbour Study Area

8.10.2 Summary of archaeology and history of the Portsmouth Harbour study area

The Portsmouth Harbour study area in early prehistory

Portsmouth Harbour is bounded by a single Pleistocene gravel deposit. This rests on the surface of the Gosport and Portsmouth peninsulas where it is identified as Solent Valley East, Terrace 2. It has been provisionally equated with the Pennington Lower Gravel in the West Solent (Bates, 2001). This gravel has been accorded a date in Oxygen Isotope Stage 6 (Bates, *ibid*). The outcrop of the gravel runs to the revetted edge of the harbour and it is reasonable to believe that material recovered from the foreshore and floor of the harbour can be derived from this deposit. This may apply to the Palaeolithic implements and flakes reported from Tipner, Cams Bay and Wicor Lake.

In a detailed archaeological and palaeoenvironmental investigation of Langstone Harbour, Allen and Gardiner have contrasted the deep incised channels of the Portsmouth Harbour with the shallow sub-bottom bathymetry of Langstone (Allen & Gardiner, 2000, 200, fig 60). Deep submerged peats have been detected in Portsmouth Harbour at levels between -6 and -4m OD (Godwin, 1945). These are old investigation bereft of absolute dating and new field data is now needed from these deep levels.

Finds from the Mesolithic period include a number of flints and implements found along the shoreline of Tipner and the upper reaches of Portsmouth Harbour. These items, mostly found along the shoreline, allude to occupation of a land-surface that is related to a lower sea-level of the past. Recent Investigations in Langstone Harbour and on the Wootton-Quarr coast of the Isle of Wight show that peats and submerged forest timber in these contexts can be highly instructive indicators of past sea-level and climate-change. The reported flint finds in Portsmouth Harbour are target markers for fieldwork yet to be carried out.

The Portsmouth Harbour area in later prehistory

Assemblages of flint tools and waste from the Neolithic period have been found in locations that are now to be found on the beach south of Portchester Castle. The context of these items could well prove to be similar to that postulated for the Mesolithic flints.

Some reported finds and features of Bronze Age date attest some human activity on the 'Isle of in the Portsmouth' but no archaeological evidence is known that can help with the behavioural history of the harbour and the Portsmouth coastline during this period.

During the Iron Age, a settlement with a defensive earthwork seems to have developed in the area later occupied by Portchester Castle. The relationship between this site and a subsequent retreat of the coastline could prove useful in measuring the expansion of the natural harbour as a result of sea-level rise.

The Portsmouth Harbour area during the Roman period
In the 3rd century AD the area of the old Iron Age settlement at Portchester became the site of a coastal fort supporting the Roman navy. Nothing is known of the waterfront serving the fleet but its presence must be suspected within the harbour.

The Portsmouth Harbour area during the medieval period
The Portchester Castle area became a Saxon settlement in the middle of the 5th century. This occupation persisted until the end of the 9th century. The old stone fortress of the Roman period became a useful stronghold. Its proximity to the harbour made it ideal for channel crossings.

There is no mention of Portsmouth in the Domesday survey because the settlement associated with the harbour is still sited at Portchester. The town is commonly regarded as having been founded in 1180 by John of Gisors. Its genesis follows an assembly of naval forces near the mouth of the port during the reign of King John. The earliest detailed references to Portsmouth can be found in the Southwick cartularies. Medieval finds have been recovered from several sites in old Portsmouth, where some evidence of the town's earlier dock facilities and industrial activity survives.

Buildings belonging to the later part of this period have been archaeologically recorded in the 'old town' and some still survive in areas where military and trading enterprises were related to the harbour. Most of these structures are 'listed' and are afforded some protection against development.

The Portsmouth Harbour area during the post-medieval period
The erection of defences continued during and after the Tudor period when some structures in the town were replaced or renovated. The Square Tower is a particular example, being built in 1494. It was used as a fortified residence for the military governor. It continued in use as a gun-powder magazine until 1580. Subsequently, it was used as a meat store in 1779 and later a semaphore station in 1823-1848. The foundations of this building penetrate the active shingle beach and provide a valuable measure of coastal behaviour since the 15th century

Southsea fort was built in 1544. It was designed as a major gun battery to protect Portsmouth and the Solent. It was enlarged in 1814 and then further strengthened in 1860 during Palmerston's renewal of national defences. The Gosport defences were extended throughout the 18th century. These are now mainly built over but some remain in the naval barracks.

The Portsmouth Harbour area in recent times

Portsmouth has always played an important role national defence. It has accommodated the Royal Navy since the days of King John. Many of its buildings accommodate military storage, housing or barracks. In the 1820's a lighthouse was built and is still in use today. During the Second World War further defensive structures were erected. By the end of the War the earlier buildings on New Gunwharf had all been removed to accommodate new offices and a training school.

Portsmouth Harbour has since taken on a different aspect. While still focused on the needs of the Navy, the town has now given emphasis to urban regeneration, new development and tourism. The result has been an increased demand for new building and an accelerated rate of land reclamation.

8.10.3 Summary of geology and geomorphology within the study area

The physical nature of the study area

Portsmouth Harbour comprises a large, sheltered estuarine basin supporting extensive inter-tidal mudflats. The harbour has only a narrow connection to the sea. It receives comparatively little freshwater and has an unusual hydrology. The mudflats support large beds of marine vegetation. There are also two saline lagoon-like habitats. Other areas include supporting scrub and broad-leaved woodland.

The low lying land has a high-density of urban development and some recreation areas of high value. Much of the shoreline is taken over by promenades or historic fortifications. These are mostly fronted by a shingle beach. The backshore area at Old Portsmouth is subject to flooding. This is due to both overtopping and to high levels of groundwater during storm surge conditions.

The harbour behaves as a relatively self-contained unit despite being connected by shallow channels to the northern reaches of Langstone and Chichester harbours. The area outside the harbour entrance is a sink for sand and shingle. This has been extensively dredged.

Coastal geomorphology

Examination of maps indicates that much of the shoreline environment comprises reclaimed land at or below mean high water level. Erosion has been prevented by protective artificial bunds, earth banks and sea walls. While only 10% of the harbour shoreline has been classified as 'eroding' in the regional SMP (HR Wallingford, 1997), this may be altering rapidly due to widespread dieback of protective *Spartina* marsh. This can leave formerly sheltered foreshores exposed to wave-action.

During the mid and late nineteenth centuries, dock excavation in Portsmouth Dockyard provided spoil to be used in the construction of artificial islands, e.g. Burrow and Horsea (HR Wallingford, 1997). Pewit is the only natural island in the harbour. Large areas of Portsmouth Harbour have since been reclaimed. These have mainly been connected with marina developments. Some sites have been created, and others extended, through the use of landfill.

Very little information is available regarding the sedimentology of Portsmouth Harbour. At the beginning in the twentieth century, substantial parts of the harbour became colonised by *Spartina anglica.* This cord grass progressively displaced the indigenous species *Spartina maritima*. This new development interrupted water flow and increased sedimentation so that large areas of high level *Spartina* marsh accreted up to 1.5m above the level of the adjacent mudflats.

Since the early 1950s a dieback of *Spartina* anglica has occurred but the indigenous species is now diminished. The harbour now contains low eroding bluffs separating mudflats from residual areas of *Spartina*, e.g. Fareham. The bluffs vary from 0.5m to 1m in height. Through borehole analysis it is found that the estuarine deposits in the upper harbour are a maximum of 2.0m to 2.5m thick. The suspended sediment concentrations are greatest in the central and western parts of the harbour.

Coastal management issues
The Portsmouth Harbour frontage has a very high public recreation value for both Portsmouth residents and an important tourist industry. There are a large number of important historic and archaeological sites around Old Portsmouth and at Southsea Castle, including scheduled Ancient Monuments. Old Portsmouth is an historic conservation area.

The harbour also accommodates an extensive inter-tidal saltmarsh, mudflat and sandbank habitats. There are also co-adjacent areas of upper saltmarsh, terrestrial and brackish grazing marshes, lagoons and sites of vegetated shingle.

The "hard" defences around the harbour perimeters create an increase in both wave and tide energies. These stresses will be naturally increased by the rise of relative sea-level and the future influences of climatic change during the next few decades. The same factors will also contribute to coastal squeezing of the inter-tidal habitats. They will also impact on the low-lying land and will affect the marginal balance of future sustainability.

The inter-tidal and sub-tidal zones at Portchester clearly befit further investigation. The Roman walls at Portchester are scheduled with respect to their national importance but the monument surely has an unexamined dimension below high water mark and this should be considered within the shoreline management plan.

8.10.4 Coastal units within the study area

Portsmouth Harbour falls within the Eastern Solent Shoreline Management Plan. It is also encompassed by the Portsmouth Harbour Management Plan which sets forward a series of prescriptions for the interior of the harbour.

8.10.5 Results of scoring

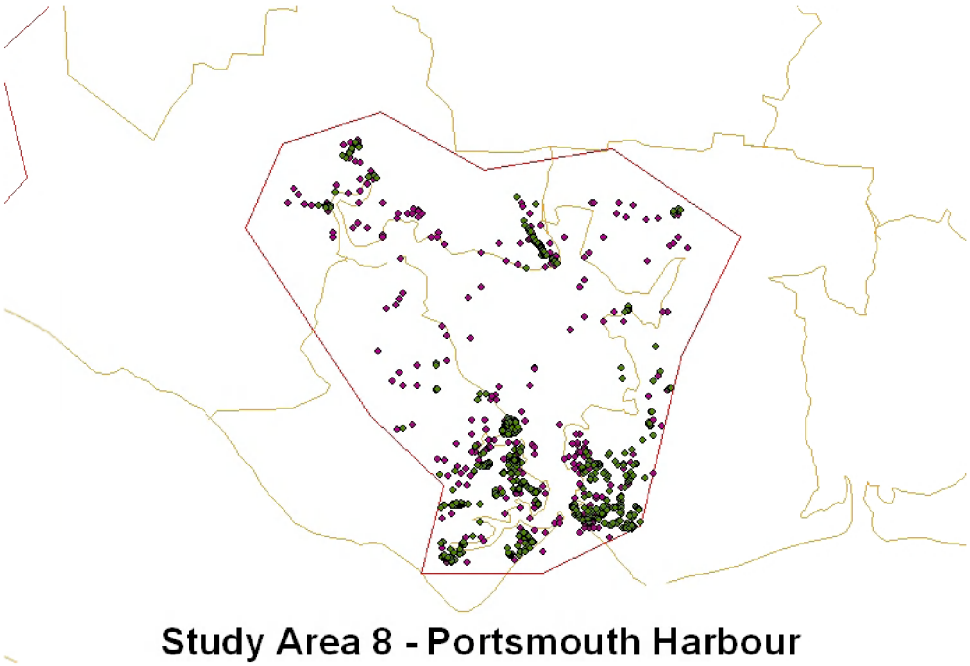


Figure 8.38 Map showing distribution of sites within the Portsmouth Harbour study area

The total numbers of sites achieving a score in the Portsmouth Harbour are relatively low. At the outset, 1545 sites were considered but this was reduced to 356 (figure 8.38) when many listed building were excluded from the calculation. Scores could be achieved for only 89 sites and this left a perturbing blanket of ignorance concerning the remaining 47%. Not all listed buildings were removed from the sample. Those lying in close proximity to the shoreline were recognised to offer some perceptible potential. The distribution of the twenty highest scoring sites are shown in figure 8.39.

SMR_NO	SITE_NAME	SITE_TYPE	PERIOD	Sea Level Change	Environmental Change	Climatic Change	Chronology	Fragility	Total Scores
54654	WELL	MONUMENT		2	2	2	2	2	10
33713	WELL	MONUMENT		2	2	2	2	2	10
51494	WELL	MONUMENT		2	2	2	2	2	10
28001	CASTLE	MONUMENT		1	2	3	2	2	10
28006	AUGUSTINIAN MONASTERY	MONUMENT		1	2	3	2	2	10
PM 172	Mesolithic implements from Portsmouth H	Findspot	Mesolithic	2	2	2	1	3	10
PM 156	Palaeolithic Flints from Cams Bay/Wicor L	Findspot	Palaeolithic	2	2	2	1	3	10
PM 166	Neolithic flint from beach at Portchester	Findspot	Neoltihic	2	2	1	2	3	10
PM245	Pot boilers from Paulsgrove foreshore	Artefact scatter	Roman	2	2	1	2	3	10
PM 23	Round tower- Boom tower	MONUMENT	Medieval	2	2	1	2	3	10
20117	SALTERN	MONUMENT		2	2	2	1	2	9
24548	SALTERN	MONUMENT		2	2	2	1	2	9
54742	SALTERN	MONUMENT		2	2	1	2	2	9

20148	TIDE MILL	MONUMENT		2	2	1	2	2	9
54689	OSIER BED	MONUMENT		2	2	1	2	2	9
53066	WRECK	MARITIME		1	2	1	2	3	9
53076	POST ALIGNMENT	MARITIME		1	2	1	2	3	9
53075	POST ALIGNMENT	MARITIME		1	2	1	2	3	9
53074	WRECK	MARITIME		1	2	1	2	3	9

Table 10 Scoring results from the top twenty sites within the Portsmouth Harbour study area

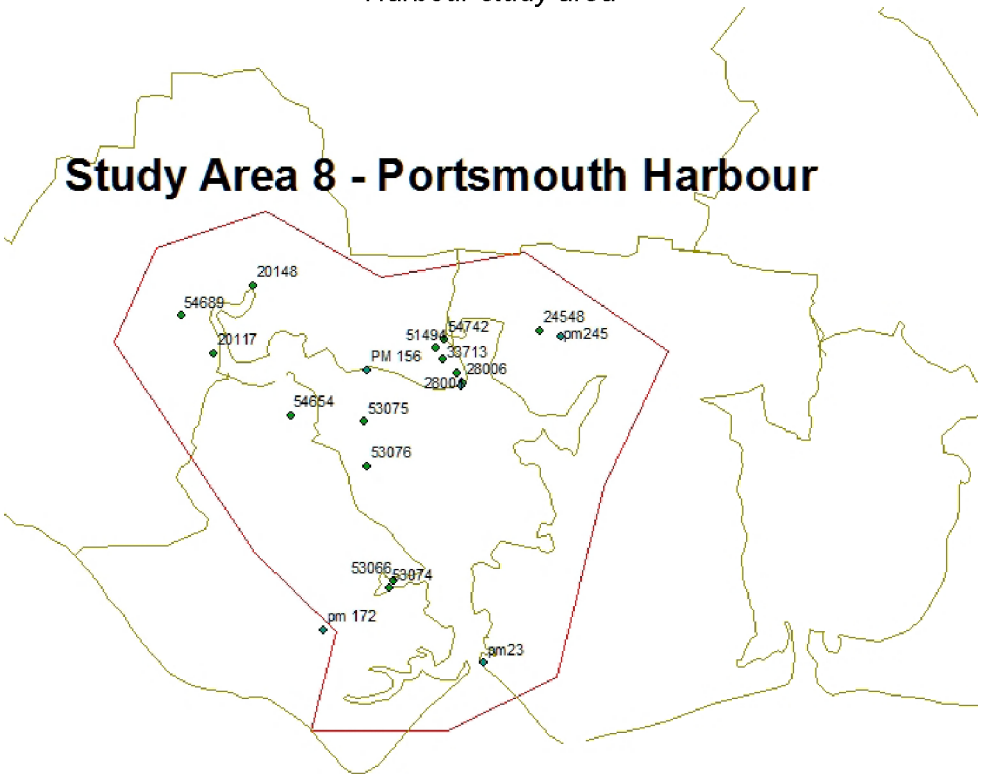
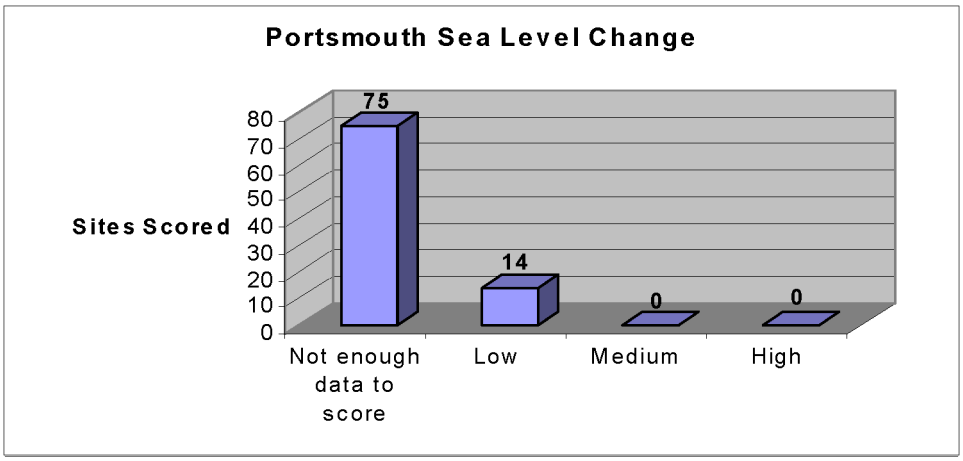


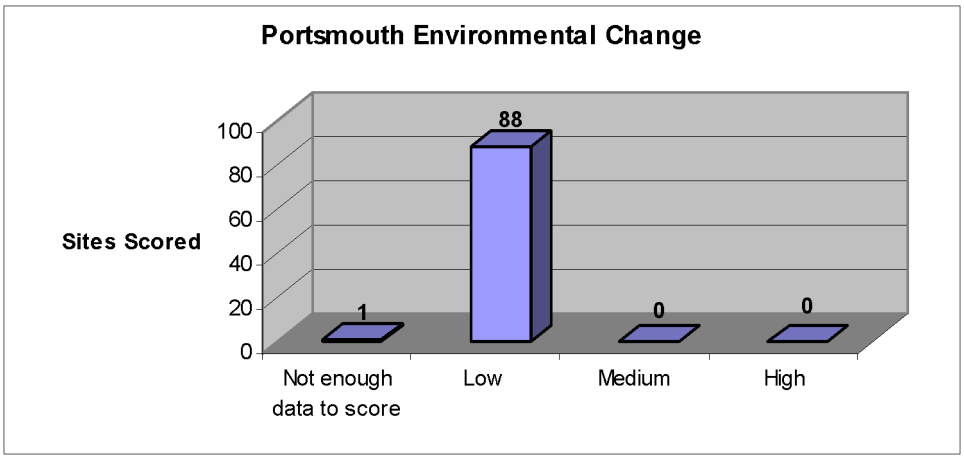
Figure 8.39 Distribution of highest scoring sites within the Portsmouth Harbour Study area

Scores for sea-level change



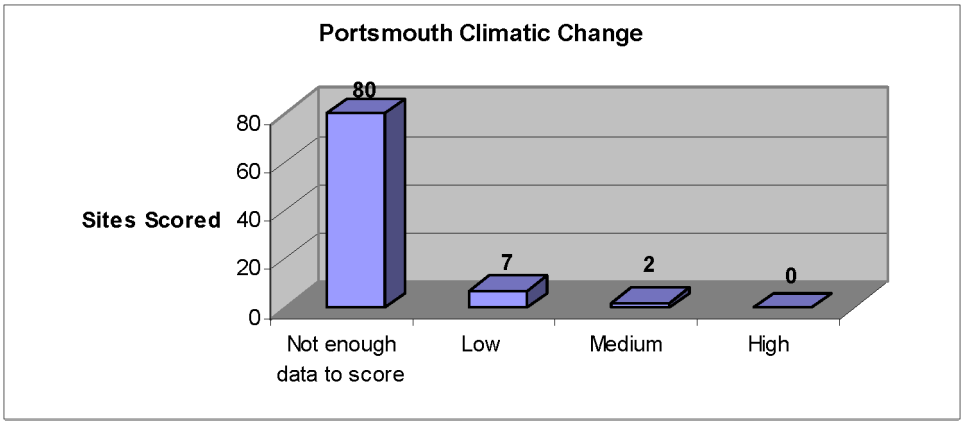
All sites fall within the 'not enough data to score' category or are of 'low' potential.

Scores for environmental change



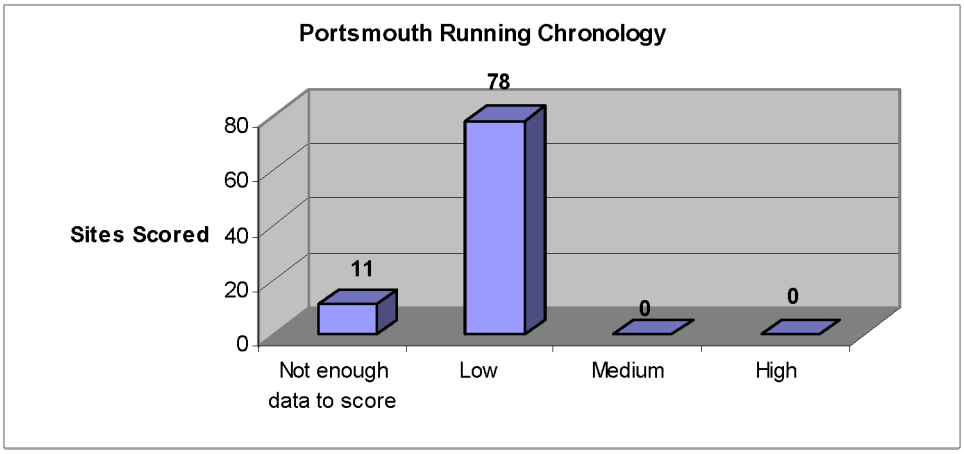
All sites fall within the 'not enough data to score' category or are of 'low' potential.

Scores for climatic change



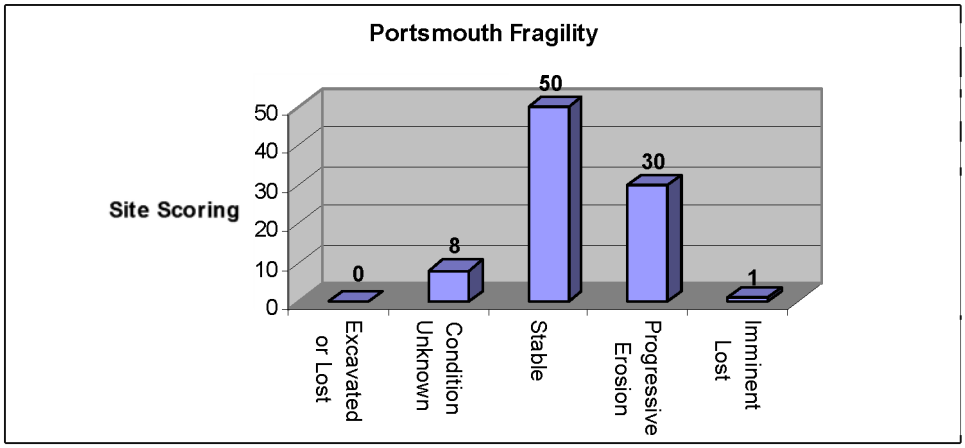
Within this category, two sites have obtained a 'medium' potential score. These are a castle and an Augustinian monastery. The antiquity of these sites means that they have the potential to demonstrate a reaction to changing climatic conditions.

Scores for running chronology



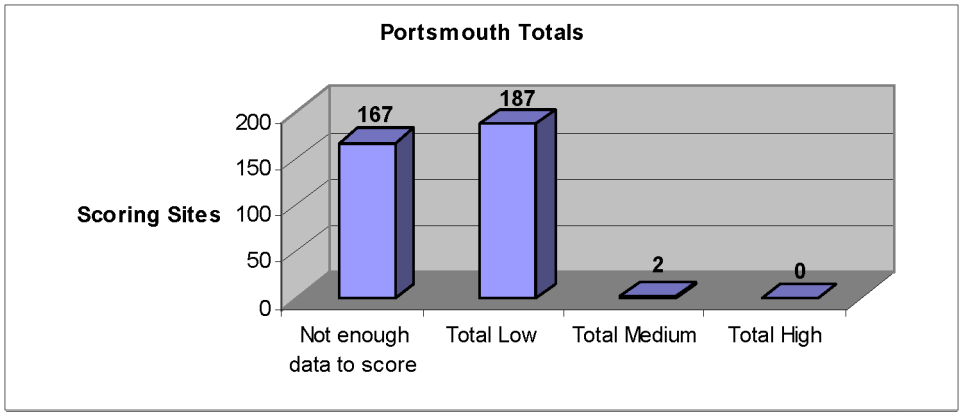
Most sites have a 'low' score for their potential to provide evidence on temporal continuity within the area.

Scores for fragility



It was possible to score most sites within the fragility criteria. Many sites are stable, however there are 30 which are deemed to be at threat from progressive erosion, this reflects the dynamic nature of parts of the Harbour as most of these 'at risk' sites are in areas directly along the coastline.

Combined total scores



Only two 'medium' scores have been attributed within the study area. Both of these have been awarded for climatic change. The high incidence of un-scored sites is perturbing, especially when viewed against the very poor results at medium and high level.

8.10.6 Discussion of scoring results

It is disturbing to see that 47% of the identified sites offered insufficient data for scoring. This is a reflection of the very low level of survey, inspection and site-monitoring around Portsmouth Harbour. The poor score is particularly unsettling given the pressing need to understand the long-term trend of down-warping and coastal behaviour in a highly populated urban and industrial area that demonstrably susceptible to flooding.

The relatively low score for this study area must certainly not be seen as a lack of overall potential. It is a reflection of a poor level of current knowledge. It is widely acknowledged that Portsmouth Harbour is in need of more detailed and consistent archaeological and palaeoenvironmental appraisal. This has become particularly apparent since these issues have been pursued in the neighbouring harbour at Langstone.

8.10.7 Implications for shoreline management in this area

Portsmouth Harbour is a drowned tidal basin where a process of submergence poses particular threat to a large human population settled on land that is notable vulnerable to flood-risk. The natural configuration of the harbour has been subject to many human interventions including land reclamation and dredging. The natural environment of the harbour is clearly stressed and it is surprising to see so little evidence of field investigation, recording, monitoring and analysis within the confines of the harbour.

A project design is required that will redress the present lacunae and will focus resources on recognising the long-term behavioural trends in the tidal and fluvial filling of the harbour and the safe settling of communities around its rim. It is evident that the sediment archives of the harbour include peat deposits and these should be interrogated for the information they contain on past environmental changes and the incidence of episodic events such as floods and overtoppings. The need for systematic archaeological and palaeoenvironmental investigation of the harbour should be built into the revised shoreline management plan where the objective of reviewing the past behavioural history should be clearly set.

8.11 Chichester – Selsey

8.11.1 Introduction to the Chichester-Selsey study area

The Chichester-Selsey study area includes the eastern frontage of Chichester Harbour as well as Selsey Bill. The harbour is a drowned river basin subject to down-warping and progressive inundation. The coastal zone of the Selsey peninsula is an exceptionally complex environment that can be subject to severe erosion. The Bill is a well-defined headland separating shorelines of differing orientations. The composition of Selsey Bill is no more than light soils resting on the soft sands of the Bracklesham Beds.

The archaeology and history of this area suggest that a notable maritime settlement at Selsey was abandoned in the 1st century AD. This appears to mark a move to a more sheltered site at Chichester. At the close of the 1st millennium AD a further migration of this type is suspected.

Although these lessons of history have indicated the vulnerability of Selsey, they were not applied when Victorian entrepreneurs set out a street system and established a seaside resort here in the mid 19th century. Since that time, coastal defences have been devised and installed to protect the resurrected settlement. Meanwhile, in the inter-tidal and off-shore zones, archaeological evidence continues to appear that gives testimony to an earlier Selsey that failed to survive the advances of the sea.

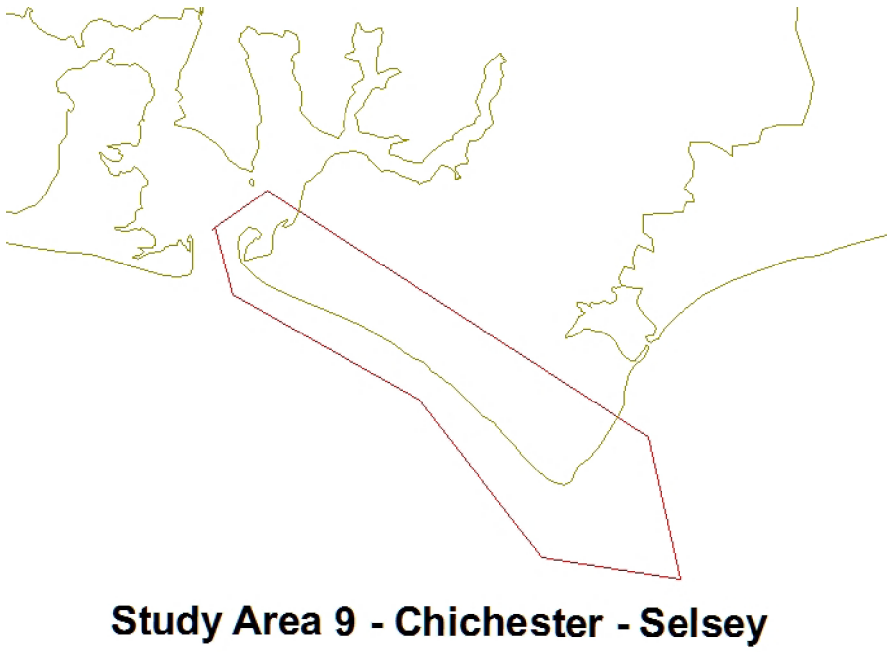


Figure 8.40 Map showing the Chichester – Selsey study area

8.11.2 Summary of the archaeology and history of the Chichester-Selsey study area

The Chichester-Selsey coastal area in early prehistory

East of Portsmouth the coastal outcrop of Solent Terrace 2 is lost onshore although its continuation may be suspected below sea-level (Bates, 2001, 34, fig 4.4). This may account for the palaeolithic implements recorded as beach finds between West Wittering and Selsey.

In the Selsey-Wittering area a complex of Pleistocene palaeochannels has been opportunely investigated at various times. Bates (2001) observes that some of these small palaeochannnels contain brackish water faunas and can be detected at or below current sea-level. Proposed dates range from early Middle Pleistocene to Ipswichian (West & Sparks, 1960).

Of particular interest is the relict drainage system now represented by the Broad Rife and its feeders. This is a meandering channel of Holocene age that may once have offered drainage to land formerly present in Bracklesham Bay. An offshore find of Mesolithic flint items noted near Selsey adds further support to the loss of substantial terrain. Sediment archives in the course of the Broad Rife may offer at means obtaining environmental data on the behavioural history of this coastline since the mid Holocene.

The Chichester-Selsey area in later prehistory

For most of later prehistory, the archaeology of the Selsey peninsular shows a modest scatter of farming communities displaying little association with the sea. It is not until the 1st century BC that there emerges a specific maritime community at Selsey. The siting of this community may have been related to a more southerly extension of Selsey Bill, reaching to or towards the Mixon rock. A convenient anchorage was also available at a point since known as 'the Park' (Tomalin, 2006).

The Late Iron Age coastal community at Selsey was clearly large and prosperous. There are on-shore traces of a substantial defensive earthwork. The inter-tidal zone has yielded gold bars and coins that suggest the presence of a mint. Abandonment of this site in Roman times seems to coincide with the establishment of a new tribal capital at Chichester. A new landing place was now favoured at the head of the Chichester Channel at Fishbourne. At present no palaeoenvironmental evidence is available to show whether this first retreat from Selsey was triggered by a particular erosion or inundation event. We have yet to establish whether the behavioural history of the past offers comparison with the conditions we now see at Selsey.

The Chichester-Selsey area in the Roman period

The demise or decline of the established settlement at Selsey is not well understood. In the latter half of the 1st century AD local stone was quarried for the construction of the new Roman palace at Fishbourne. It seems that the stone supplies for the palace included consignments won from Mixon Rock. This now lies at a submerged level some 2km offshore from Selsey Bill but in the 1st century it was apparently accessible to a quarrying team.

A Roman wall, a quarry, a standing stone and a presumed Roman lighthouse have all been reported by divers in the vicinity of the Mixon rock. If a level of occupation can be established at any of these structures it will have important implications for the calculation of shore-retreat and sea-level rise at Selsey.

In Chichester Harbour and the Chichester Channel the longer timetable of down-warping and sea-level rise is not well understood. The possible survival of Roman salt-working sites in the inter-tidal zone of the harbour deserves investigation because these sites can be a truly informative means of establishing past sea-level.

At Fishbourne mill pond, a deeply submerged Roman well-head has been identified during an underwater investigation (Wallace, 1990). The depth of this structure has clear implication for the scale of the post-Roman rise in local sea-level.

The Chichester-Selsey area in the medieval period

It may be suspected that second migration from Selsey and the coast occurred at the opening of the Medieval Warm Period. In AD 1014 King Canute made his famous demonstration against the advancing of the waves. His palace at that time was situated near the shore at Bosham and tradition insists that his shore-side gesture was made here. Later, the Saxon See at Selsey was promptly re-located at Chichester. Both events may have been triggered by unwelcome natural changes to the coastline. In 1324 a large portion of eastern Hayling was lost to the sea including the church of St Peter and St Swithun. It seems that this was an episodic event that may well have had effects on other parts of the coast.

Some medieval buildings in the study area, including churches, may still retain a tree-ring record of the medieval climate in some of their timbers. The wells of this period were dug to a water-table that was controlled by the climate of the 'Warm Period'. Well-depths of this period may be instructive when compared with those of other times.

An overview of long-term environmental changes in the region may be obtained from sediment archives in coastal peats and salt-marsh. These are resources that have not yet been flagged up the Historic Environment Record. Their survival around Chichester Harbour and the Chichester Channel seems likely. The same must said of the Selsey area where the course of the Broad Rife and its feeders offers a further opportunity to locate wetland sediment archives.

The Chichester-Selsey area in the post-medieval period

During the post-medieval period the minor port of Bosham drew close to the shoreline. This included a public highway that was destined to suffer from tidal flooding. Itchenor is known to have operated as a harbour but elsewhere the population of the Selsey peninsular shows little interest in the sea. In the offshore zone, the loss of the warship *Hazardous* in 1706 was to create an underwater 'milestone' from which the subsequent progress of local seabed processes might be measured. This site is now nationally designated under the Protection of Wrecks Act 1973. While this addresses its cultural importance its palaeoenvironmental significance should not be overlooked.

The population of the Selsey peninsular was to remain sparse and rural until an explosion of resort development brought new urban colonisation to East Wittering, Bracklesham and Selsey in the later 19th century. It would be these new populations that would create particular demands for coastal protection on this formerly remote coast.

The Chichester-Selsey area in recent times

It is the resort development at East Wittering, Bracklesham and Selsey that now characterises this coast. Within the coastal landscape an array of anti-tank blocks, bombing decoys and machine gun emplacements also provide historic testimony of the 2nd World War. Most of the built cultural assets of this coastline are less than 100 years old yet there is now sufficient head of population and property to fulfil the cost-benefit criterion for coastal protection.

8.11.3 Summary of geology and geomorphology within the study area

The physical nature of the study area

The shore environment and the coastal processes of the study area are complex with a principal division falling at Selsey Bill. To the west, Bracklesham Bay presents a swash-aligned shoreline leading Selsey Bill and the Mixon Rock. The reef at this point has been instrumental in protecting the southernmost shoreline from a west and south-western wave climate.

Geomorphologists have noted that that there is no large river system within the coastal plain of Chichester Harbour. This suggests that, during the Holocene, patterns of sedimentation in these areas is likely to have differed significantly from the major river valleys such as the Solent and Arun (Bates 2005). Through archaeological and sedimentological investigations a former continuous tidal creek has been detected linking Pagham Harbour with Bracklesham Bay (Heron-Allen, 1911). It is believed that this may date back at least 2,000 years, perhaps resulting from a major breach of an earlier barrier beach at Bracklesham Bay in the locality of Medmerry (Wallace, 1990). The Medmerry barrier is believed to have re-formed and breached several times during subsequent centuries. At times it may have isolated the Selsey peninsula to form an island. Archaeological evidence suggests that in late prehistoric times the coastline was some 2 to 3km seawards of its present position (Cavis-Brown, 1910; White, 1934; Wallace, 1967).

It seems that coastal erosion may since have occurred at a rate at least as fast as that recorded for the nineteenth and first half of the twentieth centuries (May, 1966). Documentary evidence for the medieval period (Bone, 1996) also indicates rapid coastline recession, especially during major storms.

Coastal geomorphology

The solid geology of the Selsey coastline comprises the Bracklesham Group of sandstones and clays. These provide a soft foreshore substrate that is highly susceptible to erosion. These are overlain by Quaternary drift deposits.

Prior to the construction of comprehensive "hard" defences, between 1962 and 1969, much of the tip of the Selsey peninsula provided inputs of easily eroded sediment from wave-induced cliff and shore-face erosion. This had been the case for over 1300 years. This can account for over 2 km of coastline retreat since the second or third centuries AD (Ballard, 1910; Heron-Allen, 1911; White, 1934).

There is a rich, yet partially explored, offshore archaeological legacy of submerged Roman, Saxon and early medieval landscape features (Heron-Allen, 1911; Wallace, 1990). Further information on past retreat is offered by documentary and archival sources.

During the last Interglacial (the Ipswichian stage), a raised beach was formed over the earlier Quaternary deposits (Reid, 1892; West and Sparks, 1960). Traces of these deposits are now restricted to a few localities.

During the Late Devensian, or perhaps the early Holocene, loamy silts were laid down on the raised beach deposits. These now provide a substrate to the modern soil profiles. These deposits overlie the most recent of a sequence of marine erosional platforms that extend 25km inland. The platforms have been interpreted as the product of successive sea-level transgressions during the Middle Pleistocene. They have been punctuated by regressive stages that have been subsequently displaced by neo-tectonic movements (Bates, 1998, 2000; Hodgson 1964).

Coastal management issues

Key contemporary habitats include ‘vegetated shingle’ at Pagham spits and Bracklesham Bay and sand dunes at East Head. There are also inter-tidal mudflats and saltmarsh in Pagham Harbour and behind East Head spit.

Beach management operations throughout this area involve gravel recharge and re-profiling. There are also structures that now largely control sediment transport and

attempt to maintain beach stability. However, the low-lying and erosive nature of this shoreline and its modest supply of natural sediment present a perplexing future. The potential effects of climate change and sea-level rise create further uncertainties concerning the sustainability of the present line of defence (Halcrow, 2002).

8.11.4 Coastal units within the study area

The Chichester-Selsey study area falls within two shoreline management plans. The first is the East Solent Shoreline Management Plan covering Chichester Harbour to Selsey Bill. To the east, the South Downs Shoreline Management Plan covers Selsey Bill to Pagham Harbour. It also offers some overlap at Selsey Bill.

The area falls within four management units (shown if figure 8.41). These are:-
Unit 2, East Beach to West Beach, Selsey. HOLD THE LINE
Unit 3, West Beach, Selsey to Bracklesham; HOLD THE LINE IN THE SHORT TERM
Unit 4 from Bracklesham to East Wittering HOLD THE LINE
Unit 5 from Cakeham Estate to East Head. HOLD THE LINE

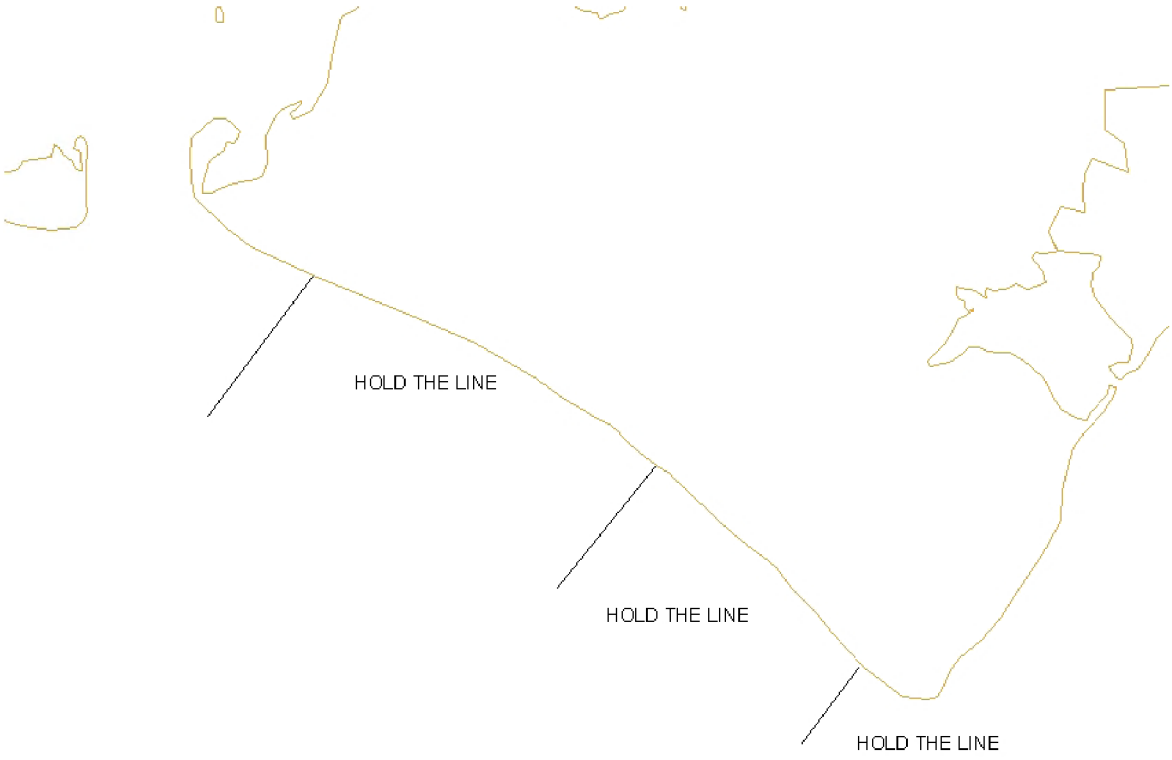


Figure 8.41 Map showing the Chichester – Selsey Study Area coastal management cells

8.11.5 Results of scoring

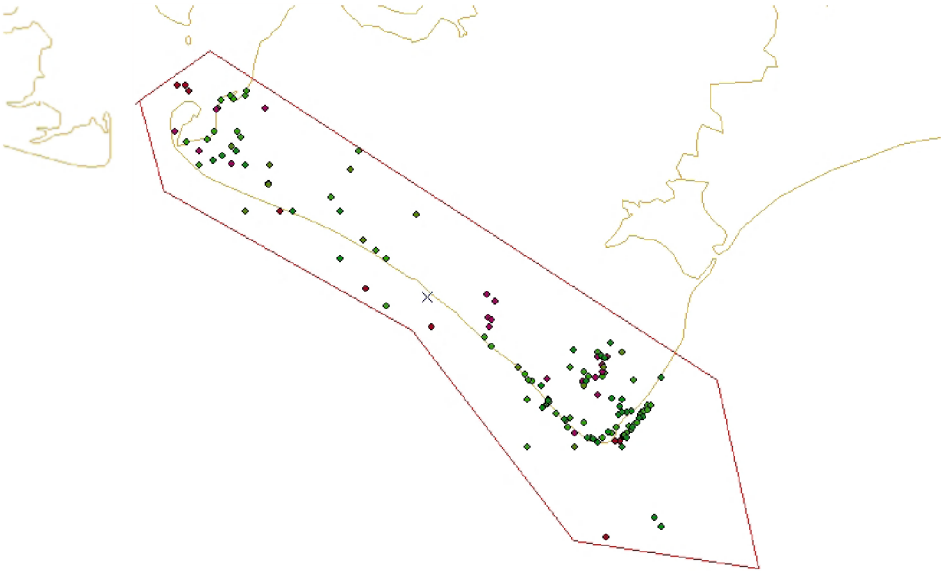


Figure 8.42 Map showing the distribution of sites within the Chichester - Selsey study area

Rapid coastal erosion in this study area has created a high proportion of offshore sites that were once part of the terrestrial environment. A total of 184 sites fell within the study area (figure 8.42). Of these, it was possible to assign scores to 73, the twenty highest scoring of these have been shown in figure 8.43.

SMR_NO	SITE_NAME	PERIOD	Sea level Change	Climatic change	Environmental Change	Running chronology	Fragility	Total Score
WS4054	Roman Lighthouse - Mixon Hole	Roman	4	3	4	2	3	16
WS5713	Mammoth remains - offshore - Selsey	Prehistoric	3	3	3	3	3	15
WS1701	Mesolithic implements - offshore - Selsey	Mesolithic	3	2	3	3	3	14
WS1381	Palaeolithic axe - foreshore West Wittering	Palaeolithic	3	2	3	2	4	14
WS1384	Neolithic site - Chi Harbour(CH-2)	Neolithic	3	2	3	2	4	14
MHM36	Warship Hazardous Wreck		3	2	3	2	4	14
WS1386	Neolithic site - Chi Harbour(CH-6)	Neolithic	3	2	3	2	4	14
WS3386	Neolithic pottery - Selsey shoreline	Neolithic	3	2	2	2	4	13
WS1695	Palaeolithic implements - Selsey	Palaeolithic	3	2	3	2	3	13
WS1706	RB pottery - offshore - Selsey	Roman	2	2	3	2	4	13
WS1383	Neolithic site - Chi Harbour(CH-1)	Neolithic	2	2	3	2	4	13
WS1382	Poss. Neolithic site - Chi Harbour(CH-5)	Neolithic	2	2	3	1	4	12
WS1657	RB pottery - offshore - Selsey Bill	Roman	2	2	3	1	4	12
WS1663	Medieval wells - offshore - Selsey	Medieval	2	2	3	2	3	12
WS1669	Quarry - Mixon Shoal	Roman	3	1	3	2	3	12
WS1691	RB pottery and Roman coin - Selsey beach	Roman	3	1	3	2	3	12

WS1710	Mesolithic axe - offshore - Selsey	Mesolithic	2	2	2	2	4	12
WS1712	RB pottery - Selsey	Roman	2	2	2	2	4	12
WS5174	Brick kiln - foreshore West Wittering	Post Medieval	2	2	2	2	4	12
WS5750	Greek finds - Selsey	Iron Age	2	2	3	2	3	12

Table 11 Scoring results from the top twenty sites within the Chichester - Selsey study area

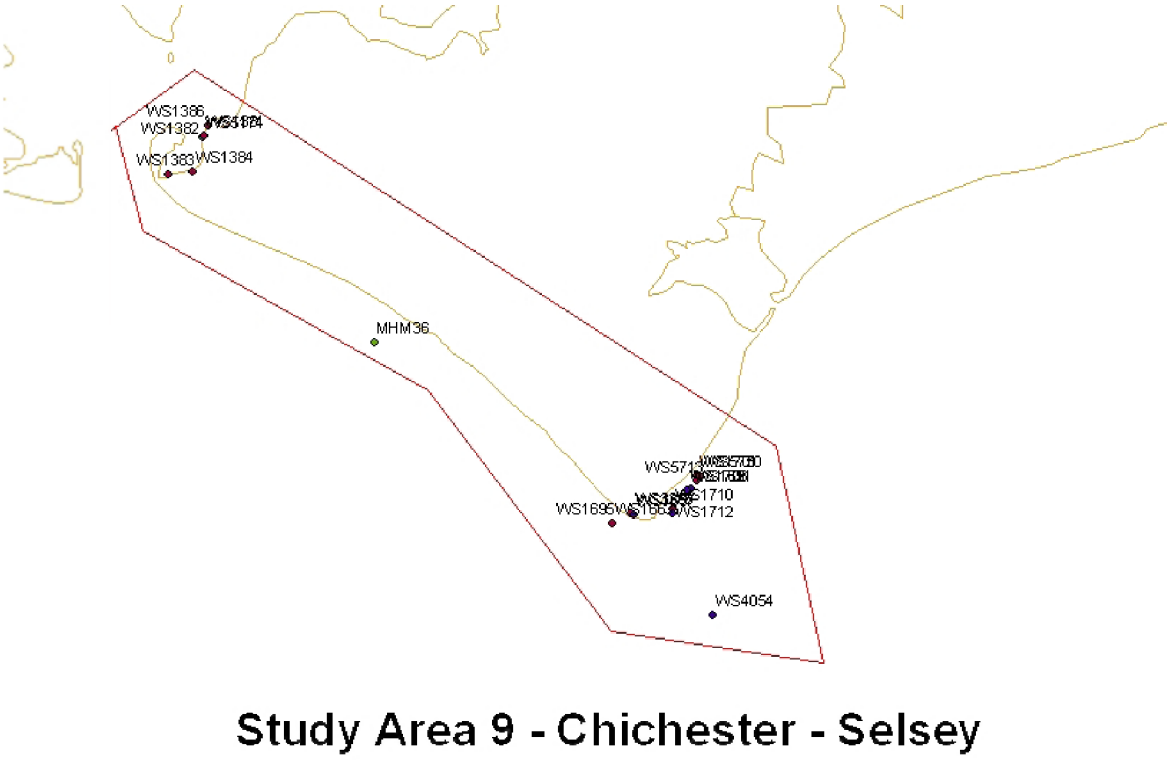
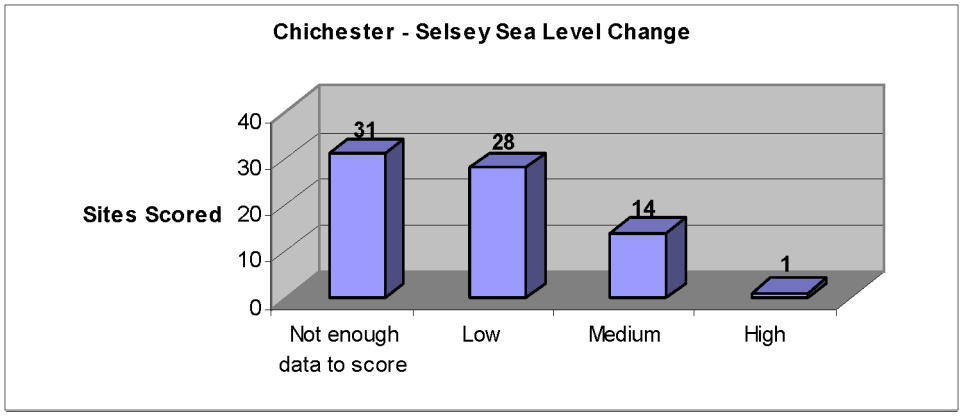


Figure 8.43 Map showing the distribution of highest scoring sites within the Chichester - Selsey study area

Scores for sea-level change



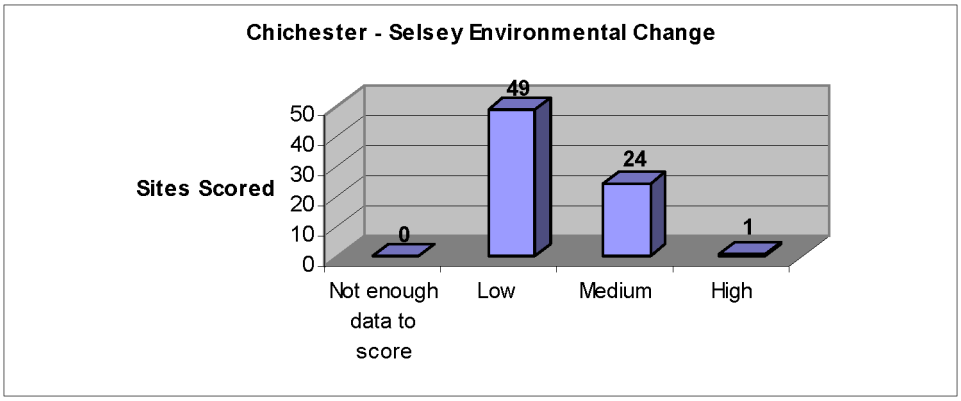
A good range of scores were ascribed within this category with 14 sites offering 'medium' potential and one site scoring 'high'. These sites are those of the earlier and later

prehistoric periods. They include a number of discoveries off the Selsey coast as well as sites around the harbour.

Iron Age and Roman structures are included in the scores. It has long been postulated that Roman occupation is preserved offshore, the Mixon Hole Quarry being one possible site. The site with the highest score in this section is the possible remains of a Roman lighthouse at the Mixon Hole.

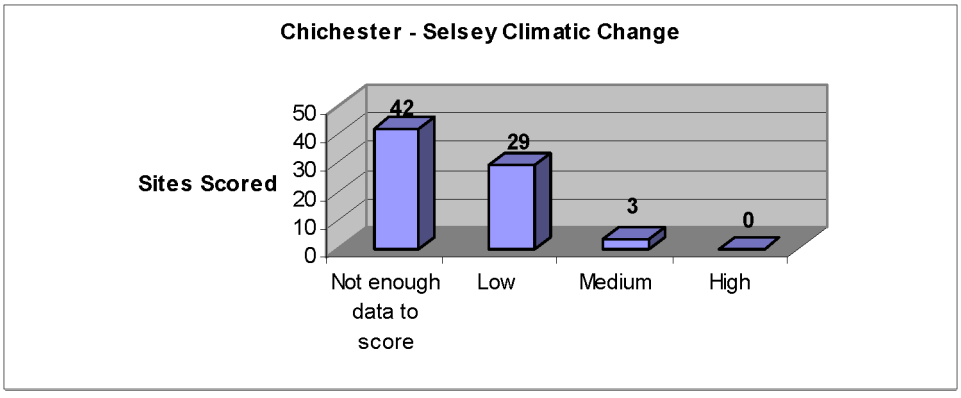
The nationally important historic wreck site of the warship *Hazardous* also features as a 'medium' score. The vessel can provide information on sea-level at the time of its wrecking and data on progressive changes leading to present day erosion.

Scores for environmental change criteria



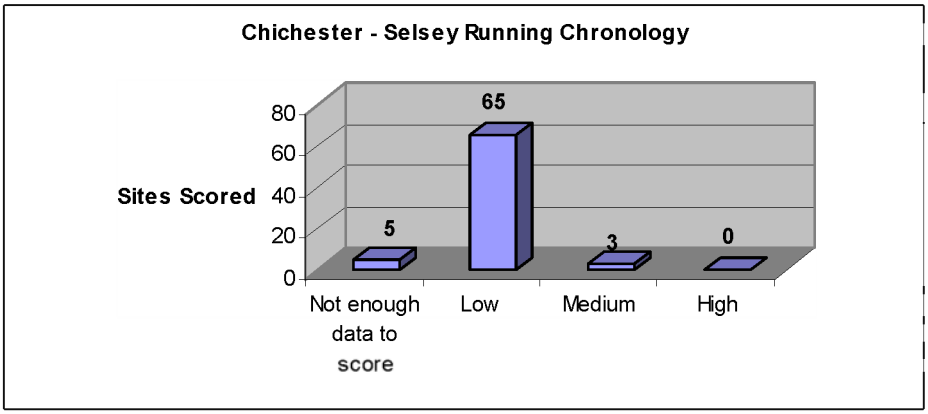
All sites have scored for this criterion. 24 sites are deemed to offer 'medium' potential and one site has been scored 'high'. The pattern of scoring is similar to that for the sea-level change category. An interesting member of the highest scores is the medieval well discovered off Selsey.

Scores for climatic change criteria



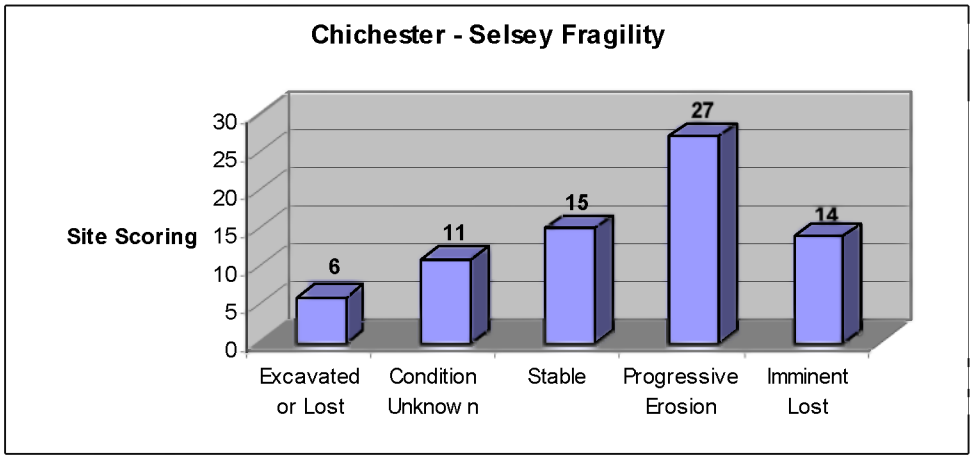
Three sites offer 'medium' potential to inform on climatic change. These include the possible Roman lighthouse off Selsey and a sediment archive with mammoth remains on the foreshore.

Scores for running chronology



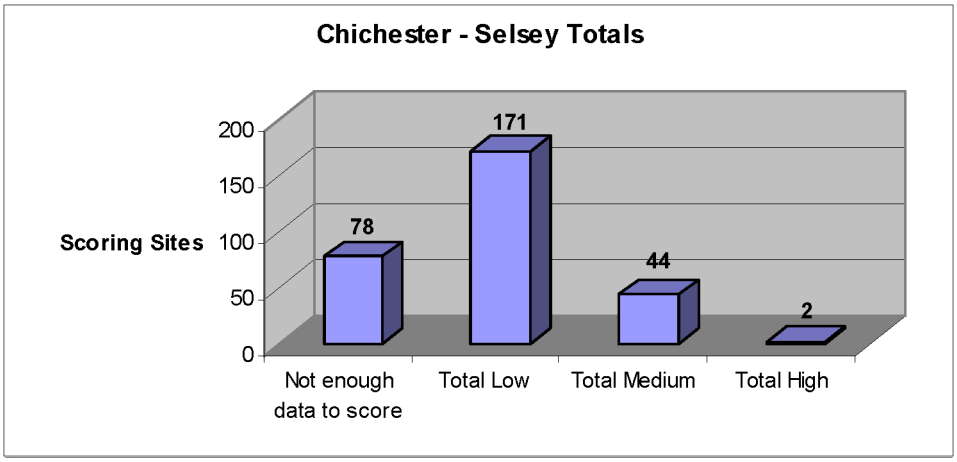
Three sites offer 'medium' potential under this criterion. Here the sediment archive with mammoth remains has been recognised along with Mesolithic implements found offshore. The dates for these two sites are many thousands of years apart. They demonstrate the need to pursue all datable evidence that can provide data on temporal continuity and change.

Scores for fragility criteria



A proportionally high number of the scored sites were considered to be at risk of 'progressive erosion' or 'imminent loss'. This is not surprising given the highly dynamic nature of this soft exposed coastline.

Combined total scores



The score totals for this exercise show that only 26% of the sites showed insufficient data for scoring.

8.11.6 Discussion of scoring results

This study area differs from most by virtue of the notable number of offshore sites of significance to coastal studies. It seems re-assuring to see in the score of 'totals' that the number of sites with insufficient scoring data is no more than 26%. Although two sites have won high scores, their specific contribution to the overall problems on this coast will still be limited. It is amongst the 44 sites of medium potential that further and helpful information may be won.

It is important to note that the number of ancient wetlands and potential sediment archives for the Holocene period in this region may not necessarily be well covered by the present Sites and Monuments Record for West Sussex. The presence of biostratigraphical deposits attesting the past inundation history of the Selsey region will be of the greatest value to future coastal planning. It is strongly suspected that the most propitious sites are still unrecognised and will have escaped this desk-top evaluation.

8.11.7 Implications for shoreline management in this area

The study area encompasses some severe coastal management problems where a relatively 'young' episode of coastal settlement and development has brought a significant population to a weak coastline with a long history of rapid erosion and coastal retreat.

At present the Shoreline Management Plan attempts to HOLD THE LINE while knowledge of the nature scale and pace of preceding coastal change is still poorly understood. Archaeology in the offshore zone offers some explicit examples of coastal-loss but it currently fails to provide a calibrated timetable of past and proceeding coastal changes.

The prescription for Management Unit 3 recognises the technical uncertainty of successfully maintaining the line of sea-defence on this coast. An informed appraisal of future possibilities and scenarios is needed. This should be based upon wisdom of hind-sight that can draw from a clear understanding of the past.

The revision of the Shoreline Management Plan should recognise the need to gather quantitative and qualitative evidence of the past behaviour of this coastland including earlier inundation, storm floodings, estuarine and riverine behaviour and changes in topography. An appraisal of the nature and movement of past human settlement is needed and a survey and investigation of sediment archives is particularly required.

Particular attention should be given to the course of Later Holocene events that have led to the present scenario in this coast. A project design should now be prepared that will enable fieldwork and fresh data-gathering to commence. The results should guide the course of the revised shoreline management plan.

8.12 Arun

8.12.1 Introduction to the Arun study area

This is the most easterly of the study areas. It is centred on the mouth and lower course of the Arun River, its immediate surroundings and the off-shore zone. The open shore has a long yet poorly calibrated history of rapid erosion. Temporal and causal connections with coastal changes at Selsey deserve particular attention.

The Arun is the longest river of Sussex. Its tidal penetration runs from Littlehampton to Pallingham; a course that has cut deep through the chalk of the Sussex downs. This river has been tidally navigated at least since Roman times.

There are two major centres of settlement on the river. Arundel is a medieval town and a diminished riverine port lying 6km from the sea. Littlehampton is a post-medieval port and resort on the east bank of the rivermouth. The Arun valley is a broad alluvial plain offering low-lying grazing marsh with some relict areas of peat that mark the former presence of bog. The lower valley was once a wider estuary but it has since been in-filled by natural sedimentation. This has been assisted by successive reclamations that have constrained the course of the river. This history of embanking and draining covers some 500 years (Wallace, 1990). The sediments of the valley floor offer a valuable archive of the Holocene events that have shaped the river, its mouth and its coast.

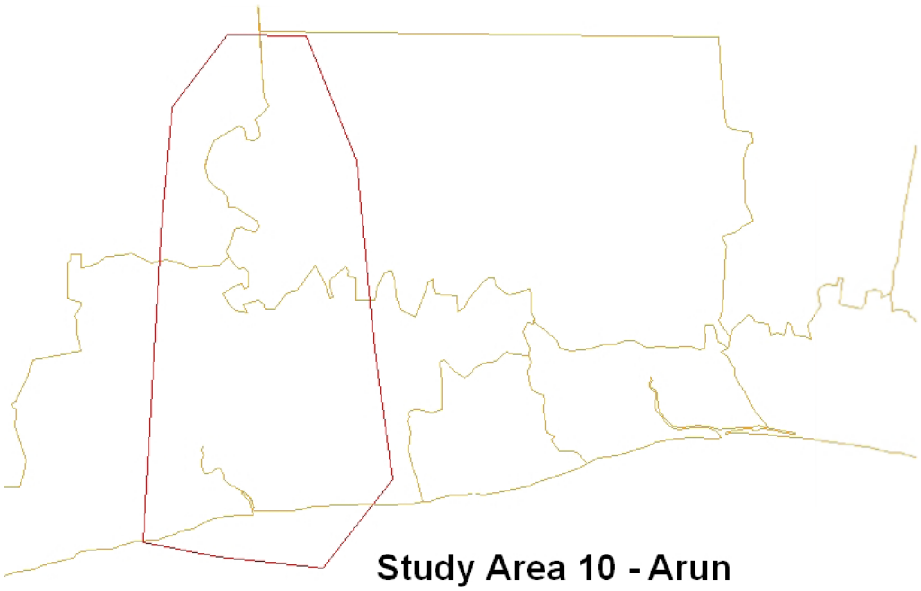


Figure 8.44 Map showing the Arun study area

8.12.2 Summary of the archaeology and history of the Arun study area

The Arun River and coastal area in early prehistory

Research in the offshore zone has demonstrated that the Pleistocene Arun was a longer river that once provided a tributary to the larger 'English Channel River'. The confluence lay some 30km off the present coast of West Sussex (Bates 2001). Recent offshore investigations have located the palaeochannel where the early Holocene sediments of this lost portion of the river have been traced at depths of -20m to -40m OD. These submerged sediments reveal the character of the river margins around 9000BP (Scaife, pers. com). The general character of the submerged landscape on the 'Sussex shelf' has been further examined with the help of vibra-core samples (Bellamy, 1995).

In the onshore zone, some evidence of the Holocene sedimentation of the Arun River has been examined at Felpsham and Arundel. At Felpsham, archaeological investigations have produced biostratigraphical evidence showing that the mouth of the Arun in mid Holocene times was sufficiently obstructed by shingle barrier bars to create back-ponding. Up-stream near Arundel, at the Swanbourne Lake, these conditions have been confirmed in a 9m core sunk through peats and silts in the valley floor. No absolute dates have been obtained from this core but the character of the pollen record suggests that the samples in this section begin in the 1st millennium BC and terminate before AD1700 (Scaife, pers. com). This core failed to 'bottom' the valley fill and its uppermost sediments had been disturbed.

Episodes of estuary expansion and contraction have recently been recognised in south coast rivers in the Southampton region (Long, Scaife & Edwards, 2000) but the past behaviour the Arun has yet to be fully established. Temporal and causal links between this coast and coastal behaviour in the Selsey study area deserve particular investigation.

Palaeolithic implements and hand axes have been found, most notably on West Beach. Several sites containing Mesolithic material have been found in the study area. These include a flint working site at Barn Nursery and a possible settlement site at Lickfold Farm. Further evidence is provided by artefacts at Bracklesham Bay.

The Arun River and coastal area in later prehistory
Prehistoric settlement on, and skirting, the floodplain of the Arun can offer helpful evidence of the past behaviour of the river and the water-table. On the coastal plain, similar evidence may be gathered at low-lying locations at Felpham, Middleton-on-Sea, Littlehampton, Rustington and Angmering-on-Sea.

The Middle Iron Age saw human settlement focused on hillforts on the high chalk. This reveals nothing of the river valley and the coast. The late Iron Age shows a population shifting to a spread of small enclosed farmsteads. These settlements are especially notable on the West Sussex coastal plain. Within the floodplain of the Arun, prehistoric dug-out canoes have been found in earlier times. Such finds can be particularly instructive with regard to contemporary water-table, environment and climate. It is unfortunate that these were not better recorded. Their find-spots should be considered appropriate sites for future coring. At Swanbourne Lake a sediment archive yielding a detailed pollen record demonstrates a high potential for recovering a long-term evidence of the past behaviour of the river under back-ponded and flooded conditions.

The Arun River and coastal area during the Roman period
During the Roman period various buildings were erected in the Littlehampton area. A high status villa building was also constructed at Arundel where it does not appear to have been occupied much beyond the 1st century AD. Upstream, at Wiggonholt, a successful pottery industry and settlement was nurtured and Roman roads were constructed across the valley floor in the neighbourhood of Hardham. The relationship between the roads and settlement and the valley alluvium may be instructive.

The estuarine river from the Hardham-Pullborough area to the sea offered an export route for Wealden products including pottery and iron ore. The relationship between the early villa at Arundel and the villa-type buildings of the Littlehampton area may be instructive. A failure of villa life at Arundel and the rise of Roman settlement in the area of Littlehampton and Angmering may reflect navigation difficulties for larger boats attempting to move upstream. More information is needed on the relationship between

Roman settlement on the river and coastal margins and the nature of the contemporary sea-level and water-table.

The Arun River and coastal area during the medieval period

The coastal zone

It is evident that a major loss of coastal land began on this coast during the late medieval period. This concerns the loss of the community of Cudlow. In the early 14th century this parish embraced four prosperous manors at Ford, Climping, Ilsham and Atherinton. A well stocked demesne farm was also present here. A successful port was in operation and was sufficiently prosperous to send a ship to support the King's expedition to Brittany. This gesture places Cudlow on par with the ports of Pevensey and Seaford (VCH, 1997).

It seems that Cudlow expanded its holdings by building banks and ditches that could reclaim natural marshland on the margins of the Arun estuary. Some early earthen defences can still be identified on the riverine boundaries of Climping, Ford and Atherington (VCH, 1997). As early as 1362 problems were emerging when the lord's income from land in Cudlow was reduced as a result of flooding. These were early indications of greater misfortunes that were yet to come.

The estuarine zone

Arundel claims origins as a late Saxon town or *burh* sited on a steep chalk spur on the west bank of the Arun. It seems to have replaced an earlier defended *burh* on the opposite side of the chalk gap at Burpham. The switch may well be related to contemporary shifts in the course of the estuarine river.

Arundel flourished after the Norman Conquest when a robust castle was built here and waterfront facilities developed to service a growing Anglo-Norman trade. The port was of note at the time of *Domesday* and, later, pottery, tile-making and brick-making developed as local industries. Eventually, a road from Southampton to Canterbury established Arundel as the lowest bridging point on the river. These developments should have enhanced the town's prosperity but trade declined after the mid 15th century. The causes are not clear but we should consider possible changes in the character the lower Arun estuary and the access it might naturally permit or deny to shipping.

The Arun River and coastal area during the post-medieval period

It was after the arrival of Cornelius Vermuyden in England the early 17th century that large-scale land-drainage scheme was pursued on a national scale. These changes were promoted by an English Act of Parliament of 1600. This sought to encourage '*the recovering of many acres of marshes*' and it was driven by the popular Protestant sentiments of 'making good of waste' and 'prospering through endeavour'. Faith would be cruelly tested on the harsh threshold of the sea.

On the floodplain of the Arun it is possible that the reclamation of 'waste' wetland and the construction of containment banks imposed a significant impact on the mouth of the river and its adjacent coast. The course of events has been well documented in the diminished coastal parish of Cudlow where enterprising reclamations had been pursued since at least the 13th century. These endeavours had proceeded in parallel with a series of natural events that were to completely undermine and destroy this port community.

By 1511, flooding and erosion in the coastal zone had reduced church income at Cudlow to a pitiful level. This was soon followed by incursions of the sea in the neighbouring manor of Atherington; here rent incomes had to be promptly reduced.

Between 1606 and 1751, the neighbouring hamlet of Shortsmare lost 57% of its land to coastal erosion. By 1774 eye-witnesses considered that 'a considerable part of the coast was being swept away each year' (VCH, 1997). At this time 12 timber groynes were erected at West Cudlow but 'daily encroachments' were still to follow. By c.1790 the cost of maintaining these defences seemed to outstrip the value of the land.

In the 19th century coastal erosion was still continuing in western and central parts of Cudlow parish. Groynes had been positioned in five places by 1843 and more were installed before 1900. A severe gale of 1875 damaged these defences.

An unknown element is the relationship between the train of erosion episodes on this coastline and the course of events in the adjacent study area at Selsey Bill. It was from the latter that the principal supply of sediment appears to have come. One response to erosion at Selsey may be shifts in the position of the mouth of the Arun. By 1587 an eastward deflection of the mouth had been created by the formation of a small spit. During the 17th century this spit was sufficiently large and obstructive to warrant intervention. This was achieved by cutting the present channel under an Act of 1733.

It was not until 1816 that the 'wandering' river mouth of the Arun was finally stabilised. This was achieved by the construction of two walled piers. For seafarers, this presented an attractive change in favour of Littlehampton as a point of anchorage. It would also accelerate the decline of Arundel as a regular port. Up until the seventeenth century Littlehampton had a population of no more than 150 people. In 1801 it had risen to 584 and by 1824 its developing port was already receiving four times the amount of sea-going traffic that was arriving at Arundel. Nevertheless, Arundel's commerce was still expanding and was especially assisted by the opening of the Wey and Arun canal in 1816.

In the 1840's the arrival of the railway made the growth Littlehampton assured. Larger ships could now unload here and thereby avert the tiresome upstream navigation of the river In the mid 19th century, coal as well as timber was still being sent up-river from Arundel into Surrey. By 1886 Arundel's chief traffic was barges rather than ships. These numbered no more than twenty and carried timber, coal, and building materials. By 1904 a few large sea-going vessels would still reach the wharves of Arundel when using the tide.

The Arun River and coastal area in recent times

In 1901 Christ's Hospital took out a foreshore lease in the south-west corner of the old Cudlow parish. This permitted the construction of beach defences that would protect the hospital's land-holdings. New groynes were installed on this coast in 1906 when the cost was then considered to be a heavy expense on the owners of the neighbouring land. Later, during World War II, the area was populated with an array of military defences. Some if these may now offer a yardstick with which to subsequent coastland changes might be measured. In 1991 the protection of this coast against coastal processes was improved by the installation of a concrete wall.

The history of the demise of the port of Cudlow shows that past losses of land at the mouth of the Arun have been achieved by a combination of coastal erosion from the south and riverine inundation from the east. In 1913 the river bank of the Arun was breached by a storm and in 1960 another flooding occurred. These floodings appear to mirror earlier events when the effects of inundation were not always reversible.

8.12.3 Summary of geology and geomorphology within the study area

The physical nature of the study area

The Arun flows for 25.5 miles and rises 120 metres above sea-level at its source at St Leonard's Forest near Horsham. It is the second fastest flowing river in the country and it is prone to flash flooding after heavy rainfall. The Arun river channel has been embanked and its estuary has been almost completely reclaimed. This has reduced the tidal prism and the inlet-flushing capacity of the river.

Along its course the Arun it has cut a deep channel through the chalk bedrock of the Sussex downs. This course it has subsequently in-filled with alluvium. This process of sedimentation has been described by Bellamy (1995) who has examined the valley fills in a buried channel offshore. This cross-section has been seen at a point where an earlier portion of the Arun is now submerged on the 'Sussex shelf'. Here the river once served as a tributary of the 'Northern Palaeovalley' of the 'English Channel River'. This ancient river-course belongs to the Devensian glacial period.

The modern shoreline of the study area has a slightly arcuate plan-form and a near west to east alignment. Its continuity is interrupted by the Arun. Most of this coastline is open to a moderate to high-energy wave climate driven by wind-generated waves from the English Channel. The waves generally approach from the south-east, south and south-west. There are also swell waves that are propagated from the west and diffracted around the Isle of Wight.

Coastal geomorphology

The coastline of the study area is dominated by littoral drift moving from west to east. Its pathway follows the gravel of the upper beaches and the sands of the lower foreshores. The direction of movement is demonstrated by Shoreham Spit where the mouth of the Arun has been historically deflected to the east.

An analysis of the historical evolution of the mouth of Arun by Jezard (2003) reveals a number of changes in the river-mouth. These have included the installation of the first piers in the early 19th century. These mark the first steps in straightening and 'training' the river into a course better suited to navigation. Movement of the beach is now managed by a near-continuous train of groynes. Intensive management of the shoreline over the past 100-150 years has inhibited the natural tendency for landward migration of the shoreline. The first reliable map to show the offset alignment of the West Beach and East Beach is dated 1830. Before that time there is some documentary record of changes in 1793 and 1825.

Along the East Beach, a retreat of more than 100m has occurred in the position of low water between 1875 and 1979 (Gifford Associated Consultants, 1997). Much of this represents adjustment following the construction of the piers and training works. Most of this sediment-bypassing scheme had been completed by 1900. However, a further advance of low water mark has been recorded since 1930 (Jezard, 2003).

Tidal scour at the mouth of Littlehampton Harbour has maintained the inlet and the depth of clearance over the harbour bar. The bar has an inner and an outer component; the inner being the more dynamic. Here, there has been little overall morphological change since the late nineteenth century.

Coastal management issues

The study area is of particular interest for its gravel beaches and its embanked tidal river. The river occupies a wide low-lying flood plain that has been formed from a reclaimed

estuary. Its artificial embankments are of notable antiquity and are the only means of retaining the river from its tendency to resume its natural course.

Historical evidence shows the coastline has been subject to drastic recession. Some erosion may have been sustained over long periods. Other attacks may belong to specific rapid advances of the sea that have yet to be calibrated or understood. Some of these episodes may be associated with a train of coastal changes that are also poorly understood in the neighbouring study area of Selsey Bill.

Since some interventions were made in the nineteenth century, coastal erosion between Bognor and Littlehampton has shown some reduction (Harper, 1985). Present interventions involve gravel recharge, re-cycling and bypassing. These are supported by control structures that have been carefully designed to maintained and manage sediment-transport and to promote beach stability. Given the low-lying and degradable nature of this shoreline, and its limited supplies of natural sediment, there is uncertainty concerning its future resilience. Predictions for sea-level rise and climate-change create further uncertainties regarding the long-term prospects of holding the present line of coastal defence (Halcrow, 2002).

8.12.4 Coastal units within the study area

The Arun study area falls within the South Downs Shoreline Management Plan. It encompasses three management units all of which propose to HOLD THE LINE.

8.12.5 Results of scoring

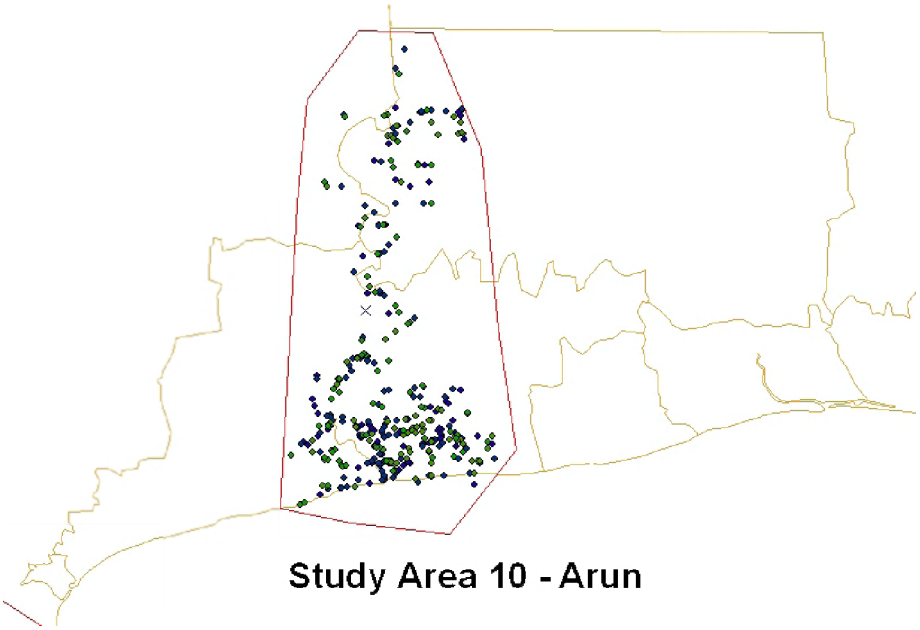


Figure 8.45 Map showing all distribution of sites within the Arun study area

Of 423 sites within the study area (figure 8.45), 58 could be scored. The remaining sites showed no direct relationship with the coast or any relevant changes. These were removed from the dataset so that the enquiry might be refined. The score excludes some palaeoenvironmental sites that showed high value but were not identified in the SMR database.

Twenty highest scoring sites

SMR_NO	Site Name	SITE_TYPE	PERIOD	Sea level Change	Environmental Change	Climatic change	Running chronology	Fragility	Total Score
WS2748	Dugout canoe – North Stoke	MON	Iron Age	3	3	3	3	4	16
WS2706	Homestead moat – Burpham	MON	Medieval	2	3	3	3	2	13
WS3460	Roman pottery – Rustington	MON	Roman	2	3	2	2	4	13
WS3790	Burpham Camp	MON	Medieval	2	3	3	3	2	13
WS3102	A-S sculpture – Ford	FS	Medieval	2	3	2	2	4	13
WS3460	Roman pottery - Rustington	MON	Roman	2	3	2	2	4	13
WS5589	Homestead Moat - Pythingdean Farm	MON	Medieval	2	3	2	2	3	12
WS2732	Beaker pottery and arrowhead - Wiggonholt	FS	Bronze Age	3	3	3	2	1	12
WS2976	Post Medieval house and well – Arundel	MON	Post Medieval	2	3	2	2	3	12
WS2986	Tide mill – Burpham	FS	Medieval	2	3	3	2	2	12
WS3101	St. Andrew's Church – Ford	MON	Medieval	2	3	2	3	2	12
WS3161	St. Mary's Church - East Preston	MON	Medieval	1	3	2	2	3	11
WS3147	St. Margaret's Church – Angmering	MON	Post Medieval	1	3	2	3	2	11
WS3385	Atherington DMV	MON	Medieval	3	3	2	2	1	11
WS3106	Harbour works – Littlehampton	MON	Post Medieval	3	3	2	2	1	11
WS5760	Dock – Ford	MON	Medieval	3	3	2	2	1	11
WS3356	Fittleworth Bridge	MON	Medieval	3	3	1	2	2	11
WS2921	Greatham Bridge	MON	Post Medieval	3	3	1	2	2	11
WS2767	St. John's Church – Bury	MON	Post Medieval	2	2	2	2	3	11
WS2695	Augustinian priory and hospital - Arundel	MON	Post Medieval	3	3	1	2	2	11

Table 12 Scoring results from the top twenty sites within the Arun study area

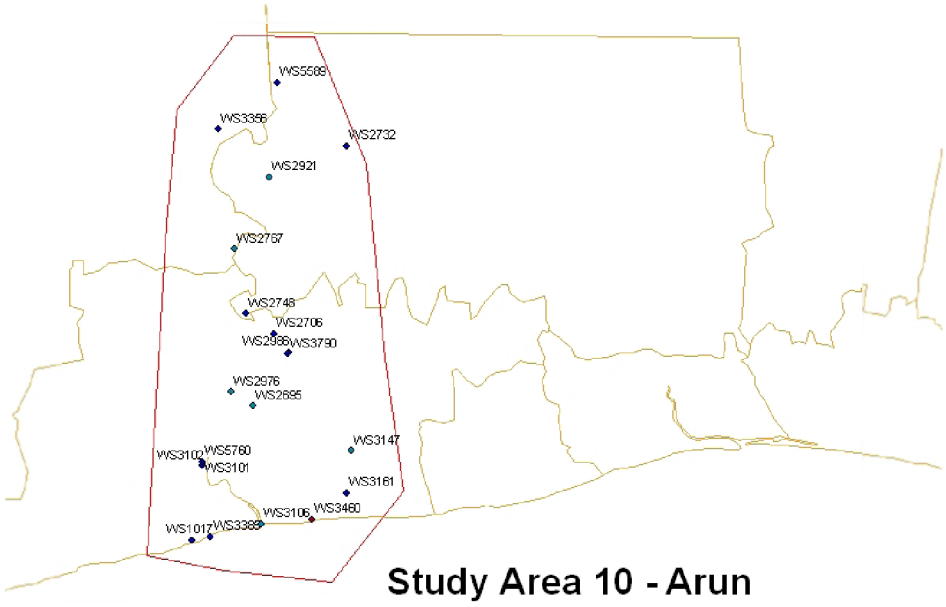
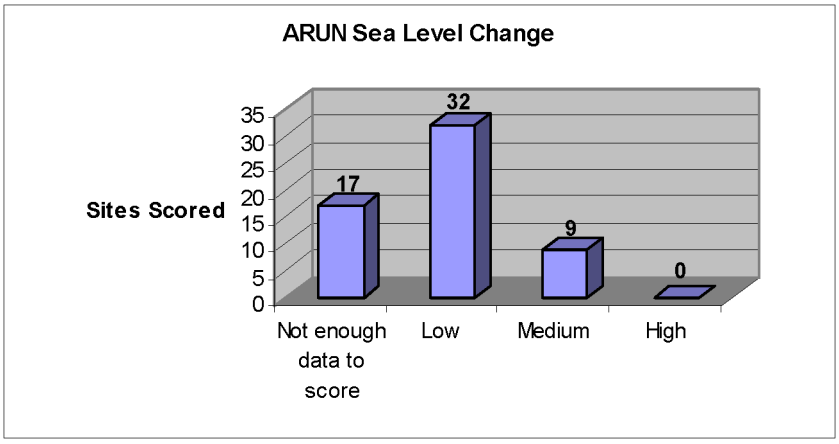


Figure 8.46 Map showing distribution of highest scoring sites within the Arun study area

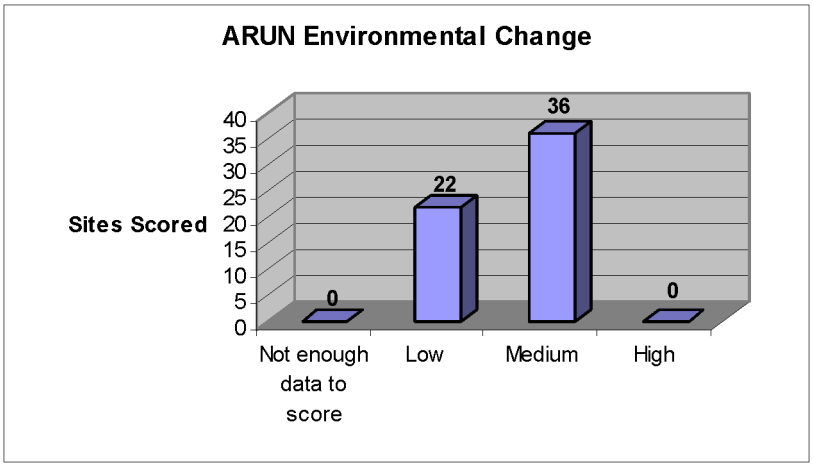
Scores for sea-level change



No site offered a 'high' score with regard to sea-level change. Seventeen sites failed to show enough information yet these could not be discounted because their status might be altered by future investigation.

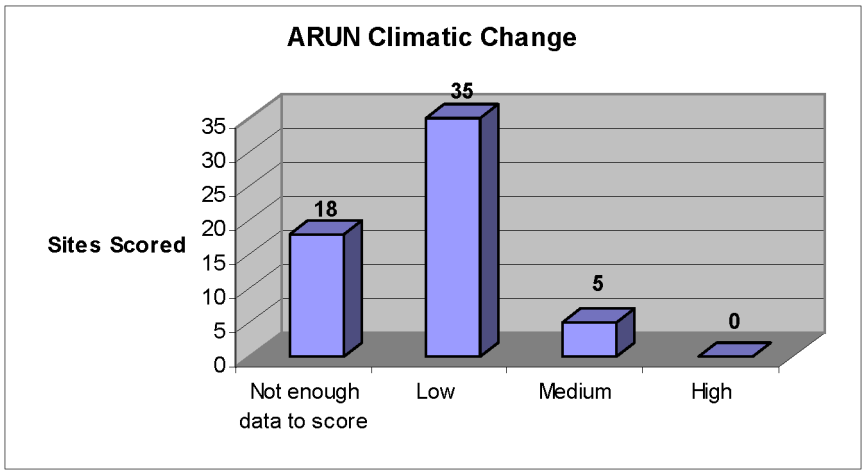
Seven sites offering 'medium' potential include harbour works, bridges and shore-side settlements. Sites of particular interest include the find-spot of an Iron Age log-boat and floodplain sediments containing Bronze Age artefacts.

Scores for environmental change



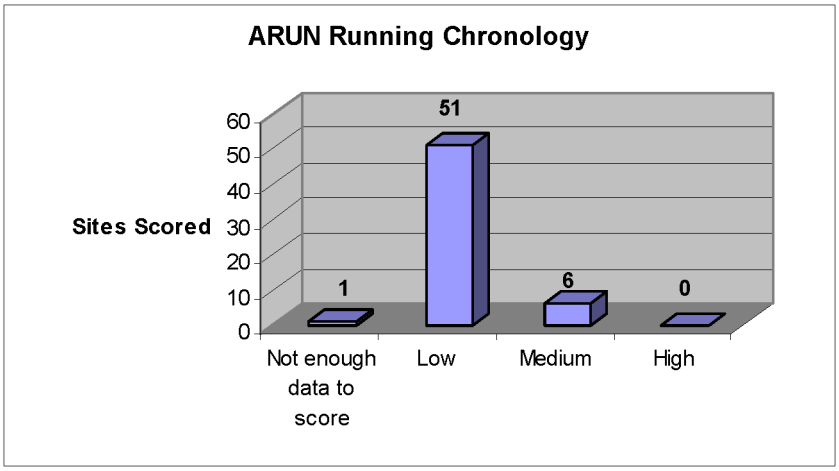
All sites were scored for this criterion. A very high proportion proffered a 'medium' contribution to the study of coastal environmental change. The range of sites includes some medieval settlements and river-side buildings. It should be noted that some particularly informative sediment archives, such as the cores at Felpsham and Swanbourne Lake, were not included in the SMR database. They therefore escaped formal evaluation. This omission reflects current disparities concerning the inclusion of palaeoenvironmental sites in County Sites and Monuments Records.

Scores for climatic change



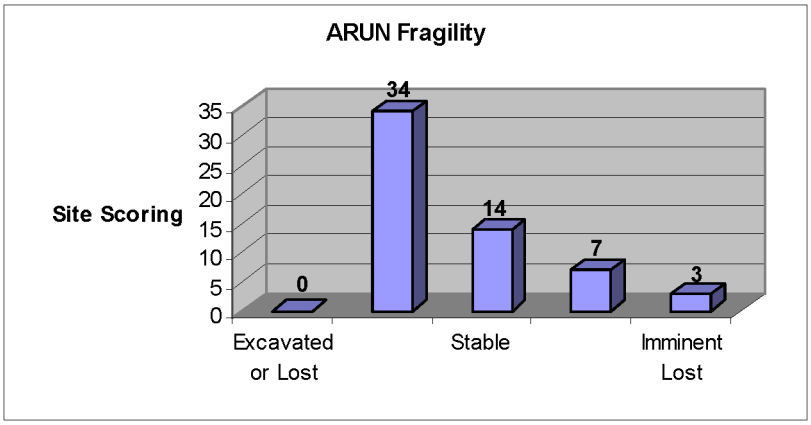
Only five sites achieved a 'medium' score for climate change. These included the log-boat and a potential sediment archive suspected to lie below the valley bluff at the Saxon settlement at Burpham. The context of Bronze Age artefacts found in the floodplain of the Arun also received a medium score. Palaeoenvironmental archives at Felpsham and Swanbourne Lake escaped the scoring procedure.

Scores for running chronology



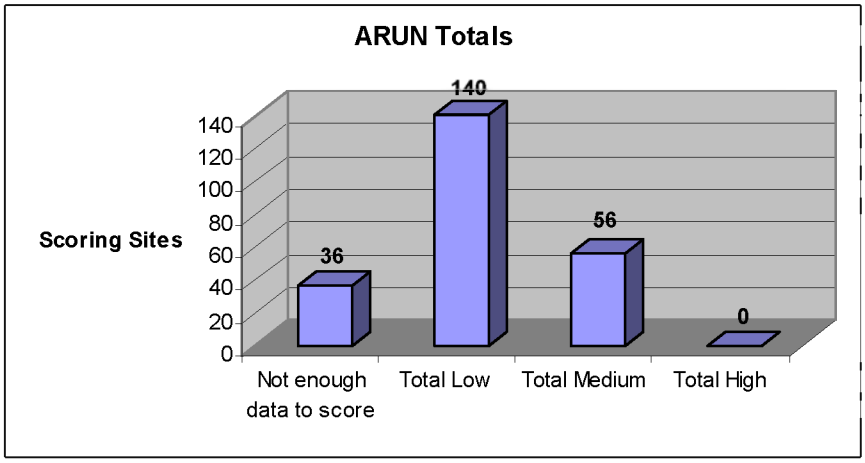
Six sites claimed 'medium' scores for their potential to provide evidence of temporal changes. These included the potential sediment archive at Burpham and two medieval churches that might offer tree-ring evidence. The low positions of the churches could also indicate the presence of helpful stratigraphic evidence of past water-tables and minimum building levels on the alluvial margins of the Arun valley.

Scores for fragility



Not all sites could be scored with regard to the fragility criterion. The seven sites threatened by 'progressive erosion' and the three sites in danger of 'imminent loss' demand further evaluation within the life of the revised shoreline management plan. It is perturbing to see that 59% of all sites could not be assessed with regard to their fragility. Further threat must be anticipated within this group and further investigation is required.

Combined score totals



The chart presents the number of sites that have scored either of low, medium or high in their potential to produce evidence of coastal change in each of the scoring categories. Within this study area there are no sites which, using currently available levels of knowledge can claim high potential to reveal evidence of coastal change. It should be noted, however, that sediment archives such as those noted, in this text, at Felpsham and Swanbourne Lake have not been included in this calculation.

8.12.6 Discussion of scoring results

The sites thrown up in this analysis are more the product of random finds and fortuitous survivals rather than a reflection of the archaeological and palaeoenvironmental resource that is actually present. Much of this study area is rural pastoral landscape which has experienced little disturbance or investigation. A lack of disturbance commonly leads to a lack of data in the historic environmental record. This is especially true of the Arun floodplain. This landscape offers a very high potential to conceal and preserve archaeological and palaeoenvironmental evidence that is pertinent to the past behaviour of the estuarine river and the coast.

The nature of the dataset currently available from the Sites and Monuments Record is such that significant sediment archives of high value to this study may be largely absent from the scoring exercise. The potential of such sites and the need to locate and interrogate them is emphasised in this commentary.

A high number of sites dating from the medieval period fall within the twenty highest scores. This reflects high levels of activity on the river during this period. Their good state of preservation is likely to be due to their abandonment in the post-medieval period.

8.12.7 Implications for shoreline management in this area

The loss of the port of Cudlow and the observed retreat of this coastline during the 19th century show that more needs to be known of the behavioural history of this coastline. A history and assessment of past impacts on human populations and property need to be assembled. Littoral drift links this coast with the Selsey study area where the incidence of past episodes of marked coastal erosion and relative still-stand is also poorly understood.

It is evident from the medieval and post-medieval history of the Climping area that the alluvial wetlands near the mouth of the Arun have been long reclaimed by means of river embankments. Some of these banks are known to have failed. The Arun is now artificially constrained by soft earthen banks throughout its lower course. The geography of its

former configuration is poorly understood. Under flood conditions it is the old course that the river will seek to re-adopt. It is evident that the constraining banks of the river are of some antiquity and their future life may be uncertain. It is also known that the river is historically susceptible to flooding events.

It is possible that there have been inundation and regressive phases in the past history of the river and its floodplain. Potential links between river behaviour, coastal behaviour and climate should be investigated. The behaviour of the river during and after the medieval warm period is of particular interest because the onset of the warm period may reflect the changes now occurring at the opening of the 21st century.

The revised shoreline management plan should recognise that that protection of this coast cannot proceed without integrated objectives linked to the Arun River Management Plan. Both plans need to be fully informed of the past behavioural history of the coast and the river since the mid-Holocene.

A project design is required that will identify and interrogate the principal sediment archives concealed in the coastland and the course of the Arun river. A strategy for field coring and sampling is required building information now gathered at Felpsham and Swanbourne Lake. It should also embrace relevant evidence of past human activity linked to the changing boundaries of the shoreline and the river. The purpose must be to seek and interpret past environmental scenarios that can inform best-knowledge prediction of future coastal and estuarine events.

8.13 Results of the scoring exercise

The present scoring exercise may tell more of the state of contemporary databases rather than the potential of sites that have so far been identified in the field. The greatest proportion of sites with insufficient evidence to award scores fell in the study area of Lyme Regis. This amounted to 243 sites and represented 77% of the entries for this area.

At Poole the number of 'un-scorable' sites was 827 amounting to 62% of the area total. This poor score arose from weak information currently available from the Historic Environment Record. In the West Solent these sites still remained high at 58% followed by Sandown at 49%, Hamble and Portsmouth both at 47% and Chichester/Selsey at 26%. In the Arun study area the 'un-scored' sites fell to a re-assuring 16% but there are caveats in this area concerning a low count for all sites. Here, it is suspected, a broad array of palaeoenvironmental sites have yet to be recognised.

The proportion of sites receiving low scores varies from 60% in Arun to 23% in Lyme Regis. In some instances it can be seen that a low score has occurred because of poor recorded knowledge of the site rather than a proven record of weak scientific evidence contained within the ground.

The number of sites with medium and high scores is low in all of the study areas. Due to the very high incidence of weak documentation at Lyme Regis, no medium or high-scoring sites could be identified. The same problem of documentation has pertained in the Fleet area where only three sites (1%) scored at medium level and no high scores could be awarded.

The largest number of medium-scoring sites occurs in Arun where the total amounts to 56 (24%). In the Chichester/Selsey area the number is 44 (15%). Elsewhere, the proportion of 'medium' scores falls drastically to 3.8% in West Solent, 2.6% in Poole and 2% or less in the remainder. In West Solent the proportion was low but a high number of entries in the Hampshire and Isle of Wight databases still produced a total of 50 sites.

The total number of high-scoring sites identified throughout the SCOPAC region was ten. This amounted to just 0.132% of the 7,570 sites evaluated in the scoring exercise. The high scores comprised 6 sites in Poole, 2 sites in Chichester/Selsey and an individual site each in Hamble and the West Solent. A caveat must be applied to a further site at Bouldnor (West Solent) and to palaeoenvironmental sites at Felpsham and Swanbourne Lake (Arun) that escaped the formal scoring procedure.

Using the scores

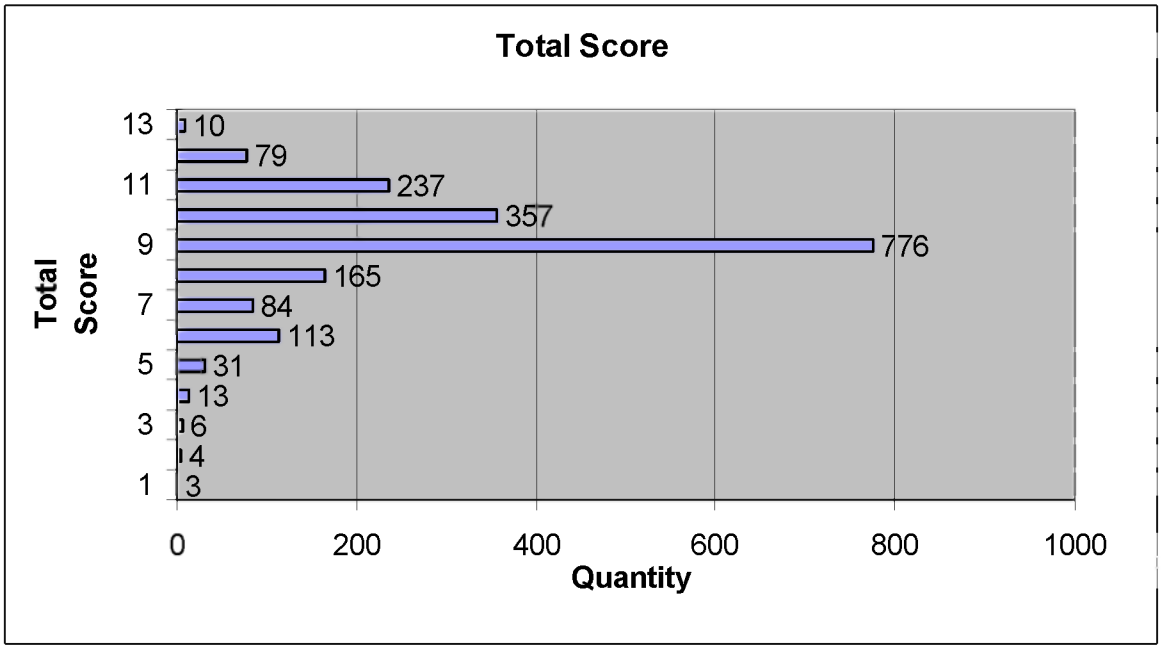
The scores assembled in this report are best used as a means of identifying future sources of information that can guide and reinforce shoreline management plans. They demonstrate that of all the archaeological sites that have been identified in the coastal region, the number offering significant coastal information seems unlikely to exceed 24%.

The score for fragility has been used as a means of weighting some attention on sites that may soon disappear. 'Threat of loss' and 'need of specific coastal information' may prove to be conflicting issues. These will have to be resolved during the next round of shoreline management plans.

Scoring totals

The graph, below, uses the 'total score' assigned to each site (this is a combination of score for the 'sea-level change', 'environmental change', 'climatic change' and 'running

chronology'). It shows how the total scores have been distributed across all of the sites considered.



There is an interesting distribution of results. A classic curve can be seen with the total score of '9' being the most common.

8.14 Review of the scoring exercise

The scoring exercise has usefully identified a small number of sites of specific and immediate value to the development of coastal protection strategies. These are some twelve sites falling in the high-scoring category.

The exercise has also identified where pertinent knowledge concerning the nature, scale and pace of coastal change might be sought amongst archaeological and palaeoenvironmental sites that are currently poorly understood. A few of these sites may be concealed in the low-scoring class but more are likely to be hidden in the body of sites that could not currently be scored.

It would be reasonable to assume that high-scoring sites should be immediately drawn into the shoreline management plans while other sites should be subject to a process of further assessment and review. Further desk-top assessment is particularly needed on the Dorset coast where the current level information can be extracted from the Historic Environment Record has not been sufficiently detailed to permit effective scoring.

Scoring has been an ambitious exercise. It has posed detailed technical queries in a database that has been gathered primarily for the curation of cultural resources rather than palaeoenvironmental ones. The following reflections on the scoring exercise are offered.

The principal difficulties encountered in the scoring:

- Entries for sites and contexts in the county Historic Environment Records and Sites and Monuments Records contain very few records of heights related to Ordnance Datum. This has impeded evaluation.

- Some County Historic Environment Records do not contain a field for 'coastland type'.
- None of the County Historic Environment Records currently contain a field for recording the coastal management unit of the Shoreline Management Plan. This is a particular impediment.
- The use of a single line description from the HER is a poor basis for scoring
- There is a requirement for an experienced archaeologist to undertake the scoring as the process does need a well-rounded background in the historic environment.
- Sites were considered in isolation, rather than in relation to adjacent sites, finds or deposits.
- It is possible to overlook a site that scores 'low' as a single example yet, taken with others nearby, a higher collective significance might be recognised.

Positive aspects of the scoring:

- The creation of a database that has broad scope for interrogation and interpretation on a number of themes and issues related to coastal management
- Enabling the review of large volumes of data against a set of criteria
- The highlighting of individual sites of high potential
- Identifying site types that are most capable of providing information on coastal change

The greatest outcome of the scores is not a list of sites noted for future action. The scores lead to specific areas and environments on the SCOPAC coast where questions concerning the links between past and present coastal behaviour can be positively pursued.

In some cases the type of questions to be asked of the past cannot be clearly framed within the present shoreline management plans. This is because the link between present coastal processes and past coastal processes can still be poorly understood. The scoring process helps to identify particular lacunae in shoreline knowledge. These can be bridged in each of the study areas as knowledge improves. Prescriptions to resolve these gaps in knowledge are set out in the section dealing with '*implications for shoreline management*' in each of the study areas.

8.15 Implications for detailed assessments

This study has revealed that certain types of site and deposit can gain consistent positive scores for their potential to inform on coastal change. Some of these sites can represent single and short-lived episodes. These might include a shipwreck or a prehistoric camp-site. Sites of this kind can occur at a particular height, location or time that is pertinent to the understanding of shoreline-change.

Other sites can offer a broader range or sequence of chronological and environmental information. They can include biostratigraphical evidence such as pollen records in peat deposits, diatoms in accrued marine sediments and plant macro-fossils in river valley alluvium.

Where short and single-line descriptive texts have been entered into an HER, it is very easy for some of these qualities to escape assessment. In some instances, old and poorly recorded find-spots may suggest the presence of a greater archaeological or palaeoenvironmental resource, even though no such evidence has yet been documented. This can be the case where a scatter of artefacts has been loosely recorded from a floodplain or from a submerged landscape on the coast.

While possibilities such as these have been taken into account in this report, they can only lead to a perceived value and not to a proven one. The move to proven potential can only come with a detailed assessment based a more detailed review of current documentation. This should be followed by a field inspection. In the following annex six sites have been selected for a detailed desk-top assessment to be followed by field inspections in the next phase of the project.

9. The assessment sites - description and consideration

The assessment sites presented in this section have been chosen to demonstrate the range of sites that can provide evidence of coastal change. The character of each site is first described then the archaeological and palaeoenvironmental evidence it may offer. Methods of investigation and analysis are also identified. Finally, an assessment is made of the potential contribution the site may make to an improved understanding of coastal behaviour and coastal change.

9.1 Selection

The rationale behind this selection has been to portray an array of sites that are representative of the variety and complexities by the SCOPAC region. Selection has been guided by a need for geographic diversity and the desirability of considering differing states of preservation and differing time-scales. It has been explained elsewhere in this text that the criterion of fragility or vulnerability has received a score because this issue must be addressed during the planned lifespan of each shoreline management plan. The sites, described below, all proffer information on the nature, scale and pace of coastal change while the criterion of fragility has also influenced their selection.

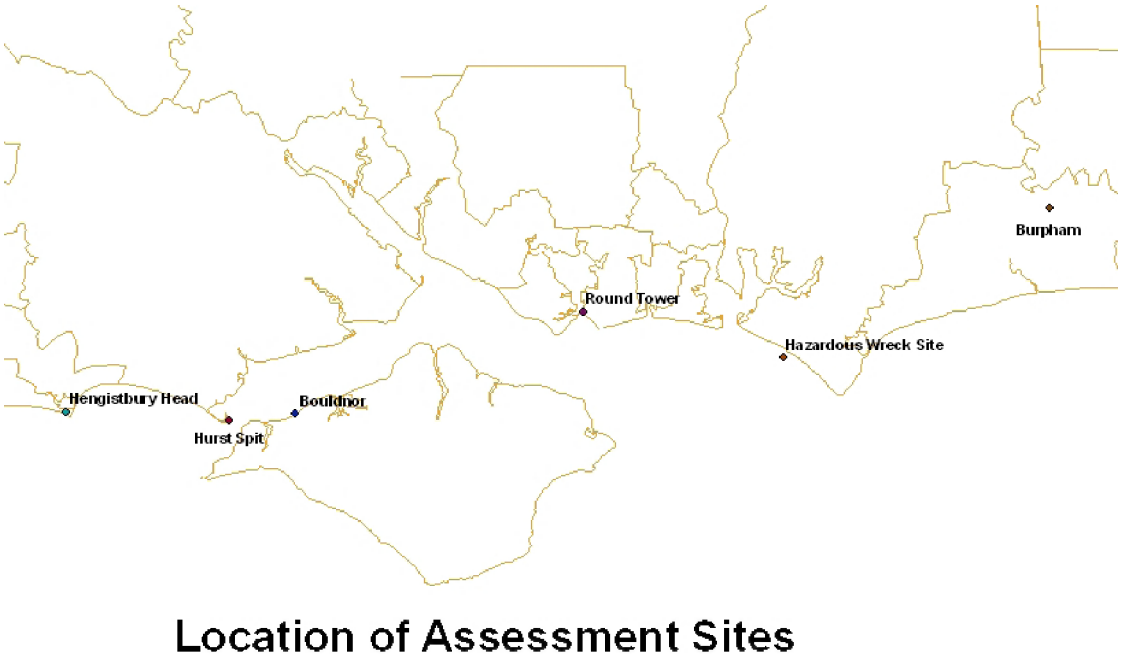


Figure 9.1 Location of the six Assessment Sites

9.2 Bouldnor Cliff

9.2.1. Introduction to site

The geomorphological evolution of the Bouldnor cliff site in the Western Solent has been controlled by climatic change and sea-level fluctuations during the late Pleistocene and Holocene.

There are two cliffs at Bouldnor. The present cliff is some 50m high and is composed of soft Tertiary clay. It is the site of active erosion and rotational slippage on the south shore of the Western Solent seaway.



Figure 9.2 Present day shoreline at Bouldnor with location of submerged site marked by buoy in the foreground

Some 200 m offshore there is a second cliff that is completely submerged. It descends to a submerged landscape at -11 to -12m OD. Palaeoenvironmental and archaeological material from this submerged landscape can be related to a key episode in the creation of the Solent coastline.

The composition of the submerged cliff is compact marine sediments belonging to the middle and later Holocene. In the basal layers of this sequence are terrestrial deposits that include the trunks and boles of ancient woodland. There are also hearths and flint tools left by a Middle Stone Age 'hunter-gather' community. Studies of this ancient land-surface and the marine sediments that cover it are offering 'first order' evidence of the time and nature the genesis of the Solent seaway. This is the starting point for all of the coastal processes that are now shaping and carving the Solent coastline.

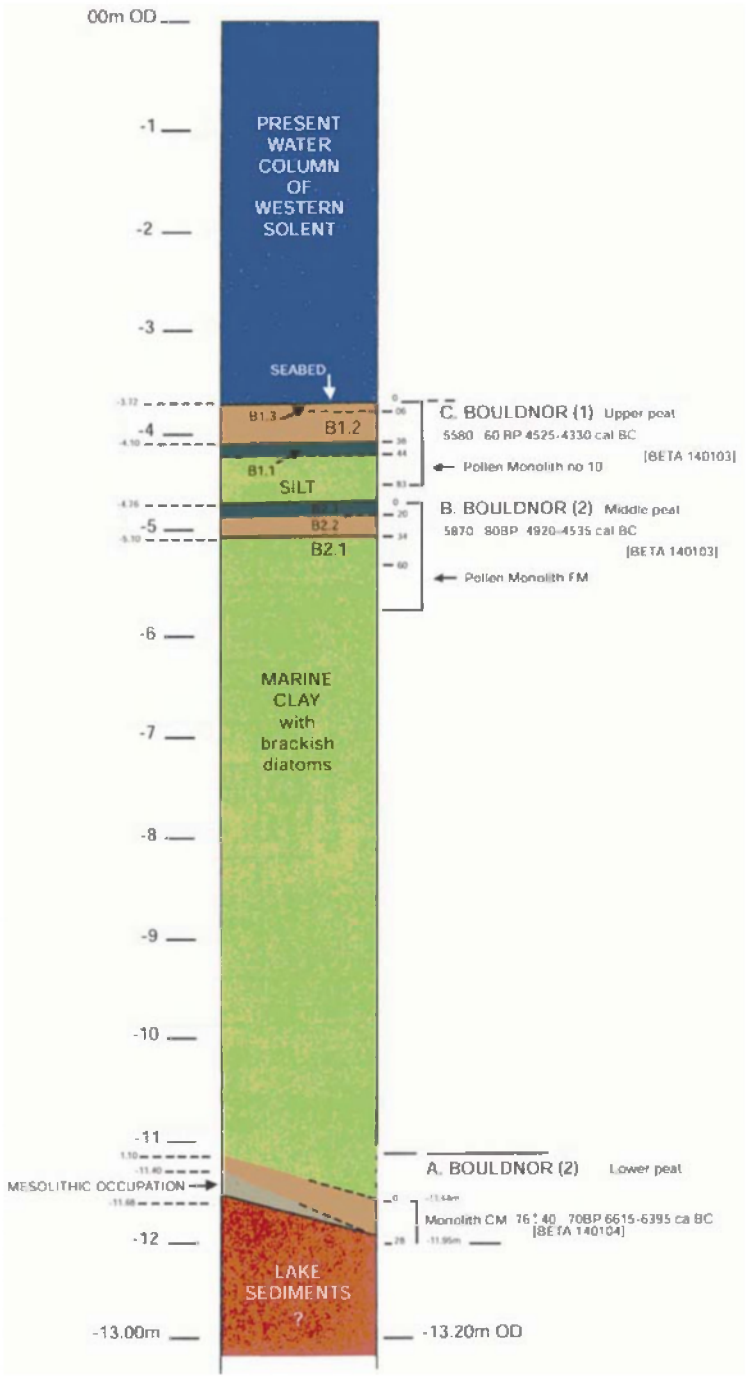


Figure 9.3 Representation of the sediment archive preserved in the submerged cliff-face at the Middle Stone Age site at Bouldnor (LIFE Project)

9.2.2. Archaeological evidence

The submerged landscape at the foot of Bouldnor cliff contains *in-situ* remains of Mesolithic hearths and scattered flint tools and charred remains of food.



Figure 9.4 Worked flint tools from Bouldnor Cliff

The flint tools are in fresh sharp condition and show no signs of marine abrasion. They demonstrate that the site was promptly overwhelmed by seawater during the rapid advance of the 'Flandrian transgression'.

9.2.3. Environmental evidence

The campsite of the Middle Stone Age community was close to the course of a small freshwater stream. The sediments in the stream show gravel, sandy, silts and peat being replaced by marsh and then brackish mudflat conditions and then full marine invasion. The nature of the changes is confirmed by analysis of the diatoms and foraminifera in the mudflat sediments. The development and impact on the surrounding landscape has been revealed by a study of the pollen contained within the peat.

Above the inundated land-surface are marine sediments some 7m thick. They are finely stratified and offer a record of further environmental and climatic changes leading to the present state of the coast. The upper sequence is interrupted by at least two more horizons of peat showing later periods of still-stand or respite in the retreat of the coastline. The deposits were laid down over a 2,000 year period before being overwhelmed by full marine conditions. These deposits offer a precise record of sea-level change which reflects highly significant 'episodic' events leading to catastrophic flooding.

These submerged 'sediment archives' are exposed in a face that is actively eroding and retreating in response to marine processes. In places the cliff-face is near-vertical and its sediments are cleanly exposed. Elsewhere the face has been eroded back to form an inclined or battered profile. When fresh material is exposed by current collapses and slips in the underwater cliff, it is soon degraded and removed by bed processes.

Marine growth on the disturbed flint tools suggests that the survival period of the palaeo-landsurface on which they sit after exposure is no more than four years. The 'archived' sediments in upper part of the cliff-face offer the very best means of securing a record of

the progressive behaviour of the coastline over the past seven thousand years. This record has yet to be fully interrogated.



Figure 9.5 Monolith sediment sample from Bouldnor Cliff

9.2.4. Discussion of site scoring

The Bouldnor area featured several times in the best score table for the Western Solent study area.

SMR_NO	SITE_NAME	SITE_TYPE	PERIOD	Climatic change	Environ change	Fragility	Running Chronology	Sea Level Change	Total scores
189	Bouldnor	FINDSPOT	Mesolithic	1	3	3	2	3	12
186	Bouldnor, Mesolithic Tranchet Axes	FINDSPOT	Mesolithic	1	3	3	2	3	12
1292	Bouldnor	FINDSPOT	Prehistoric	1	3	3	1	3	11

Records of Mesolithic flint axes found on the beach provided a hint of a concealed inter-tidal or sub-tidal context that might offer a much more rewarding natural archive of coastal information. In this case this was confirmed by a targeted underwater archaeological survey and investigation offshore.

The detailed assessment of this site demonstrates that it is important that individual sites or find-spots are not considered in isolation of one another. It is also important to use archaeological and geomorphological knowledge to perceive what might be concealed within a coastal environment such as this.

In the hands of general environmental consultants, Bouldnor Cliff could readily register as no more than some flint axes on a beach. An awareness of spatial relationships and

potential types of context is particularly important when dealing with evidence that may be scattered through the terrestrial, inter-tidal and sub-tidal zones.

9.2.5. Archaeological methodologies employed for site investigation

The points targeted for specific underwater investigation at Bouldnor Cliff are a very small part of an area that has been subject to medium scale visual surveys and large scale geophysical surveys. The following methodologies have been employed on this site: -

- Bathymetric and geophysical surveys were used to determine the general sedimentology and topography of the submerged landscape.
- Fixed reference points were installed to measure vertical and horizontal changes in the site. By this means erosion could be measured and monitored using survey, video and still photography.
- Diver investigation was used to verify quantitative images produced by the geophysical survey and to carry out measured survey and the recovery of samples.

For sampling and dating, a variety of techniques were employed: -

- Auger samples were used to track submerged deposits under the alluvium
- Monolith samples were extracted for palaeoenvironmental analysis
- Monolith samples were extracted for geoarchaeological and sedimentological studies
- Tree samples were obtained for dendrochronological dating and analysis
- Radiocarbon dates were obtained from organic deposits. These dates could fix episodes of sea level change and vegetational change.

9.2.6. Evaluation of archaeological methodologies in relation to coastal change

Stratified evidence for long-term coastal change

The underwater site of Bouldnor cliff has been subject to intensive archaeological investigation. This investigation has been largely driven and funded by cultural objectives. These have focused attention on a particular location at the foot of a submerged cliff-line that is some 13km in length. Geophysical investigations along the submerged cliff-line have been highly instructive in reconstructing past and present erosion processes on the floor and margins of the Western Solent. This is now beneficial to a chain of management units on this coastline.

At Bouldnor archaeological methodologies have been applied to an extremely small area of the submerged landscape. Here attention has been specifically focussed on the environmental context of two small prehistoric cooking sites. Biostratigraphic investigations here have largely concentrated on deposits that make up the pre-inundation and early post-inundation context of these Middle Stone Age hearths. This has produced evidence concerning the nature of the coastal environment around 6,000 BC yet it leaves unaddressed the evidence for Solent coastal change in the critical period following this event.

There remains in the submerged cliff-section at Bouldnor a substantial sediment archive concerning the later Holocene behaviour of the Western Solent. This contains a minerogenic and, biostratigraphic record of the events and processes that lead to the present coastal regime. There is now a need to ensure that the advantages secured by archaeological investigation are fully exploited in the interests of informed coastal management and protection. This should begin with interrogation of the upper sediments.

Opportunities for monitoring coastal change

The archaeological methodologies employed on this site have been very successful in addressing the cultural questions posed by this project. The evidence gathered at Bouldnor may be localised but it provides information on, sea-level change and geomorphological and environmental responses that are significant throughout much of the Solent region.

The monitoring strategies employed at Bouldnor have been developed to investigate the specific loss of submerged cultural features over the short duration of the archaeological project. Now that they have been installed, these same monitoring tools offer a means of obtaining accurate measurements of sub-tidal erosion and bed behaviour over a sustained period. Extended monitoring from this baseline can certainly assist study of the scale and pace coastal processes in the Western Solent. The efficacy of maintaining these measurements should now be reviewed with regard to coastal management objectives.

9.2.7. Conclusions on known and potential evidence for informing on coastal change

Bouldnor Cliff is an example of an archaeological investigation that has been designed to address cultural questions yet it has thrown up a wealth of coastal geomorphological and biostratigraphic information. These results are of 'first order' importance to shoreline management on the Hampshire and Wight shores.

Studies at Bouldnor Cliff have led researchers to the point of genesis for the formation of the Western Solent seaway and the severance of the Isle of Wight. Radiocarbon dating at this site is now offering a baseline date in the mid Holocene from which all other coastal changes and processes in this region can be gauged. For the first time, coastal managers have a timescale in which the development of such vulnerable features as Hurst Spit might be set.

The sediment archives at Bouldnor Cliff have responded well to investigations using diatom analysis, pollen analysis, palaeobotanical studies, faunal studies and tree-ring dating. These studies have concentrated on the environment of a Middle Stone Age coastal community and they have yet to be focussed on the post-inundation history of this coastline. It is these latter events that are of particular value to coastal planners in their calculation of the duration and intensity of the coastal processes that are now affecting the Solent shoreline. The underwater archaeological investigation of this site has established that a sediment archive of later history of the coastline can be recovered from the underwater cliff. This archive may offer climatic evidence that is so important in establishing cause and effect in coastal changes of the region.

The deposits at Bouldnor Cliff are visibly eroding and the window for investigation appears to be limited. The opportunity to study settlement with tangible archaeological features is steadily diminishing at Bouldnor. Not only can this archaeological site inform studies of sea level rise, it provides source material for a graphic reconstruction of past human occupation and activities on land that succumbed to coastal change.

This submerged landscape and its sediment archive is an example, par excellence, in which coastal management interests and the interests of cultural resource management must work closely together to maximise the recovery of pertinent information from a fragile and diminishing site.

9.3 Round Tower, Portsmouth

9.3.1. Introduction to site

In the time Henry VIII, Portsmouth was one of the most heavily defended areas in Northern Europe. Due to the attention of successive monarchs it had become a vital naval port with extensive facilities for shipbuilding, re-fitting and victualling.



Figure 9.6 The Round Tower in its modern setting, still strategically guarding the entrance to the Portsmouth Harbour

Portsmouth's 'round tower' is one of the town's earliest defensive structures. When it was first designed to protect the harbour entrance it was constructed in wood. This early work dates from 1418. It was followed in 1480 by a stone tower. Successive changes and additions were to follow throughout the 16th, 18th and 19th centuries. Despite this train of alterations, original components still survive within all of the structure (Corney 1980).



Figure 9.7 Looking west across the Round Tower at the mouth of Portsmouth Harbour

9.3.2. Archaeological evidence

Archaeological and historical evidence attests the construction of a wooden tower followed by a stone replacement in the 15th century. The earliest surviving traces comprise Tudor stonework in the bottom levels of the structure.

It is of particular interest that documentary accounts tell of early problems concerning undermining by the sea. This was severe enough to warrant an unusual Tudor regulation. This required passing ships to deliver an annual dump of rocks in front of the tower. It seems that this remedy was only partly successful because, in 1585, it was proposed that the height of the tower should be reduced in order to steady the foundations (Webb 1997).

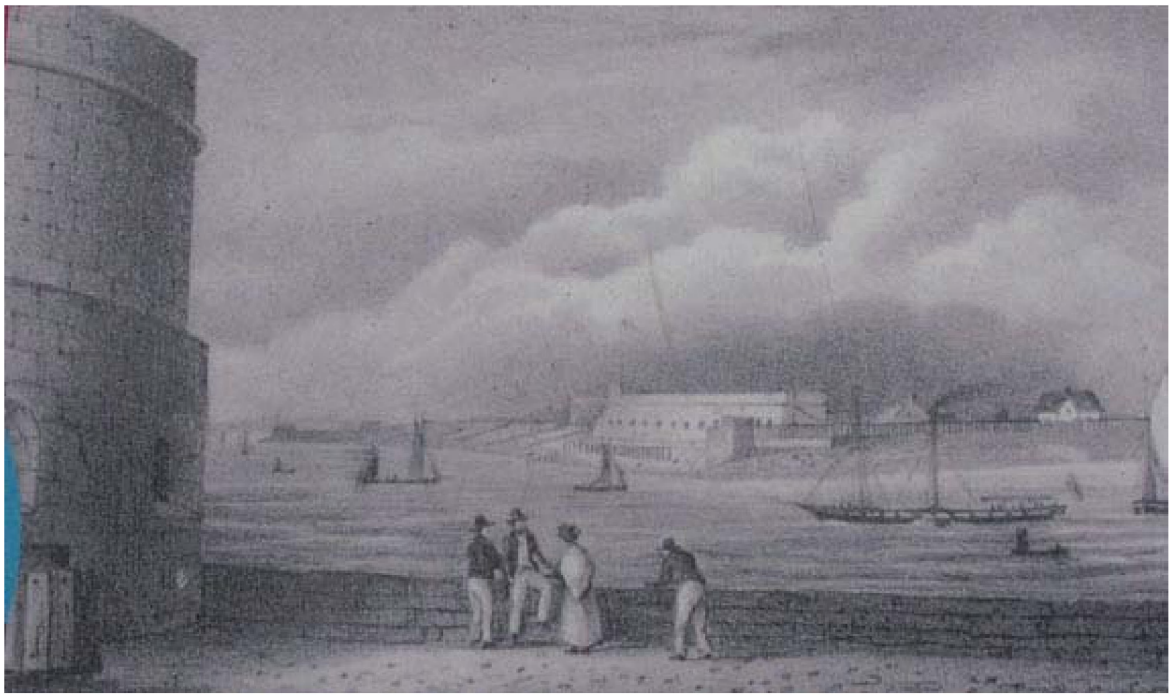


Figure 9.8 The Round Tower in 1840, just one example of a historical representation that can be studied to examine coastal change

In 1977 the round tower was found to be showing major cracks. This was due to a weakening of the foundations brought on by fluctuations in temperature (Pratt & Smith 1977). The cause was attributed to a cold tidal wash meeting walls that had been warmed by the sun. This induced a differential contraction between the outer and inner walls of the tower. The fact that the tower had stood for more than 500 years before showing these symptoms is an interesting reflection on climate-change. The cracking episode appears to have followed the notable drought of 1976.

9.3.3. Environmental evidence

No known environmental assessment or investigation has taken place at or within the vicinity of the Portsmouth Round Tower.

9.3.4. Discussion of site scoring

In the sphere of coastal studies, Portsmouth Round Tower claims significance due to its age, its history of instability and its position. Sited on the edge of the harbour-mouth it offers a natural yardstick by which to gauge erosion and sediment behaviour on the edge of the tidal channel. Some of the vulnerabilities of this structure to the sea have already been considered by Webb (1997). Further investigations into the basal structure of the tower and its abutting sediments may provide evidence of localised coastal behaviour at the edge of the town. A time range of covering the past 500 is an appropriate measure of change.

9.3.5. Archaeological methodologies employed for site investigation

At present the main documentary sources of information for the round tower have been paintings, drawings; historic photographs and published accounts. Manuscript records concerning expenditure on earlier repairs and modification could be particularly revealing.

9.3.6. Evaluation of archaeological methodologies in relation to coastal change

Although the structure of the Portsmouth Round Tower has been well studied, information on the tower's relationship with its fickle maritime environment has received scant attention.

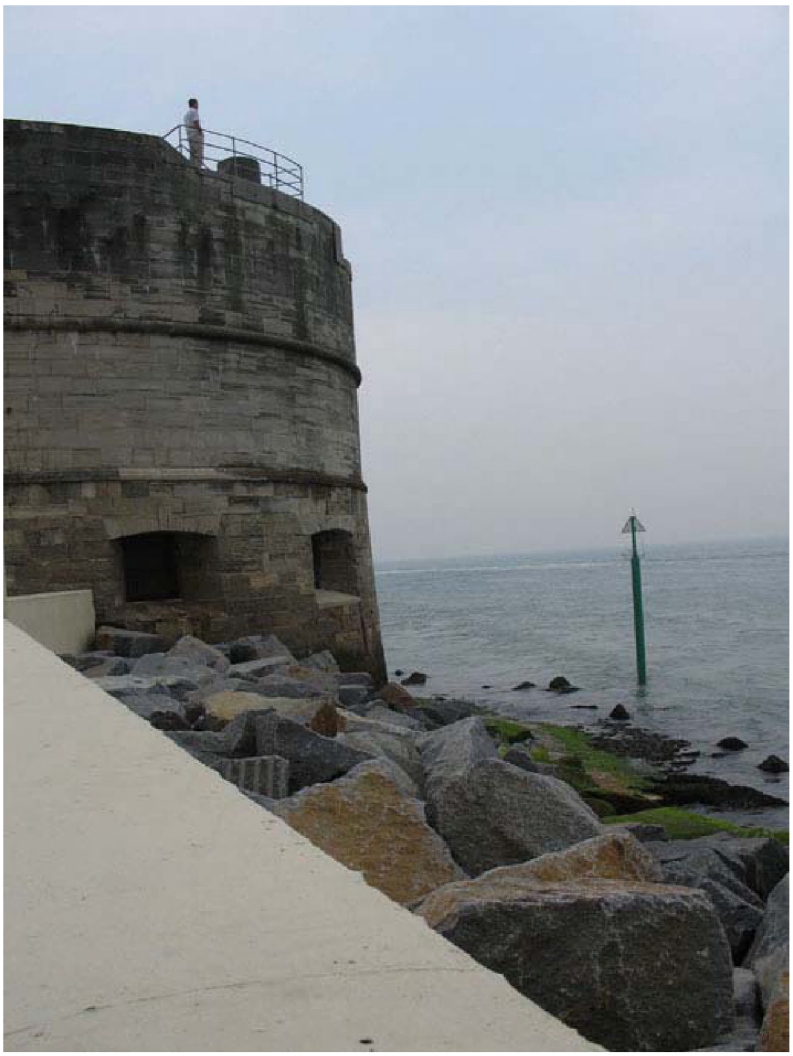


Figure 9.9 Modern coastal protection works employed at the base of the Round Tower, Portsmouth

9.3.7. Conclusions on known and potential evidence for informing on coastal change

Due to its position and its documentation, the round tower is a good example of a historic building that can offer evidence of medium-term coastal changes. These changes concern a coastline that is notably vulnerable to flooding and erosion. Further archaeological and environmental research into this structure and its setting could offer helpful information on changing sea levels and coastal behaviour on a coast that is of high concern to a large population. Historic records show that a changing coastal environment has caused undermining of this structure in past and present times. Further study of the building's history could reveal more detailed qualitative and quantitative data on coastal change.

9.4 Warship Hazardous

9.4.1. Introduction to site

Warship *Hazardous* is one of only 54 'Protected Wrecks' around the coast of Great Britain. Its designation under the Protection of Wrecks Act 1973 recognises its cultural value rather than its significance as a source of palaeoenvironmental information.

Le Hazardeux was built in 1698 in France. This was a 3rd rate ship-of-the-line in the navy of Louis XIV. The ship carried a crew of 350 and 50 guns. In 1703 this craft was captured by the English and refitted as a 4th rate ship-of-the-line with 54 guns. The vessel was re-commissioned as *Hazardous* in 1704 but she lasted only two years. She was wrecked on her return from Chesapeake Bay, Virginia. In poor weather the ship sought shelter in the Eastern Solent but was driven into shoal waters in Bracklesham Bay.



Figure 9.10 The site of warship Hazardous exposed on the seabed

9.4.2. Archaeological evidence

Archaeological investigations of *Hazardous* have been pursued since the 1980s. A full pre-disturbance plan of the wreck site has been completed and many artefacts and structural remains have been raised from the site.

Surveys have established that the wreck now comprises the lower hull. A transverse breach is present through the centre of the structure. Forward of this point, the bow section is now buried within the seabed. Here the port side appears to rest at a slightly higher level than the starboard side. Aft of the breach, the stern of the ship has survived less well where it has been weakly protected by shallower sediments.

9.4.3. Environmental evidence

The *Hazardous* Project Group has been structured and licensed to pursue cultural objectives and it has not been resourced to give high priority to the environmental history of the site. During the late 1980's changes were noticed in the pattern of erosion over the wreck of the *Hazardous*. Timbers, concretions and artefacts were being freshly exposed. Due to the excellent state of preservation of the timbers it was assumed that up until this time, the wreck had remained relatively stable since the ship was lost in 1706.

In response to the new problem of erosion, an exploratory excavation was carried out in 1988 and 1989. A trench on the port side revealed a good state of preservation in the

bow of the ship. The stratigraphy here was relatively undisturbed and structural features and loose artefacts were found to be preserved in secure contexts.

During the early and mid 1990s, monitoring of the wreck continued. Artefacts and concretions threatened by erosion were recovered. Since 1998 annual survey and investigation has focused on the centre of the wreck where the erosion is most intense.

Improved procedures for monitoring erosion were set up in 2002. Particular datum points were installed to monitor bed levels and timber erosion. The main focus of work on the site is now the recording of natural exposure and degradation of the craft. The change from benign accretion to dynamic erosion over the wreck site still requires an explanation.

In 1991 an interim report by Norman Owen provided a helpful diagram showing how seabed processes were dislodging artefacts from the ship and dispersing them in a discernable pattern across the seabed (Owen 1991). This information was assembled from archaeological survey and diver observation and it provided a historic testimony of a significant change in sediment behaviour within this area of the coastline.

9.4.4 Archaeological methodologies employed for site investigation

The *Hazardous* wreck site has undergone opportune archaeological investigations during the past 20 years. The principal activities have been diver inspection, measured survey and the selective recovery of artefacts that have been subject to seabed erosion.

The deployment of a suite of geophysical investigations could greatly enhance the interpretation of this site as a sediment archive of past and present seabed processes.

Since 2002, new initiatives have been developed to record the natural exposure of new portions of the wreck and to measure the progressive degradation of previously exposed components. The project has been heavily dependent upon voluntary support and this has restricted the amount of attention that might be given to the broader potential of the site as an index of past and present coastal behaviour.

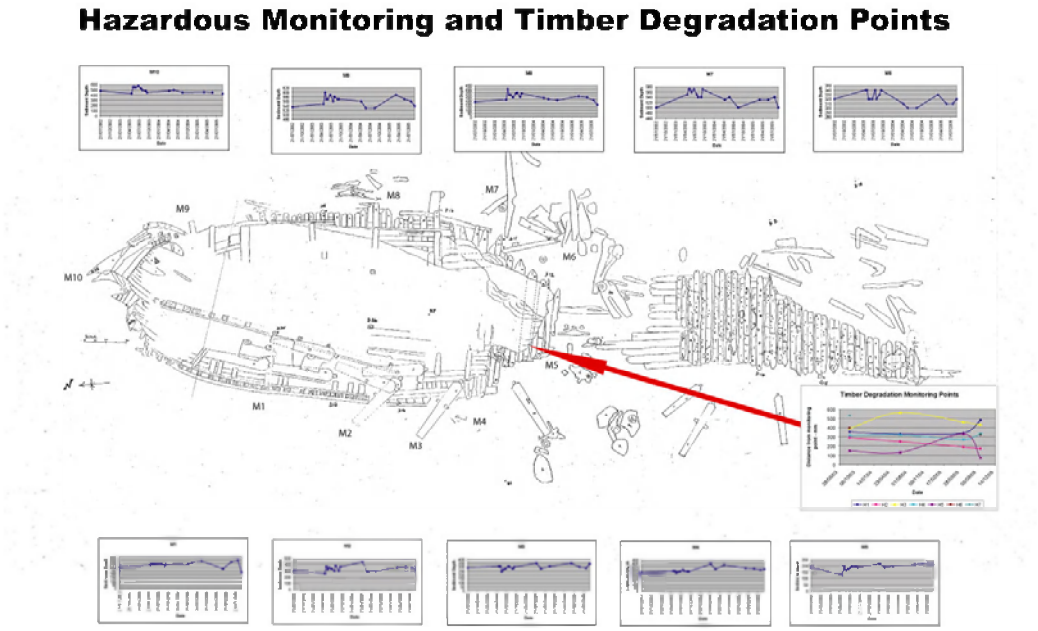


Figure 9.11 Sediment and timber monitoring points around the wreck of Warship Hazardous

9.4.5 Evaluation of archaeological methodologies in relation to coastal change

Since warship *Hazardous* was lost in Bracklesham Bay in 1707, the wreck of this ship has become an archaeological assemblage sealed by an 'archive' of accrued sediments. At present, select artefacts are being recovered from this site as and when they are exposed by a new regime of active erosion. The programme of recovery helps to document the progress of erosion but it has not identified the broader effects and causes of this phenomenon and the geography of change across the floor of Bracklesham Bay.

Annual inspection and measurement of the exposed timbers of the wreck offer a further means of calibrating the rate and impact of new erosion but this, too, fails to measure the wider impact on the coastline. There is a need to develop new methodologies that can investigate the nature and extent of the changed seabed environment that has now been recognised at this site.

9.4.6 Conclusions on known and potential evidence for informing on coastal change

Through the archaeological monitoring of this historic wreck, it can now be seen that an environmental threshold was crossed in the late 20th century. It was at this point that the benign encapsulation of this shipwreck suddenly turned to a new and destructive regime of dynamic erosion.

The wreck is of particular interest to coastal studies because its soft wooden components show a former state of benign preservation. This had apparently lasted for some 270 years. Archaeological monitoring since 1980 shows that the change to active erosion has since been sustained.

To date, studies of this shipwreck have been guided by cultural objectives. The environmental history of the wreck shows that a major change in coastal behaviour is taking place on the floor of Bracklesham Bay. There is now a need to examine the wider dimensions of this phenomenon and to assess the possible implications for the sustainability of the present shoreline.

9.5 Hengistbury Head

9.5.1 Introduction to site

Hengistbury Head is a low-lying promontory obstructing the seaward approach to Christchurch Harbour. Here it impedes the outflow of the combined course of the rivers Stour and Avon. The interface between riverine and marine processes is of particular interest because the medieval town of Christchurch stands on the edge of the floodplain of the river. The town is naturally vulnerable flooding arising from interactions or changes in the relationship between the river and the sea.



Figure 9.12 Hengistbury Head as seen from the air (LIFE Project)

Hengistbury Head is a multi-period archaeological site. It was occupied in both early and late prehistory. In early Roman times it functioned as a port. In the 19th and 20th centuries it was used for coastal mining. At this time the foreshore was dredged for iron nodules or 'doggers' eroded out of the cliff. Since the 19th century the site has continued to be affected by coastal erosion. In the past decade cliff regression has substantially increased.

9.5.2 Archaeological evidence

Hengistbury was first occupied towards the end of the Ice Age. Palaeolithic hunters camped here when the English Channel was still a river valley and hunting ground. Further camp sites followed in Middle Stone Age times when the sea was beginning to advance into this region. Evidence of these early camp sites is now being eroded from the cliff.

During the later prehistoric period Bronze Age burial mounds were constructed on Hengistbury Head. The mounds can cover small areas of preserved Bronze Age land-surface where contemporary pollen can hold a record of the past coastal environment. A search for wetland deposits on the headland may reveal further and more-revealing pollen archives.

In Iron Age times a large promontory fort developed on the headlines and massive ditched ramparts were erected. The banks of these 'Double Dykes' offer a further opportunity to investigate buried land-surfaces and to recover pollen evidence of the past coastal landscape. The survival of these earthworks on the low-lying terrain of the

headland suggests that throughout much of the past 3,500 years the rate of coastal erosion has been relatively slow. A geomorphological reconstruction suggests that cliff recession may have achieved less than 300m since the 1st millennium BC (Cunliffe, 1987, fig. III.12). Postulated at a constant rate, this would amount to a nominal retreat of some 0.15m per year.

In contrast with the postulated retreat of the past, a present rate of erosion of 1.4m per year suggests a notable degree of acceleration in coastal erosion at Hengistbury. This may be a phenomenon of recent times. Mining of the beach, attempts to construct a pier and the pursuit of off-shore dredging are all human interventions that may be responsible for this unwelcome change.

9.5.3 Environmental evidence

Environmental sampling has revealed significant changes in coastal vegetation at Hengistbury Head. At Barn Field Inlet, shoreline archaeological investigations have identified evidence of lower sea-levels during prehistoric and Roman times. A rise in sea level and increased wave attack has significantly affected Hengistbury Head and its prehistoric monuments but there remains uncertainty concerning the intensity and direction of past and current events.

9.5.4 Discussion of site scoring

Hengistbury Head appears twice in the top twenty scored sites of the Christchurch study area. The fragility of these sites features strongly in the scoring.

MONUID	NAME	TYPE	PERIOD	Sea Level Change	Enviro mental Change	Climatic Change	Chronolo gy	Fragility	Total Score
WX1136*	Hengistbury Head	SITE	Upper Palaeolithic	2	2	2	1	3	10
WX1092*	Hengistbury Head	OCCUPATIO N SITE	Prehistoric	2	2	1	2	3	10

9.5.5 Archaeological methodologies employed for site investigation

Investigations at Hengistbury Head have been pursued by standard archaeological means. These have aimed at revealing the cultural complexion of prehistoric and Roman settlement on this low-lying promontory. Reconstructions of the past coastal environment have been secondary to this aim.

Archaeological fieldwork has revealed a number of locations where more focussed investigations of the past coastal environmental might proceed. This would include soil sampling, and the analysis of pollen, diatom and other biostratigraphical evidence.

9.5.6 Evaluation of archaeological methodologies in relation to coastal change

The past course of the Double Dykes offers a particular opportunity to examine the rate, character and extent of coastal change at the mouth of the river over the past 2000 years. Cunliffe (1987, 68) has been proposed that some 300m of the Double Dykes has been lost in the off-shore zone. Photos of the cliff-truncated dykes in 1911 suggest that the dyke ditch may survive below beach level. This is certainly a possibility that should be pursued in the inter-tidal and sub-tidal zones. The search might be assisted by sub-bottom profiling.

On the northern shore of the promontory, the Iron Age 'dykes' pass into a coastal wetland at Wickhams Marsh. An exploratory archaeological trench has revealed a sediment archive here in which sea-level rise and environmental changes can certainly be detected. In the interests of reconstructing the coastal history of this area there is clearly more to be done here to identify and calibrate the precise course of events.

Accrual of wind-blown sand has occurred on the promontory since Iron Age times. These sand movements may have been triggered by vegetation shifts and climate changes. More needs to be known of the dating of these events and whether the current flora of the area shows any similarity with past environmental scenarios.

9.5.7 Conclusions on known and potential evidence for informing on coastal change

Archaeological investigations on Hengistbury Head have revealed an array of sediment archives that can tell of rises in sea-level and changes in the coastal landscape. These events are important because the headland at Hengistbury is an obstruction to the river at a point where back-ponding and flooding can be generated close to Christchurch town. The headland is also a defence against sea-advance into Christchurch Harbour but this line of natural defence has been succumbing to notable coastal erosion since the late 19th century.

Fieldwork by coring and marine geophysical survey can by accompanied by a suite of palaeoenvironment investigations to establish the behaviour of this coast over the past two or three millennia. There is a need to know whether past environmental changes mirror current events and whether the future of the headland may be linked to increased flooding on the margins of the town.

9.6 Hurst Spit

9.6.1 Introduction to site

Hurst Spit is a cuspate shingle foreland dominating and protecting the entrance to the Western Solent. This feature is best known to most for the presence of Hurst Castle. The castle is a national historic monument and tourism asset situated at the tip of the spit. Its survival depends on the future stability of the spit yet, by its very nature, the spit is an evolving coastal beach-form capable of dispersal or migration.



Figure 9.13 Hurst Spit in relation to the coastal landscape

For observers of shoreline behaviour, the spit is of particular importance because of the natural protection it has long provided for the sheltered coasts and habitats of the Western Solent seaway. The spit is an ephemeral coastal feature that is capable of changing its form and shifting its position. It is now known that its entire development must lie within the past 8,000 years.

Some perceptible shifts in the configuration of the spit are evident in recent history. The last 200 years has also shown a notable retreat of the drying-line along that part of the Hampshire shore that is protected by the spit (Tubbs, 1999, 91, fig. 7.2). Association between the retreat of this shoreline and the behaviour of the spit has yet to be investigated.

There are ancient stake alignments within the spit and there are salterns, submerged peats and shipwrecks in its vicinity. All may provide evidence of past and current changes in coastal behaviour.

9.6.2 Archaeological evidence

Hurst Castle is a stone artillery fort comprising a 12-sided keep and a 9-sided curtain wall. It was originally surrounded by a moat. The first stone fort was erected here between 1541 and 1544. It was one of a series of coastal fortresses commissioned by Henry VIII. This fort contained guns that were perfectly set to control entry into the Needles Passage.

The fort was extensive re-modelled and enlarged in the 19th century. Its east and west curtain walls were added in the period 1861-1875. The castle continued in use throughout World War I and was re-armed in World War II.

On the eastern, leeward, side of Hurst Spit are salterns and stake alignments. Some seem to be associated with documentary accounts. Some of the stake settings may be of greater antiquity. Ancient stake alignments have also been observed on the west side of the spit but they have not yet been dated. The presence of stakes beneath the shingle offers a helpful means of dating the migratory movements of the spit.

Further evidence of the changing coastal landscape is witnessed through offshore peat deposits at around –4 m

9.6.3 Environmental evidence

Hurst Spit has been subject to a number of studies concerning its formation, its morphology and its behavioural changes. Most of these concern beach mechanics and shoreline movements. They are well reviewed in the present shoreline management plan.

Earlier environment evidence pre-dating the formation of this beach-form has been obtained from a buried channel that has been traced beneath the shingle at the northern end of the spit (Nichols, 1987). A problem shared between Hurst Spit and Calshot Spit is a lack of absolute dates for the events that mark the genesis and the development of these massive shingle features. At both sites it is evident that long and informative sediment archives are contained in riverine and estuarine deposits sheltered within the cusp of the spit.

At Hurst the presence of submerged peat has been traced around -4m OD on the east side of the spit. This marks a starting point from which the arrival and advance of the spit-building process might be dated and studied. By dating the advance of shingle across a rising gradient of former land surface, the overall history and stability of the spit might be finally assessed.

9.6.4 Discussion of site scoring

Hurst Spit is an example of a coastal geomorphological feature that is of particular importance to our understanding of the formation of the Western Solent. It is instructive to see that the spit has failed to register this significance within the current historic environment record. At present it has been Hurst Castle and some recorded alignments of stakes that have been evaluated in this present study. The Holocene stratigraphy and palaeoenvironmental archives within and below the spit have could not be detected within the formal scan of present records.

SMR_NO	SITE_NAME	SITE_TYPE	PERIOD	Climatic change	Environ change	Fragility	Running Chronology	Sea Level Change	Total scores
MHM60	Hurst Spit wooden stakes	FINDSPOT	Prehistoric	2	2	3	2	2	11

9.6.5 Archaeological methodologies employed for site investigation

Much of the present information for this site comes from architectural studies of Hurst Castle. These include a well-documented building history and observations that some of the lower rooms of the castle now flood at high water. Offshore there has been some limited mapping of peat deposits as a result of drift dives. A geo-referenced swath bathymetric survey has also been conducted between Hurst Castle and Lymington River. There is a need for further investigation in the inter-tidal and sub-tidal zones with a view

to identifying the best locations to core and interrogate those sediment archives that relate to the behavioural history of the spit.

9.6.6 Evaluation of archaeological methodologies in relation to coastal change

It seems that some of the built components of Hurst Castle, particularly the floor-levels of certain rooms, may offer evidence of sea-level change or coastal change. The date and configuration of ancient post alignments beneath the shingle offer an opportunity to obtain radiocarbon dates related to past positions of the spit. The submerged peats, when fully plotted, can offer a long-term archive of past changes affecting the spit, the coastland and sea-level.

It must be emphasised that studies of this spit are not simply directed towards the future survival of a principal ancient monument here but to the continued good management of a swathe of the Western Solent coast that is protected by the spit. This tract of coastland extends at least 8km to the east.

9.6.7 Conclusions on known and potential evidence for informing on coastal change

By its very nature and position, Hurst Spit holds a key position in the natural protection of the coast of the Western Solent. The shoreline habitats to its east are clearly dependent upon its survival and on the nature of its configuration.

Despite these dependencies, far too little is known of the evolution of the spit and its eastward migration. Little is also known of the sediment history of the coastal wetlands that the spit may, or may not, continue to protect. A principal historic building on the spit offers some prospect of observing recent changes in sea-level or water-level in later historic times. If dated, some ancient alignments of wooden post might possibly extend observations into the later prehistoric period.

It is in the un-studied sediment archives that the highest potential may be found at this location. Some of these lie in the cusp of the spit where there is an opportunity to gain firm knowledge of the long-term agenda of spit-formation and coastal behaviour that is shaping this vulnerable coastline.

9.7 Burpham

9.7.1 Introduction to site

The village of Burpham is sited on the eastern shoulder of the Arun valley and some 7km from the sea. It is now a modest village but in the 1st millennium AD it was a principal Saxon settlement and port. The medieval village is attended by a defended chalk spur that is the site of the lost Saxon community. This site is now a cricket field. It may be suspected that towards the close of the 1st millennium AD, Burpham was the principal port and settlement on the lower Arun until it was eclipsed by the rise of Arundel. The switch could well be associated with a shift in the behaviour of the river.

At the foot of the valley bluff, the channel of the river Arun makes a sharp sweep as it passed from one side of its floodplain to the other. This is an east-west traverse of approximately 1.5km. There is also a north south channel to the river at this point. This was cut to improve navigation in the 19th century.

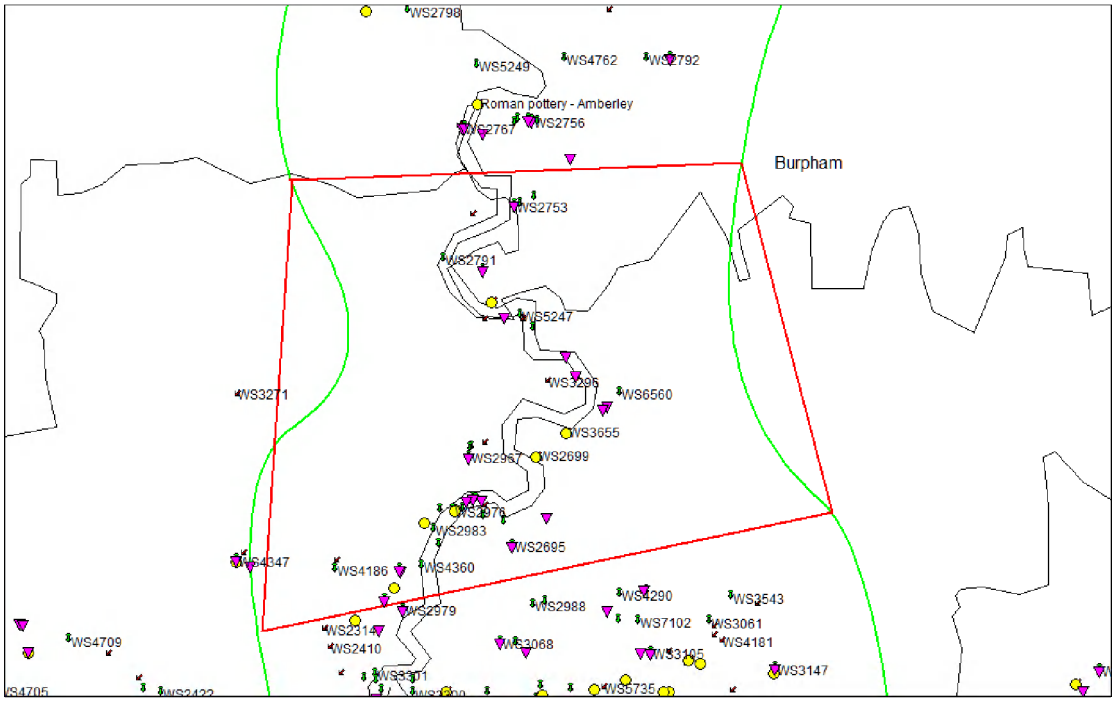


Figure 9.14 Showing the location of Burpham in relation to the Arun and surrounding sites and monuments

9.7.2 Archaeological evidence

Burpham is cited in the *Burghal Hidage* of the 10th century. Its defended township or 'fort' occupies the summit of a long, narrow, elevated tongue of land south the present village. Here it overlooks the floodplain of the Arun.

The Saxon settlement is bounded by steep 'bluff' chalk scarps on all but the north side. The north side is enclosed by an earthen rampart up to 7m in height. The ends of the rampart rest upon the edges of the bluffs. Midway is an original simple-cut entrance. The interior falls gently southwards, the cliffs reducing in height from some 15m to 4.5m. To compensate for the weakening natural defences southwards, a bank encircles the south half of the promontory at the base of the bluffs. This is some 8m in width and 1m in

height. It has been much reduced by flood waters. The inner ditch has been completely silted up.

On the floor of the Arun valley a log-boat of Iron Age or Roman date was discovered in 1862. This denotes a potential for datable artefacts to survive at significant levels within the valley alluvium. Neolithic and Bronze Age artefacts have also been noted on the floor of the valley floor in this area. These artefacts imply that the there may have been earlier periods when human settlement could be pursued at levels that would later succumb to water-logging.

If the record of human habitation is to be pursued on floodplain, it seems that the most propitious location is that where past activities have also clustered on the shoulder of the valley. Few areas could offer such a rewarding location as the floodplain between Burpham and Arundel.

9.7.3 Environmental evidence

The Arun floodplain west of Burpham offers a particularly promising opportunity to secure a long-term record of estuarine behaviour and the flooding characteristics of the Arun River. Elsewhere in this study we have established that land-loss in the Climping–Cudlow area is historically related to the behaviour of the river as well as coastal erosion.

On the west side of the Arun floodplain lies Swanbourne Lake. Here, recent fieldwork has established the presence a deep palaeoenvironmental archive below the present valley floor. The quality of palaeonvironmental evidence at this location is very high and it suggests that this will be the most productive location to commence a complete valley cross-section. The east sweep of the river at this point offers a particular opportunity to prospect the valley floor by a marine seismic survey using the course of the river. The results can then be followed up by specific targeted coring.

9.7.4 Archaeological methodologies employed for site investigation

Archaeological investigations into the sites around Burpham have all deposited significant archives with clear site plans and information concerning finds. This information is all lodged with the HER of West Sussex and made accessible through West Sussex County Council.

9.7.5 Evaluation of archaeological methodologies in relation to coastal change

To date the archaeology of Burpham and its fortified Saxon settlement has focussed upon the historic and cultural significance of this community. There has yet to be an assessment of past human activities within of the changing wetland environment of the valley floor. Coring and analysis of the biostratigraphy at Swanbourne Lake point the way to a planned investigation of the long-term behaviour of the lower Arun river. Future investigation should seize the opportunity of marine seismic survey through the bed of the river in its east-west traverse of the valley floor.

9.7.6 Conclusions on known and potential evidence for informing on coastal change

Historic records show that flooding and coastal erosion on the Littlehampton coast have been the jointly promoted by the action of coastal erosion and by shifts in the behaviour of the Arun River. Human interventions in the course of the river are a further factor for consideration and questions concerning past spates and changes of the floodplain water-table have yet to be resolved. The sampled sediment archive and the scattered find-spots on the valley alluvium are the starting points for a planned investigation into the full behavioural history of the lower Arun and its interaction with the coast.

10. Implications of scoring and recommendations for coastal management in the study areas

Specific conclusions for the SMP process

Archaeological and palaeoenvironmental sites in the SCOPAC region offer vital information on past and future trends in coastal behaviour. Opportunities to anticipate Nature's timetable can be gained through good management and planning. The following text summarises the issues and opportunities to be seized within each of the SCOPAC study areas.

10.1 Lyme Regis

Issues

- Lyme Regis is a medieval town and nominal port that has been reliant on an ancient stone breakwater known as the Cobb.
- The town sits at the head of a small bay where there is an uncertain history of sea advance.
- The security of the town has been long compromised by coastal erosion and a suite of active slope movements. Processes include mudslides, translational rockslides and compound failures.
- Since the 19th century the town has expanded as into a narrow and confined hinterland yet the opportunities to secure safe building land near the sea seem limited.
- The future scenario of shoreline change and ground movement is not well understood and little evidence has been gathered on the nature, scale and pace of changes in the past.

Recommendations

- The revised SMP should be guided by an area-specific data-collection strategy seeking explanation and dates for past and ongoing changes in the geomorphology of this coast.
- New data-collection should provide for the investigation and analysis of exposures of colluvial deposits, buried land-surfaces and sediment archives that are pertinent to past behavioural changes in the coastland.
- Opportunities should be seized to recognise pattern and explanation in the course of ground behaviour and coastal erosion within the environs of the town.
- Coastal protection projects within the shoreline management plan should include archaeological and palaeoenvironmental advice at the earliest stage of planning.
- Archaeological and palaeoenvironmental advice in the execution of the revised SMP should give regard to the wider ambit of SCOPAC's need to reconstruct the behavioural history of its coastline.

10.2 The Fleet

Issues

- Chesil Beach and the Fleet lagoon are components of a World Heritage site that is subject to a suite of environmental sensitivities. Both features appear vulnerable to the effects climate change.
- Now that the shingle supply to Chesil Beach has been naturally terminated the possibility of future overtoppings and breachings must be assessed.
- The impact of future changes to Chesil Beach are best calculated from the past behavioural history of the beach and its entrapped lagoon.

- The prime source of field data lies beneath the beach and the Fleet lagoon while some further evidence appears to lie in the offshore area.

Recommendations

- A programme of geophysical investigation and coring is required within the Fleet and offshore of the Chesil Beach.
- Coastal protection works within this study area should include archaeological and palaeoenvironmental advice at the earliest stage of planning.
- A specific objective should seek new field evidence pertinent to SCOPAC's need for an overview of the long-term behavioural history of the coastline and a prediction of future behaviour.

10.3 Poole Harbour

Issues

- Poole Harbour is a river basin that is being progressively drowned by the sea.
- There is much developed land and vulnerable settlement on the northern, eastern and southern margins of the harbour.
- The harbour is vulnerable to sea-level rise.
- Where the margins of the harbour and its islands are undeveloped there is palaeoenvironmental evidence of past estuarine behaviour. This is contained within palaeochannels, submerged peats and inundated sites of prehistoric and later habitation.
- This assessment identifies notable lacunae in knowledge of events that have led to the present configuration of the coastline.

Recommendations

- A research design should address the need to survey, identify, monitor and interrogate archaeological and palaeoenvironmental sites within and around the harbour where they offer an opportunity to establish the history of this submerging coastline.
- The collection of field data should give specific regard to the need to identify future scenarios in the changing character of the harbour.
- The investigation should identify options for prudent and sustainable management of the harbour margins, its habitats and settlement.

10.4 Christchurch Harbour

Issues

- Christchurch Harbour is a fluvial catchment for the Stour and Avon rivers. The rivers converge on a floodplain close to the medieval town.
- The propensity of the rivers to flood in future environmental scenarios remains to be assessed. Sediment archives relating to history of the floodplain have yet to be identified.
- The rivermouth is diverted by the Hengistbury Head promontory. This accommodates palaeoenvironmental deposits pertinent to the long term environmental history of the rivermouth area.
- There is evidence of long-term sea advance along the frontage of Christchurch Bay.
- For the purpose of investigating past coastal behaviour, the coverage of the historic environment record is currently weak.

Recommendations

- A project design should initiate a programme of fieldwork, research and monitoring to address the problem of recognising the long-term agenda for coastal change in this area.
- The project design should examine the open shoreline as well as the interior of the harbour and the floodplain adjoining Christchurch town.

10.5 Western Solent

Issues

- The shoreline of the Western Solent is low-lying, soft and inherently susceptible to inundation and erosion.
- The open seaway is relatively young and may still be establishing its general form.
- The spits at Hurst and Calshot may be part of the formative process but their age and past configuration is poorly understood.
- East of Hurst Spit, the saltmarsh buffer on the northern shore of the seaway has shown sustained diminution and retreat over the past 200 years. It is clearly dependent upon the survival of Hurst Spit.
- The Wight coastline of the seaway shows active cliff recession but little is known of the long-term scale and pace of this retreat.

Recommendations

- A date of genesis should be established for the Western Solent and the commencement of its coastal-shaping processes.
- The history of the spits should be established and their stability assessed.
- The subsequent behavioural history of the Western Solent coastline should be established by interrogation of pertinent sediment archives.
- A project design with a fieldwork strategy should be integrated into the revision of the shoreline management plan.

10.6 Sandown Bay

Issues

- Sandown Bay accommodates a major seaside resort that is no more than 150 years old.
- The town is defended by a seawall and promenade of Victorian origin.
- The town is sited at the head of a bay that shows a long history of marine advance.
- The presence of an extensive shore platform on this coast shows that long period of cliff-recession has taken place.:
- The head of the bay impinges on a river floodplain that is susceptible to flooding.
- The terrain between the river and the sea is a reclaimed wetland.
- A palaeochannel is suspected to offer a line of weakness under the sea wall.
- The behaviour of the river Yar in severe storm events is uncertain because no sediment archive of its past behaviour has yet been fully interrogated.

Recommendations

- An approved project design within the revised SMP should ensure that evidence of the long-term behaviour of the Yar river and the bayhead fully guide the development of the plan.
- There is a need to understand cliff stability rates around Sandown Bay where their recession will impact urban settlement. The results would help inform planning bodies/insurance companies of stability/instability issues.

10.7 Hamble

Issues

- There is a high level recreational and leisure activity in the lower course of the river.
- There is a particular need to monitor and protect vulnerable archaeological and palaeoenvironmental features along the course of the river.
- This assessment awards high score to a small number of ancient craft entombed in the silts of the river
- The assessment has been weakened by a high number of other craft that are currently unable to offer a score.

Recommendations

- An approved project design within the revised SMP should provide for survey, identification and a management plan for significant archaeological and palaeoenvironmental resources embraced by the course and the margins of the river.
- Wooden structures and palaeo-environmental deposits in the inter-tidal and sub-tidal require observation and monitoring and some should be viewed as specific indices for measuring environmental change.

10.8 Portsmouth Harbour

Issues

- Portsmouth Harbour is a drowned river basin accommodating the fourth largest expanse of mudflats and tidal creeks on the south coast of England
- The progressive drowning of the basin has not been generally recognised by past human communities settling around the harbour margins.
- In the past, erosion of the harbour margins has been resisted by the erection of walls, banks and bunds.
- A die-back of the *Spartina* cord grass is increasing the threat of erosion to further margins of the harbour.
- The hard defences around the harbour create an increase in wave and tide energies.
- Stresses on the harbour margins will increase with the progression of climate change and sea-level rise.
- A natural expansion of the harbour can readily impact upon intense commercial and urban properties beyond the present margins of the harbour.
- Little is known of the past behavioural history of the harbour and its margins.
- Knowledge of archaeological and palaeoenvironmental sites within the boundaries of the harbour is currently weak and is unable to offer guidance drawn on past behaviour.

Recommendations

- A project design should address the present lacunae in the evolution history of the harbour.
- The revised SMP should pursue an understanding of the long-term behavioural trends in the tidal and fluvial filling of the harbour.
- Sustainable options should be identified that best reconcile the needs and safety of the urban population with the ecological resources of the harbour. These options should be based upon wisdom of hindsight drawn from an interrogation of sediment archives and other pertinent evidence arising from new targeted survey.

10.9 Chichester-Selsey

Issues

- Chichester Harbour is river basin that is still progressively drowning.
- Selsey Bill is a low-lying promontory composed of Pleistocene gravels and sands.
- The Selsey area is also crazed with ancient in-filled river channels of Pleistocene and Holocene date.
- The ancient river systems of the area have been truncated by past advances of the sea.
- Archaeology and history indicate notable retreat of the Selsey coast since Roman times but the true scale of retreat is currently unquantified.
- Selsey is a 19th century resort town speculatively built despite a long history of coastal recession at this location.

Recommendations

- Qualitative and quantitative evidence should be sought of the past behaviour of this coastline. This should include evidence of earlier inundation, storm flooding and estuarine, riverine behaviour and their impact on human settlement.
- The revised SMP should include a programme of fieldwork and data-gathering that can identify well informed management options based upon a clear understanding of the past and developing behaviour of this coast.

10.10 Arun

Issues

- The open shore of the Arun area has a long history of coastal retreat
- The estuary of the Arun is readily navigable to Arundel and was once regularly navigated to Pullborough and beyond.
- The river occupies a broad floodplain that has been vulnerable to flooding. Under flood conditions it is the old course that the river will seek to re-adopt.
- The river is constrained in its course by earthen banks that are some 500 years old.
- The loss of the medieval town and port of Cudlow suggests that past inundations may have resulted from a combination of coastal erosion and riverine erosion.
- Littoral drift connects the Arun coast with Selsey. Past episodes of erosion may be connected.
- It is suspected that sediment archives pertinent to the behavioural history of the coast and estuary are well preserved in the Arun area yet these have failed to emerge in the present dataset of historic environment sites.

Recommendations

- The revised SMP may fruitfully consider a shared research objective with the Arun River Management Plan. Both plans need to be fully informed of the past behavioural history of the river and coast and of the potential course of future natural changes.
- A project design should identify potential sediment archives within the study area and to advance a suite of analytical measures that will unlock the history of past and developing behaviour.
- Potential links between river behaviour, coastal behaviour and climate should be investigated. The behaviour of the river during and after the medieval warm period is of particular interest because the onset of the warm period may reflect the changes now occurring at the opening of the 21st century.
- The revised shoreline management plan should recognise that that protection of this coast cannot proceed without integrated objectives linked to the Arun River Management Plan. Both plans need to be fully informed of the past behavioural history of the coast and the river since the mid-Holocene.

11. Guidance for good practice

The coastline is dynamic. It is constantly under attack yet has the ability to source natural material for its own defences. However, where supplies of sand, shingle or silt are curtailed, the coastline is placed under great stress. The long term causes of sediment redistribution around the coast and the impact on our shoreline when patterns are interrupted must be understood if we are to manage our coastal zones effectively. The consequences of past change can be extracted from the archaeological and palaeo-environmental archive. These data can provide invaluable information for strategic coastal planning, providing managers with a tool to view a coastal unit holistically in both time and space.

A considered examination of archaeological and palaeo-environmental evidence can provide graphical demonstrations of coastal change which can aid our understanding of how the coastline has evolved. The sediment archive or recorded history of a coastal region can identify areas at greatest risk as the sea level rises and the climate gets wetter. These concerns can only be comprehensively managed where the underlying causes are understood and risks identified. However, caution should always be exercised when proposing a solution to perceived problems of coastal migration when the origin of the any change is not fully understood. The analysis of relevant archaeological and/or palaeo-environmental data can help inform that understanding of coastal change. Good practice would ensure that all important data becomes accessible, it is interpreted by experienced archaeologists and its interpretation is assessed by coastal managers to ensure informed decision making.

11.1 Good practice guide for the use of archaeological and palaeo-environmental data for coastal management

The Historic Environment Record (HER) is an essential device necessary to inform coastal managers about past events along the coastline. The practices listed below should be implemented to strengthen its value as a tool when assessing future risks to the coastline:

1. Record and describe any palaeo-environmental material identified at an archaeological site in the HER. This is necessary to develop the value of the record and scoring protocol when assessing coastal change.
2. The depths/height of archaeological and palaeo-environmental features in the coastal zone should be recorded relative to Ordnance Datum.
3. There is a need to include a ‘coastland type’ field within all HERs which recognises a site as being able to inform coastal studies.
4. There is a need to integrate the HERs with Shoreline Managements Plans (SMPs) more effectively by recording the coastal management unit and relevant SMP.

To ensure good practice for coastal managers and planners when assessing future risks to the coastline, and ensuring all data is accessible and appropriately interpreted:

5. Due consideration should be given to the importance of the archaeological and palaeo-environmental record. Submerged and inter-tidal prehistoric sites, landscapes and palaeo-environmental material can provide data that will inform of past change.
6. Advice should be sought by the developer at the earliest opportunity and liaison should take place between archaeologists, coastal managers and engineers at the outset of any development or coastal protection project. Improvements in

liaison and consultation between relevant parties including off-shore operators and port and harbour authorities may offer a helpful objective for the Round 2 revision of the shoreline management plans.

7. The HER and archaeological curator should be consulted by coastal managers and/or developers. It is clear from this report that a large part of the palaeo-environmental resource is not adequately recorded on the HERs. Therefore, due consideration should be taken of the potential resource before development and an assessment should be commissioned to quantify the sites which offer the greatest potential to inform managers of coastal change.
8. Archaeological and palaeo-environmental sites should be considered in relation to adjacent sites finds or deposits rather than in isolation.
9. The advice of an experienced archaeologist will always be required to undertake any scoring or assessment of relative archaeological/coastal geomorphological importance if the significance is to be realised.
10. Shoreline Management Plans should be revised to recognise the need to gather quantitative and qualitative evidence of the past behaviour of coastal zones including earlier inundation, storm floodings, estuarine and riverine behaviour, cliff line retreat and changes in topography. A project design with a fieldwork strategy assessing and monitoring ongoing geomorphological changes to the coast should be integrated into the revision of shoreline management plans.

11.2 Good practice guide for the collection of archaeological and palaeo-environmental data

The lack of statutory recognition for HERs has discouraged the gathering of information on the inundation and submergence of coastal historic environmental assets. The net effect is poor field observations on heritage-loss in the coastal zone and a low level of chronological information in the forum of strategic decision-making. The statistics generated in this current report confirm a general neglect of sites that offer a particular pertinence to the study of coastal change. This is hardly surprising because the case has never been clearly articulated.

This document has identified the value of the archaeological and palaeo-environmental resource as a tool that can inform the process of coastal management. SMPs should be revised to ensure data is recovered from this resource. The following methods can be employed to recover archaeological or palaeo-environmental evidence:

1. An assessment should be conducted to quantify the archaeological and palaeo-environmental potential of the site to be developed and its potential to inform on issues concerning coastal zone management and coastal change. This should be conducted within the framework of an Environmental Impact Assessment.
2. The results of the assessment should recommend the investigation of *in-situ* archaeological and palaeo-environmental archives in line with good coastal management practice. Any necessary data collection should provide for the investigation and analysis of exposures of colluvial deposits, buried land-surfaces and sediment archives that are pertinent to past behavioural changes of the coastline. Ground behaviour and coastal erosion should also be assessed.
3. Monitoring of geomorphological, archaeological and palaeo-environmental features could help predict future events by recognising current trends. Wooden structures such as fish-traps and wrecks in the inter-tidal and sub-tidal require observation and monitoring and some should be viewed as specific indices for measuring environmental change. A reactivation of inactive cliff-lines and the growth of marginal beaches and spits would also act as salient indicators.

4. Geophysical survey is a method used to investigate submerged landscapes. This could include sub-bottom profiling, side-scan sonar, swath bathymetry, single beam bathymetry and possibly bathymetry.
5. Sediment archives should be cored and examined to obtain a complete history of past coastal behaviour. This may include analysis and dating. Coring using vibrocores, gravity cores or deep boreholes recovered for engineering purposes often contain the data necessary for initial palaeo-environmental assessment. Discussion with the local curator before coring begins should help identify the best locations for sampling.
6. Survey and field-walking is a quick and effective way to identify, record and locate pertinent features within the landscape.
7. Where more detailed site inspection following field-walking is warranted, hand held augurs can be used to interrogate buried landforms which lie within a few metres of the surface.
8. Where archaeological or palaeo-environmental material of sufficient significance is identified. Excavation ahead of development may be required. The nature of any excavation and amount of material sampled or recovered should be proportionate to the nature and size of the development, and appropriate to answer the questions being tackled. Such issues would be decided following consultation with the local curator.
9. Where important remains are discovered during development, mitigation should be decided inline with national and local government practice following consultation with the local curator. Data retrieved should be assessed to inform understanding of coastal development.
10. This report has demonstrated that much can be gained by discussing and sharing interpretation of the data. This is an objective that can now be nurtured by SCOPAC.

12. Future work

This report has demonstrated that submerged and inter-tidal archaeological sites, landscapes and palaeo-environmental material can provide data that will inform coastal managers of changes to the coastline. They can provide indices of past change, current trends and areas vulnerable to threats as the climate warms. This information is of value to coastal planners and engineers as it can provide baseline data against which informed judgements can be made when presenting prescriptions for management units.

For best value to be gained from assessment of the resource within the SCOPAC region, the following initiatives are recommended.

12.1 Methodological improvements

- The results from the scoring exercise have highlighted the need for more data pertinent to studies of coastal change. In many areas, lack of data made it impossible to score sites. To address this shortfall the regional Historic Environment Records need to be provided with the necessary information for its database.

- To achieve this, there is a need to improve the methods by which archaeological and palaeo-environmental material is recovered from areas under development. (see section 11.2 above).

- A requirement to recover archaeological and palaeo-environmental samples that would aid assessment of past coastal change should be integrated into any impact assessment ahead of development.

- To gain best value from any new information, local curators should be given support to develop their HERs to accommodate new data fields. Enhanced databases could assist in the interpretation of results and provide a direct link to issues of concern in shoreline management plans. Recommendations that would help to achieve this have been outlined in section 11.1, 1-4 above.

12.2 Extending ranking to whole SCOPAC region

- Strategic development of the ranking system has the potential to qualify the significance of the archaeological and palaeo-environmental resource across the whole SCOPAC region.

- The strength of the scoring system is realised when sites are ranked relative to each other. In this way valued judgements can be made when assessing coastal stability characteristics and long-term flood risks within shoreline management plans. For the process to be of greatest benefit and serve the needs of all SCOPAC members, the system would need to be applied to the whole coastline.

12.3 Further consideration of assessment sites

- This project has interrogated the available data held by the HERs for selected assessment sites. The results have presented a valuable critique and provided signposts to the most important archaeological and palaeo-environmental archives within each area. The next stage is to develop site-specific project designs and data-collection strategies to unravel past and ongoing changes in the geomorphology within the selected areas.

- Recommendations for actions to be taken at specific assessment sites are presented in section 10. The results should be integrated as baseline data into shoreline management plans, increasing our understanding of long term coastal change.

12.4 Development of investigation and sampling programme

- A broad spectrum of baseline data is essential if we are to construct an accurate record of coastal change along the SCOPAC coastline. A well managed strategic programme of field investigation and sampling should be designed to avoid repetition and maximise efficiency.

- HER assessments should be conducted in line with the protocols described in this report to identify the potential of an area to provide information relevant to shoreline management plans. The methods employed to collect data from each management unit should be determined by the information sought.

- The results realised within this report have taken the first step to achieving this goal by addressing the sampling necessary for the areas assessed. This should be developed to formulate a defined archaeological programme for field investigation and analysis that can inform shoreline management plans prescriptions.

12.5 Inter-disciplinary relations

- There is a need to investigate current levels of knowledge about archaeology and the palaeo-environment within the coastal management community. A review of the mechanisms by which archaeologist and coastal managers currently communicate in each county/unitary authority would be worth undertaking.

- Where requirements of different disciplines in coastal schemes are not fully understood across relevant sectors, improved methods of communication should be identified. In this way information recovered for one discipline may be used by another whereby reducing costs and negating the need for repetition. An example is the assessment of geotechnical borehole data which is collected for engineering purposes but can enhance knowledge of archaeological and palaeo-environmental potential.

- Further work should include the development of protocols to ensure data exchange between coastal engineers, coastal managers and archaeologists.

12.6 Awareness and dissemination

- The historical and archaeological record is rich with examples of coastal settlements that have been consumed by the sea. The potential to demonstrate the inevitability of coastal change is wide and varied.

- The first task should be to make those empowered with the responsibility of coastal management aware of past events and their causes if they are to be given due regard in the next round of shoreline management plans. The production of a code of practice or guidance note for coastal developers in a format that would be practical and accessible would be very valuable. Such a document should be published on hard copy and placed on the SCOPAC website.

- A guidance note could be complemented by training sessions or workshops aimed at raising understanding. This would demonstrate that the SCOPAC region is leading the country in developing awareness programmes directly linked to improving the Shoreline Management Plan process.

- A second task would be to increase pubic consciousness of the inevitability of climate change and sea level rise. The archaeological and palaeo-environmental record can be used to demonstrate past catastrophic events while examples of human resettlement can provide tangible evidence of human responses to coastal change.

- A method of dissemination to be considered would be the production of a leaflet for the SCOPAC region that draws on the examples in this document. A complementary course of action would be a series of public presentations where the audience could be treated with visual examples of the changing coastline through time.

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14. Appendices

14.1. Data licence agreements

Data Licence agreements for data supplied by the various Sites and Monuments Record Offices are listed below:

West Sussex County Council

- West Sussex County Council holds copyright of the WSCC computerised SMR data. No reproduction of WSCC SMR data in the form of a direct copy of the original will be allowed.
- The information in the WSCC SMR although verified as far as possible, is not definitive.
- At the time of enquiry, information may exist concerning archaeological sites hitherto unknown to the County Council which will not therefore be included in the computerised SMR.
- The location of artefacts or secondary sources referred to in the WSCC SMR but not held by West Sussex County Council cannot be guaranteed.
- At the discretion of West Sussex County Council, certain data may be withheld under the provisions of the Data Protection legislation.
- The West Sussex SMR must be acknowledged where data is used in publication.

Isle of Wight Council

- Isle of Wight Council holds copyright of the compiled SMR information. No reproduction of the compiled information will be allowed as a direct copy of the original.
- The information contained on the SMR, although verified as far as possible, is not definitive.
- There may be information concerning existing or new archaeological sites or finds which is as yet unknown to the Council and which is not recorded in the SMR at the time of the enquiry.
- The whereabouts of any artefacts, other material, documentary sources or air photographs referred to in the SMR and not kept in the SMR reference files cannot be guaranteed.
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- Where SMR information is used in reports or publications its source must be acknowledged.
- The information from the SMR will only be used for the purpose stated below and will not be stored beyond the life of the project for which it was acquired.
- No records, books, maps, files, photographs or any other materials belonging to the SMR or its archive shall be removed from the County Archaeology and Historic Environment Service without prior permission.

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- Hampshire County Council holds copyright of the compiled AHBR information. No reproduction of the compiled information will be allowed as a direct copy of the original.
- The information contained on the AHBR, although verified as far as possible, is not definitive.
- There may be information concerning existing or new archaeological sites or finds which is as yet unknown to the County Council and which is not recorded in the AHBR at the time of the enquiry.
- The whereabouts of any artefacts, other material, documentary sources or air photographs referred to in the AHBR and not kept in the AHBR reference files cannot be guaranteed.
- Some information may be withheld because of its sensitive nature and the requirements of the Data Protection Act.
- Where AHBR information is used in reports or publications its source must be acknowledged.
- The information from the AHBR will only be used for the purpose stated below and will not be stored beyond the life of the project for which it was acquired. Original digital media

(CDs, disks etc) should be returned on completion of the project and the AHBR data deleted from all computers and networks.

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- SMR data is provided for the sole use of the licensee for the purposes specified below and will not be passed on to third parties or used for other purposes than that for which it was supplied. The SMR data must not be used for purposes which may result in unlawful damage to archaeological sites, historic buildings or historic landscapes. Misuse of the information provided will result in the licensee being denied access to SMR information in the future.
- The use of the SMR data is licensed for a period of ……. months/years. Requests to extend the licence period must be made in writing not less than 7 days before the expiry of the licence. It is the responsibility of the licensee to ensure that updated information is obtained from the Southampton SMR where there is a significant delay between the supply of SMR data and the production of a report.
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- The data is the copyright of Southampton City Council and should not be reproduced in the public domain without the written permission of the Southampton Sites and Monuments Record Officer, except as an abstract in documents/reports explicitly covered by the licence agreement. The Southampton Sites and Monuments Record should be suitably acknowledged as the source of the information (for instance © Southampton City Council 2005). The licensee will provide either a paper copy or a digital copy of each document/report produced as a result of using the SMR data, for inclusion within the Southampton SMR, within …..months of the completion of the document/report; the digital copy will be in either rich-text format or in PDF format, with the file security set to allow copying and printing. The licensee will give permission for this document/report to be passed on to any bona fide archaeological or local history researchers on similar Licence terms to those contained within this Licence.
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14.2 Minutes of Discussion Session of Technical Workshop

Minutes of SCOPAC 'Archaeology and Coastal Change' Project Workshop

29 July 2005

Portsmouth City Council, Meeting Room 1

The workshop was held after a meeting of the SCOPAC technical officers.

SCOPAC officers in attendance:
Dr R McInnes – Isle of Wight Council, Chairman
Ms H Bloomfield – Isle of Wight Council
Prof A Bradbury – New Forest District Council
Mr A Brown – Eastleigh Borough Council
Mr L Cairns – Havant Borough Council
Ms G Conway – Solent Forum
Mr D Court – IW Area of Outstanding Natural Beauty
Mr B Curtis – Worthing Borough Council
Mr R Edmonds – Dorset County Council
Mr M Goater – Purbeck District Council
Mr D Green – Arun District Council
Dr D Harlow – Bournemouth Borough Council
Mrs B Herbert – for the Secretary
Mr T Kermode – Environment Agency – Hants & IW
Mr D Lowsley – Chichester District Council
Ms A Pulham – West Sussex County Council
Ms D Smith – Isle of Wight Council
Mr B Symons – DEFRA
Mr D Watkins – Fareham Borough Council Regards

Other workshop participants:
Ruth Waller (IOWC County Archaeologist)
Rebecca Loader (IOWC Archaeologist)
Stephen Appleby (Hampshire CC Archaeologist)

SCOPAC Project Staff:
Garry Momber (HWTMA Director)
Julie Satchell (HWTMA Archaeological Officer)
Gavin Stone (HWTMA Archaeologist)

All attendees were circulated papers prior to the meeting which introduced the project aims and objectives.

Garry Momber gave a presentation on the work of the project to date, a copy of this presentation is included on the accompanying CD.

The following minutes are a record of the Workshop discussion session. The following key is used:
Q = Question
A = Answer
C = Comment

Q (RMG) – Is there anything arising from the scoring criteria that indicate which site types might provide more information? This would be good to know when working at certain coastal sites.
A (GM) – Shipwrecks do tend to be less important for long term change, but this can depend on their age and exact location. Boreholes do often hold relevant information, they may contain laminations of deposits which can be dated to reflect events through time. Other environmental evidence which can be analysed includes diatoms or foraminifera which can indicate salinity.

Q - Is the scoring based on existing sites.
A -Yes

Q – Can the criteria be used to reflect certain issues? For instance coastal change is highest on the agenda for SCOPAC officers.
A (GM) – The results are showing that it is possible to focus on certain coastal and environmental issues, this will be explored in the final report.

Q – Given that there is a large time difference between the deposition of archaeological material and the present day, how relevant is information from periods hundreds of years ago to SMP's that are currently being prepared?
A (GM) – The project has considered sites dating from the end of the last Ice Age onwards. There is a wide variety of site types represented that do span the millennia right from Mesolithic submerged landscapes to WWII pill boxes which are now out at sea. So there is long term evidence that demonstrates continual change. Examples would include flooding events which can be identified in the palaeo-environmental record. When these records are comprehensively studied, patterns may emerge showing changes through time. This type of data has relevance to monitoring change and understanding the way the coastline has evolved and adapted as a consequence of past sea level change.
Another example is where dated archaeological evidence can tell us about relative sea level change between one area and another. As well as rising sea levels, the land has also been moving. However, the speeds at which areas shift up and down relative to each other may differ even within 10's of miles. If archaeological and palaeo-environment material can be collected from different coastal locations and dated, and the position relative to sea level can be established, the differences between depths of the same date material may enable the calculation of land movement. Knowing the different rates of change of sea level relative to the land at points along the south coast would help inform coastal managers when making decisions about the height of coastal structures such as sea walls.
Understanding the response of the coastline to past climate change can be used to help anticipate future change.
It should also be stressed that archaeological examples can be very appropriate for demonstrating to the public that coastal changes have been ongoing for many millennia.
C (RMG) – 'The wisdom of hindsight'. We can learn lessons from the story of the past to see what the effect may be on the future.

Q – Are palaeoenvironmental records included on the Historic Environment Record?
A – (R Waller) – Yes, if people let us know that the data has been gathered we can add it to the HER. If we have it, it will be on the record.

C – (A Bradbury) – We need to tease out the data that is genuinely useful to coastal managers. Particularly examples that can be used to inform the public. Many people don't believe sea-level is changing – this project will show otherwise. The projects outputs should provide graphic demonstrations of this.

Q – Can we see evidence that the landmass is dropping?
A (GM) – This has not yet been seen in the results and indeed we may not see it unless the resolution of data is high enough. We will be assessing this and the need for better data to answer these questions in the future.

C (RMG) – Wessex Archaeology have undertaken a study on how archaeology has been incorporated into the Round One SMP's.
Guidance for the Round Two SMP process is currently being drafted by DEFRA.
The DEFRA Future Coast project will be relevant to this project.

It would be useful to compare the Round One SMP guidance with the proposed Round Two guidance and highlight any changes or differences. This could be added to the report.

C (S Appleby) – There is an English Heritage initiative ongoing to design an 'Add-on' to the HER's database system for environmental material. This will help in the future to identify sites that would warrant further investigation.

Q – Is the advice outlined in the Draft Guidance Notes aimed at the Strategic Level or more focused at site specific?
A (GM) – It currently covers a range of issues at a variety of levels.

Feedback on the project is welcomed. If there are any comments on the project to date please feed back before the end of August.

C (RMG) – it is recommended that a further presentation is made to the SCOPAC research sub-group prior to finalising the report.

Bill Simons from DEFRA can help with the latest finding on the Round two SMP process and pilots.

14.3 Full scoring Results