Maritime Archaeology Trust

Warship *Hazardous*

Site Evaluation Report and Statement of Research Potential

Hazardous Project

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Warship *Hazardous*: Site Evaluation Report and Statement of Research Potential

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Contents

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ii. Acknowledgements

The Hazardous Project Group (HPG) has been undertaking investigation, survey and monitoring of the Designated Protected Wreck Site of Warship *Hazardous* since its discovery in the 1970s. The Maritime Archaeology Trust (formerly the Hampshire and Wight Trust for Maritime Archaeology (HWTMA)) have been working to support the Hazardous Project Group since 1998. The HPG consists of a dedicated and experienced group of volunteers. This project demonstrates the potential for volunteer groups, with professional support, to make a significant contribution to knowledge and understanding of one of England's most important marine historic assets.

This report is based on two separate reports produced as part of the project *Warship* Hazardous *Site Evaluation: Assessing the seabed archive, rescuing the resource and answering research questions*. The fieldwork outlined within this report was undertaken in 2008 and 2010 following a lowering of sediment across the site exposing new features and structure.

The project reports were produced in support of work undertaken by the Warship Hazardous Project Group (HPG). The project 2008 – 2011 was managed by Julie Satchell. This report has been written by Julie Satchell. Site plan illustrations have been produced by Julian Whitewright (unless otherwise stated) based on a range of figures produced during previous work by the Hazardous Project Group and newly acquired data. Comments on the reports were provided by Iain Grant (Site Licensee) and David Johnston (HPG team member) and Hazardous Project Group members.

Illustrations and photographs produced by members of the Warship Hazardous project have been reproduced with their permission. These images should not be used without seeking prior permission.

This element of project work has been supported through funding from English Heritage's Historic Environment Enabling Fund, the Heritage Lottery Fund Awards for All Fund, Interreg IVA Archaeological Atlas of the Two Seas project (A2S), Sussex Archaeological Society Margary Research Grant and the Warship Hazardous Project Group.

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v. Summary

The Warship *Hazardous* is a Designated Protected Wreck site which lies off the coast of West Sussex. The ship was originally a French 3rd rate ship of the line built in 1698. After capture by the English the ship was refitted into the Navy as a 4th rate, but wrecked in 1706. The site was discovered in the late 1970s and since this date has been investigated by the Hazardous Project Group who have held a continuous licence for the site since its designation. A large archive of data and objects has been accumulated over the past 30 years and provides the opportunity to study one of the UKs most important marine historic assets.

The wreck site is in a dynamic, shallow water environment. Its depth at around 8m at high water springs means that it is affected by wave and tidal conditions in addition to winter storms. In 2007, it was discovered that sediment levels around the site were reduced, exposing material not previously seen with structure, features and artefacts now at immediate risk of loss. Plans for an excavation were rapidly developed for the 2008 season, unfortunately due to very poor weather conditions the work had to be suspended several times. Further attempts to reschedule the work twice in 2009 were also thwarted by the weather. Meanwhile exposed areas of the main wreck site and features and artefacts in an area of clay gullies to the north west were exposed to degradation and loss.

There were plans to reattempt excavation in 2010, however, diving early in the season discovered further large changes had occurred on site with a massive influx of sand into the main wreck site. This movement had covered the area of the proposed excavation to such an extent that excavation was not feasible to attempt. Plans for work on site were adapted to concentrate on the survey of an area of structure off the north east bow of the wreck that was still uncovered and survey and recovery of features and at risk artefacts in the area of gullies.

Results from the on-going monitoring of the site by the Hazardous Project Group and the survey work in 2008 and 2010 have provided further evidence of the extent to which the site is under threat. Recent results have been compared to a previous study of the environmental factors affecting the site and have highlighted the extent to which the direction and severity of winter storms seem to affect the sediment regime around the site. As a result the site is highly likely to become uncovered again in the future requiring a rapid response to prevent further loss of data.

Additional site data recovered between 2008 – 2010 added to the accumulated understanding of the wreck site and its environment. This evidence was taken into account when undertaking a review of the research potential of the site and its associated archive to develop key questions to shape future evaluation and analysis.

1. Introduction and Brief Site Background

The site of Warship *Hazardous* has been under archaeological investigation for thirty years. This work has been undertaken by the Hazardous Project Group (HPG) (308 Sub Aqua Association) with the support of a range of archaeological advisors and organisations. *Hazardous* is one of only 49 Protected Wrecks around the coast of England. It is designated under the Protection of Wrecks Act 1973 and all diving and archaeological investigation must be licensed.

Over the past seven years in particular English Heritage (EH) and other funders have supported the HPG in its work with the Maritime Archaeology Trust (formerly the HWTMA) to develop and deliver a number of phases of work on the site and its related archive. Completed elements of work include:

- Archive assessment, enhancement and deposition for the Protected Wreck Site Warship *Hazardous* (EH Project 3793); and
- Quantifying the *Hazardous* Threat: an assessment of site monitoring data and scoping of available environmental data sets (EH Project 3794)

The full reports are available via the Archaeology Data Service on-line archive for the site at:
http://archaeologydataservice.ac.uk/archives/view/hazardous_eh_2005/downloads.cfm

The 'Site Evaluation' detailed within this report, was initiated in response to an urgent need to address erosion threats on the site and gather more data to help qualify research questions. Excavation was originally planned to take place in June 2008, however, poor weather prevented it being completed. The excavation was then rescheduled for 2009, unfortunately both attempts to undertake the work (in May and July) were beset with more stormy weather, further postponing work.

Early dives in 2010 discovered a massive influx of sand over the wreck site covering previously exposed areas with over a metre depth of sand, whilst off the north west of the site an area of geological gullies known to hold material related to the wreck which had been buried for many years had been exposed. These changes to the on-site sediment meant it was not possible to excavate within the hull structure and plans for diving work had to be adapted to these new conditions.

This report details the results of the diving fieldwork undertaken in 2008, 2009 and 2010, it also draws on the work of the HPG to monitor and record the site between 2007 and 2010 (Section 3). The changes on the site witnessed over the past four years are then reviewed against the results of the assessment of long term site monitoring data and environmental conditions that was reported in *Quantifying the* Hazardous *Threat* (Satchell & Van Rensburg 2007) (Section 4). Following a brief consideration of management implications of the recent changes to the site (Section 5), the report concludes with a detailed assessment of the site research potential to help direct future evaluation and analysis (Section 6).

1.1 Brief Site History

The following brief history is presented to provide context to the work undertaken between 2008 and 2010. Further information on the site is available from other

publications such as Owen 1988 & 1991; Holland *et al* 2005 or Satchell & Van Rensburg 2007.

1.1.1 Vessel History and Wrecking

Le Hazardeux was built in 1698 in France. The vessel 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 *Le Hazardeux* was captured by the English and refitted as a 4th rate ship of the line with 54 guns. The ship was re-commissioned as *Hazardous* in 1704 but was wrecked only two years later in Bracklesham Bay, West Sussex (See Figure 1.1 in Section 1.3 for location).

The capture and refit is important in the archaeological significance of *Hazardous*. Techniques of ship design and construction developed by the French are present on the remains of the ship. Of particular interest are the 'cant frames' present in the bow of the vessel which are angled (or canted) from the keel, providing a stronger method of hull construction. When captured by the English, the vessel was studied and the framing design was eventually incorporated into English naval ship construction. There is a range of other interesting and unusual evidence, such as the use of lead caulking strips and laminations of lead sheet between hull elements that provide a rare opportunity to record the physical evidence of 17th century ship construction.

1.1.2 Discovery, Protection & Archaeological Investigation

Hazardous was discovered in 1977 by sport divers. The wreck was designated in 1986 under the Protection of Wrecks Act 1973 and is now managed by English Heritage. Archaeological investigation of the wreck by the HPG began in earnest in the early 1980's, and has continued for the past thirty years. Over this period the Group has held a range of licences including survey, surface recovery, excavation and visitor licences.

Survey and artefact recovery work have indicated the identity of the site as that of *Hazardous*. The remains comprise principally the lower hull on the port side, with the bow half of the ship being better preserved. Since the late 1980's, there has been a rapid increase in erosion which exposes artefacts and fresh wooden structure. The most extreme example being when the southern half of the hull structure was lost over a single winter. In response to the erosion, an initial evaluation trench was dug across the vessel in 1990. This began to reveal the extent of the preserved stratigraphy, features and artefacts still present in the remaining hull structure. Since that date monitoring and survey of the site has been continued. This has confirmed the rapid rate of loss of the sedimentary and associated artefact and environmental archive, underlining the urgency for rescue excavation to prevent further loss of *in-situ* archive. However, the complexity of the sediment movements in the area of the site has been further demonstrated through a recent rapid build-up of sand over the southern area of the site between 2009 and 2010.

1.2 Evaluation Project

As previously highlighted, what remains of the wreck of Warship *Hazardous* is at threat from loss due to continued erosion. This has been witnessed, documented and reported by the HPG over the past thirty years, and was summarised in the project report *Quantifying the* Hazardous *Threat: an assessment of site monitoring data and environmental data sets* (Satchell & Van Rensburg 2007: 53) which stated:

> "The site is being degraded through two principal mechanisms: long-term net sediment loss across the whole of Bracklesham Bay and isolated storm events. These factors combine to equal a site which is under extreme pressure and at high risk. Inevitable loss of the cultural heritage archive on the seabed means that there is an urgent need to consider the possible management options for the site and put in place a strategy which is agreed between all stakeholders."

While there is an urgent need for threat-led intervention on the site there are also other drivers for intrusive work, these include:

- The need to establish the current extent of the seabed archive to inform future investigation and management;
- Understanding the research potential of the site through establishing the extent and preservation of the hull remains; and
- Assessing the quantity and quality of the object assemblage still preserved within the seabed.

The increasing loss of sediment and uncovering of previously buried areas within the hull between 2006 and 2007 prompted the development of an evaluation excavation project. Successful proposals for funding were developed for the Heritage Lottery Awards for All Fund and English Heritage. The excavation was due to take place in 2008. However, poor weather conditions prevented the excavation from taking place on multiple occasions in both 2008 and 2009. Early dives in the 2010 season found an influx of sand over the site which rendered excavation within the hull impossible due to the volume of material that would require moving. In response the planned work was adapted to be directed to the most urgent work on site.

1.3 Project Aim, Objectives and Adaptation

The original project aim was 'To undertake an evaluation excavation on the Protected Historic Wreck Site of Warship *Hazardous'.* However, the project variation meant this was amended to a 'Site Evaluation'. Despite the changes in the site work undertaken, the project objectives remained relevant:

- To enhance understanding of the seabed archive;
- To gather data to help develop a research agenda for the site; and
- To rescue at risk elements of the seabed archive.

As mentioned above, this site evaluation project has undergone a number of variations in response to weather and environmental conditions, these include:

- 2008: Mobilised for excavation week, but poor weather meant that only four days of the planned nine were spent on site and the rest of the week was postponed.
- 2009 – May: Limited mobilisation occurred, however, a large storm meant that operations would not be possible and the week was postponed.
- 2009 – July: Half of the team mobilised to Bracklesham, however, once again stormy weather prevented work on site.

Initial dives by the HPG in April 2010 discovered a large amount of sand had moved onto site over the winter. Subsequent dives quantified this to being over one metre in depth. Such a large movement of sand had not been witnessed for over 20 years. Due to the extent of the sand covering, it was not possible to undertake the excavation in the central area of the site; there was not enough time to remove the accumulated sand overburden.

Conversely, there had been a movement of sand away from gullies in the underlying geology which had been uncovered some 20 years ago but since reburied and from which a significant number of artefacts had been recovered. Figure 1.1 shows the wreck site, the reef to the south and the area of gullies to the north west where material was recovered in the late 1980s. It is based on a figure by Norman Owen. The reduction in sand levels in this area was noted again in 2008. However, it had increased by 2010 with *in-situ* (since the wrecking process, rather than within their original vessel position) artefacts being located such as a wooden spar and stray finds including a copper alloy buckle, some lead tingles and glass shards from onion bottles. In response to these changes the work on site in 2010 was adapted (see Section 2 for further details).

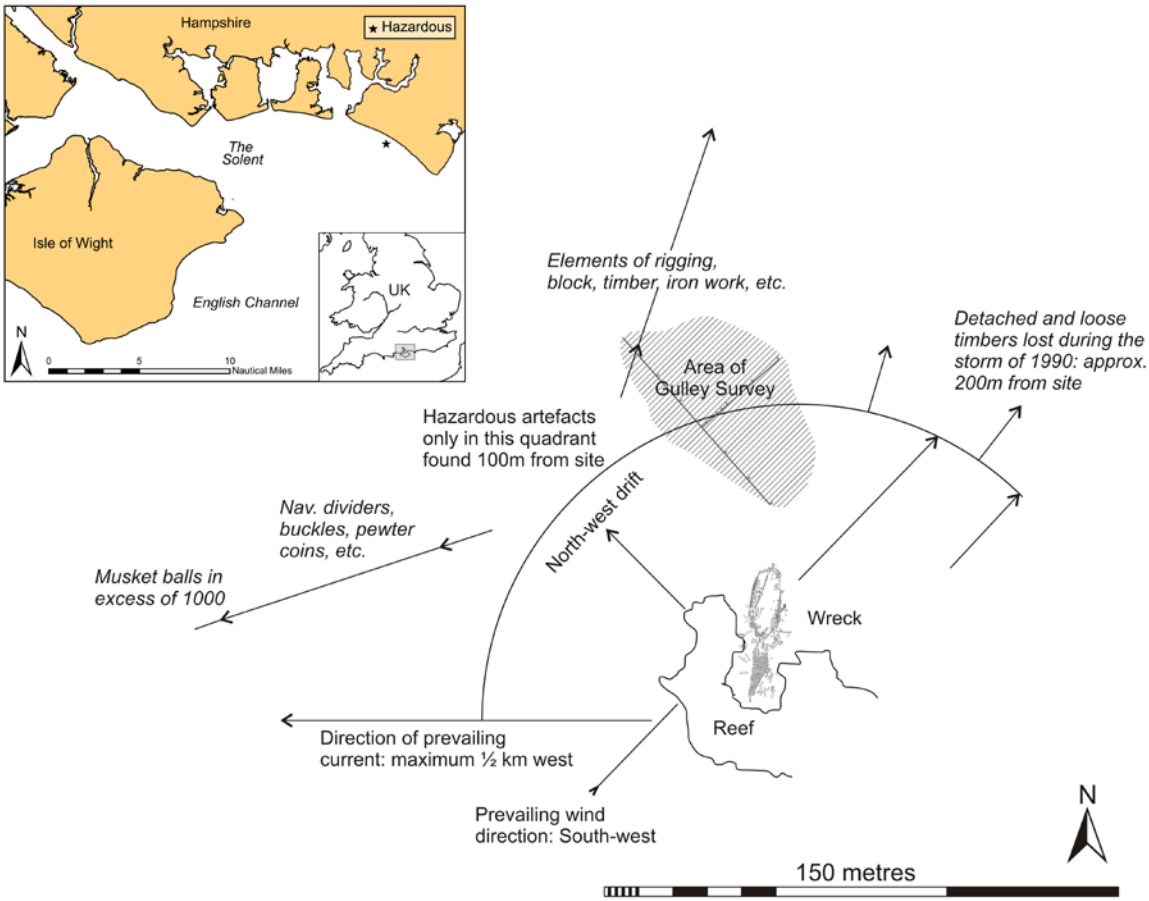

Figure 1.1 Location of the Hazardous *wreck in relation to the reef to the south and the area of gullies to the north west*

2. Methodology

This section provides an overview of the project methods related to the work undertaken on the site and archive. Where survey methods are relevant to a particular aspect of the work they have been included with the relevant results in Section 3.

2.1 Permissions

Prior to evaluation fieldwork being undertaken permissions for the works were gained from:

- DCMS (excavation licence)
- The Crown Estate
- Marine Management Organisation (former Marine and Fisheries Agency)
- Natural England (formerly English Nature)

The initial permissions gained for the 2008 excavation were renewed for 2009 and then a revised version renewed for the 2010 survey work.

2.2 Logistics and Diving

The logistics required for excavation included the preparation of the project base to receive artefacts in addition to the organisation of a wide range of equipment and paperwork related to diving operations and underwater excavation.

Diving activities took place from Bracklesham Bay and involved a number of boats used as working platforms for the diving team. All diving was undertaken using Self Contained Underwater Breathing Apparatus (SCUBA). The team consisted of the HPG working alongside divers from the HWTMA, diving operations were conducted within the Health and Safety Executive Scientific and Archaeological Approved Code of Practice.

As the site is subject to tidal influence work was scheduled over neap tides when the slower speed of water movement means diving is possible during most states of the tide. The maximum depth of the site is 8 metres. Visibility encountered on the site varied between 0.25m and 2m.

2008: All work required for the planned excavation was completed and the team and equipment were mobilised to site on the 21st June. Two days of diving were undertaken (23rd and 24th June), during which a pre-excavation plan was produced and an excavation frame installed. However, further storms prevented more diving in this season.

2009: Mobilisation was undertaken in May, however, a large storm once again postponed work. A week in July was then selected for excavation, however, after a limited deployment of divers and equipment it became clear that further storms were expected preventing diving taking place.

2010: The build up of sand over the wreck site during winter 2009/10 meant it would not be possible to undertake excavation in the central area of the site that had previously been exposed through erosion. Responding to this change, fieldwork was undertaken between the 3rd – 6th July; this included planning exposed structure on the north east edge of the main wreck site and the investigation, survey, position fixing and recovery of at risk artefacts from the area of gullies (for methods used see section 3.2 and 3.3).

The structure off the north east of the site consists of a substantial section of hull. Early plans of the wreck site do include a number of timbers in this area, but the material shown is not as extensive as the material exposed from 2007. The uncovering of this area provides further evidence of the extent of sediment movements.

The diving work in July 2010 included 42 dives with around 50 hours spent underwater.

2.3 Artefact Recovery and Archive Work

All artefacts raised from the site are handled in line with recommendations set out in 'First Aid for Underwater Finds' (Robinson 1998). A number of surface recoveries were undertaken in 2008, 2009 and 2010 from both the main wreck site and the area of gullies lying to the north west. Individual artefacts were surveyed in position prior to being recovered. Most of these recoveries have been made by the HPG during regular diving on the site when monitoring, recording of exposures and rescue recovery was undertaken.

The Warship *Hazardous* archive is housed at the project base at Earnley Gardens, the portacabin includes a 'wet' area for conservation and a dry area for other archive work and storage of stable finds.

Conservation work has been taken forward with the assistance of Paul Simpson of the Isle of Wight Museums Service.

3. Results

This section presents the results of work undertaken on the *Hazardous* site between 2007 and 2010. It concentrates initially on evidence of changing seabed levels and resulting impacts on the structural remains and artefacts that have been observed and measured by the HPG. These changes provide the background context for the development of the excavation project and subsequent work in 2008, 2009 and 2010.

3.1 Monitoring Change

The changes on site are being measured through a range of mechanisms. Monitoring points were established from 2002 specifically to measure seabed levels, data from these points in addition to diver observations of key features provide evidence of change. Artefact exposures and recoveries provide further evidence of areas of the site becoming more exposed and under threat.

3.1.1 Seabed Changes 2007 - 2010

The changes in seabed levels which were most extreme between the 2006 and 2007 seasons had caused areas of structure to be uncovered that had not been seen previously. These changes prompted the development of plans for excavation. Over the course of the fieldwork between 2007 and 2010 a range of data has been gathered related to the changing seabed conditions on site. This includes evidence from diver observations and measured data from monitoring points. The changes noted from survey of these points between 2002 – 2006 were presented in the report *Quantifying the* Hazardous *Threat: an assessment of site monitoring data and scoping of available environmental data sets* (Satchell & Van Rensburg 2007). Although over the past few years a number of these points have been lost due to damage caused by gribble worm, some are still in position and the practice of measuring seabed levels in relation to stable elements of the ship structure and objects (such as cannon) is now established. This section presents measured and observed changes of the conditions on site, these have been summarised from the annual report to the Advisory Committee on Historic Wrecks (ACHWS) (Grant 2007; 2008; 2009 and 2010), the implications of these changes are then examined further against the results of the 2006 report in Section 5.

2007 Seabed Changes

The 2006 season had witnessed reduction in seabed levels in some areas around the site, however, diving in 2007 found extensive changes had occurred over winter. In particular the following observations and measurements were taken:

- Scour had occurred in the north of the site with a drop in sand level both inside and outside the hull along the west and east of the site.
- Outside of the hull there was a loss of up to 0.5m of sand, causing undermining of the hull, in some places the underlying Bracklesham Bed form geology was visible. The reduced levels of sand continue up to 10m away from the bow to the north and more than 20m to the west of the site.
- A gun carriage axle with wheel attached was discovered loose on the seabed north of the beak. This was in good condition and had not been affected by gribble worm suggesting recent exposure (this has since been recovered and is undergoing conservation by the HPG).

- Outside of the hull off the forward starboard quarter there are artefacts and structure exposed including a substantial piece with paired frames and planking attached.
- Inside the hull a considerable drop in sand level had exposed four barrels – two standing on their ends and two lying on their side - between the cannon ball mound and the pile of three guns, in addition to large timbers and sections of heavy textile, thought to be canvas.
- Loss of sediment inboard of the port side guns revealed new timber structure.
- Gun deck beams and the top breast hook, last seen during excavation in 1989 and 1990 are now proud of the seabed. A gun and carriage which were still in position on the gun deck and which had been sheeted and re-buried after excavation were becoming uncovered with a carriage wheel and the stepped part of the carriage visible and suffering severe gribble worm attack.
- South of the site there has been an increase in sand levels, the 'reef' which is part of the Bracklesham Beds formation, to the south is now only around 0.2m proud of the surrounding bed levels. Sections of this 'reef' material up to 1m across have become dislodged and have moved considerable distances. The increase in sand levels had buried substantial parts of the Diver Trail on the site making it inoperable.

These significant changes on the main wreck site and area of gullies to the north west (represented on Figure 3.1) prompted the development of plans for an excavation in 2008 which would be aimed at recording and recovery of archive from the central area of the site where the barrels had been exposed. (See end of Section 3.1.1 for Figures, please note that area of gullies that lies to the north west of the main wreck site (also see Figure 1.1) has been included as an inset box where relevant to demonstrate key changes in these areas within the same Figure).

2008 Seabed Changes

Observations during this season on the main site included:

- The beak remained undercut to the same depth as in the previous season, but there was increased scour in this area.
- West of the beak the seabed was uncovered down to the clay of the Bracklesham beds, this appears to have affected the area adjacent to the hull where there had been some undercutting.
- East and north of the hull, there has been a 0.5m drop in seabed level, most extensive between the bow and the cannonball mound, where large sections of hull planking with frames attached had become freshly uncovered.
- The barrels in the central area of the site were still uncovered and protruded up to 0.05m from the seabed.
- Diver trail cables were buried under sand overburden for two thirds of the total trail length, making it impossible to run the trail.
- Sand has moved in from the south heading towards the main wreck site, but currently at a distance of around 30m from the wreck (See Figure 3.2 below).
- To the south east of the site there is some reduction in sand with areas of the Bracklesham Bed and small 'reef' in the south uncovered.

Observations from gullies to the north west of the site demonstrated:

- Due to large amounts of sea bed movement a number of artefacts were discovered in this area including a large double sheaved rigging block, pieces of timber, a

number of iron concretions and an iron gun. Also in this area of gullies were a 'carpet' of approximately 100 musket balls and a brass shoe buckle.

Changes outlined above on or close to the main wreck site and in the area of gullies are shown in Figure 3.2, while those related to the wider area are included in Figure 3.6.

2009 Seabed Changes

Observations during this season included:

- Early in the season it was reported that the sand encroaching from the south appeared to have increased in extent and depth as the three guns to the south were now buried as were the barrel staves in the centre of the site. The lower of the three guns in a pile, was now touching the sand again (0.2m – 0.3m increase) in this area. However, it should be noted that diving in September recorded that sand levels in the centre of the site were beginning to drop again.
- East and north of the site there had been a reduction in seabed levels, this caused scour around the beak, and full exposure of an area of frames and planking off the north east side of the main hull. The area between the bow and cannonball mound remained at the same level as in 2008.
- There also appears to have been further loss of sediment to the west of the site.
- The area of the clay gullies to the north west of the wreck site remained uncovered and a small further drop in sediment levels had occurred. The reduced seabed level in this area has led to degradation of artefacts and features noted in this area and had uncovered further iron concretions.

Changes outlined above, on or close to the main wreck site and in area of gullies, are shown in Figure 3.3, while those related to the wider area are included in Figure 3.6 (below).

2010 Seabed Changes

Observations during this season included:

- Significant movements of sand into the wreck site from the south had covered many datum points and most of the remaining diver trail. The sand extended into the site to an area between the cannon ball mound and pile of three cannon (also see Figure 3.6, table 1 & 2).
- Sand levels had increased to the south, east and west of the wreck site (see Figures 3.4 and 3.6).

Specific measurements taken early in the season included:

From	***To***	***Measurement***	***Change***
Top of 3 cannon pile	Seabed	0.90m	
Top of cannon ball pile	Seabed	0.77m	
M9	Seabed	0.63m	Increase in sand of 0.12m since Sept 2009
M10	Seabed	0.68m	Increase in sand of 0.10m since Sept 2009

Table 1: Monitoring measurements taken April 2010

Further measurements on 17th October recorded:

From	***To***	***Measurement***	***Change***
Top of 3 cannon pile	Seabed	0.70m	Increase in sand of 0.20m in 6 months
Top of cannon ball pile	Seabed	0.70m	Increase in sand of 0.07m in 6 months
M9	Seabed	0.60m	Increase in sand of 0.08m in 6 months
M10	Seabed	0.55m	Increase in sand of 0.13m in 6 months

Table 2: Monitoring measurements taken October 2010

These results show that the active processes related to the movement of sand were still continuing throughout the summer season.

Extensive changes occurred to the *Hazardous* site area of gullies and surrounding areas between 2006 and 2010. Figure 3.5 shows all of the changes during this period to provide a representation over the longer term. In summary, winter 2006/07 saw a large reduction in seabed levels causing areas of structure and previously unseen wreck features and contents to be exposed. The main movement of sediment over winter had been a reduction in the north and west with some increases to the south of the site.

In 2008 there was a reduction of sediment in the north and west of up to 0.5m, while the centre of the wreck was relatively stable. To the south of the wreck there was a further extensive build-up of sand. The seabed loss to the north and west of the wreck caused gullies in the underlying geology to be exposed.

Changes between the 2008 and 2009 seasons were less dramatic than previous years, but there was a continuation of net loss of sediment from the north and west and net gain in the south.

Winter 2009/10, and continuing through the 2010 season, saw very large changes to seabed levels with a significant increase in deposits. Such a large change had not been witnessed previously. Further measurement taken across the six months of the diving season demonstrated that changes were continuing through the summer season.

These changes inevitably pose questions over the environmental factors related to the site and surrounding sediments in the direct locality and across Bracklesham Bay as a whole. These issues are explored further in Section 4.

Figure 3.1 Changes on the Warship Hazardous *wreck site recorded in 2007*

Figure 3.2 Changes on the Warship Hazardous *wreck site recorded in 2008*

Figure 3.3 Changes on the Warship Hazardous *wreck site recorded in 2009*

Figure 3.4 Changes on the Warship Hazardous *wreck site recorded in 2010*

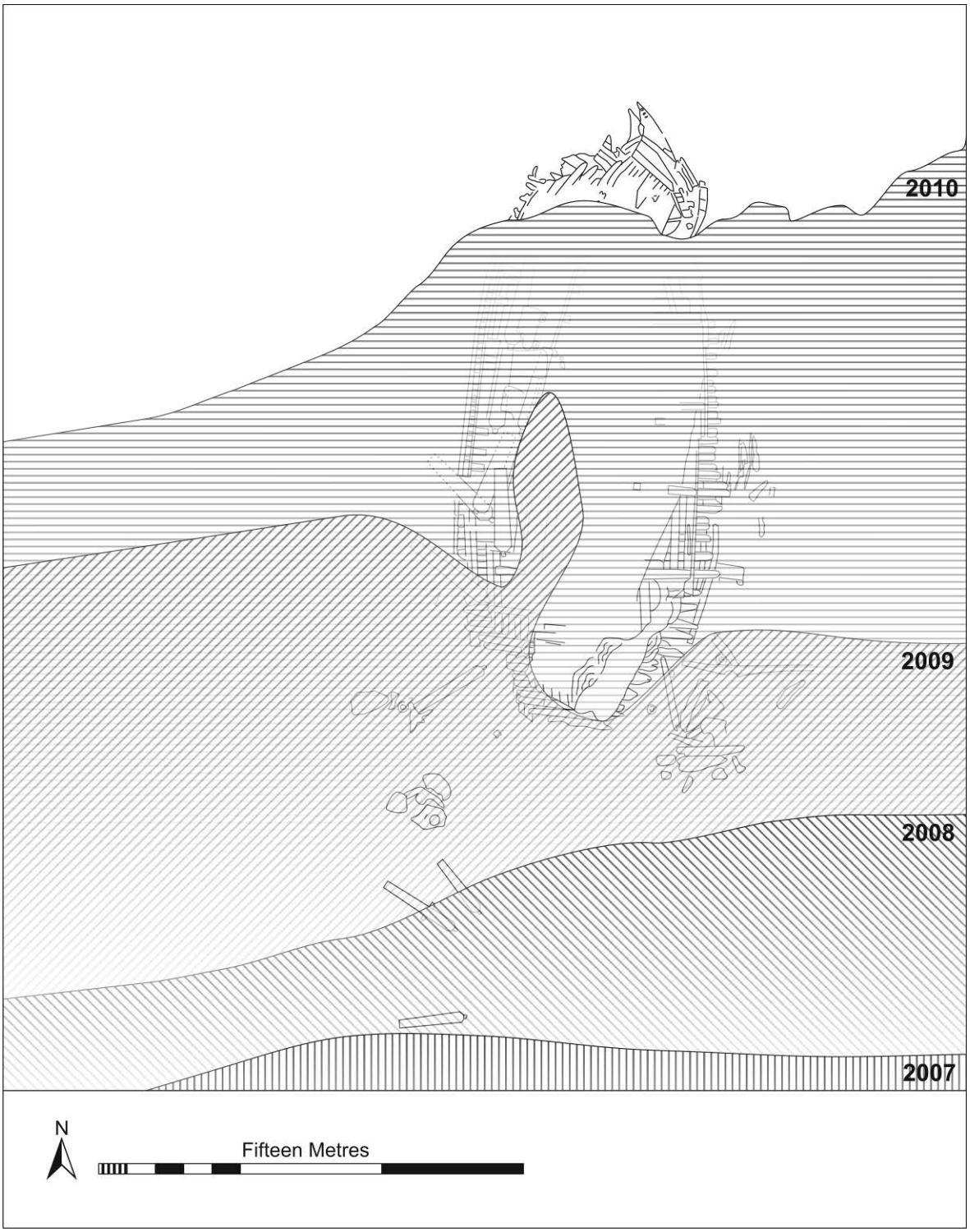

Figure 3.5 Site plan showing areas of significant change in each season 2007 – 2010

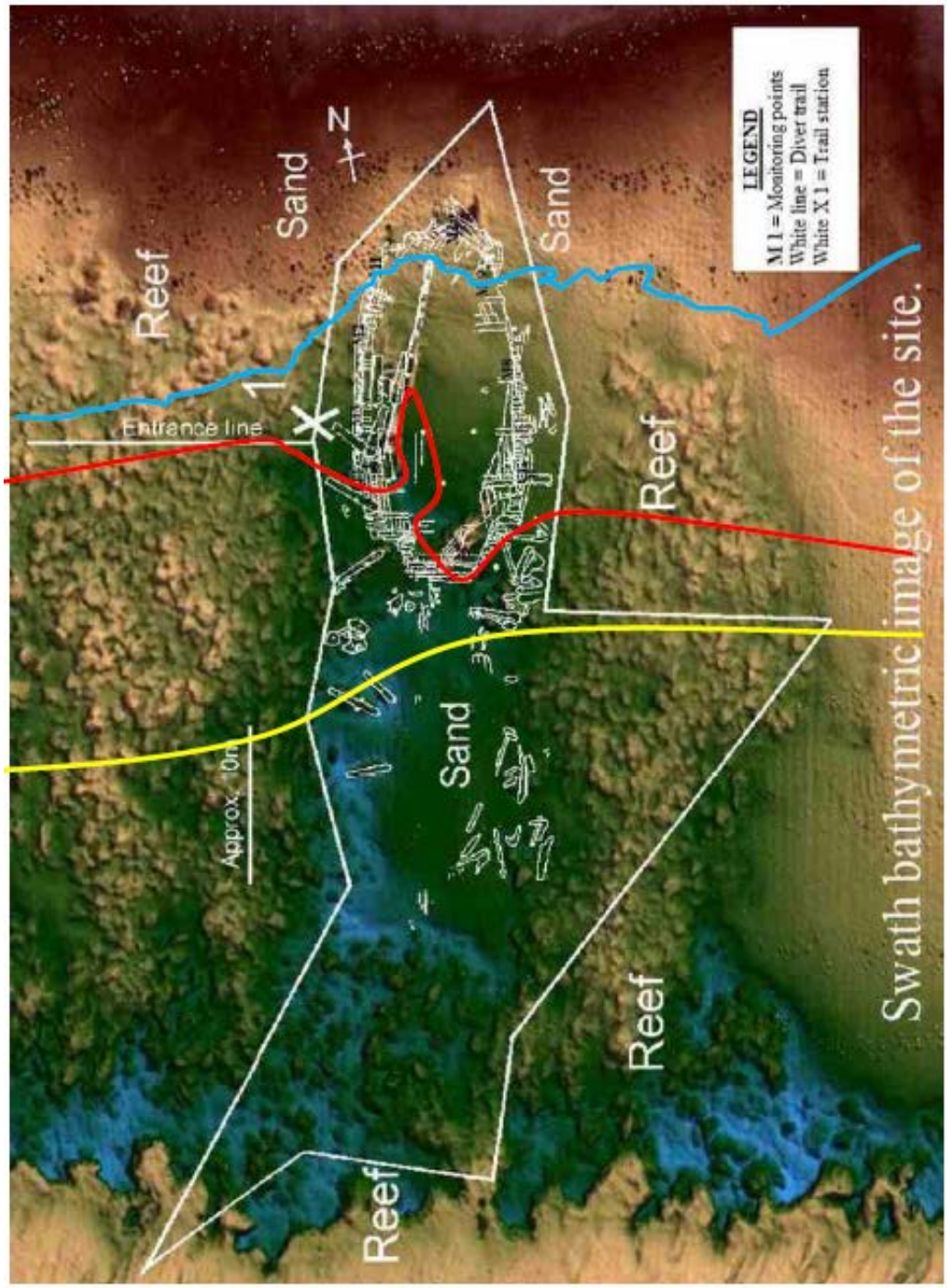

Figure 3.6 The position of sand which is encroaching from the south across the Hazardous *site on an annual basis shown over a swath bathymetric image of the site, Yellow line = 2008, Red line = 2009, Blue line = 2010 (Composite image produced by Iain Grant, underlying geophysical survey English Heritage/ Wessex Archaeology).*

3.1.2 Artefact Recoveries and Exposures 2007 - 2010

The distribution of exposures and frequency of artefact recoveries from the site is directly related to the changing seabed levels. A review of data from the annual reports to the ACHWS (Grant 2007; 2008; 2009 and 2010) reveals the position of the recoveries during each season. Figure 3.7 (below) shows the area from which artefacts were recovered by season. This, at least in part, reflects shifts in areas being dived due to seabed changes.

2007: Due to the large amount of sediment loss there was significant exposure of artefacts on site. Particularly, a large number of lead tingles (sheathing) and caulking strips were spread across the site. These were not recovered as many of these have been recovered previously and hence are well represented in the object archive.

Twenty-four artefacts were recovered during this season (Figure 3.7). The distribution of material includes items recovered from the area inside the hull from the break of hull and forwards of this position, several artefacts from north of the site (including an intact ceramic jug and gun carriage axle from just beyond the beak), and other material from outside of the hull to both the east and west which included red earthenware pottery.

2008: Four artefacts were recovered after their positions were recorded. Two items came from the main site, a copper pin from inside the hull and a bone from outside of the hull. The other two items were from the area of clay gullies to the north west, they were, a sample of lead musket and pistol balls and a brass shoe buckle. Also located in the area of gullies but not recovered were the remains of a large double sheaved rigging block, some sections of timber (possibly spar), a number of iron concretions & one iron gun (Figure 3.7).

2009: Three artefacts were recovered. One brass pommel from the main site and two pulley sheaves from the rigging block in the area of gullies (Figure 3.7).

2010: Eleven artefacts were recovered from the area of gullies (Figure 3.7). These included more brass buckles and pieces of pewter plates.

As expected, the numbers and distribution of artefacts recovered are directly related to the seabed movement, and the effects of this on diving operations undertaken. The recovery of twenty four artefacts in 2007 is a relatively large number and reflects the extent of the loss of covering sediment which occurred over winter 2006/07. The recoveries in 2008 and 2009 are relatively small in number, but they also reflect the ongoing loss of sediment from both the main wreck site and areas of gullies. In 2010, no items were recovered from the main wreck site due to the large increase in sediment, while a larger number were collected from the gullies which is a product of both continued loss of sediment covering and the period of fieldwork in that area.

Figure 3.7 Distribution of artefact recoveries from the main site 2007 - 2010

3.2 Survey on Main Wreck Site

Detailed structural survey on the main wreck site was undertaken in both 2008 and 2010. The initial work was related to the area where excavation was planned to take place prior to the postponement due to bad weather, while the later work is concentrated on exposed structure to the north east of the site.

3.2.1 2008 Season

The area to be targeted by excavation had been selected due to being at severe risk due to erosion and as it held the highest potential for answering research aims and objectives.

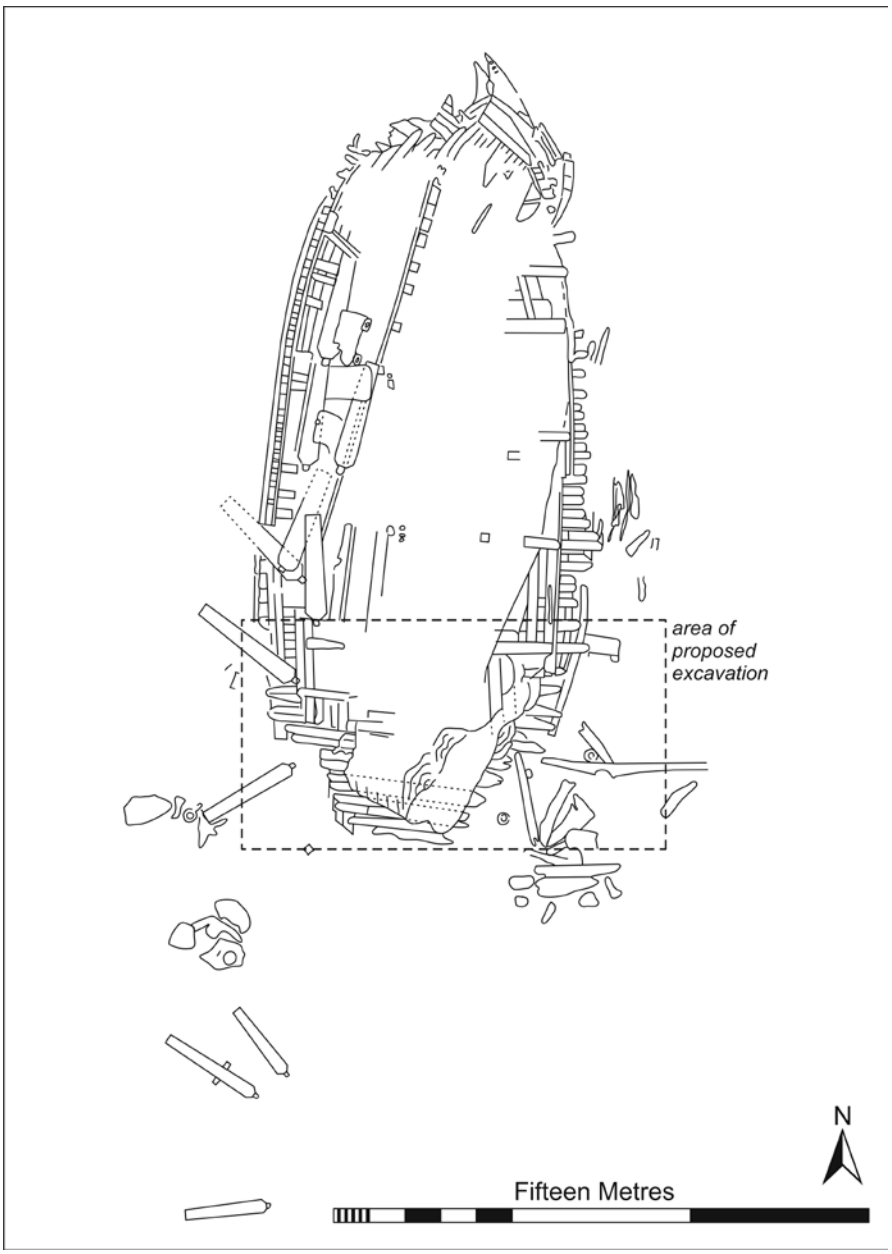

Figure 3.8: Proposed trench location for the 2008 excavation

Four datum points were established in this area, T106, T107, T108 and T109, and surveyed into established points using trilateration (direct survey measurement).

A pre-excavation plan of the area was then produced by establishing baselines between the datum points and using metre-square planning frames to produce a plan at 1:20 scale. A total of 14 square metres were surveyed in detail (see Figure 3.9).

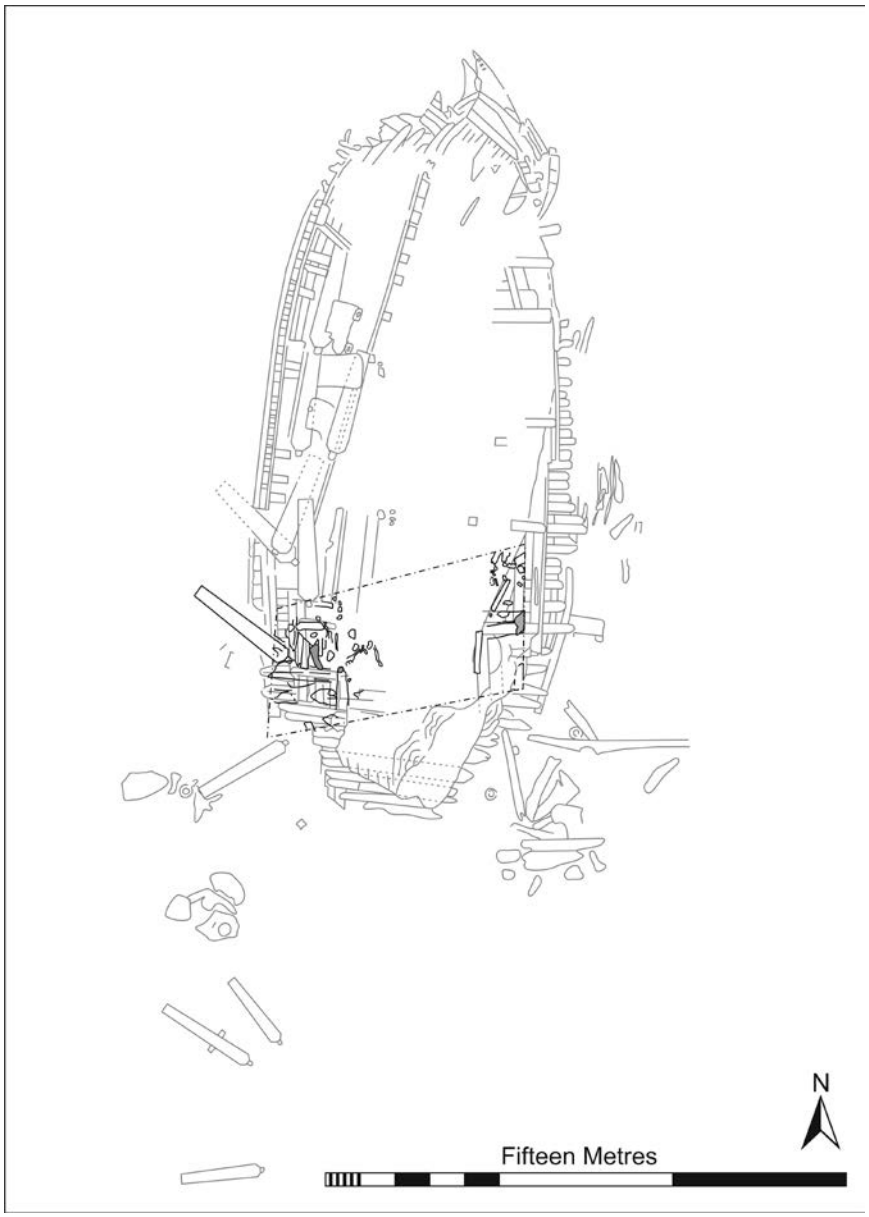

Figure 3.9 Pre-excavation plan of trench area targeted in 2008 prior to having to postpone the excavation.

3.2.2 2010 Season

Work during this season concentrated on gaining a plan of exposed structure lying to the north and east of the main wreck. It was important to gain a record of these remains due to the encroaching sand moving in from the south. The HPG established a range of datums on the structure to aid planning. A base line was established which extended

from the main wreck site over the area of structure to be planned. This allowed the newly exposed material, which is separated from the main wreck by a gap of around 3m to be tied into the main structure. Planning frames were employed to create a scale drawing at 1:20 of 10 square metres of structure (Figure 3.10). The drawn record was complemented by photographs and video. However, poor visibility and high levels of suspended matter in the water meant photographs were not clear (see Appendix 8.1 for example photographs). The video record is clearer than photographs. This was used to gain a number of 'stills' for this report (Figures 3.11- 3.15).

The structure represented in this area appears to be a section of hull which has broken away from the hull. Parts of eight (possibly nine) frames are uppermost (Table 3), with remains of outer planking below them. The remains of eight hull planks are visible (Table 4).

Frame dimensions are:

Frame no	Length (max)	Sided dimension (max)	Notes
F1	1.8	0.30	
F2	1.1	0.10	Labelled as a frame but is likely to be an additional piece of timber inserted aft of F1 rather than a full frame.
F3	2.05	0.30	
F4	1.4	0.22	
F5	2.95	0.30	
F6	2.1	0.28	
F7	1.95	0.20	
F8	2.30	0.56	Although drawn as a single timber, this is likely to be a pair of frames.

Table 3: Frame dimensions of structure off north east starboard bow of wreck site

Plank dimensions are:

Plank no	Length (max)	Sided dimension (max)	Notes
P1	1.2	0.26	Separate from continuous structure. Assumed to be a plank due to orientation and size.
P2	4.6	0.40	Longest continuous plank
P3	0.75	0.20	
P4	3.7	0.30	Assumed to be continuous although sand covers between F4 and F5
P5	3.7	0.30	Assumed to be continuous although sand covers between F4 and F5
P6	1.2	0.30	
P7	1.5	0.23	Partially covered between F4 and F5, but is continuous
P8	0.75	0.28	

Table 4: Plank dimensions of structure off north east starboard bow of wreck site

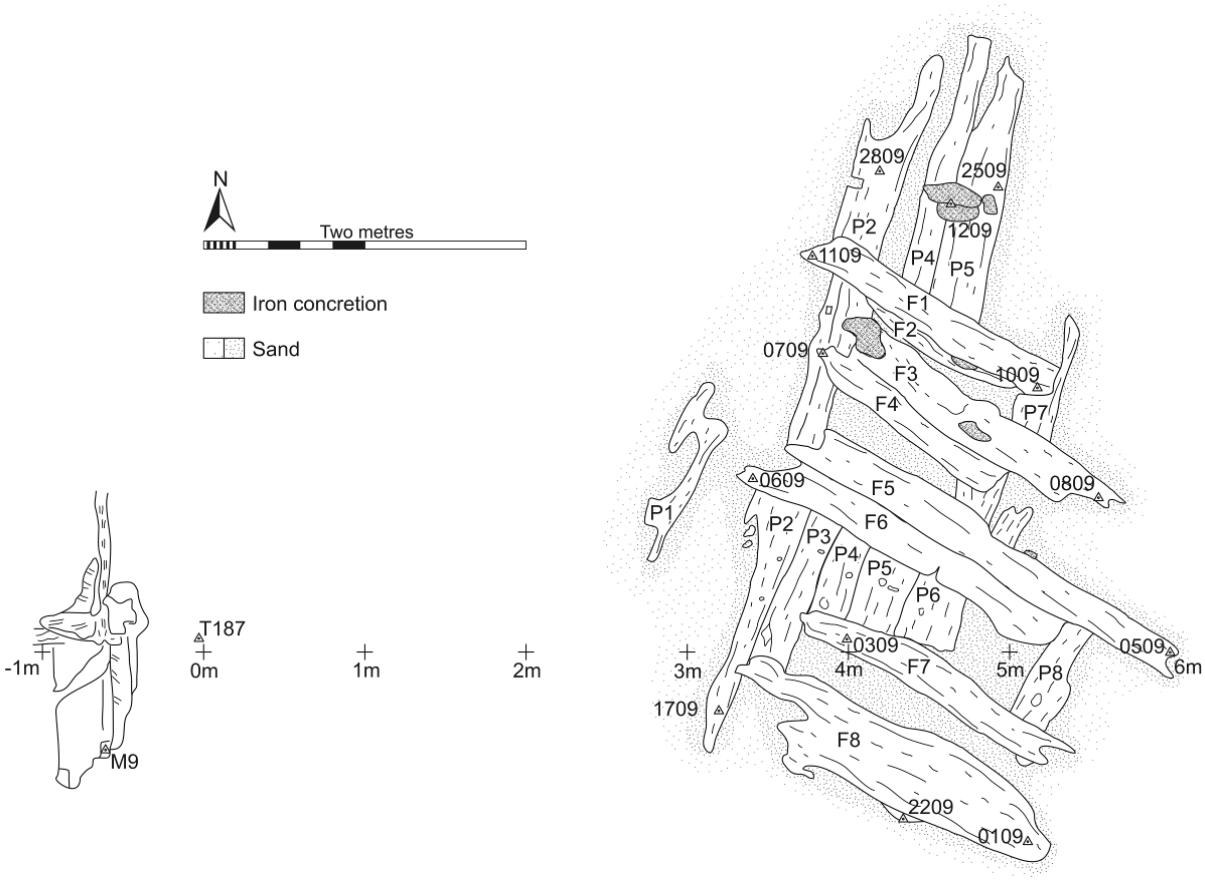

Figure 3.10 Plan of timbers exposed to the north east of the main site

Framing: The surviving frames have been affected by erosion and attack by wood boring organisms - gribble and teredo. Gribble worm in particular have caused the wood surface to become degraded from its original surface (Figure 3.11). However, it is possible to see a clear pattern of paired frames. It is likely that there would have been another frame to the north as a pair to F1 as the timber which has been labelled F2 is too small to be a frame remnant. There is also a frame missing that would have been to the north of F7 to form a pair. The fastening holes that would have held this frame are visible on the planking below. The timber labelled F8 has been drawn as a single piece but is thought to be two adjacent timbers. Its size and the shape of the western end of the timber gives further weight to this interpretation.

Figure 3.11 Close up of west end of Frame 1 showing effect of gribble worm across timber surface and a teredo worm cast in centre

Discounting F2 and dividing F8, the sided dimensions of the frames all fall within the size range of 0.20m – 0.30m, with 0.30m being the most common measurement (also see Table 3). Taking account of the degradation of the timber, it is expected that all frames would have measured closer to 0.30m. No measurements of the moulded dimensions were taken during the survey but, using images derived from video, it is possible to gain information on both these dimensions and curve of the timber frames. Figures 3.12 and 3.13 show the western ends of Frames F1, F5 and F6. It is clear the frames have a moulded dimension of at least 0.30m. The curve of this area of hull structure is particularly shown in Figure 3.12 where the top and bottom of the frame can be seen curving along with the outer planking below. There appears to be quite a significant curve here. This would be expected in an area of hull that was close to the bow where a lateral curve is needed to shape into the stem. The vertical curve of the hull is also pronounced. Further research to compare these dimensions to available ships plans and models should help identify which area of the forward starboard structure is represented.

Figure 3.12 Looking north showing the western end of Frame 1 and the edge of Plank 2 beneath

Figure 3.13 Looking east showing the western ends of Frames 6 and 5 (Frame 4 is visible in the background), the edge of Plank 2 is visible beneath the frames

Assuming the interpretation of the missing frames is correct, this would provide a measurement between centres of frame pairs of around 0.68m. This measurement is consistent across the newly recorded area. It is likely that an area of concretion which overlies P4 and P5 would have been related to the position of a further pair of frames. The spacing of this is consistent with the distance between the other pairs. The frames overlie the planking at an angle of around 60 degrees.

Planking: the sided dimensions of the planks is between 0.23m and 0.40m, with 0.30m being the average width (see Table 4). Discrepancies in the width of some planks may be due to the fact they were not completely uncovered from the surrounding sand. Figure 3.14 shows plank P6 which was visible between frames F4 and F5, where the sediment has very recently been removed by hand fanning to facilitate planning. The surface of plank P6 is much better preserved than the adjacent frames where marine boring organisms have affected the surface and marine growth is attached. Beneath the divers hand on the right of the image marine growth can be seen encroaching on the plank. An interesting feature in this area of plank P6 is what appear to be three incised lines running perpendicular to the grain, two of these lines are just visible in the photograph in the centre and centre left. These marks appear to be contemporary with the ships use, but it is unknown whether they are related to construction, re-build or the vessels use. Further areas of planking are expected to be preserved in the area adjacent to the structure.

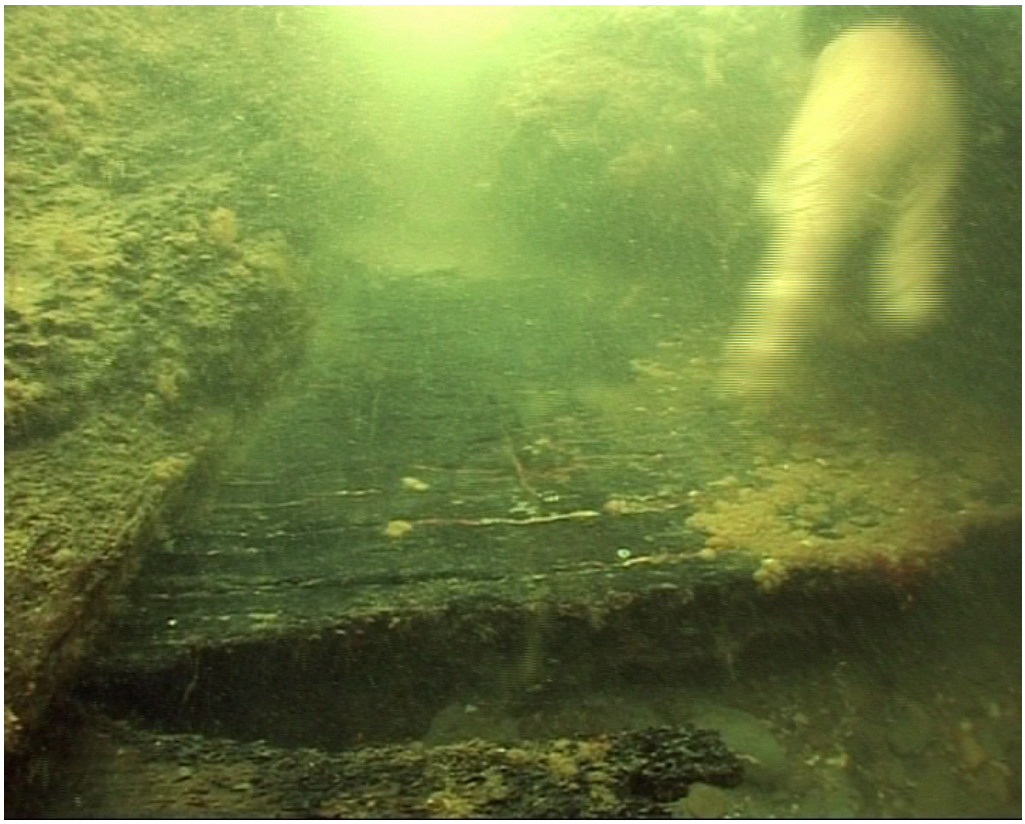

Figure 3.14 Exposed area of plank 6 between frames 4 and 5, with incised marks just visible (looking north west)

Fastenings: It was possible to see some fastening details, particularly where iron fastenings have left concretions and where holes have been left due to timbers having been lost. The iron concretions in the northern area of planks P4 and P5 and on frame F3 suggest bolts were used in this area of structure. They may be the remains of driven or through bolts related to fixing timbers which are part of the bow construction from which this area of structure has been broken away. Owen (1991: 327) notes the presence of iron fastenings, in particular, that frame pairs have been fastened together laterally with iron bolts. The concretions in the newly exposed area may be the remains of such bolts.

There does not appear to be evidence of treenail fastenings on the inboard side of the frames recorded, this may be due to the degraded nature of the timbers or that low visibility on site meant they were difficult to discern. The presence of round fastening holes in the planking north of F7 shows a run of holes across the planks (P3, P4, P5 and P6) which once held a frame. These holes are just visible in Figure 3.15. These indicate that the frames are fastened by treenails to the outer planking.

Along the length of plank P2 a number of square holes have been recorded. These are in alignment with frames which have been lost. The square shape of these holes in this area may indicate a different type of fastening used, probably spikes or nails. Owen (1991: 327) notes evidence of square headed iron nails within the structure, the holes found in the newly exposed area appear to provide further evidence of this.

Figure 3.15 Looking south east at the forward side of Frame 7, Planks P4 and P5 are just visible below including the holes where treenails were once fastened

Comparison with known wreck structure: The paired frame construction of the ship has been noted in previous publications (Owen 1988; 1991), so the recently exposed material can be directly compared to earlier plans. The structure towards the south of the site, which has been lost, clearly shows the frame pairings in this area.

The position of the newly recorded area of hull near the bow of the vessel can be compared to the extant timbers recorded on the port side. Although only a small area on the port side is visible, it is possible to identify frames overlapping the hull planking just to the west of the beak. The angle at which these frames align with the hull planking appears to be similar to the angle on the newly recorded structure from the starboard side. Immediately to the west of the beak, the frames appear at an angle of around 60 degrees to the planking. However, further work is required to establish which area of the hull is represented by the detached section.

Inevitably in this area of the ship, the framing becomes more complex as it reaches close to the bow where the curve of the ship becomes more extreme. An interesting feature of *Hazardous* are the cant frames in the bow (Owen 1991: 327). This was a French development which was later copied within English naval shipbuilding. There is clear scope for further research to compare the bow structure of *Hazardous* with historical sources and other relevant archaeological examples. This would help shed light on the development of ship technology during the late 17th and early 18th centuries.

3.3 Gullies survey

The exposure of the area of gullies within the underlying geology north west of the main wreck had been recognised in 2008 with a range of artefacts and structural features being exposed. The level of exposure of these features was last seen over 20 years ago. During those early stages of the project a range of artefacts from the wreck were recovered from the area. The data recovered was used to help understand the prevailing conditions on site (see Figure 1.1).

Diving early in 2010 revealed the gullies were further uncovered and artefacts such as potential spars from the ships rigging were exposed on the seabed along with small finds such as shoe buckles. In order to both recover items at risk from the seabed and assess the position of the gullies in relation to the protected area, a program of survey was developed.

3.3.1 Survey Method

To establish the survey one of the most prominent linear features in the area, a large timber element which is thought to represent part of the ships rigging (possibly a spar), was used as a central datum. This feature was known to lie around the centre of the identified exposed material. Datum points were established at each end of the spar which measures just under 8m in length and lies on a north-east to south-west alignment. The north-easterly end of the spar was used as the centre point of a survey grid which extended from this point 30m to the north-west, south-east and north-east (See Figure 3.15).

The position of the centre of the survey was established by fixing a surface marker buoy directly to the spar, ensuring the line to the surface was as taught as possible and then using a GPS system to fix the position of the buoy on the surface. As the water depth here is only 6m and the line was taught there should be little error in the position which is thought to be accurate to within 0.20 - 0.30m. The position is N: 50,45.178/ W: 00,51.521.

With the base lines established, pairs of divers were able to use these to undertake corridor searches. Due to the visibility, corridors of 4m width were usually established with a tape running down the centre of the corridor and a diver on each side of the tape, this meant each diver concentrated on a 2m wide strip of seabed. When artefacts or features were encountered the position was then recorded in relation to two of the four main baselines. During the diving an area of 1,820 square metres was searched. Divers also noted when they reached the edge of the exposed area of clay gullies and the covering sand started. This allowed a picture of the extent of the exposed area to be gained (Figure 3.16). The presence of sand did not mean the search stopped. In fact, a number of timber features were noted protruding from the sand, particularly in the western sector of the search grid.

3.3.2 Survey Results

The results of the survey show a range of timber elements scattered across the area, with particular concentrations in the northern and eastern sectors. Other than the possible 'spar' feature many of these remain partially buried and difficult to identify. Further details of dimensions recorded by divers include:

Sector	*Name*	*Length (longest visible)*	*Width (horizontal)*	*Height (vertical measure)*	*Notes*
Northern	T1	1.78m	0.23m	0.08m	
Northern	T2	4.20m	0.26m	-	
Northern	T3	1.39m	0.16m	-	
Eastern	T4	-	-	-	Small, loose on seabed
Eastern	T5	0.70m	0.06m	-	Buried at both ends
Eastern	T6	-	-	-	Possible knee
Eastern	T7	2.4m	0.35m	0.30m	Timber, slightly curved, with hole and iron concretion.
Eastern	T8	1.45m	0.40m	0.15m	T2 on Arch log
Eastern	T9	0.70m	0.15m	0.15m	Square timber protruding from seabed T3 on Arch log
Eastern	T10	1.10m	0.10m		T4 on Arch log

Table 5: Dimensions of timbers located during survey of gullies in 2010

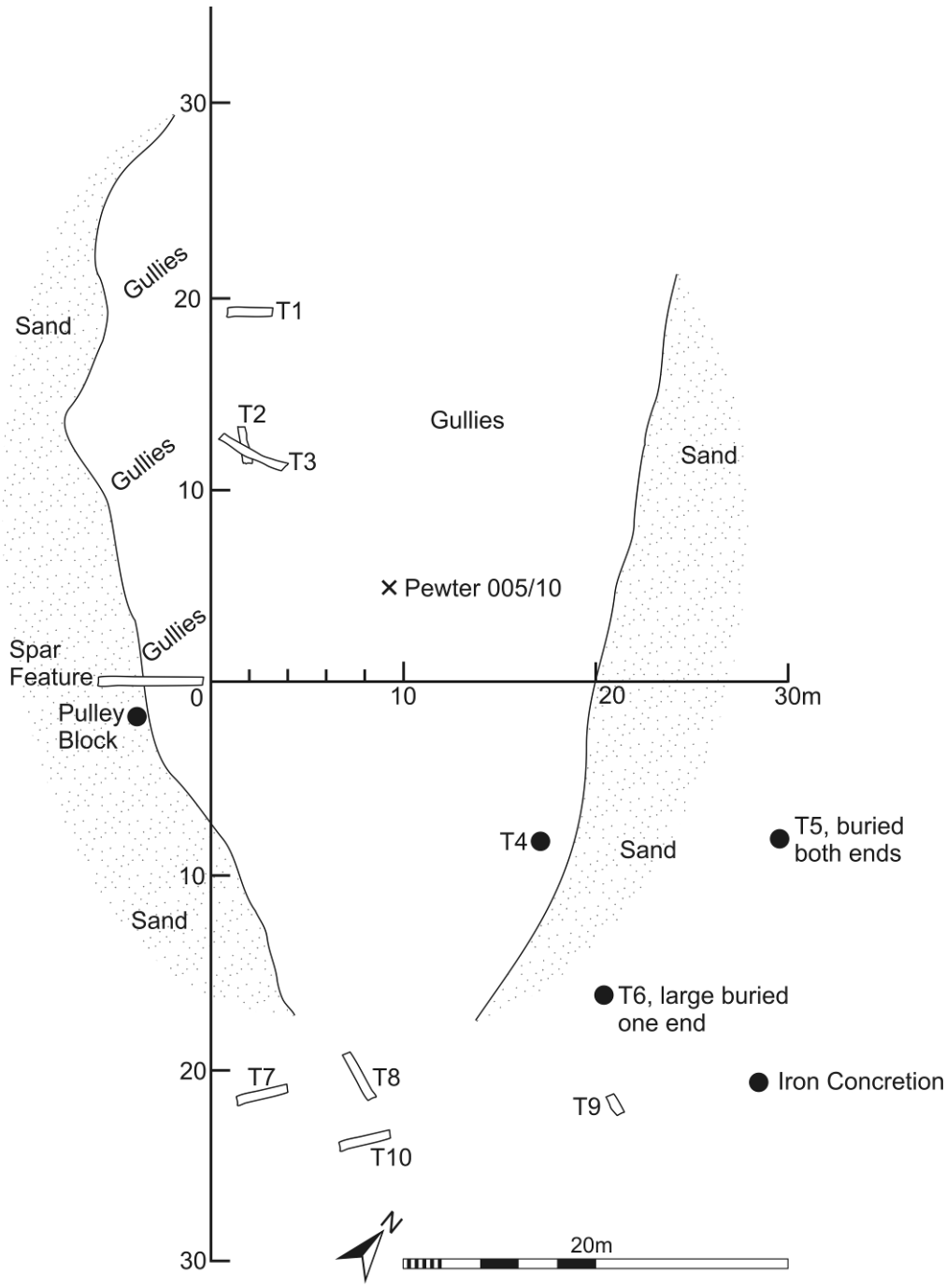

Figure 3.16 Survey of area of gullies undertaken in 2010

Artefacts located and recovered during the survey on the 3-4 July added to the collection recovered in 2010 which total 11, these are:

HZA/01/10 Brass shoe buckle
HZA/02/10 Brass shoe buckle
HZA/03/10 Brass Buckle centre

HZA/04/10 Piece of pewter plate
HAZ/05/10 Piece of pewter plate
HZA/07/10 Lead weight
HZA/08/10 Shoe buckle copper alloy
HZA/09/10 Plate rim pewter
HZA/010/10 Shoe Buckle copper alloy
HZA/011/10 Red brick - galley

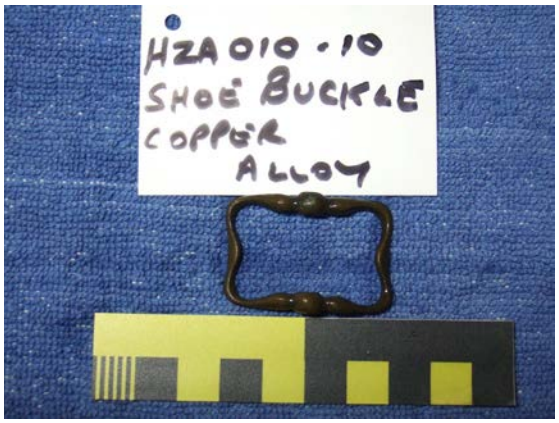

Figure 3.17 (left) Copper Alloy shoe buckle recovered from gully area.
Figure 3.18 (right) Brass buckle centre (Photos: Iain Grant)

Despite the extensive area that was surveyed the cannon, which had been previously seen to the north west of the site in 2008, was not relocated.

The distribution of the timbers and artefacts does not appear to show any particular patterning. Timbers of differing sizes from relatively large to much smaller are scattered equally. The key factor in the distribution of material seems to be the presence and size of the clay gullies which until recently have been buried below covering sand. The presence of these gullies some distance from the main wreck site would indicate that material trapped here is related to the break up of the vessel. Some of the timbers are firmly lodged within the geology which seems to indicate they have been there for a significant period. The relatively large size of some of the timber elements and their suspected identity as parts of rigging adds further weight to the interpretation that they have been in this position since soon after the vessel wrecking. However, it must remain a possibility that smaller items and artefacts could have become trapped in this area as the wreck has broken down and eroded over the past 300 years. The erosion noted since the 1980s has certainly increased exposure and loss from the wreck with many items likely to have become dislodged and moved across the seabed.

The presence of the gun discovered to the north west of the main site raises questions over whether the wreck may have originally become beached further to the north west and later moved to the south and east as it began to break up. This theory would help explain some of the apparent 'debris trail'.

3.3.3 Comparison with Previous Recoveries

Prior to the recent work, the last time the gullies were uncovered was between 1986 and 1988. During this time 60 artefacts were recovered. These included:

- 8 items of apparel, all parts of buckles

- 5 coins, 4 William III and one William & Mary
- 1 furnishing/ fixture – likely to be part of a door lock
- 14 galley related items – 6 plates or fragments of plates, 6 spoons, 1 knife handle and 1 piece of a drinking vessel
- 1 personal/ leisure related item – a pewter cockerel
- 3 medical items – 2 syringes & appothacary weight
- 5 items related to navigation – 3 pairs of dividers, 1 brass meridian ring and a protractor
- 2 personal/ tools – a sailmakers palm and some pins
- 3 rigging elements – a pulley block, a stay and a ring hook
- 11 items of ship structure/fittings – 10 tingles/ patches and a pipe
- 4 entries for musket shot, however, each of these represents multiple recoveries with over 900 having been recovered
- 1 tool – an axe
- 1 possible galley related copper alloy piece with an 'M' stamped on it
- 1 bone knife handle.

This collection represents a high number of small artefacts as well as a number of elements of rigging such as a pulley block. The general mixed nature of this collection compares similarly to the recoveries in 2010. Large numbers of lead musket shot were recovered during the 1980s. In 2010, large numbers were noted as being present in the base of gullies but not recovered due to the amount already in the collection. The presence of these lead shot in the newly exposed area of gullies may indicate this is a different area of gullies than was previously exposed in the 1980s as many lead shot were recovered at this time.

3.4 Archive and Artefact work

During the 2008 season work on the existing collection continued. As poor weather prevented diving the team were able to utilise this time working on the collection.
Tasks achieved during 2008 included:

- Conservation – specialist assistance from Paul Simpson (Isle of Wight Museums Service), helped provide detailed advice on future conservation of artefacts. Some artefacts had been either in wet storage or active conservation for some time and a program was established to complete their conservation.
- With finds specialist Kathryn Dagless assisting, all artefacts were reviewed in terms of their storage material and boxing. A photographic record shot of every artefact was created during the process of review, to create a visual identification record that can be used during assessment and analysis.
- All conserved artefacts were split into material types, making them ready for future specialist assessment.

4. Interpretation in Relation to Environmental Conditions

The changes that have taken place on the *Hazardous* site and the surrounding environment over the past four years have been significant. After an initial large movement of sand away from the site in winter 2006/ 2007 there then followed a gradual encroachment of sand from the south in 2008 and 2009. This was followed by a large movement of sand into the site in 2010. To attempt to understand these processes, the recent changes have been compared to data collated in the report *Quantifying the* Hazardous *Threat: an assessment of site monitoring data and scoping of available environmental data sets*, which included data up until 2006. Additional data has been gained from available monitoring reports from the Channel Coastal Observatory for the period 2007 – 2010 to establish whether there has been any unusual patterns to environmental conditions or seabed sedimentation.

4.1 Monitoring of Seabed changes

Following the installation of monitoring points around the wreck site in 2002, detailed measurements were taken that allowed changes in sediment levels to be tracked. Figure 4.1 shows the site, the monitoring points and the accumulated monitoring data from a period covering 2002 – 2005. Figure 4.2 shows the monitoring point data in more detail (it should be noted that the scale on the left indicates an increasing depth from the monitoring point to the seabed, so when the line rises this indicates a loss in seabed level).

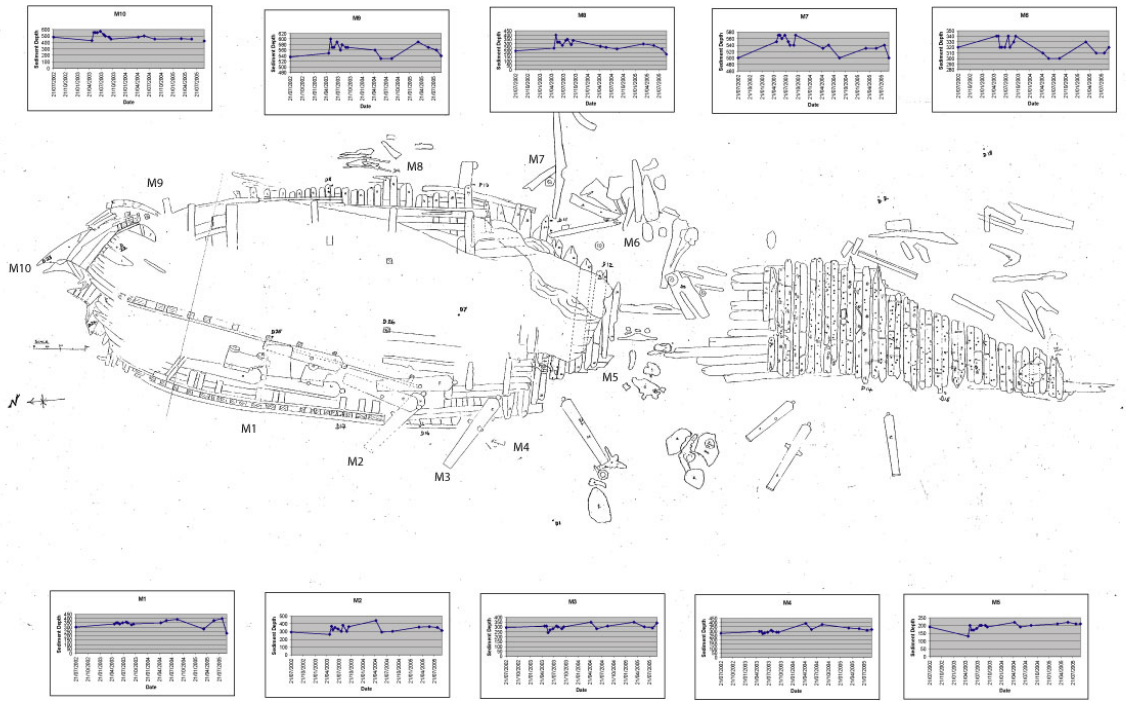

Figure 4.1 – Location of the Hazardous *monitoring points and associated data*

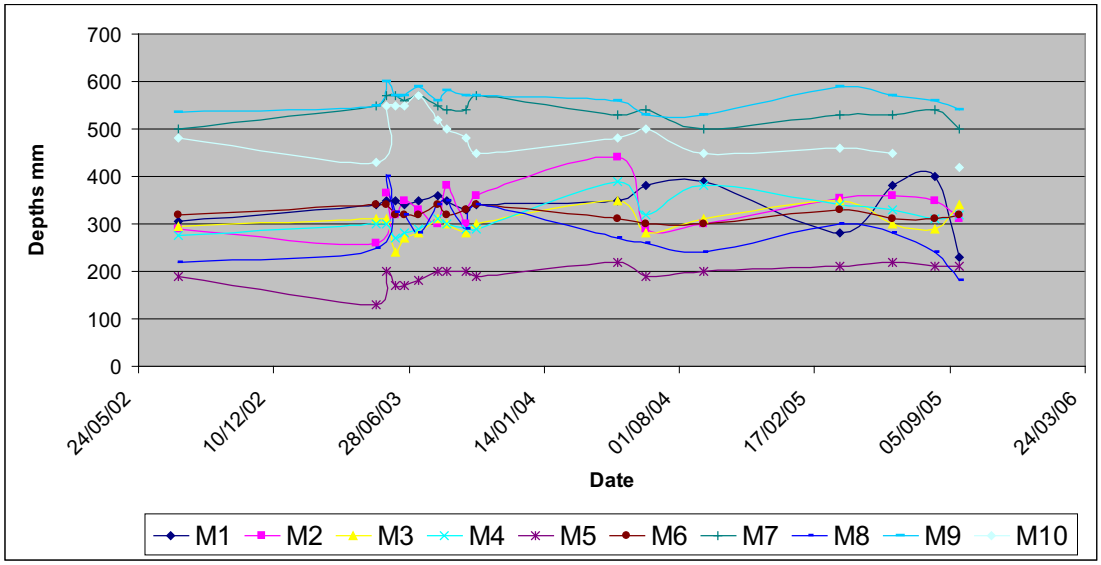

Figure 4.2 – Detailed data from all sediment monitoring points

Figure 4.1 includes graphs which reflect the sediment movement recorded at each Monitoring Point (M) from 2002 to 2005. It is apparent that along the western side of the site (M1 to M5) and the northern edge of the site (M10) there are small degrees of sediment movement occurring, although localised scouring does occur. Along the eastern side of the site (M9 to M6) the sediment processes are more dynamic with large changes of accretion and scouring. These dynamic changes also affect the amidships section of the site (M6) and to a lesser extent (M5).

There appears to be a cyclical trend of accretion occurring mid-way through each year with a slow decline in sediment levels towards the end of the diving season. The degree of change occurring within each year varies over time with sediment movements being in the range of 100mm for certain years (2004) to in excess of 200mm for other years (2003 and 2005).

It is important to note in relation to the monitoring between 2002 and 2005 and for the more recent diving work that no measurements were obtained during the winter months, this is due to environmental conditions which preclude diving during this period. The extent to which sediment movement varies over the winter months is currently unknown.

Comparing these results with sediment movements recorded between 2007 and 2010 demonstrates notable differences. In summary these years noted:
2007 – an extensive reduction in seabed levels around the whole of the area of wreck site covered by the monitoring points (See figure 3.1), although an increase in sand was noted to the south of the site.
2008 – reduction in sediment levels, especially to the north and east of the wreck (area of M6 – M9), and increased scour to the west of the structure (area of M1 – M4), also see figure 3.2.
2009 – General loss of sediment around the north, east and west of the wreck, while an accretion of sand from the south was now beginning to reach the area of exposed wreck. Further sand movement to the north and west of the main site had occurred exposing the gullies.

2010 – While there was further loss of sediment in the area of the gullies, on the main wreck site there was a very large movement of sand over the structure. There is data available from this season to directly compare against monitoring point measurements from 2002 – 2005 for M9 and M10 (it should be noted that an increasing number of the original monitoring points have now been lost from the wreck due to gribble worm activity).

Measurements taken in 2005:
M9 – 0.54m
M10 – 0.42m
Measurements taken in April 2010:
M9 – 0.63m
M10 – 0.68m

Although there is a five year gap between these measurements it shows there has been a loss of 0.09m at M9 and 0.26m at M10. These measurements also occurred when the sediment levels had begun to increase after three years of continual reduction.

4.2 Artefact Recoveries

Work undertaken for the environmental project demonstrated that:

> "In the early years of 1986 and 1987 there is a spread of artefact exposures at the southern end of the site. However for 1988, 1989 and 1990 this spread is much wider, with larger quantities of artefacts being recovered and a larger area being exposed. Through comparison with the dive logs it becomes apparent that the cause of this is storm events during these years. After these storm events the general spread of artefacts tends to centre more along the amidships section. It would appear that the general scouring effects on *Hazardous* were initially in the southern end of the site and have gradually progressed north into the amidships area where scouring is now having a significant effect." (Satchell & Van Rensburg 2007: 3-37)

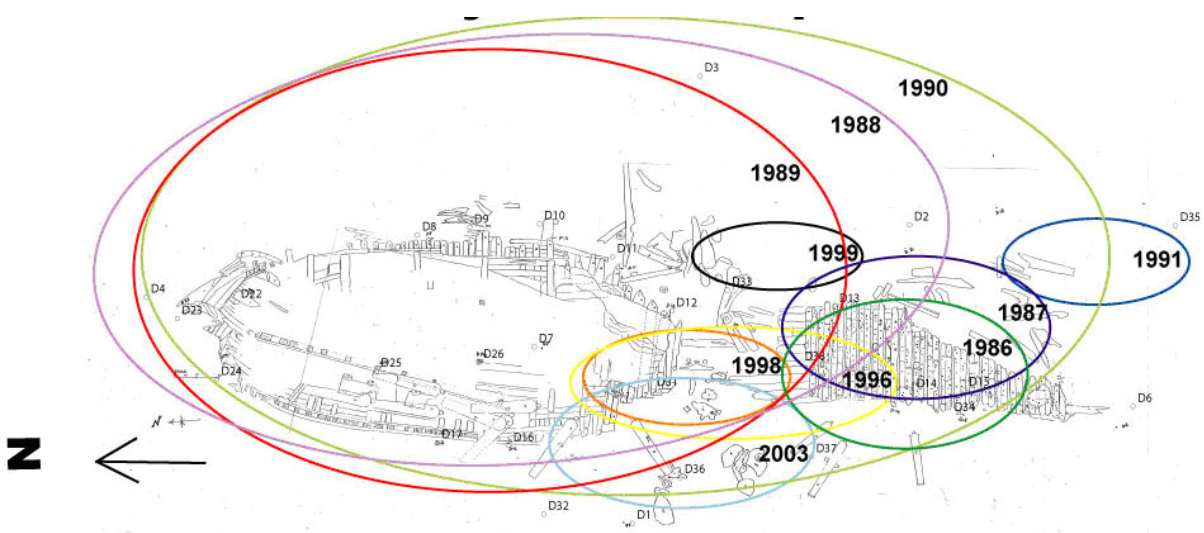

Figure 4.3 Distribution of artefact exposures from 1989 to 2003

These results can be compared to the distribution of material from 2007 – 2010 as shown in Figure 3.7. This shows that the pattern of exposure of material appears to be moving northwards across the site. Following the large exposure of artefacts after the 2006/07 reduction in sediment levels there has been a concentration of recoveries in the northern section of the wreck and from the gullies to the north west. Following the influx of sand from the south no recoveries were made from the main site in 2010.

4.3 Agency of Change

The changes witnessed over the past four years are the result of environmental processes, however, the seemingly unprecedented changes seen both through sediment loss in winter 2006/07 and following two years of gradual loss, the large gains seen during winter 2009/10 are clearly the result of external influences.

4.3.1 Sediment Processes

The environmental report noted that sediment processes in the Bracklesham Bay area are characterised by a net drift of shingle sediments in an east to west littoral drift pathway operating closest to the coast (Figure 4.4). Slightly further out there is then a compensatory west to east movement of shingle and sand, within this zone of movement there is a reversal in the area to the west of the wreck site, providing further complexity of sediment movement. Comparing the position of the *Hazardous* site with the coastal transport data it appears that the *Hazardous* lies in the area between the littoral drift processes. Further out to shore again there is another change to littoral drift of shingle and sand back from east to west. SCOPAC who are the authors of the sediment transport model recognise that the data on which this is based is most reliable close to the coast, becoming less well tested further out.

It is interesting to note that beyond the area of littoral movement of sediment the dominant process is different becoming a wave driven offshore to onshore transport of shingle (based on reliable data). The movement of sediments into the Bay and then in patterns within the Bay is clearly complex. It should also be noted that areas of the coastline here are under extreme pressure with areas becoming lost. It is possible that there may have been an increase in wave driven transport into the bay which could have contributed to the influx of sediment over the site.

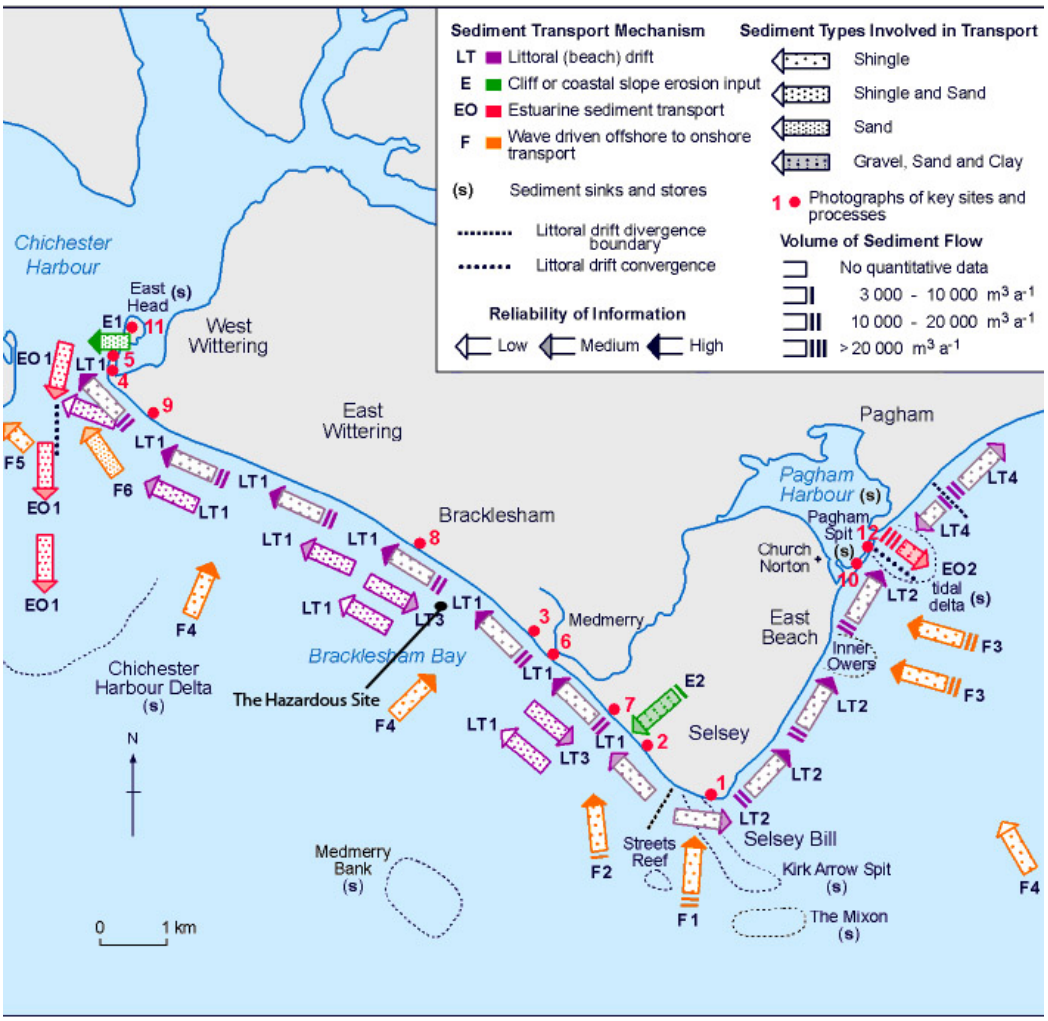

Figure 4.4 – SCOPAC map showing sediment transport patterns (SCOPAC ©)

4.3.2 Environmental Patterns and Coastal Changes

This section has been based on the results of the Southeast Strategic Coastal Monitoring Program which is undertaken by the Channel Coastal Observatory (www.channelcoast.org). This program means there is a high level of data available for the area surrounding the wreck site. Review of their annual monitoring reports (Stratton 2008; 2009) has been undertaken to extract the most relevant data (see Appendix 8.2 for detail).

Wave Climate and Storms

The available wave data from June 2007 – 2008 (Hayling Island Wave Rider Buoy) and June 2008 – 2009 (Bracklesham Bay Wave Rider Buoy) and raw data from the CCO website for 2009 - 2010 (See Appendix 8.2.1) provides details of the average wave climate throughout the years. The recording of storms is reported separately for both 2007-08 and 2008-09, Appendix 8.2.2.

Data demonstrates the average wave direction 2007 – 08 varied from between 153 – 214 degrees with a relative spread of changes across this scale. This contrasts with 2008-09 when the direction is recorded as being between 197 – 213 degrees and

remains more constant within this range. 2009 -2010 data shows a slightly wider spread again between 169 - 212 degrees.

2007 – 2008 wave height varied between 0.42m to 1.19m with the highest waves being in Dec, Jan and March. 2008 – 09 wave heights were between 0.49m – 1.04m with October and January recording the highest heights. Between 2009 – 2010 heights varied from 0.4m to 1.41m with November having the greatest height, it should be noted that other than November the wave heights in this year remained relatively constant. This is likely to reflect the severely cold winter during which temperatures were very low, but there were fewer storm events.

However, as has been previously noted storm events can have a significant impact on the wreck site. Storm data is available from 2007 - 2009 (Appendix 8.2.2). This along with comparative data reviewed by the CCO demonstrated that in 2007 - 2008:

> "The pattern of higher frequency of storms in the previous reporting year [2006-07] was repeated this year, but with an increased magnitude of the higher storms. December 2007, January and early February 2008 were generally rough. Storm direction varied but was usually from between S and SSE…….. The highest waves measured by the Waverider since its deployment in 2003 occurred on 10 March 2008. This storm coincided with equinoctial spring tides and was accompanied by a significant storm surge, although the peak of the storm occurred just before Low Water" (Stratton 2008: 8).

It is interesting to note that both 2006-07 and 2007-08 had a higher frequency of storms with the magnitude increasing in the latter period. Although the detailed data from 2006-07 could not be accessed from the CCO website at the time of reporting, the reference to the high frequency of storms in this period, plus the wave direction from the south, indicates they are likely to have had an effect on the large movement of sand from the wreck site in this period. The storms of winter 2007-08 appear to have continued the sediment loss, this is seen both on the wreck site, but also in the gully area where significant change was recorded over this period.

Between 2008 and 2009 there are also a number of storm events, the highest recorded being in Oct, Nov and January. The main difference from the previous year is that the prevailing storm direction was SSW or SWbS, this contrasts with the S and SSE direction in the 2007 - 08 season. Comparing this data with the changes in sediment levels recorded on the wreck site shows that in the 2008 season there had been a particular loss to the east and north of the site, with scour on the western edge (Figure 3.2) as well as loss in the area of gullies. This corresponds with the prevailing S and SSE winter storms. Changes recorded during the 2009 season show loss to the east and west of the wreck with scour to the north as well a further loss from the area of gullies (Figure 3.3), this has occurred after winter storms from the SSW or SWbS.

At the time of reporting only the wave data from the CCO was available for 2009-10, this covers the winter period that was severely cold with fewer storms. Reviewing this against the changes on site (Figure 3.4), which witnessed a significant build-up of sand from the south, would appear to indicate that when winter storms are infrequent the dominant movement of sediment is from the South.

Coastal Change

Topographic Survey by the CCO is based on survey profiles which extend around 300m offshore, while this does not reach the *Hazardous* wreck site it does provide detailed information on adjacent coastal change. The wreck site lies in the far western area of Coastal Management Unit 3 (Bracklesham Bay and Selsey), close to the border with CMU4 (East Wittering).

Survey of CMU3 between June 2007 – May 2008 demonstrated that the western area of this unit showed less than 5% change across all profiles. The following year of survey between June 2008 – May 2009 revealed "The majority of this unit has been very stable over this period seeing less than a 5% change in cross sectional area since spring 2008.." (pg 20), Figure 4.5). The report then compares this with the archive of survey data from CMU3 for 2004 – 2007 which shows that "the profiles towards Bracklesham have shown some localised loss, but in general have remained stable since 2004" (Also see Figure 4.6).

In CMU4 between June 2007 – May 2008 it is reported that "In contrast to lasts years report, where nearly every profile showed an accretion of sediment, this year the majority show some level of erosion. Several show losses of 5- 15%. (Sutton 2008: 20). Interestingly the following year this seems to have reversed where "nearly every profile showed some level of erosion, this year nearly all profiles have shown some level of accretion" (Sutton 2009: 20).

Although the coastal surveys and profiles provide data on the impact of sediment movements within Bracklesham Bay they do not appear to show direct correlation with the micro-scale data from the wreck site. The coastal zone is dominated by the littoral drift processes which appear to have a wider range of influences related to human use and defense of the coast in addition to the wider environmental impacts.

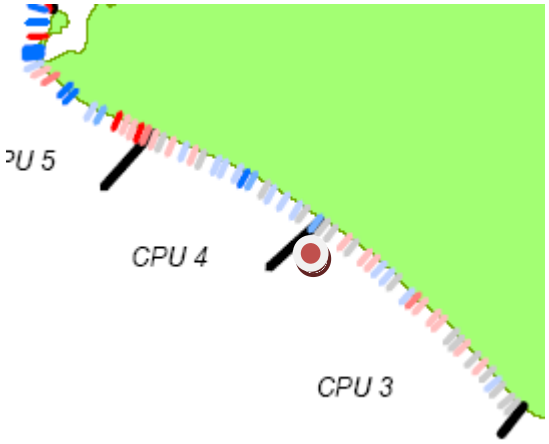

Figure 4.5 Extract from Channel Coastal Observatory coastal survey showing actual change to shoreline profiles in management units 3 and 4 between spring 2008 and spring 2009, red and pink indicates erosion, grey = no change, blue indicates accretion (Image Courtesy of Channel Coastal Observatory www.channelcoast.org). Red circle shows approximate position of the Hazardous site.

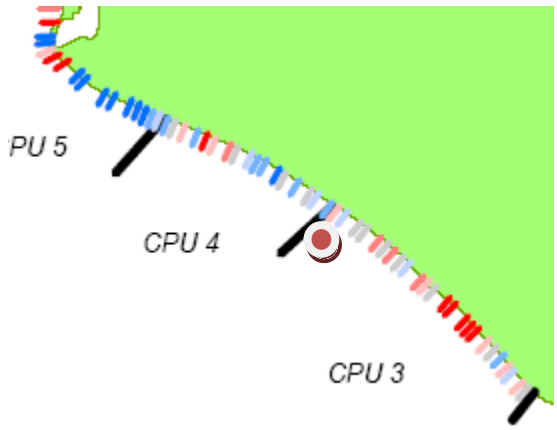

Figure 4.6 Extract from Channel Coastal Observatory coastal survey showing actual change to shoreline profiles in management units 3 and 4 between 2003 and 2009, red and pink indicates erosion, grey = no change, blue indicates accretion (Image Courtesy of Channel Coastal Observatory www.channelcoast.org). Red circle shows approximate position of the Hazardous site.

Summary

It is clear that the environmental processes at work within Bracklesham Bay are complex and it is often difficult to resolve the micro-scale changes recorded on the wreck site with the broader movement of sediments and available data from across the area. However, it appears that the frequency and severity of storms has a significant impact on sediment movements in and around the wreck site. The comparison of the dominant wave direction and storm events appears to show a corresponding impact on the sediment around the wreck site. The winters of 2006-07, 2007-08 and 2008-09 had a relatively high number of storm events which appear to have impacted on both the wreck site and the area of gullies through loss of sediment with slight differences in area of loss seeming to depend on the prevailing direction. However, over the winter of 2009-2010, which was characterised by cold weather and fewer storms there has been a significant increase in sediment. The lack of storm activity appears to have allowed the wave driven offshore to onshore movement of sediment to have dominated, and hence more of the site has become covered.

The broad scale processes recorded across the bay provide 'macro scale' data that appears to be reflected in the 'micro scale' of the wreck site. However, it is important to note that the only reliable method of monitoring the wreck site in this dynamic and complex coastal environment is through diver measurement and observation.

4.3.3 Fishing

Although not directly related to the sediment movement in and around the site it should be noted that a cause of damage to the wreck site, particularly noted in 2008, is likely to come from fishing equipment. In 2008, it was recorded that several datums were damaged or lost, due to a suspected trawl having passed through site. In particular a large robust datum peg D8-07 in the centre of the bow section of the hull had been bent over by something passing in a west to east direction.

5. Management Considerations

The changes on the *Hazardous* wreck and the adjacent area have further demonstrated the dynamic nature of the site. Although the evaluation excavation did not take place the alternative work undertaken between 2007 and 2010 has added to understanding of the processes impacting the seabed archive in addition to achieving the objectives of rescuing at risk artefacts and developing future research priorities.

5.1 Site Stability

The changes to the sediment regime witnessed between 2007 and 2010 have had a significant impact on the wreck site. The large drop in sediment levels during the winter of 2006/07 and further loss in the following two years uncovered elements of the wider wreck site that had never been seen by the project team before, and may not have been revealed since the wreck of the vessel in 1706. The extent to which the wreck structure was exposed will have caused biological and physical degradation of the seabed archive. Features such as the *in-situ* barrels in the centre midships area have the potential to hold undisturbed contents, the exposure of elements of barrel staves between 2007 and 2009, revealed their presence, but also allowed degradation. The impact of wood boring marine organisms (Gribble worm) is rapid once structure and artefacts become uncovered from protective sediments. This has been shown on the area of structure exposed to the north east of the bow, which was planned in 2010, where newly uncovered planking retains detailed surface marks (Figure 3.14), but adjacent timber had already been attacked.

The movement of sand from the north west of the wreck which has exposed the area of gullies provides further evidence of large scale movements in and around the wreck. It also highlights the extent of the scatter of material, this material may have been carried a significant distance or may be related to the original 'beaching' position of the wreck. With the previous exposure of the gully area being in the 1980s, movement of sediment here seems to be a relatively unusual occurrence.

These changes highlight the importance of regular monitoring of the wreck and the surrounding seabed to enable a rapid response in order to rescue elements of the seabed archive that are at risk. The influx of sand into the main wreck site which has been slowly moving northwards during 2008 and 2009 with a rapid influx during winter 2009/ 2010, has temporarily reduced the immediate risk to artefacts and structure which had been uncovered. However, not all of the structure is covered and it is unclear whether the levels of sand will continue to increase in the future, or have dropped again in 2011.

It is likely the site will become uncovered again at some indeterminable time in the future, due to the dynamic environment and the extent to which the changes on site seem to be affected by storm conditions. There is a need to be ready to mobilise quickly to take advantage of future exposures as the ongoing degradation of the site is taking its toll on the seabed archive. While the recovery of at risk artefacts provides some data, by the time artefacts become exposed and are discovered they are often moved from their primary context and hence valuable information on context has been lost. The extent of this movement was demonstrated by Sarah Holland's study of the movement of traceable bricks across the site over a short period (Holland pers. comm).

5.2 Site Management and Protection

The *Hazardous* site poses a range of challenges in terms of management and protection. The site is already on the English Heritage At Risk Register (English Heritage 2010), where it is listed as having 'extensive significant problems', with the trend being 'significant decline' (EH 2010: 84). Although the movement of sand over the main wreck site during winter 2009/ early 2010 has reduced the risk for some of the seabed archive, it is likely that future movements of sand will re-expose the main site again.

5.3 Site Archive and Future Research

The recovery of at risk artefacts from the main wreck site and from the area of gullies has added to the object archive. This new data adds to the collection of over 450 objects which include ship structure, fixtures, fittings, armament, crew apparel, evidence of shipboard life and personal effects. Data gathered related to the position of the recoveries will enable further analysis of the break-up of the ship and of the distribution of material in the area of gullies to be undertaken.

Survey of the structure uncovered off the north east bow has demonstrated the level of detail that is still preserved on timber which has been buried and has also provided the opportunity to record a section of hull which has not previously been exposed to this extent. The wreck structure is subject to continuous degradation particularly due to the marine boring organisms, and any opportunities to record new exposures should be maximised. The gathering of detailed ship structure data adds to the already extensive archive related to the ship form and construction. This information has significant potential to add to understanding of warship construction and re-fit in the late 17th and early 18th century.

The results from the field seasons 2007 – 2010 was used in support of the detailed appraisal of the sites research potential which is outlined in Section 6.

6. Review of Site Research Potential

The *Hazardous* archive provides a unique opportunity to enable further understanding of a period when ship design was being developed within the broader context of European conflicts and expanding globalisation. A review of the site archive, both recovered and extant on the seabed, has been undertaken to develop a detailed research agenda for the wreck and its associated collection.

6.1 Brief Summary of Known *Hazardous* Biography

The following summary of the currently known history of the *Hazardous* is provided here as background for the consideration of more detailed research questions in later sections.

Build: Le *Hazardeux*, was built in 1698 at Port Louis, France. The ship was a 50 gun 3rd rate ship of the line which displaced 725 tons and carried 350 crew. Built of oak and pine the ship was well decorated as demonstrated by a print held in the Museé de la Marine, Paris, and said to be 'ornately carved and guilded in a tribute to Louis XIV, the Sun King' (Owen 1988:285).

Use: (French). Little is currently known about the career of Le *Hazardeux* within the French navy. However, in 1703 the ship was loaned by the French Navy to the ship owner and privateer De Beaubriand of St Malo.

Capture: In November 1703, the ship was under the captaincy of de la Rue when it was captured by the English Channel Squadron under the command of Admiral Sir Clowdsley Shovell. In the action which lasted over six hours, Le *Hazardeux* was seriously damaged and was said to be 'Reduced to a perfect wreck'. The vessel was then towed into Portsmouth.

Refit: The ship was rebuilt and fitted out within six months. Following the refit the ship maintained a length of 137 feet and possessed a 38-foot beam but the displacement was increased to 875 tons and the armament was increased to a total of 54 guns, a mix of both English and French varieties (Owen 1988: 285). The ship was commissioned as an English 4th rate ship of the line in March 1704 and renamed *Hazardous* at that time, it carried a crew of 320.

Use: (English). Very little is known about the use of *Hazardous* within the English Navy at present. It is known that the ship was escorting a fleet of two hundred merchant vessels, along with three other warships, back from the Chesapeake Bay colony in Virginia prior to wrecking. The ship left Virginia on the 18th September 1706, however, due to storms enroute many of the merchant fleet were scattered and a smaller number progressed across the Atlantic.

Wrecking and salvage: *Hazardous* beached/ wrecked two months after leaving Virginia on 18th November during a severe storm approximately 800 meters southeast of Brackelsham Bay, off the coast of West Sussex (it should be noted that the shoreline has regressed since the wrecking). There is much detail of the wrecking due to Naval records, this information is presented in a number of publications (Owen 1988; Holland et al 2005; www.hazardousproject.info).

Following the wrecking there were salvage activities, accounts include an example from 10 days after the wrecking which indicates 'major part of the small arms' had been recovered and that some guns from the upper and quarterdecks might still be salvageable if the weather improved but that 'those below and to leeward are continually under water'. The only other account of salvage so far discovered has been from 1715 when documents in the Dockyard Archives at Portsmouth indicate that six brass and iron guns were removed (these add to the collection on the seabed which number 12, and 2 that were raised in the 1990s).

6.2 Vessel Structure and History

6.2.1 Ship structure, construction and re-construction

Surviving structure: The bow section of the vessel survives from the bow itself in a continuous section that stretches for around 24m to the south where it appears there has been a break in the hull which meant that the after part of the hull was less well protected and hence has not survived to such an extent. More of the port side bow is preserved than the starboard side which would have been more exposed above the seabed. When the ship was initially investigated there was a substantial area of wooden structure surviving to the south of the site which stretched a further 20m from the current remains, but this was lost during one winter's storms.

The extant remains of the forward section of the bow suggest that the ship has angled over to port during the wrecking process. This is demonstrated by the large number of guns which appear to be *in-situ* down the western edge of the site and for a number of timber elements visible on the eastern (starboard) side of the hull, but which are buried under the sand further to the west.

Owen (1991: 325) states that the southern section of structure was of a lighter construction to that of that to the north. The southern section is thought to represent part of the port hull.

Planking: Owen (1991) notes that the sided and moulded dimensions of the planking visible on site differs considerably even within a relatively small area of the hull. He states "Attached hardwood planking is approximately 0.150m wide by 0.075m thick and is fixed with a combination of wooden tree nails and iron bolts approximately 0.025m thick. This planking is sheathed in a skin of softwood, probably pine, to protect the hull against marine borers; this sheathing is approximately 0.050 to 0.075m in thickness". (1998:291)

Framing: There are paired frames throughout the vessel, Owen 1991:327 provides the following details related to framing:
General framing throughout the vessel: these "Are of oak and have been arranged in pairs fastened laterally together using iron bolts approximately 52cm long and 25mm in diameter. The iron bolts appear on average to be staggered by 20cm on each set of frames. Frames have been centred on average 65cm between the scarf of each frame pair. This gives an average siding of a set of frames of 52cm. The space between each set of frames varies between 100mm and 125mm in width and the average moulding of the frames is 40cm.

Station frames: "are present, three in number…… The distance between each set of station frames is approximately 3m which allows for four pairs of filling frames between them; this type of construction appears to be typically French".
Cant frames: Further detail of the presence of cant frames was revealed through excavation. It was clear that the angle of the frames in relation to the keel line increases significantly towards the bow.

Unfortunately dendrochronological work on site in 2002 proved inconclusive in terms of dating due to the small number of samples taken and relatively short sequences (Momber & Nayling 2003). This work could have enhanced understanding of the use of timber within the vessel in terms of species identification, age and provenance of the timber. This area of research remains on the agenda for the future, with further seabed assessment and a larger sampling program required.

The archive of site plans holds detail of a range of structural components of the wreck. The digitising of these plans will aid future analysis in support of outstanding research questions which include:

- What section of the full ship is still represented through the physical remains on the seabed?
- How has recording of further structure exposed from the mid-1990s onwards added to understanding of the detail of hull components and construction?
- What comparative archaeological examples exist to help enable the review of construction techniques within late 17th and early 18th century French and English shipbuilding?
- What was the first English vessel built with canted bow frames?

Fastenings: Owen (1991: 327) states: "The fastenings comprise wooden treenails approximately 25mm in diameter and iron round-headed nails approximately 25mm in diameter as the main fastenings for attaching the hull planks to the frames. Other fastenings noted, which are square-headed iron nails approximately 15mm in diameter and wooden treenails of approximately the same size, were used for attaching the ceiling planking."

Research Questions related to fastenings include:

- Can the types and patterning of fastenings inform on the construction techniques and do they reveal evidence of the refit of the vessel?
- Are there archaeological parallels to the fastening patterns, types and techniques found on *Hazardous*?

For instance, in the late 17th and early 18th centuries French shipbuilders fastened their ships with iron spikes, but English and Dutch used wooden treenails as iron and oak react badly to each other tending to shorten the lives of French ships (Rodger 2004: 222). If *Hazardeux* had greater numbers of iron fastening and these still remain on the vessel it may indicate that English shipbuilders did not replace these with their favoured method of fastening during refit.

Lead caulking, lead sheets/ sheathing: There are very large numbers of lead caulking strips and sheets of lead loose on the seabed, as well examples of both being still *in-situ* within the hull remains.

Research questions related to caulking and use of lead:

- How much of the ship would have had lead sheets between the timber elements and or been sheathed in lead?
- Does the lead sheets mean that the outer planking of the vessel was considered a 'sacrificial' layer which would have regularly been replaced?
- What other archaeological comparative examples of the use of lead caulking, sheeting and sheathing exist?
- Were the lead caulking strips rolled, folded or solid?
- How was the caulking fitted? Was it driven with caulking irons or via other methods?
- Was the caulking backed up with ticking, hemp or other materials?

Rebuilding/ refitting of the vessel: The capture and refit of the *Hazardous* are documented as having taken place, however, to date no specific documentation on the extent or method of the rebuilding and refitting have been located. Although the practice of 'prize rebuilding' was a common occurrence in the late 17th and early 18th Century, few records seem to survive. It isn't until the 1720s that there are more records available detailing this practice, these accounts suggest some ships were virtually dismantled before being surveyed and rebuilt after capture (Momber & Nayling 2003).

Research Questions related to the rebuilding/ refitting of the vessel:

- How extensive was the 'refit' of the vessel in 1703/04? Was this primarily a repair of the damage that had reduced the ship to a 'perfect wreck' and possibly changes to the armament. Or did this involve the removal and replacement of a significant amount of the structural components?
- Are there any historical records related to the rebuilding/ refitting of the ship?

Determining this will help the interpretation of the seabed remains and whether they are primarily representative of French construction or more of a hybrid design.

Wrecking, salvage and re-use: The break up of the ship must have resulted in the local foreshore being scattered with timbers and other elements of rigging and stores. It is currently unknown whether there are any local records of the wrecking and potential subsequent salvage. However, this must remain a possibility. It is a common occurrence for timber from wrecked vessels to be re-used within buildings.

Possible research questions:

- Are there any local accounts available from the period of wrecking?
- Are there any records of local buildings having re-used ship timbers incorporated into their construction?

6.2.2 Hazardous in context

Hazardous is from a period when the 'line of battle' ships had already been developed and refined and thus would then be little changed until the advent of steam. However, during the late 17th and early 18th centuries there were constant small improvements in the design of warships. *Hazardous* provides the opportunity to study some of these in particular.

The refit of the *Hazardous* would have provided the English with the opportunity to study a number of French construction techniques:

Cant frames: the use of cant frames in the bow of vessels to increase strength was a French development which wasn't adopted in English vessels until comparatively later (1715).

- How does the *Hazardous* fit into understanding of these developments?

Paired frames: the *Hazardous* has paired frames throughout. Owen 1991 states that English warships of the period were constructed of single frames which are narrower but positioned closer together.

- How can *Hazardous* add to understanding of this area of ship technology?

Lead caulking and sheeting/ sheathing: the globalization of shipping meant wood was under constant attack from wood boring organisms. These were combated through the development of methods of 'sheathing' and regular re-planking of vessels. The presence of lead sheets on the *Hazardous* site raises the following questions:

- How does the presence of this material on site reflect understanding of developments in ship design to reduce the impact of marine boring organisms?
- It became known that lead caused corrosion of iron fittings, how does the *Hazardous* fit into these developments?

The development of the steering wheel: the steering wheel was developed to replace the tiller and whipstaff to improve the handling of sailing vessels. This was an English innovation in the 1690s, which it is believed that the French didn't adopt for another 30 years. So it is possible that Le *Hazardeux* was constructed with a tiller and whipstaff, which may have been replaced with a ships wheel during the refit.

- Is there any historical documentation related to either the build of the vessel or the refit related to the steering mechanism?

6.2.3 Historical documentation

Although work has been undertaken to trace some available sources from both British and French archives there is still work to be undertaken in this area.

Research questions related to historical documentation are:

- How much information do French archives hold on the design and build of Le *Hazardeux* specifically and more generally for this class of vessel?
- What evidence is there for the use of *Hazardous* within the French Navy in French archives?
- Does the British National Maritime Museum hold relevant archive related to *Hazardous* and/ or early 18th century 4th rate ships (eg. documents, plans, paintings, models)?
- Are there any records in existence related to the refit of *Hazardous*, or the practice of refitting vessels in the early 18th century?
- What documentation exists for vessels involved in naval actions or duties alongside or related to *Hazardous*?

6.3 Artefact Collection

The artefacts, both recovered and *in-situ*, from the *Hazardous* provide a substantial collection related to late 17th and early 18th century naval ships and shipboard life.

6.3.1 *In-Situ* Artefacts

There are a number of in-situ artefacts on the seabed that are not related to the ship structure, but are related to the ships function as a warship and sailing vessel. This section outlines artefacts on the seabed and research which is specific to their survival and location. Further consideration of functional aspects of these artefacts, along with the related recovered collection, is provided in section 6.3.3.

Cannons: 13 cannon were located on the *Hazardous* wreck site. Of these two were raised, but unfortunately didn't survive conservation by Portsmouth Museum Service (but full records survive). A further cannon has been observed off the north west of the wreck site in recent years increasing the number of cannon to 14.
The expected cannon on a 4th rate of the period are:

Gun deck : 24 guns of 24 lb length 9.5 ft;
Upper deck : 26 guns of 18 lb length 9 ft;
Forecastle : 4 guns of 6lb length 7.5ft and 9 ft;
Quarter deck: 10 guns of 6 lb length 8.5 ft.

The guns present on site do not appear to tally completely with this. Owen (1998: 291) states "The overall length of the largest, of which three are present, is 11 ft 6 in with the trunnions low; the other guns measured vary from 8 ft 6 in to 10 ft. However, it is known that *Hazardous* retained some of the French guns, so this could account for the difference".
It is believed that a third of the ships guns are still present on the seabed. Measurement of these indicate those present are a combination of guns from the forecastle, and upper and lower gun decks of the port side. An additional cannon was located near the north west edge of the designated area in 2009, but has not yet been relocated for detailed *in-situ* recording.

Research questions for cannon on the seabed:

- What can be said about the position of the cannon on the seabed in relation to their original siting?
- Some cannon appear to be in or close to their or original position, what does this add to understanding of the arming of the ship and the wrecking process?
- What nationalities are the cannons?
- What can the number and diversity of cannon tell us about the armament of a 4th rate ship of the line?
- Is this collection of cannon the largest concentration of early 18th century armament currently known? What can it add to understanding of the arming of ships of war?

Gun carriages: The *Hazardous* includes a rare survival of a gun still in-situ on its carriage. The full extent of this feature was revealed during excavation in the late 1980s/ early 1990s. At this time attempts were made to raise the funds to recover and conserve the gun and the carriage, but this was unsuccessful and after recording the feature was covered with protective sheeting and re-buried. In addition to this example there was a gun carriage axle and wheels discovered on the seabed to the north of the site in 2007. This was recovered and is currently undergoing conservation by the HPG.
The survival of late 17th/ early 18th century gun carriages is rare and the *Hazardous* provides a chance to study these alongside their cannon.

- What can the gun carriages add to understanding of the arming of early 18th century warships?

Cannon Balls: The cannon ball mound is situated near the break of hull on the eastern edge of the remains. This mound is likely to represent the remains of the shot lockers which are usually situated around the base of the main mast. This would correspond with the interpretation that the buried forward section of the hull represents the port side, with the cannon ball mound representing the centre of the ship. The contents of the mound are a concreted mass of shot. However, it is possible to make out the shape of individual shot within the larger agglomeration. This concentration of shot adds to the recovered collection, many of which have been recovered from within larger concretions.

- What does the position, dimensions and composition of the cannon ball mound reveal about stowage onboard ship?

Barrels: Seabed movements in 2007 revealed the presence of four in-situ barrels within the forward section of hull, forward of the break (there is no surviving structure aft of the break). These features had not been previously uncovered and their presence adds to understanding of the use of the hold for storage and the preservation potential within the preserved hull.

- How do the barrels add to understanding of the use on space onboard vessels?
- Could analysis of any artefacts recovered from the area of the barrels in the past help indicate what was stowed in the barrels?
- How many more barrels remain buried within the *Hazardous* site?

6.3.2 Recovered Artefacts – Materials

The materials represented within the recovered artefact collection are diverse, a summary of these has been provided below. As, to date, there have been few specialist studies of these materials the research potential of the collection is less well developed than for other parts of the archive.

Metals:

Lead: 71 recorded objects including large numbers of shot (although it should be noted there are single entries which include up to 500 shot), caulking strips and sheets. Also sounding weight, a scupper, small weights, a lid, a strainer,

Iron: 18 objects including a range of shot (round shot and bar shot), a spike and a ring hook.

Brass/ copper/ copper alloy/ bronze: 129 objects, most of which are recorded as 'brass', but are likely to be a range of copper alloys. They include dividers, buckles, buttons, pins, rings, a tube, a butt plate, a d-ring, sword pommel, stacking weights, a spout, a clip, a trefoil, a sailmakers palm, a seal and scissors.

Pewter: 74 recorded objects including plates, syringes, cutlery, buttons, buckles, studs, porringers and a gaming piece.

Silver: 5 objects, 3 coins and 2 buttons.

Organics:

Wood: 28 objects including knife handles, button, barrel staves, musket stocks, gun carriage axle, rigging blocks, carriage wheel, dice, rigging sheaves, a scoop, piece of wicker work and a number of unidentifiable fragments. There are also two combs that may be wood or bone.

Bone: 17 objects including butchered bones, a knife handle and combs.

Coconut: half a coconut shell.

Hair: 1 recorded example, possibly caulking.

Hemp/ jute: 1 piece of rope.

Horn: 1 button that may be made of horn.
Ivory/ tusks: a number of tusks have been recovered from the site in recent years, two have been positively identified as elephant ivory by Richard Sabin of the Natural History Museum, while there is further work required to determine the species of a further recovery. The inclusion of African elephant ivory onboard raises interesting questions on trading which require further investigation in relation to the ship in its full international context.
Leather: 6 objects including a shoe, part of shoe, washer and unidentifiable pieces.
Textile: small number of cloth fragments.

Ceramics: These have variously been recorded as 'pottery', 'terracotta', 'clay', 'earthenware' and one example of 'stone ware'. In total these number 45, which represent sherds and some whole vessels.
There is a single entry of 'red brick' which may be related to the galley area of the vessel. Research is required to review the form and date of the brick.

Glass: There are 27 records of glass, this includes a small number of complete vessels, with the majority being pieces of bottles.

Stone:
Flint: 5 gunflints have been recovered from the site.
Slate: there are 4 slate objects recorded, 2 are identifiable pieces, 2 are thought to be related to navigation equipment.

Composite: there are a 9 composite objects, all of them have wood as part of them. One is a well preserved sword handle.

6.3.3 Recovered Artefacts – Maritime Function

The recovered collection has high potential to reveal information which helps place the *Hazardous* within its full maritime context in relation to naval shipwrecks and the development of the globalisation of seafaring. To date there has not been extensive work undertaken to compare the *Hazardous* collection to available archaeological parallels, this means the current understanding of the research potential in this area is not as well developed as that of the vessel structure and history. The following maritime 'functions' and themes have been identified for further research.

Ship Structure: 38 recovered objects are recorded as ship structure, these include spikes, caulking, tingles/sheathing, a scupper and a pipe.
- How do the recovered items of structure add to understanding of the seabed remains?

Rigging: There are 9 objects which represent elements of the rigging of the ship. These include pulley blocks, a stay, a ring hook, rope and sheaves.
- How representative are the recovered rigging elements for what would be expected in the ship?

Armament: A variety of shot has been recovered from the wreck site which is related to armament from the smaller arms through to the large cannons. There are also parts of swords.
Cannons: There are 11 cannon on the seabed in addition to recovered elements of gun carriages – an axle and two wheels.

Small arms: This includes 2 butt plates, 3 gun stocks, 1 pistol butt pommel and five gun flints.
Iron Shot: Owen noted in 1991 that the iron shot recoverd comprised the following sizes: 18 lb shot of 5 in diameter for culverin; 12 lb shot of 4.5in diameter for 12-pounder; 0.5 lb shot of 2 in diameter for swivel guns.
Lead shot: this is represented through hundreds of lead 'small shot'
Swords: One sword handle.

- What does the armament collection from *Hazardous* tell us about the use of warships during this period?
- How does the collection compare to other known examples from the period?

Navigation:
There are a number of objects related to navigation, this includes a large number of dividers/compass, a globe meridian ring (and possible wooden mounting ring), a protractor and sounding weights. These artefacts have been considered by Heamagi (2008) in her dissertation looking at the development of navigation, however, further research questions remain.

- Is the relatively large number of dividers found from the site a 'normal' number for a naval ship? How does this compare to contemporary archaeological examples and/ or historical documentation?
- Are there further archaeological parallels in addition to those reviewed by Heamagi?

Stowage/ storage: A piece of a barrel has been recovered from the site, this adds to those extant on the seabed. It should be noted that pottery has variously been recorded as either 'storage' or 'galley', while glass has been recorded as 'storage'.

- Was the recovered piece of barrel found near the area where there are examples on the seabed?
- How does this information compare to other known examples of early 18th century barrels and stowage?

Galley: The collection of pottery, bones, cutlery, plates, porringers and glass provide evidence of the consumption of foodstuffs onboard and the equipment used to store and serve provisions.

- Are these items representative of what elite or common crew would use for dining?
- What does the collection demonstrate about victualing of early 18th century vessels that undertook an Atlantic crossing?

Medical: Of the 8 recorded medical items, 6 of these are pewter syringes, with 1 other small weight used for measuring quantities.

- What do these items tell us about health issues onboard?
- How do they compare to other known parallels?

Apparel: Large numbers of buckles, buttons and also a small number of shoes.

- Are the numbers of buckles and buckle parts usual for a naval ship of this period or do some of them represent an additional cargo?
- What does the collection add to understanding of early 18th shipboard attire?
- Does the distribution of the apparel provide evidence of divisions or use of the ship?

Personal/ leisure: This includes pipe fragments, gaming pieces, combs, scissors, pins etc.

- What do these objects tell us about life onboard an early 18th century warship?
- How do these objects compare to other known archaeological parallels?

Coins: There are 8 coins from the site, 4 are copper and 4 silver. Some coins are worn, so it is difficult to make out surface detail, however, 4 are dated to 1696 and 2 to 1694.

- What do these coins reveal about currency circulation in the late 17th and early 18th centuries?

6.3.4 Artefacts within their Shipboard Context

Many years of detailed survey on and surrounding the wreck site have developed a dataset of the position of artefact recoveries. This data adds to the collection of material derived from the single excavation that has been undertaken on the site.

- Can the distribution of artefacts provide information on structural divisions within the ship? Is the distribution purely functional or does it reflect more complex social interactions and arrangements?
- Do the positions where artefacts have been recovered help interpret the remaining structure on the seabed?
- How does the collection of artefacts from surface recovery differ from that from the excavation? What does this tell us about distributions of artefacts that may have become dislodged from their primary context? What information does it provide on the preservation potential of the remaining seabed archive?
- How does evidence from the study of tracer brick movements around the site add to understanding of the movement of materials?

6.4 Historical Context

The build, use and loss of *Hazardous* takes place during a period when rapid global developments are underway. Between 1600 and 1800 the world changed with Britain gaining a large Empire based on maritime strength and trading. Warship *Hazardous* dates to the centre of this period when maritime conflicts and naval power were key to the expansion and maintenance of Empire. (It is appropriate to discuss England in this period as the loss of *Hazardous* pre-dates the Act of Union with Scotland in 1707).

Due to ongoing conflict, by 1696 neither England or France could afford to keep their main fleets at sea, so they turned to another form of naval warfare – private ships making war on enemy commerce (privateering) (Rodger 2004: 156). *Hazardous* was completed just at the time when this change in tactics was taking place. The loaning of Le *Hazardeux* by the French Navy to the French privateer Du Baubriand appears to be an example of such 'state sponsored warfare'.

The use of *Hazardous* in the English navy as an escort for a merchant fleet returning from the Virginia Colony reflects the effects of the 'privateering' warfare as trade had to be protected from attack. The safe arrival of the merchant ships was vital to maintain the development of trading and the expansion of maritime networks.

Further hints at global trading routes are provided by the presence of elephant ivory tusks from the wreck site. It is possible that ivory was collected while *Hazardous* was in America, the ivory having been transported there through the well-established Atlantic slave trade route. Further research is required to investigate known movements of ivory along these routes.

Research questions:

- Does the design and construction of *Hazardous* reflect changes in naval tactics in the 1690s?
- Does the collection of objects discovered on *Hazardous* provide evidence of trade, exchange or goods related to voyage/s to the Americas?
- Does the elephant ivory from the wreck provide evidence of the transatlantic triangular trade routes?
- How does the career and use of *Hazardous* by the English reflect ongoing political and economic developments?

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8. Appendices

8.1 Example Site Photographs July 2010

A small number of photographs taken on site are included here to demonstrate the conditions encountered on the site during survey. Low visibility means these photographs only provided limited amounts of information.

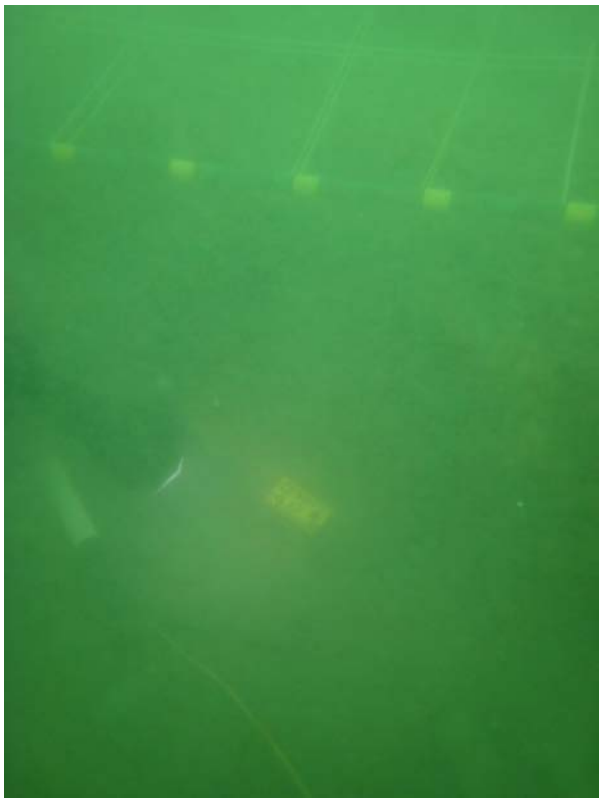

Figure 8.1 (left) Structure at the bow of the main site
Figure 8.2 (right) Planning frame in position over area of newly exposed timber being surveyed, datum 2209 is just visible with the help of torch light

8.2 Environmental Data 2007 – 2009

The following data has been collected by the Channel Coastal Observatory as part of the Strategic Environmental Monitoring Program www.channelcoast.org. At the time of writing the data for the 2006-07 monitoring year would not download and the data for 2009 – 10 was not yet available.

8.2.1 Wave Climate Data

June 2007 – May 2008

Wave Data from the Hayling Island Wave Rider Buoy shows:

Hayling Island June 2007 to May 2008						
Month	H_s (m)	T_p (s)	T_z (s)	Direction (°)	SST (°C)	No. of days
June	0.56	6.3	3.5	191	16.4	29
July	0.68	5.6	3.4	201	17.4	30
August	0.43	5.3	3.1	188	18.4	25
September	0.48	4.6	3.0	214	17.7	30
October	0.49	7.9	3.6	178	15.1	31
November	0.62	5.4	3.4	200	12.2	30
December	1.02	10.2	4.3	178	9.2	31
January	1.19	11.0	4.6	188	8.3	30
February	0.78	9.8	4.0	180	8.0	28
March	0.90	8.9	3.9	205	8.2	31
April	0.59	7.6	3.5	191	9.5	30
May	0.42	6.2	3.2	153	13.5	31

June 2008 – May 2009

The CCO Data from the Wave Rider Buoy in Bracklesham Bay shows:

Bracklesham Bay June 2008 to May 2009						
Month	H_s (m)	T_p (s)	T_z (s)	Direction (°)	SST (°C)	No. of days
June	-	-	-	-	-	-
July	-	-	-	-	-	-
August	0.61	5.0	3.4	213	17.8	9
September	0.74	6.1	3.8	197	16.4	29
October	0.90	7.2	4.2	212	14.1	31
November	0.76	6.3	3.7	205	10.5	30
December	0.67	8.2	4.2	209	7.5	31
January	1.04	11.0	4.9	201	5.5	31
February	0.57	10.7	4.5	207	5.4	28
March	0.68	8.5	4.1	211	7.6	31
April	0.49	8.7	4.4	207	10.8	30
May	0.70	7.2	3.9	204	13.2	31

June 2009 – Dec 2010

Month	Hs (m)	Tp (s)	Tz (s)	Dirp (degrees)	TSea (degrees C)
2009					
June	0.4	5.9	3.1	182	16
July	0.66	5.7	3.3	201	18
August	0.52	5.6	3.2	203	18.7
September	0.49	5.7	3.2	169	17.3
October	0.64	8	3.7	188	15.4
November	1.41	9.5	4.6	191	12.9
December	0.87	9.3	4.1	187	9.2

2010					
January	0.67	9.6	4.1	181	5.6
February	0.73	10	4.2	181	5.3
March	0.6	8	3.6	183	6.2
April	0.5	6.9	3.6	175	9.1
May	0.39	7.3	3.4	174	11.8
June	0.37	7.3	3.3	181	15.6
July	0.51	6	3.3	202	18.2
August	0.58	4.5	3.1	212	18.5
September	0.54	7	3.3	210	16.9
October	0.74	6.9	3.6	184	14.7
November	0.83	8.7	3.9	181	11.7
December	0.55	6.2	3.5	179	6.1

8.2.2 Storm Event Data

June 2007 – May 2008

Highest events in 2007/8									
Date/Time	**H_s**	**T_p**	**T_z**	**Dir.**	**Water level elevation* (OD)**	**Tidal stage (hours re. HW)**	**Tidal range (m)**	**Tidal surge* (m)**	**Max. surge* (m)**
10-Mar-2008 08:00	3.79	8.3	6.3	183	-0.16	HW - 5	4.3	0.88	1.09
18-Nov-2007 18:00	3.07	7.7	5.8	159	0.93	HW + 1	2.2	-0.14	0.22
15-Jan-2008 11:30	2.92	7.1	5.6	191	0.03	HW - 4	3.2	0.61	0.78
03-Feb-2008 23:00	2.90	7.7	5.8	159	1.17	HW + 2	2.1	0.27	0.44

June 2008 – May 2009

Recorded storm events were:

Highest storm events in 2008/9									
Date/Time	**H_s**	**T_p**	**T_z**	**Dir.**	**Water level elevation* (OD)**	**Tidal stage (hrs re: HW)**	**Tidal range (m)**	**Tidal surge* (m)**	**Max. surge* (m)**
09-Nov-2008 23:00	3.28	10.0	6.3	212	0.63	HW +3	2.57	0.21	0.41
05-Oct-2008 00:30	3.25	9.1	6.1	203	0.87	HW -1	2.49	-0.04	0.51
18-Jan-2009 01:30	3.17	7.7	6.3	205	0.37	HW -3	2.75	0.30	0.56