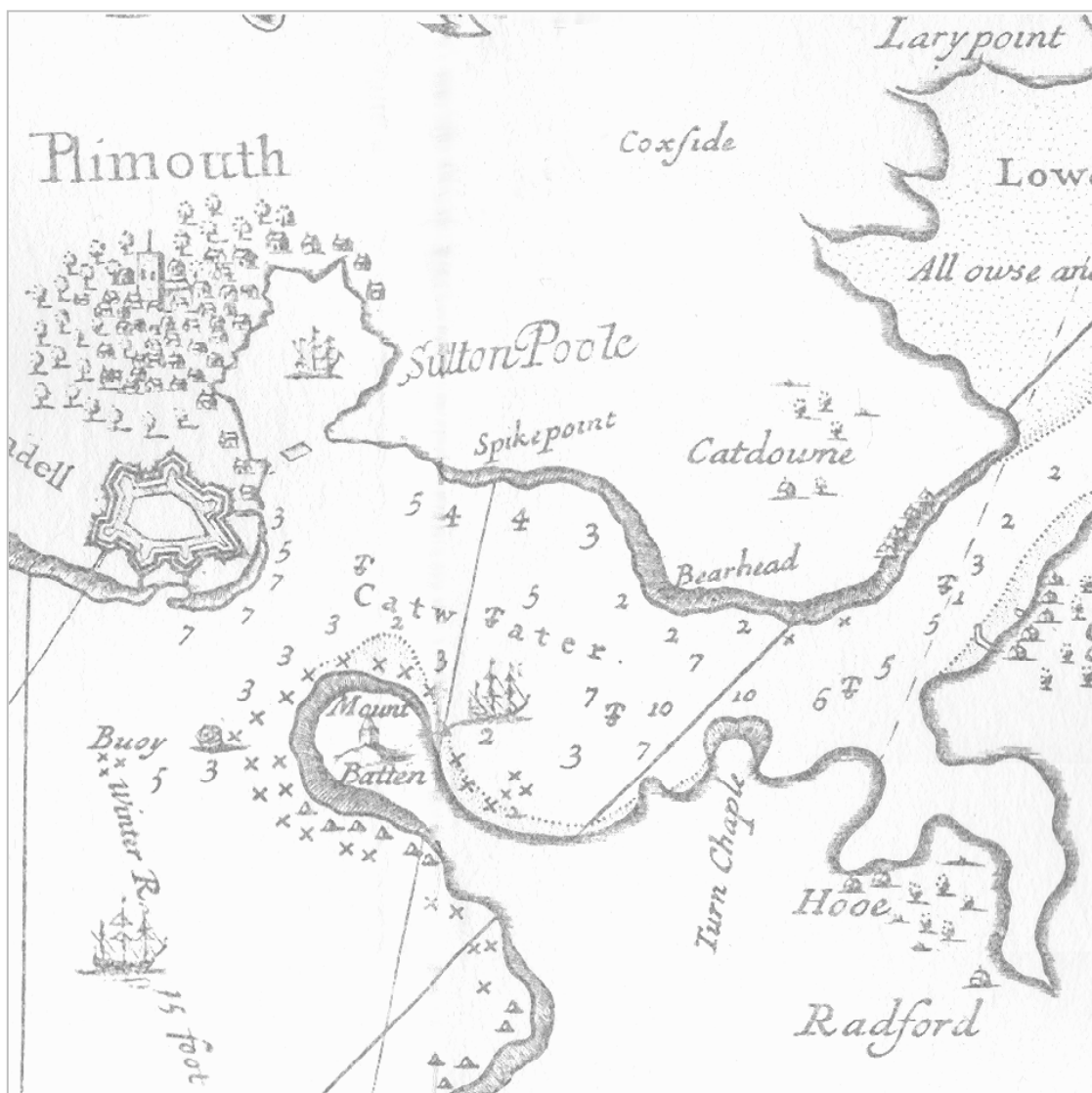


Geophysical Investigations of the Cattewater Wreck 1997-2007



Geophysical Investigations of the Cattewater Wreck 1997-2007

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Cover image from *Great Britain's Coasting Pilot* chart 16, Collins 1693

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Abbreviations

GPS	Global Positioning System
LAT	Lowest Astronomical Tide
MBES	Multibeam echo sounder
OSGB36	Ordnance Survey of Great Britain 1936 reference frame
RN	Royal Navy
SBP	Sub-bottom profiling sonar
TIFF	Tagged Image File Format
UTM	Universal Transverse Mercator projection
WGS84	World Geodetic System 1984 reference frame

Introduction

Scope

This document describes the geophysical surveys undertaken on the site of the Cattewater wreck in the lower reaches of the Plym River, Plymouth, UK, between 1997 and 2007. The work is part of a long-term project to collect geophysical data and use it to help locate shipwrecks and other cultural remains within Plymouth Sound and its estuaries.

The Cattewater

The Cattewater is the name given to the lower reaches of the River Plym, the river associated with the City of Plymouth in South West England. The Plym starts on the high ground of Dartmoor to the north-east and drains into the waters of Plymouth Sound at its north-east corner through a drowned river valley or ria. In times of a much lower sea-level, the deep-cut limestone gorge at the mouth of the River Plym met with the deep-cut limestone gorge at the mouth of the River Tamar to the west, before the confluence then flowed south towards the Eddystone Reef now 17 miles offshore. To the north of the Cattewater is the much-quarried limestone hill of Cattedown and to the south lie the quarries of Turnchapel and the promontory of Mount Batten, a mass of Devonian limestone joined to the land by a narrow strip of land.

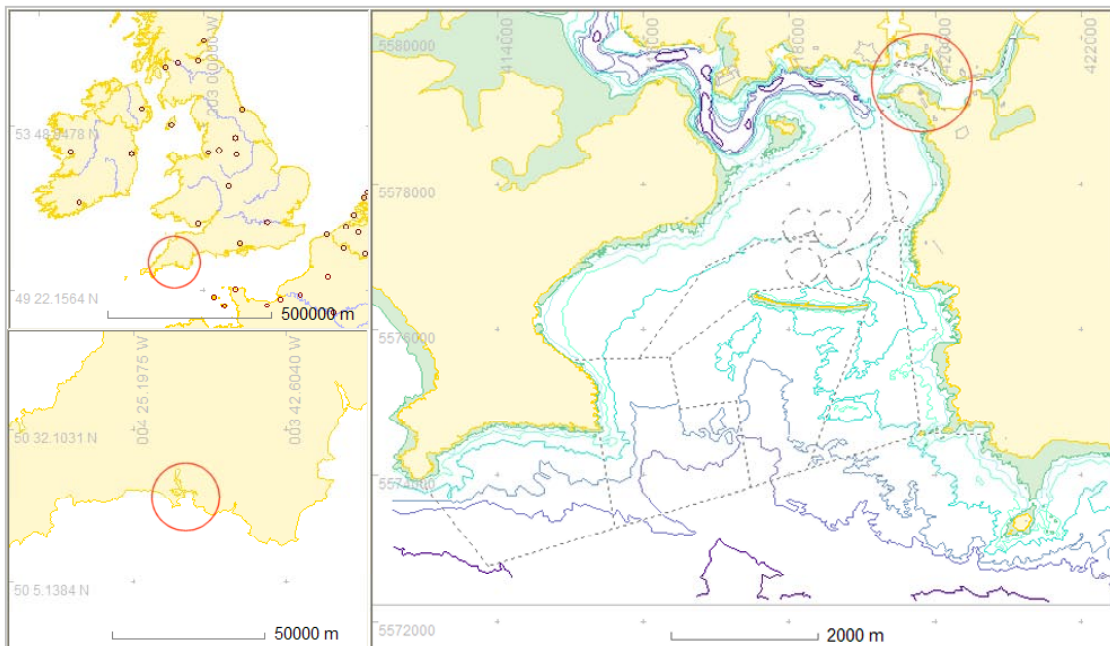


Figure 1: Cattewater location

It is known that the land around the Cattewater has been occupied since the Palaeolithic period. In caverns in the limestone quarry just up the Plym river in Oreston were found human bones in association with those of woolly rhinoceros, mammoth, cave lion and cave bear¹. Excavations at Mount Batten have produced amongst many other items flint cores from a Mesolithic kitchen midden and a Neolithic hand axe. The 'Plymstock Hoard' found in Oreston in 1868 was thought to be the stock of a merchant smith from the Bronze Age.

South-West England was not well served with roads before the coming of the turnpikes which happened sometime after 1750. Whenever possible, goods were moved by sea and transhipped to carts for local delivery or to packhorses for destinations further inland². As

¹ The Plymstock Connection, p9

² Historical Atlas of South-West England p357

transport overland would have always been difficult through the hilly terrain of South Devon and Cornwall, it can be assumed that the waters around Plymouth have been used as a harbour for transport and trade from the time when people first occupied the area. Cunliffe describes the Cattewater as 'one of the most important prehistoric ports-of-trade in Southern Britain and maintained its significance well into the Roman period.'³ The presence of the Romans in the area is demonstrated by the finding of Roman coins and roofing tiles along with bronze and pottery artefacts. Worth in 1873 reports that a ship that was supposed to have been Roman was found under marshland at Plympton⁴ (Bracken puts it at Newnham⁵), just up the river, unfortunately no further details are given. It should be noted that these reports should be treated with caution as few means of dating were available at the time so things they did not understand were often labelled as being Roman.

Metal ores were first exploited in Britain in the second millennium BC⁶ and it would have been clear at the time that Devon and Cornwall were rich in tin because of the alluvial deposits visible in the riverbeds. Recovery of the tin started with the easily accessible alluvial deposits by streaming and many streamworks exist on Dartmoor at the head of the rivers Plym and Meavy. Tin ingots found off the mouth of the River Erme⁷ a few miles to the East of Plymouth hint that tin trading would have occurred at similar locations such as the Cattewater; the heads of the rivers Plym and Erme on Dartmoor are less than 2km apart. As Mount Batten lies near a safe and convenient harbour down river from the Dartmoor tin works it suggests that it too would have been used for this purpose, in fact Mount Batten has a good claim to be the fabled site of *Ictis* mentioned by Diodorus Siculus⁸ (90-21BC).

The first recorded trade was in tin and slates exported from Plympton Earle which lies up the river Plym, at the time its furthest navigable extent. By 1328 AD, tin streaming had deposited so much silt in Dartmoor's rivers that the upper reaches of the Plym gradually became too shallow to allow access to the harbour⁹. Ships then started to use Sutton Pool at the entrance to the Cattewater to unload their cargoes and by 1200 AD the town of Sutton was a thriving community; Sutton Pool also had the advantage of allowing relatively large ships right up to the centre of the town.

In the Middle Ages, Sutton Pool was the haven for ships but the Cattewater was the roadstead for the ships even though it was somewhat exposed. Even then the silting up of the river was a perennial problem. In 1531 an act of Parliament was passed to prevent gravel from being washed downriver by tin streaming work on Dartmoor. In the reign of Queen Anne a statute was passed to deepen the water over a bank in the Cattewater called the Middle Bank¹⁰, this is assumed to be the shallow area that lay in the middle of the channel between Mount Batten and the entrance to Sutton Harbour.

Another problem was the shallowing of the river caused by the dumping of ballast, as ships taking on a cargo in Sutton Harbour would simply dump their ballast over the side whilst at anchor in the Cattewater. This was such a significant problem that it was mentioned in a charter from Charles I to Plymouth in 1637¹¹

Earliest chart of the area, dated pre-1549, shows the waters of the Sound as well as fortifications along the Hoe coastline and the Stonehouse peninsula¹². Two ships are shown at anchor in the Cattewater lying close in to Turnchapel in Clovelly Bay. By 1650 the ships had increased in size making access to the safety of the Cattewater and Sutton Pool difficult,

³ Mount Batten Plymouth, a Prehistoric and Roman Port, p1

⁴ History of Plymouth, Worth, p8

⁵ A History of Plymouth and her Neighbours, p5

⁶ The Early British Tin Industry, p15

⁷ Tin Ingot Wreck Site Interim Report May 1992

⁸ The Isle of Ictis and the Early Tin Trade

⁹ History of Plymouth, Worth, p217

¹⁰ History of Plymouth, Worth, p217

¹¹ Plymouth River, p29

¹² Lost Landscapes of Plymouth, p77

so the ships had to remain outside in the Sound. At this time there was no Breakwater across the mouth of Plymouth Sound so any ships at anchor were exposed to southerly storms.

Up until the 19th century the north bank of Cattedown and the southern bank formed by Mount Batten, Turnchapel and Oreston would have been grassy hills much like Plymouth Hoe is today. Quarrying the limestone hills has formed the landscape we see now; the John Cooke map from 1820 shows the first quarry in Cattedown on its most southern point and this was followed by many others all around the Cattewater. This too affected the seabed of the river as in 1827 there were concerns that quarry waste from Mount Batten was silting up the harbour.

The coming of the railways brought commercial wharves to Cattedown, further changing the aspect of the river. The development of Cattedown Wharf started in 1884, leading the spread of wharves up the river on both sides. The edges of the river were reclaimed or reformed by development work in subsequent years so that little or no original bank remains in the Cattewater.

Although a good roadstead for ships it was common for vessels to leave the Cattewater for the increased safety of the Hamoaze in times of bad weather. The security of the Cattewater was further improved by the completion of the Mount Batten breakwater in 1883.

The Cattewater Wreck

The area of the Cattewater to the North of Mount Batten was used as a mooring for seaplanes and then for fast air-sea rescue craft operating from RAF Mount Batten. In 1973, a dredger being used to deepen the moorings brought up timber wreckage and parts of some iron guns. An underwater investigation of the site that year produced a provisional site plan and the more controlled recovery of loose wreckage from the seabed. The hull structure was the lowest section of hull from one end past the midships area, where the dredging work had caused extensive damage. Based on the assessments the site was recommended for designation under the new Protection of Wrecks Act (1973) and the site was designated under order No 1. Further recording and excavation work on the site was carried out between 1974 and 1978¹³.

The southern end was the first to be discovered and the deposits in this area were found to be intact above the hull. An area of undisturbed deposits to the north of this area was left undisturbed, and excavation resumed northwards along the western hull edge, until the northern end of the hull structure had been located. In contrast to the southern area, the northern sector had been severely damaged by dredging, and deposits only remained in situ between futtocks. Most of the artefactual evidence came from the southernmost area of the hull, from deposits which were associated with the ship's ballast.

The name of the vessel remains unknown and the site was not fully understood as very little of the debris field was investigated. The site was visited by the archaeological diving contractor between 1986 and 1998 and once in 2003 but remained largely forgotten; local lore said that the site was inaccessible as it was buried by many metres of sediment.

The site of the Cattewater wreck lies to the south of the main ship channel in a shallow area now filled with small boat moorings.

The designated area is a circle of radius 50m. The published position of the centre of the designated area is given as:

50° 21' 41.4 N 004° 07' 37.5 W (OSGB)

This is in fact the original sextant position from the dredging work in 1973 given on the OSGB datum, so converting this to WGS84 gives an initial position estimate as:

¹³ The Cattewater Wreck - The Investigation of an Armed Vessel of the Sixteenth Century

50° 21.7243 N 004° 07.6955 W (WGS84)

The hull should present a target 11m long by 4m wide and 1m in height lying level within the seabed. The main timbers in the surviving structure were made of oak¹⁴. The sawn outer planking was fastened using a combination of iron nails and treenails so the iron nails together may present a small but detectable magnetic target. If one or more swivel guns remain on site they may be detected by a magnetometer as a ~200kg mass of iron.

Environment

Seabed

The Cattewater is shown in Admiralty chart No.1901 Smeaton Pass and the Narrows 1:5000 scale. The most recent bathymetric survey by the Cattewater Harbour Commission in 2002 shows a depth on site of 2.5m below LAT, with an extreme low tide height of 0.5m the minimum depth of water is 3m on the site. Earliest chart of the Cattewater with reliable depths is the Collins chart of 1693¹⁵ and the area of the site is shown having a depth of 2 fathoms or 4m at low water on spring tides. The 1967 Admiralty chart of the area shows that it was dredged to 1.1 fathoms (2.2m).

The area has been subject to dredging from the earliest days to remove accumulated silt and dumped ballast.

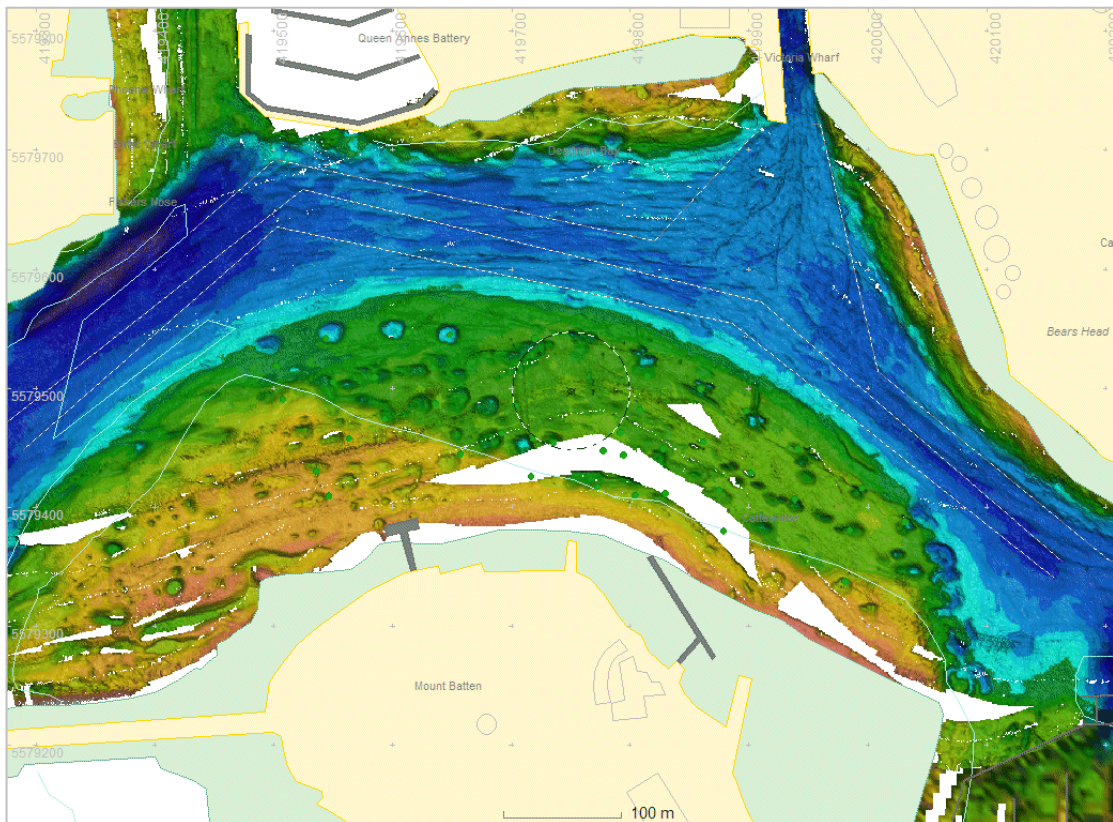


Figure 2: Seabed bathymetry in the Cattewater

The drowned river valley of the Cattewater now contains a considerable depth of sediment. Limestone bedrock was found at a depth of 30m below the seabed only 30m from the present foreshore, suggesting depths over 50m at the deepest parts¹⁶. During construction of the first

¹⁴ Artefacts from Wrecks, p73

¹⁵ Great Britain's Coasting Pilot, Plymouth, chart No. 16

¹⁶ Plymouth Sound Maritime Archaeological Recording Project, p26

Laira Bridge, the underlying rock was found below 20m of granite sand and when the new bridge was built solid rock was found 30m below the river bed.

Cores taken from Clovelly Bay before dredging work showed that the upper levels of sediment on the site are very stiff green-grey sandy clay; this is thought to be composed principally of waterborne waste from mining activity on Dartmoor. The lack of visible stratigraphy and relative homogeneity of the clay suggests that the deposit formed rapidly and without interruption¹⁷. The sediment in the area of the Cattewater wreck is formed from the same clays but it is expected to contain rock or shingle ballast dumped overboard from ships and waste from quarry workings on Mount Batten. The nature of siltation and how it has changed over time since tin streaming and china clay extraction stopped is poorly understood.

The area of the wreck site itself is now largely undisturbed by regular dredging, unlike the channel to the North which is maintained at a depth of 5m. The current Admiralty chart 1901 shows that the bank on which the site lies was dredged in 1995 to a depth of 3.1m; this is supported by the bathymetry image (Fig 2) which shows the dredged area in green and the untouched area to the south in yellow separated by a distinct straight line. Based on the information from the Collins chart the 1995 dredging work would have been above the level of the 1690 seabed by approximately 1m.

Tide and Current

- At spring tide the current reaches 0.5 kt in an East-West direction over the site and the tide height is between 0.5m and 5.5m above LAT.
- The prevailing wind is from the South-West but the site is sheltered from that direction by the land mass of Mount Batten to the South, so is not affected by significant wave action.

Visibility

- Underwater visibility on site is generally 2 to 3m if no rain has fallen in the area in preceding days.
- If rain has fallen over Plymouth then the visibility is reduced to 0.5m or less by overspill from the sewage treatment plant in Cattedown, this reduction takes 3 days to clear.
- Rain over Dartmoor also washes down silt and debris but with less reduction in water quality.

Hazards

- The area of the wreck is a mooring for small boats so contains mooring buoys, chains and ground tackle.
- Large vessels use the channel to the North of the site to access Cattedown Wharves while smaller vessels will take a short cut through the moorings straight over the site.
- The seabed will be littered with debris thrown or lost overboard from vessels on moorings or at anchor.
- The site may contain unexploded ordnance in the form of bombs dropped during WWII.
- The sediment within Hooe Lake further up the Cattewater is contaminated with heavy metal and organic pollutants¹⁸

Known Wrecks

There are more than 80 recorded wrecks in the Cattewater, with many sunk at their moorings. One of the earliest accounts tells that on 20th May 1339 a squadron of 18 French galleys and pinnaces ran into the port of Plymouth and, after burning some vessels in the Sound or

¹⁷ Clovelly Bay, Plymouth, Archaeological Assessment, 1996

¹⁸ Local Environment Agency Plan Tamar Estuary and Tributaries Consultation Report 1996 p65

Cattewater, landed a force which attacked the town and burnt other vessels lying in Sutton Pool¹⁹.

In 1886, dredging to remove 14000 tons of silt, rubble and rock off Cattewater Wharves discovered 30m long wreck of an English Civil War period ship in good condition covered with sand. A small cast iron swivel gun marked with the letter 'P' was recovered and it was found to be loaded with a ball weighing half a pound, wadding and powder charge. The ship is thought to have been a Parliamentary ship run aground under the cover of Parliamentary guns on Cattedown after being damaged by Royalist guns on the far bank.²⁰

In 1973 the Cattewater wreck itself was found during dredging work.

Coordinate Frame

Geophysical data collected and presented in this report are referenced to WGS 84 reference system and are projected in UTM Zone 30 North coordinates as specified in the survey brief.

Survey List

The geophysical surveys undertaken on the site and mentioned in this document include:

Survey Name	Surveyor	Reference Number
1997 Survey	Potten	EVT-0090
2005 MBES Survey	Dean	EVT-0100
2006 MBES Survey	Bolton et al.	EVT-0105
2006 SBP Survey	Thebault	EVT-0110
2007 Survey	Swann	EVT-0115
2007 HiRes Magnetometer Survey	Holt	EVT-0120
2007 MBES Survey	RN Hydro. School	EVT-0125

¹⁹ The Maritime History of Devon, p13

²⁰ Plymouth River, p35

Surveys

1997 Geophysical Survey (Potten)

Summary

Reference	EVT-0090
Organisation	University of Plymouth
Date	22 November 1997
Surveyor	Charles Potten
Techniques	Sub-bottom profiler, sidescan sonar

Information about this survey was taken from the dissertation 'A Pre-Disturbance Survey of the Cattewater Wreck Site: The First Survey using Remote Sensing' by Charles M Potten. The report was submitted in April 1998 as partial fulfilment of the degree of B.Sc. in Underwater Studies at the University of Plymouth.



An area 100m by 50m was surveyed using a Datasonics chirp sub-bottom profiler with nominal 10m runline spacing around Cattewater wreck at co-ordinates 50° 21' 41.4 N 004° 07' 37.5 W (OSGB). The coordinates used are the centre of the designation area. The survey was undertaken in fine weather between 09:00H and 16:30H from the University survey vessel *Catfish*.

Figure 3: Survey vessel *Catfish*

Equipment

- Trimble 4000SE differential GPS receiver provided by the University of Plymouth, position accuracy established from trials as ~0.7m
- Datasonics CAP-6600 Chirp sub-bottom profiler
- GeoAcoustics SS941 dual frequency (100/410kHz) sidescan sonar provided by the University of Plymouth
- Trimble HYDRO software provided by the University of Plymouth

Processing

Positions logged in HYDRO were in latitude and longitude, but were required to be expressed relative to local Ordinance Survey OSGB36 co-ordinates (Northings and Eastings).

Products

- A paper copy of the report is in the possession of martin Read. The report contains a track plot showing position fixes given in OSGB UTM30 co-ordinates.
- Three sections from the sub-bottom profiler showing targets and numbered position fix lines.

Targets

Target Name: 97 Potten

This sub-bottom profiler image Plate 12 shows two sections through the same target on two adjoining runs. The uppermost horizontal line shows the water surface and below that is the profile of the seabed.

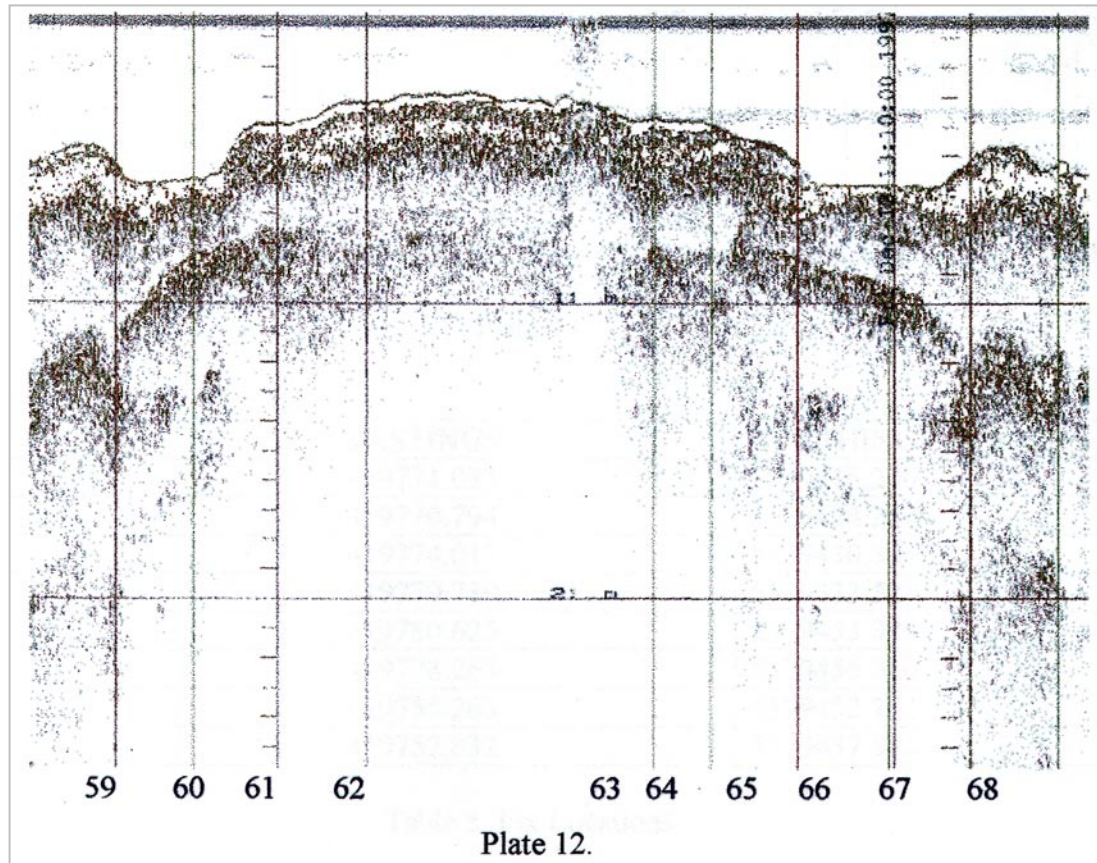


Figure 4: 1997 Potten Plate 12

The target is a hard reflector shown beneath the two significant depressions or scour pits on the seabed, dipping down towards the East between 2 and 3m below the surface. The pits are caused by the scouring action of a mooring chain and are each centred on a single mooring. The original fix positions are not recorded accurately in the report but enough information is available to georeference the trackplot image so the fix co-ordinates can be deduced. The target is estimated to lie between fix points 60 and 67 to the West of the designated area at co-ordinates:

50° 21.722 N 004° 07.746 W

The length of the target can be estimated from the positions of the fix points on the trackplot at over 20m.

Plate 13 shows a similar image of another hard reflector at the same depth below the seabed and again below a scour in the seabed. This is shown as being between fix points 101 and 102 which on the track plot give co-ordinates:

50° 21.765 N 004° 07.744 W

This is 80m north of the target shown in Plate 12 and on the Northern edge of the dredged channel.

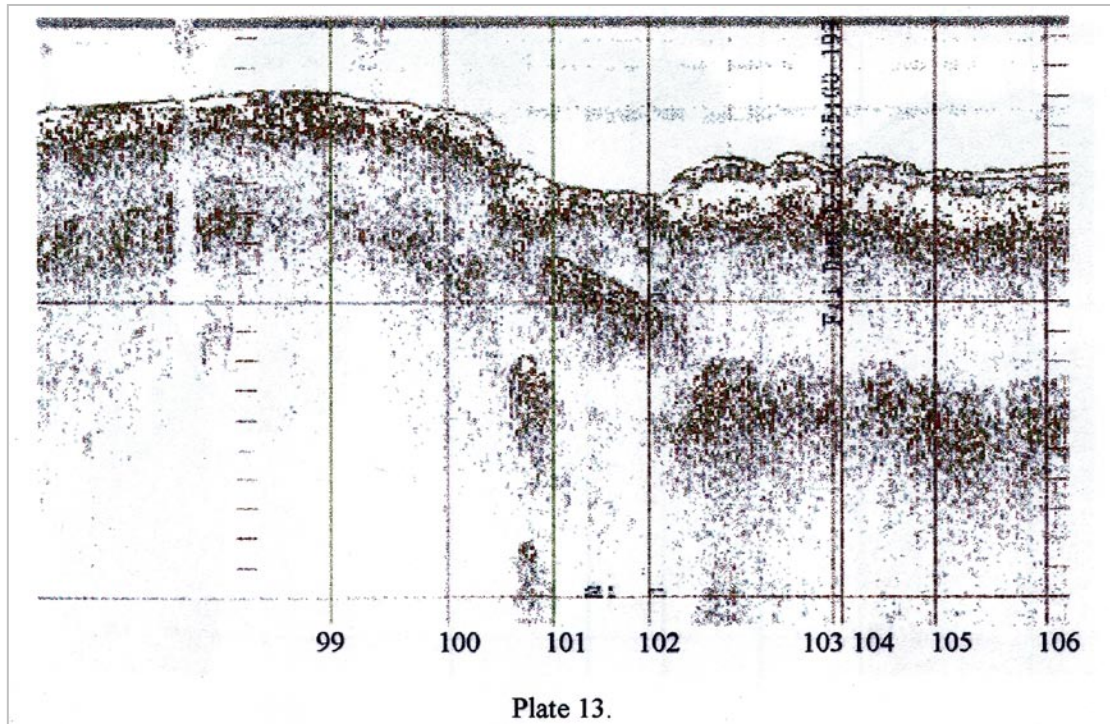


Figure 5: 1997 Potten Plate 13

The targets are similar in shape and both are shown lying beneath mooring scours so it suggests that they may be the same target. No mooring scours are in the positions given suggesting that the positions given for the whole survey are suspect. It is possible that the images are of the Cattewater wreck but they may also be an unknown buried structure as the measured length is too long and the structure is more tilted. Lack of access to the original records means that there is no other data to compare this with and so establish the significance of this feature within the data set, however only two images are shown in the report suggesting that they were considered particularly significant.

The sidescan images are of poor quality and dubious position accuracy so has provided no useful information.

The data from this survey is copyright of the University of Plymouth

2005 MBES Survey (Dean)

Summary

Reference	EVT-0100
Organisation	University of St Andrews
Date	3 May 2005
Surveyor	Martin Dean
Techniques	Multibeam echo sounder

Equipment

- Dual head Reson SeaBat 8125 multibeam echo sounder
- Applanix POS MV motion reference unit and GPS
- QPS QINSy processing software

Processing

The data was processed by Elizabeth Swann as part of the survey work in 2007 however this did not produce a useable image.

Products

- Separate raw XYZ files from the port and starboard transducers for 5 survey lines.

The data is copyright of ADUS (<http://www.adus.org.uk>)

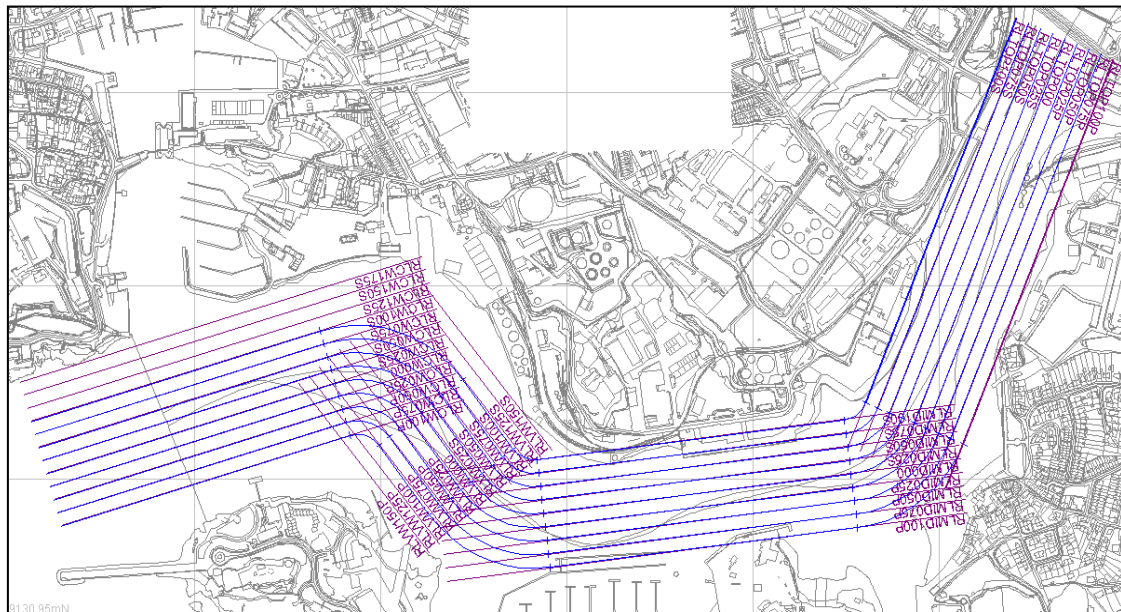
The seabed features visible on the multibeam survey images is discussed later in section on the 2007 Royal Navy MBES survey (EVT-0125)

2006 MBES Survey (Bolton)

Summary

Reference	EVT-0105
Organisation	University of Plymouth
Date	7 February 2006
Surveyor	A. Bolton, E Chartier
Techniques	Multibeam echo sounder

This survey was completed as part of coursework by A. Bolton, S &D Hand ,E Chartier
McIlroy



- GeoAcoustics GeoSwath Plus 250kHz interferometric multibeam sounder
- TSS DMS2-05 Motion Sensor
- Meridian gyro compass
- StarFix navigation software and GeoSwath Plus software

Processing

The multibeam data was processed using the GeoSwath Plus software Suite at a 1m bin size.

The data from this survey was referenced to WGS84 UTM zone 30 North.

The survey incorrectly reports the Cattewater wreck at co-ordinates 4196750, 5579500 (more correctly 419675, 5579500), but this is a direct conversion of the co-ordinates given by Potten in 1979 (EVT-0090) so does not appear to have been derived from this survey data.

Products

- The report on this work is presented by another fictitious company, Geo-Survey Solutions Ltd, and a digital copy is available.
- The multibeam data is available as a post-processed TIFF image (2455 x 1279 12MB) of the seabed bathymetry
- Processed XYZ file of depths and positions
- Fledermaus 3D Scene file
- ArcGIS .mxd of final Cattewater Chart
- ArcGIS .mxd of final Side Scan Mosaic
- ArcGIS .mxd of final 3-D images

The seabed features visible on the multibeam survey images is discussed later in section on the 2007 Royal Navy MBES survey (EVT-0125)

The data from this survey is copyright of the University of Plymouth

2006 SBP Survey (Thebault)

Summary

Reference	EVT-0110
Organisation	University of Plymouth / Innomar
Date	4 April 2006
Surveyor	Amelie Thebault
Techniques	Sub-bottom profiler

Information about this survey came from the dissertation submitted by Amelie Thebault to the University of Plymouth in partial fulfilment for an MSc in Hydrography in September 2006. The primary survey work was undertaken in an area to the North of Drake's Island in Plymouth Sound however some data was collected over the Cattewater site.

An Innomar SES-2000 parametric sub-bottom profiler was used for this survey. This profiler uses the parametric acoustical effect to transmit a low frequency, narrow beam sonar signal into the seabed. The reflected primary signal of 100 kHz is used to determine water depth while the 12 kHz secondary signal is used to penetrate the seafloor. The 3.6 degree beamwidth gives an approximate footprint of 0.5m in the depth of water over the site. Vertical resolution is up to 70mm and penetration can be up to 50m depending on the seabed type.



Figure 7: 2006 Innomar SES-2000 SBP surface unit

East-West lines were run at 20m spacing then many repeated runs were made over the estimated position of the hull timbers. North-South lines were also run but these were 20m to the West of the designated position so were not over the hull remains.

A magnetometer on loan from IXSEA turned out to be faulty so this could not be deployed.

Equipment

- Trimble 4000SE differential GPS receiver provided by the University of Plymouth

- Innomar SES-2000 Standard parametric sub-bottom profiler provided by Innomar Technologie GmbH
- IXSEA Magis 300 magnetometer (failed)
- QPS Qinsy V.7 navigation software

Processing

The processing and interpretation of the data from this survey forms part of the post-graduate thesis of a University of Bristol student, Ashley Gould, towards her MA in Maritime Archaeology and History. Unfortunately this information was not available at the time this report was written so processing was completed by Peter Holt (3H Consulting Ltd).

Products

- The primary products of this survey were a set of seismic section images through the seabed in the Cattewater site. Two images are provided for each run, one showing the 100kHz trace and one the 12kHz trace
- A raw data file for each line in Innomar proprietary .SES format is included

The raw data from this survey is copyright of the University of Plymouth

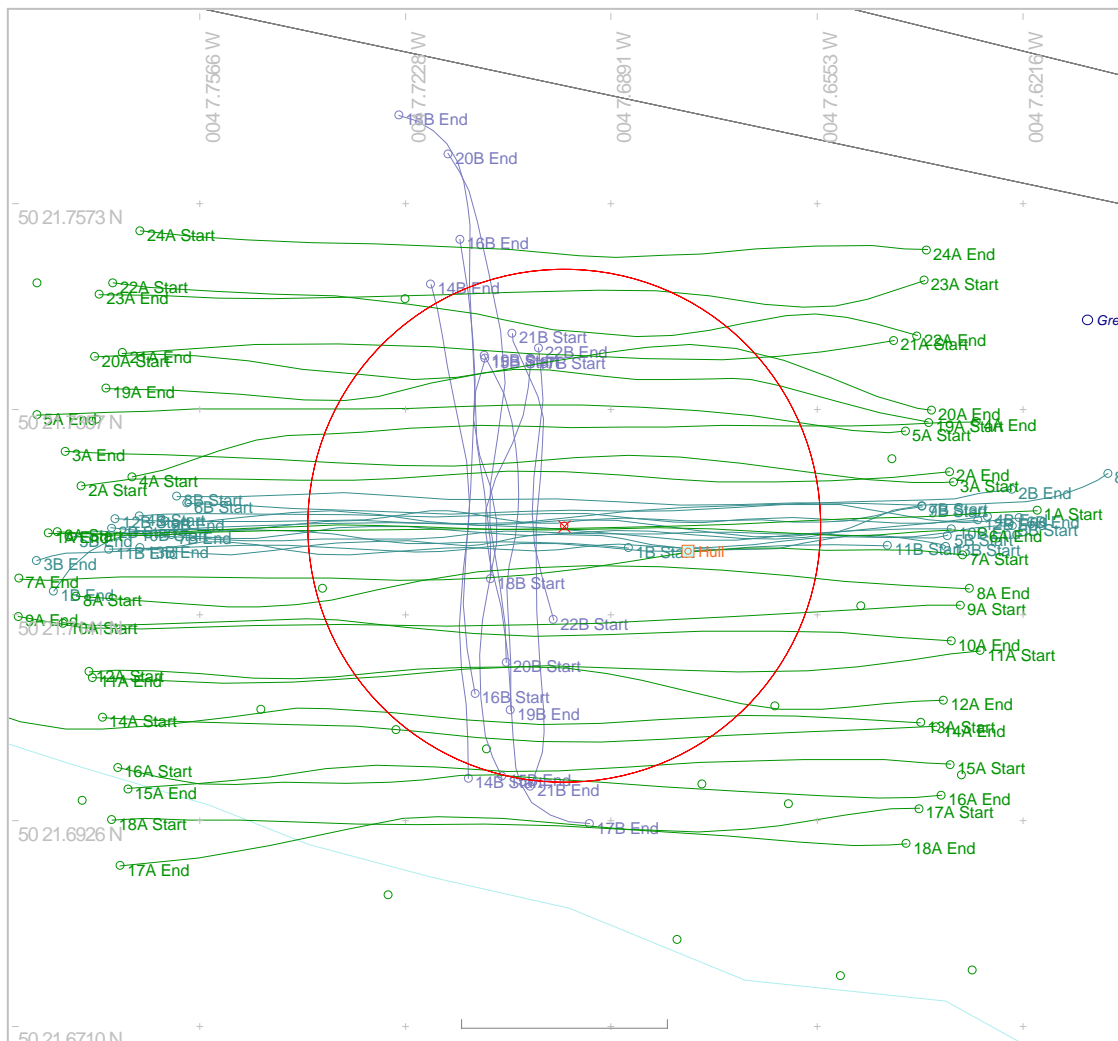


Figure 8: 2006 Innomar SBP tracklines

Targets



Figure 9: 2006 Sub-bottom profiler targets

The position accuracy of these points is approximately 2m.

Target Name: 06 F2a

50° 21.7244 N 004° 07.6818 W

Small hard target buried 800mm associated with F1a but 9m to the North-West

Survey line reference: 04042006105409

Associated with the buried hull

Target Name: 06 F11B1, 06 F11B2

50° 21.7218 N 004° 07.6750 W

06 F11B2 thought to be the Cattewater Wreck

Distinct target 2m wide, horizontal, buried 600mm

Associated with 06 F11B1 5m to the West of 06 F11B2, buried 1m

Survey line reference: 07042006103944

Associated with the buried hull

Target Name: 06 F9

50° 21.7269 N 004° 07.6850 W

Small surface feature associated with and 14m to the North-West of F11a

This may be the remains of the scaffold pole used during earlier excavation work

Survey line reference: 04042006102444

Associated with the buried hull

Target Name: 06 10B

50° 21.7229 N 004° 07.6754 W
Small seabed target
Survey line reference: 07042006103452
Associated with the buried hull

Target Name: 06 F5

50 21.6927 N 004° 07.6856 W
Small hard object in a hole in the seabed so most probably mooring ground tackle
Survey line reference: 04042006114747
Low priority

Target Name: 06 F8

50° 21.7252 N 004° 07.7376 W
2m wide target buried 400mm
Survey line reference: 04042006100644
High priority

Target Name: 06 F41a

50° 21.7048 N 004° 07.7937 W
3m wide flat target buried 800mm dipping down towards the West
Survey line reference: 04042006113628

Target Name: 06 F42a

50° 21.7026 N 004° 07.7817 W
3m wide round target buried 1m
Close to a mooring block shown on the profile at 50° 21.702 N 004 07.775 W
Survey line reference: 04042006113628

Target Name: 06 F71

50° 21.7490 N 004° 07.6959 W
Small target buried 500mm
Survey line reference: 04042006120635

Target Name: 06 F72a

50° 21.7485 N 004° 07.6646 W
14m long horizontal target buried 800mm
Survey line reference: 04042006120635
High priority

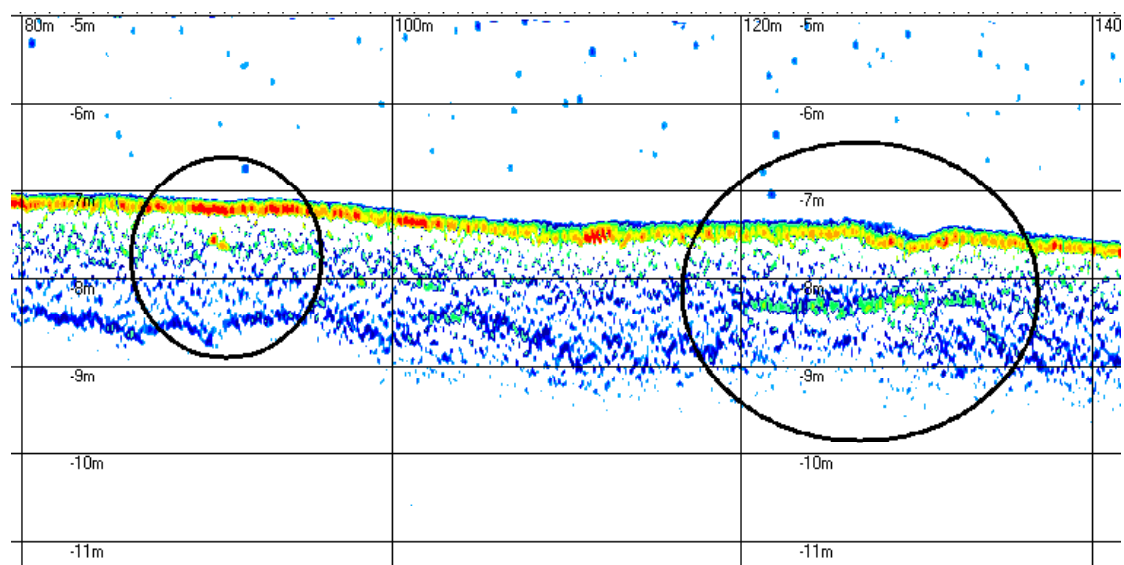


Figure 10: Target 06 F72a 100 kHz trace

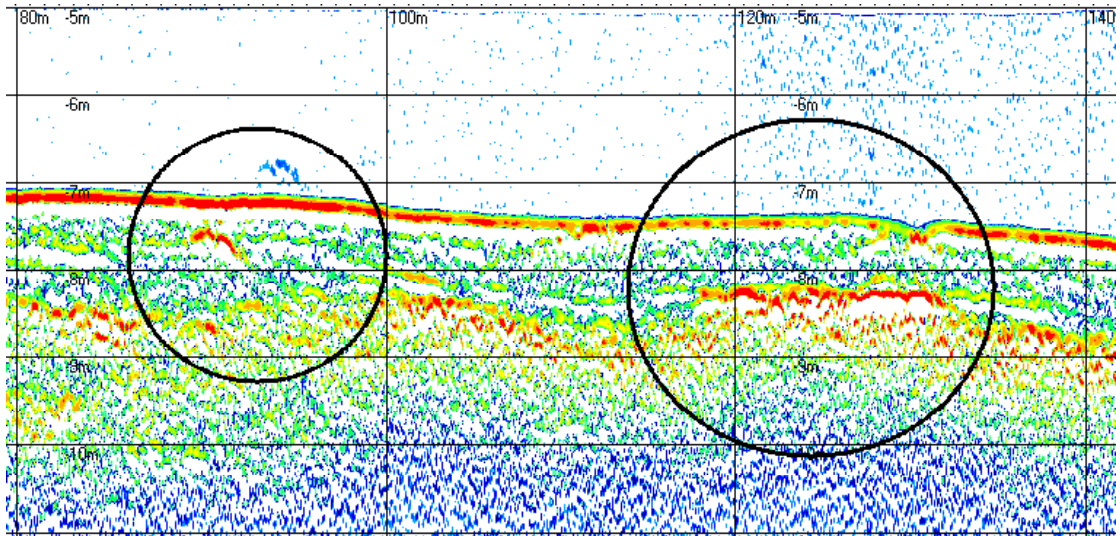


Figure 11: Target 06 F72a 12 kHz trace

Target Name: 06 19A

50° 21.7380 N 004° 07.7451 W
Small seabed target, shows on multibeam
Survey line reference: 04042006120635

Target Name: 06 4A

50° 21.7348 N 004° 07.6848 W
Small target 0.5m above seabed
Survey line reference: 04042006110427

2007 Survey (Swann)

Summary

Reference	EVT-0115
Organisation	University of Plymouth
Date	10-11 April 2007
Surveyor	Elizabeth Swann
Techniques	Magnetometer, sidescan sonar

A post-graduate student in the University of Plymouth, Elizabeth Swann, undertook geophysical survey work in 2007 as part of a thesis towards a Masters in Hydrography.

A two day geophysical survey of the Cattewater Wreck site was completed using the University of Plymouth survey vessel *Catfish* towing sidescan sonar and a caesium magnetometer. The work was done in conjunction with a course with the Masters in History and Archaeology at the University of Bristol.

Survey lines were run over the site using East-West runlines at 5m spacing however this proved difficult as the vessel had to negotiate the mooring buoys that surround the site. The towfish layback of 18.5m was corrected in post-processing.

Equipment

- Marine Magnetics SeaSpy Overhauser Magnetometer loaned by GSE Rentals of Aberdeen
- GeoAcoustics model 159D sidescan sonar towfish with a GeoAcoustics SS981 transceiver and a Coda 1000D workstation from the University of Plymouth
- C-Nav differential GPS provided by the University of Plymouth
- Fugro Starfix 7.1 navigation software

Processing

Coda software was used to process the data from the sidescan sonar survey and to produce a mosaic.

The magnetometer data was collected using Fugro StarFix 7.1. Unfortunately this program could not cope with the default data rate of 10 Hz so the rate was reduced to only 1 Hz resulting in a loss of data quality. Magnetometer processing for the Cattewater project archive was undertaken by Peter Holt (3H Consulting Ltd).

Products

- The primary product is the unpublished Masters dissertation '34 years of investigations into the Cattewater Wreck', Elizabeth Swann, 2007, University of Plymouth.
- Raw magnetometer and position data is available in electronic form as are GeoTIFF images of the processed magnetometer data.
- The sidescan mosaic is available as a GeoTIFF (3136 x 1699 5MB)

The raw data from this survey is copyright of the University of Plymouth



Figure 12: 2007 Sidescan sonar mosaic

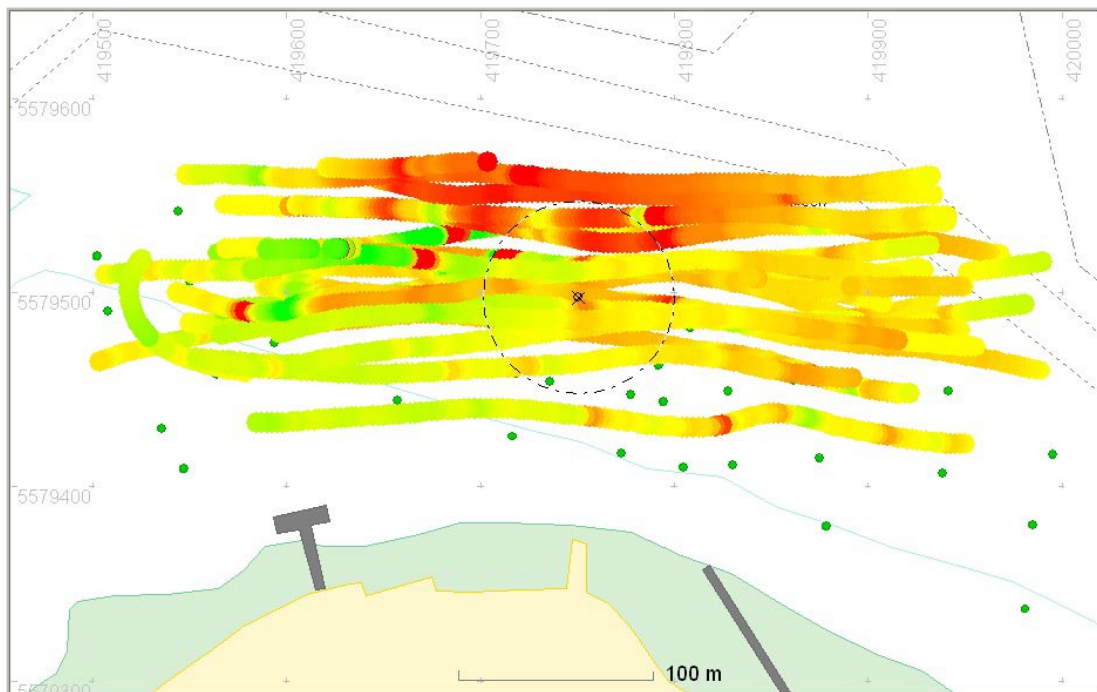


Figure 13: 2007 Magnetometer tracklines

Sidescan Sonar Targets

The sidescan sonar data was of poor quality and was not well processed.



Figure 14: 2007 Magnetometer and sidescan targets

The position accuracy of these points is approximately 5m.

Target Name: 07 SS 01

50° 21.738 N 004° 07.713 W

Small 2m x 1m hard target in a shallow scour pit close to SS Mooring 1

Probably modern debris as it lies on the surface

Target Name: 07 SS 02

50° 21.734 N 004° 07.726 W

Small target on surface close to SS Mooring 1

Possible a disused mooring

Target Name: 07 SS 03

50° 21.748 N 004° 07.688 W

Possible disused mooring

Target Name: 07 SS 04

50° 21.719 N 004° 07.674 W

Small target 1m long

Associated with the buried hull of the Cattewater wreck

Target Name: 07 SS 05

50° 21.709 N 004° 07.716 W

Scar on the seabed 7m x 3m, not visible on multibeam images

Target Name: 07 SS 06

50° 21.716 N 004° 07.675 W

4m long low object on the seabed, associated with 07 SS 04

Target Name: 07 SS Mooring 3

50° 21.717 N 004° 07.736 W

3m long target on the seabed, looks recently moved as not in a scour pit

Identified Sidescan Targets

Target Name: 07 SS Mooring 1

50° 21.742 N 004° 07.723 W

Mooring block

Target Name: 07 SS Mooring 2

50° 21.699 N 004° 07.703 W

Mooring block

Target Name: 07 SS Mooring 3

50° 21.717 N 004° 07.736 W

Mooring block

Magnetometer Targets

The position accuracy of these points is approximately 5m.

Target Name: 1400B

50° 21.741 N 004° 07.752 W

160nT monopole, 3.5 tonnes, shows as small target on the HiRes survey

Not a mooring, not in a scour pit

Survey line reference: 1400

To be investigated

Target Name: 1400A

50° 21.745 N 004° 07.704 W

40nT monopole, 860kg

Associated with magnetometer target HiRes 13 (5T)

Survey line reference: 1400

Target Name: 1314A

50° 21.723 N 004° 07.656 W

25nT monopole, 550kg

Not repeatable in HiRes survey

Survey line reference: 1314

Target Name: 1310A_1349A

50° 21.721 N 004° 07.695 W

30nT monopole, 650kg repeated on 2 lines

Not repeatable in HiRes survey

Survey line reference: 1310, 1349

Target Name: 1255A

50 21.733 N 004° 07.693 W

30nT monopole, 650 kg, repeatable on 2 lines

Not repeatable in HiRes survey

Survey line reference: 1255

Target Name: 1232B

50° 21.747 N 004° 07.666 W

40nT clean dipole, 800 kg

On the top of the area above the North edge of the dredged channel. Associated with magnetometer target HiRes 8 (0.5T)

Survey line reference: 1232

High priority

Target Name: 1228A

50° 21.722 N 004° 07.761 W

11nT monopole, 250kg, repeatable

North of mooring scour

Survey line reference: 1228

Target Name: 1218B

50° 21.758 N 004° 07.723 W

25nT dipole, 500kg

On Northern edge of dredged channel

Survey line reference: 1218

Identified Magnetometer Targets

Target Name: 1232A

50° 21.748 N 004° 07.778 W

40nT monopole, 2 tonnes

Mooring

Survey line reference: 1232

Target Name: 1255B

50° 21.735 N 004° 07.727 W

230nT dipole, 8.5 tonnes

Associated with 07 SS 02

Mooring

Survey line reference: 1255

Target Name: 1212A

50° 21.734 N 004° 07.767 W

70nT monopole, 1.5 tonnes

Mooring, in a shallow scour

Survey line reference: 1212

Target Name: 1300A

50° 21.691 N 004° 07.692 W

20nT, 1 tonne

Mooring

Survey line reference: 1300

2007 HiRes Magnetometer Survey (Holt)

Summary

Reference	EVT-0120
Organisation	3H Consulting Ltd
Date	12 May 2007
Surveyor	Peter Holt
Techniques	Magnetometer

As the previous magnetometer survey (2007 Swann EVT-0115) produced low quality data it was decided to re-run the exercise using a different method. The problem of negotiating the mooring buoys whilst towing was overcome by mounting the magnetometer on the bows of a small boat. The GPS antenna was co-located with the magnetometer to minimise position errors and avoid the problems of computing positions from layback. The low data rate limitation with the Fugro StarFix software was avoided by using the Site Searcher program instead to record the magnetometer data.

For this task a wooden vessel with a diesel engine was borrowed from Nigel Boston as the hull would not affect the magnetometer and diesel engines affect the magnetometer far less than petrol engines.



Figure 15: 2007 Rigging for the HiRes magnetometer survey

The survey was undertaken by Peter Holt, Elizabeth Swann and Kevin Camidge (CISMAS) on a windy day in May. Data was collected at a nominal 5m line spacing with East to West runs, infill was completed at the time so complete coverage of the planned area was achieved. The area to the south of the site could not be recorded as there were yachts on the moorings and data from the area to the North-West was affected by the presence of a large vessel on a mooring.

Equipment

- Geometrics G881 caesium magnetometer loaned by Martin Dean, University of St Andrews
- Trimble SPS GPS receiver loaned by the University of Plymouth
- Site Searcher data collection and processing software loaned by 3H Consulting Ltd
- Survey vessel loaned by Nigel Boston, Geosa Ltd

Processing

Processing was done using the Site Searcher software from 3H Consulting Ltd. by Peter Holt and Elizabeth Swann.

The sea swell added noise to the recorded magnetometer data and the presence of the ships on the moorings caused large variations in the background magnetic field. The effects of these problems were removed using low and high-pass filters available in the processing software.

Products

- Raw magnetometer and position data is available in electronic form as are GeoTIFF images of the processed magnetometer data.

The data from this survey is copyright 3H Consulting Ltd. (www.3HConsulting.com)

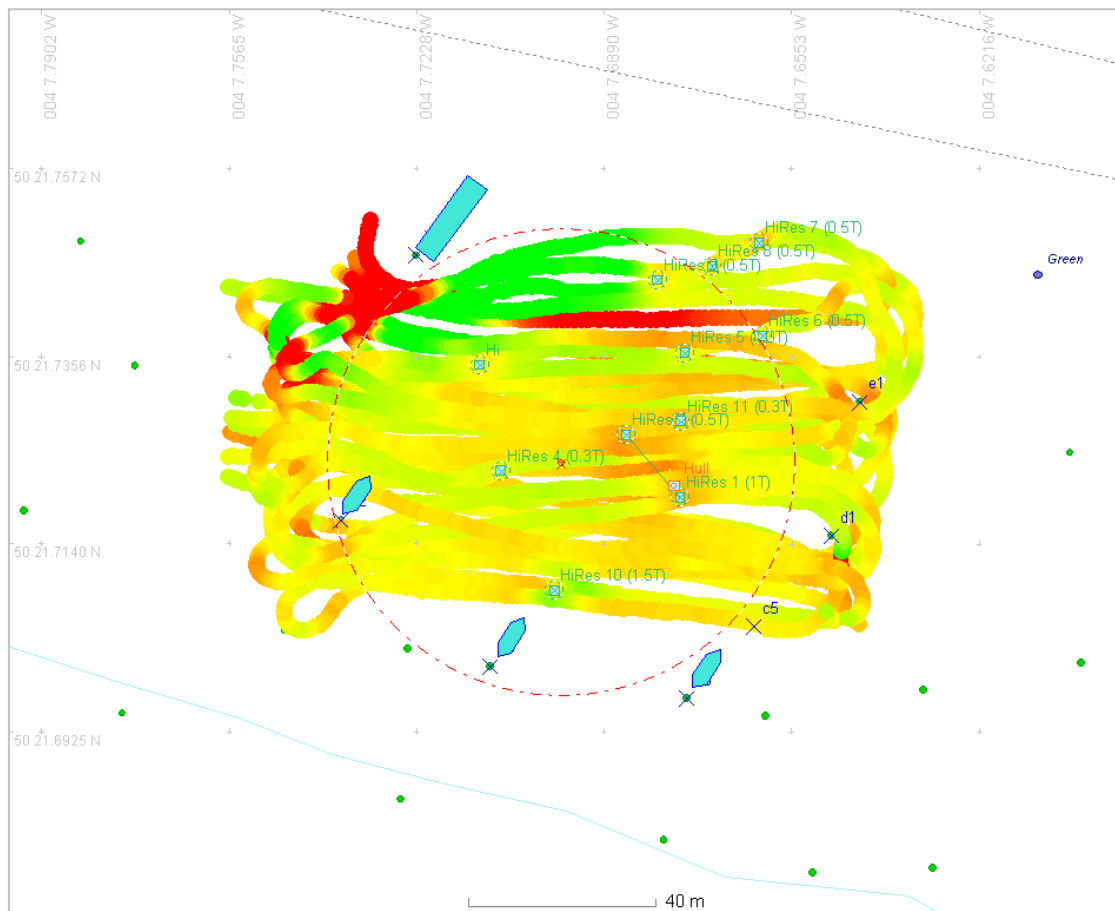


Figure 16: 2007 HiRes magnetometer tracklines

Targets

The position accuracy of these points is approximately 2m.

Target Name: 07 HiRes 1

50° 21.7205 N 004° 07.6739 W

20nT monopole, 430 kg

There is a 17m long line of magnetometer targets between this point and 07 HiRes 2

Associated with sidescan target 07 SS 04 and SBP target 06 F11a

Identified as being associated with the hull remains

Target Name: 07 HiRes 2

50° 21.7277 N 004° 07.6838 W

10nT monopole, 200kg

Associated with 07 HiRes 01 and SBP target 06 F9

Identified as being associated with the hull remains

Target Name: 07 HiRes 3

50° 21.7354 N 004° 07.7104 W

24nT monopole, 500 kg

Associated with sidescan target 07 SS 01

Target Name: 07 HiRes 4

50° 21.7233 N 004° 07.7063 W

5nT monopole, 100 kg

Target Name: 07 HiRes 5

50° 21.7372 N 004° 07.6735 W

5nT monopole, 100 kg

Target Name: 07 HiRes 6

50° 21.7393 N 004° 07.6596 W

10nT monopole, 200 kg

Target Name: 07 HiRes 7

50° 21.7500 N 004° 07.6605 W

10nT monopole, 200 kg

Target Name: 07 HiRes 8

50° 21.7471 N 004° 07.6688 W

10nT monopole, 200 kg

Associated with magnetometer target 1232B and SBP target 06 F72a

Target Name: 07 HiRes 9

50° 21.7455 N 004° 07.6786 W

10nT monopole, 200 kg

Unused mooring?

Associated with sidescan target 07 SS 03

Target Name: 07 HiRes 10

50° 21.7096 N 004° 07.6963 W

30nT monopole, 650 kg

Target Name: 07 HiRes 11

50° 21.7293 N 004° 07.6741 W

5nT monopole, 100 kg

Target Name: 07 HiRes 12

50° 21.7433 N 004° 07.7100 W

250nT monopole, 5.4 tonnes

Associated with magnetometer target 1400A

2007 MBES Survey (RN)

Summary

Reference	EVT-0125
Organisation	Royal Navy Flagship Training
Date	6 November 2007
Surveyor	Paul Lawrence, Richard Read
Techniques	Multibeam echo sounder

In 2007 the site was surveyed by a team from the Royal Navy Flagship Training at HMS Drake in Plymouth using a Simrad EM3002 multibeam. The resulting image has proved to be the highest quality achieved on this site to date.

Equipment

- Simrad EM3002 multibeam echo sounder
- C&C Technologies C-Nav GPS, accuracy 0.3m
- Applanix POS MV motion reference system
- Caris HIPS V6.1 processing software

Processing

The data was collected and processed by Paul Lawrence, Advanced Survey Course Manager, and Rick Read, Multibeam Manager, Flagship Training at HMS Drake.

The data is gridded at 0.5m using WGS 84 UTM Zone 30 N.

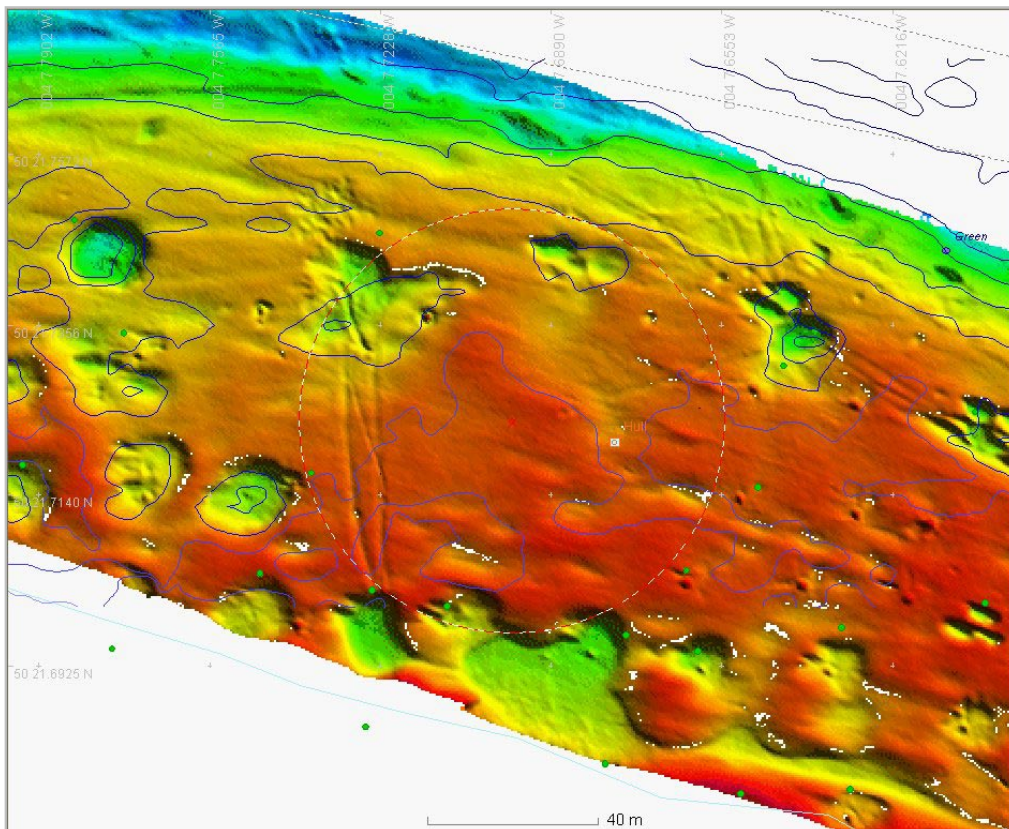


Figure 17: 2007 RN Multibeam bathymetry image

Products

- A GeoTIFF image of the seabed bathymetry (1076 x 888 222KB)

The data from this survey is Crown copyright.

The image in Fig 17 shows the topology of the seabed around the site overlaid with depth contours at 0.5m intervals. The colours exaggerate the differences in depth making the terrain look more dramatic than it is, in fact the large green scour pits shown surrounding the designated area are usually less than 1m deep.

The two parallel lines on the left side of the designated area from 50° 21.734 N 004° 07.726 W to 50° 21.703 N 004° 07.723 W appear to be caused by dragging a mooring from one location to the other.

Seabed Targets

The position accuracy of these points is approximately 1m.

Target Name: Surface 1

50° 21.7380 N 004° 07.7454 W

Possible mooring block

Associated with SBP target 06 19A

Target Name: Surface 2

50° 21.7374 N 004° 07.7124 W

Unidentified

Associated with sidescan target 07 SS 01 and magnetometer target 07 HiRes 3

Identified Seabed Targets

Mooring blocks

Mooring 1	50° 21.729 N	004° 07.648 W
Mooring 2	50° 21.727 N	004° 07.627 W
Mooring 3	50° 21.715 N	004° 07.650 W
Mooring 4	50° 21.713 N	004° 07.627 W
Mooring 5	50° 21.712 N	004° 07.612 W
Mooring 6	50° 21.704 N	004° 07.660 W
Mooring 7	50° 21.704 N	004° 07.637 W
Mooring 8	50° 21.703 N	004° 07.617 W
Mooring 9	50° 21.693 N	004° 07.632 W
Mooring 10	50° 21.693 N	004° 07.658 W
Mooring 11	50° 21.695 N	004° 07.679 W
Mooring 12	50° 21.686 N	004° 07.605 W
Mooring 13	50° 21.700 N	004° 07.705 W
Mooring 14	50° 21.738 N	004° 07.745 W
Mooring 15	50° 21.737 N	004° 07.712 W

Discussion

Data Processing

All of the datasets described above were integrated using the Site Recorder 4 information management program from 3H Consulting Ltd. This software can be used as a tool to aid the recording and preservation of cultural heritage sites by collecting together and presenting site information in an integrated and meaningful way

Raw magnetometer measurements were distilled down to a set of targets each with an estimate of position and position accuracy. Multibeam bathymetry data can be represented as a set of isobath contour lines and as a composite image where colour is used to indicate depth. Sub-bottom profiler targets are represented as a target point and in some cases the width of the target is shown as an associated line. Sidescan sonar mosaics, scanned charts and aerial photographs were added to the GIS as basemap images. The positions of the point targets are represented as circular confidence regions where the radius of the region is proportional to the position error estimate.

The combination of the data sets showed a complex mix of correlations between them leading to a mix of target groups along with single, uncorrelated or unrepeatable targets. Where target confidence regions overlap or are very close we can consider these targets to be detections of the same object on the seabed allowing for position errors.

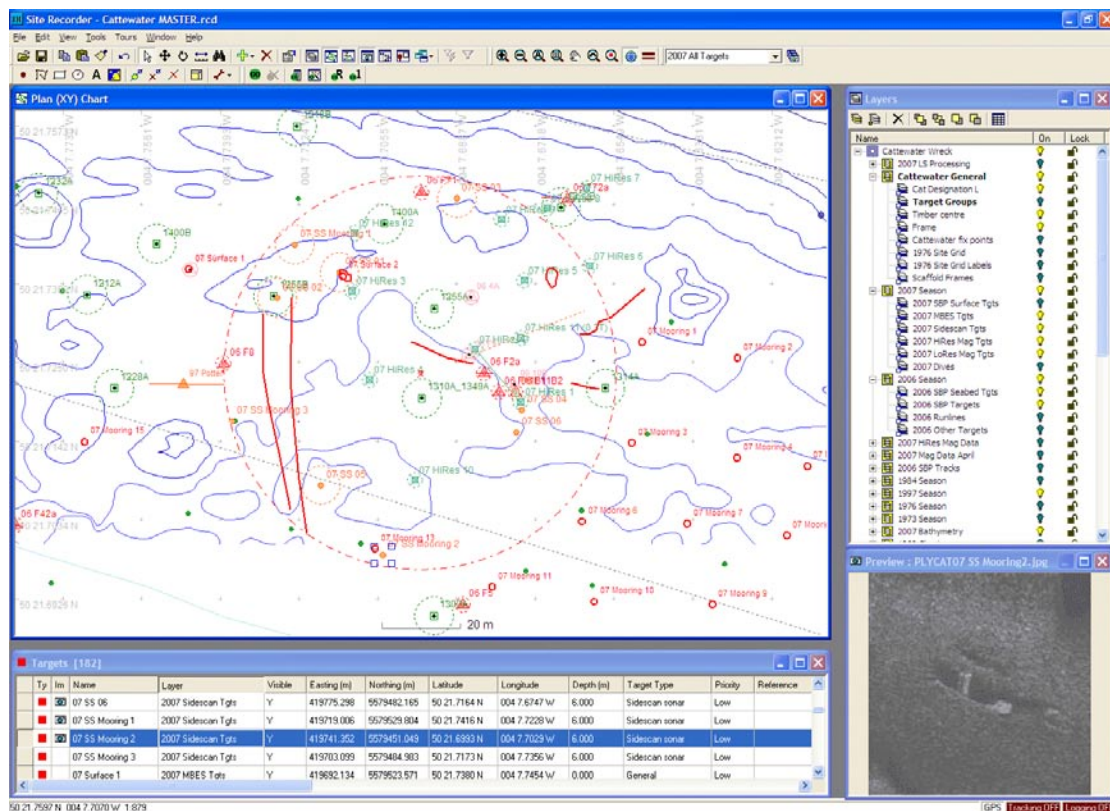


Figure 18: Site Recorder showing Cattewater targets

Target Groups

Three main target groups have been identified.

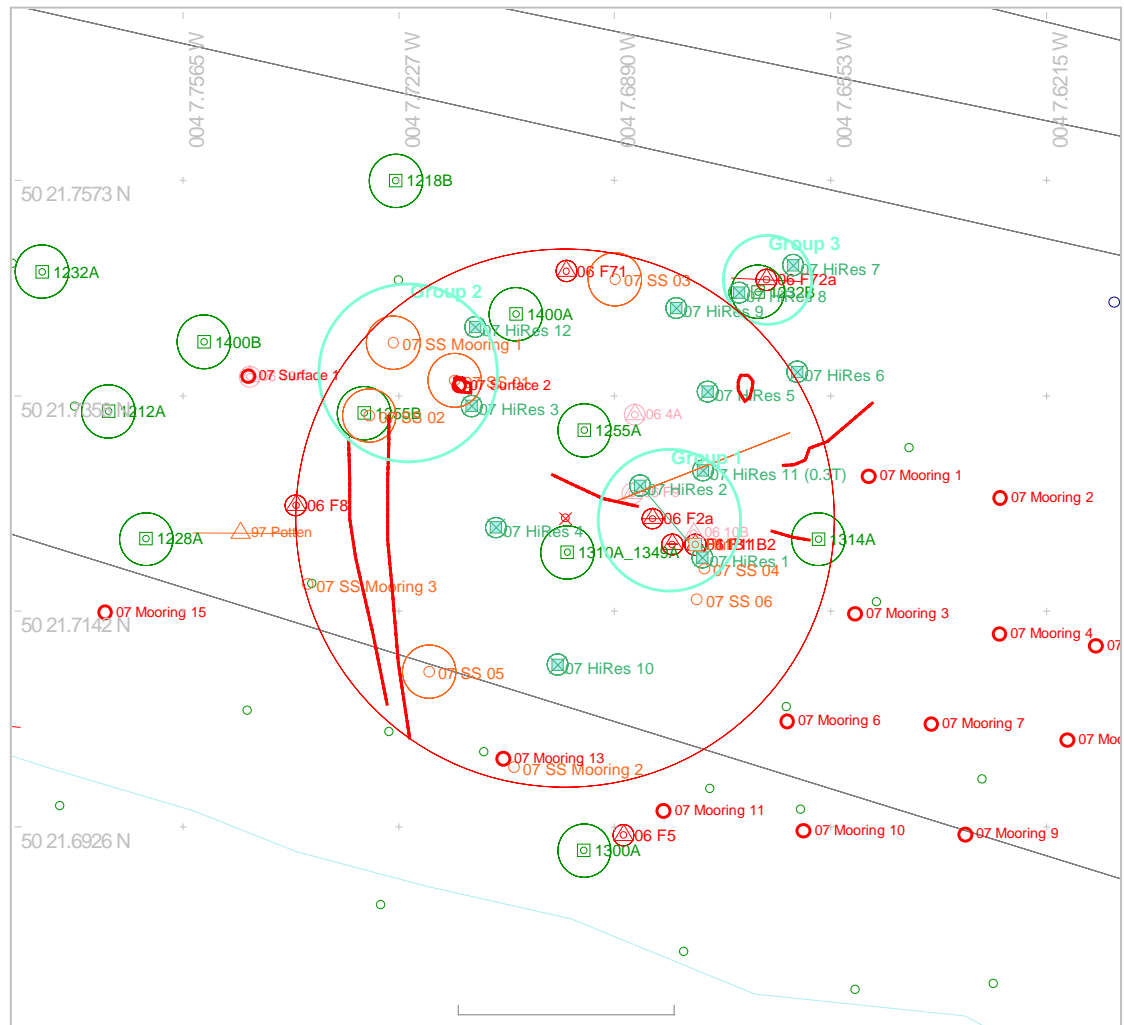


Figure 19: Target groups

The primary target Group 1 is centred on co-ordinates 50° 21.724 N 004° 07.679 W and is thought to be the actual position of the hull of the Cattewater wreck. This group is represented by four SBP targets, three magnetometer targets and a sidescan target. Both the multibeam and SBP suggest that the site is completely buried and lying in a very shallow depression.

Group 2 lies to the north-west of the designation, centred on the scour pit from an old mooring at coordinates 50° 21.739 N 004° 07.720 W. Associated with this group are three sidescan targets and two magnetometer targets. These are assumed to be the remains of an old mooring but need to be identified by divers.

To the North-East of the designated area is Group 3 which comprises three magnetometer targets and a large SBP target (F72a), at co-ordinates 50° 21.749 N 004° 07.665 W. This target lies on the North bank at the edge of the dredged channel. This is the most promising of targets as it is previously unknown and completely buried so most likely to be undisturbed.

Cattewater Wreck Position

The original position for the Cattewater wreck was obtained by sextant fix in 1973 when the wreck was first found. This position was given on the OSGB datum and was subsequently used as the centre point for the designated area. The original position was converted to the WGS84 datum before incorporating in the dataset and was originally assumed to be the correct position for the site. The orientation of the wreck was taken from Redknapp²¹ but this conflicted with the orientation given by Dean²².

The remaining buried hull timbers have now been re-positioned and aligned to the group of geophysical targets. Based on the geophysical survey work to date the co-ordinates for the centre of the hull timbers should now be:

50° 21.724 N 004° 07.677 W

The estimate of position accuracy is 5m or better, this can be improved if the remains of any scaffolding used during the excavations are found by subsequent diver search. The new estimate of hull orientation is an angle of 320° True and this more closely agrees with the original hull orientation calculated by Dean.

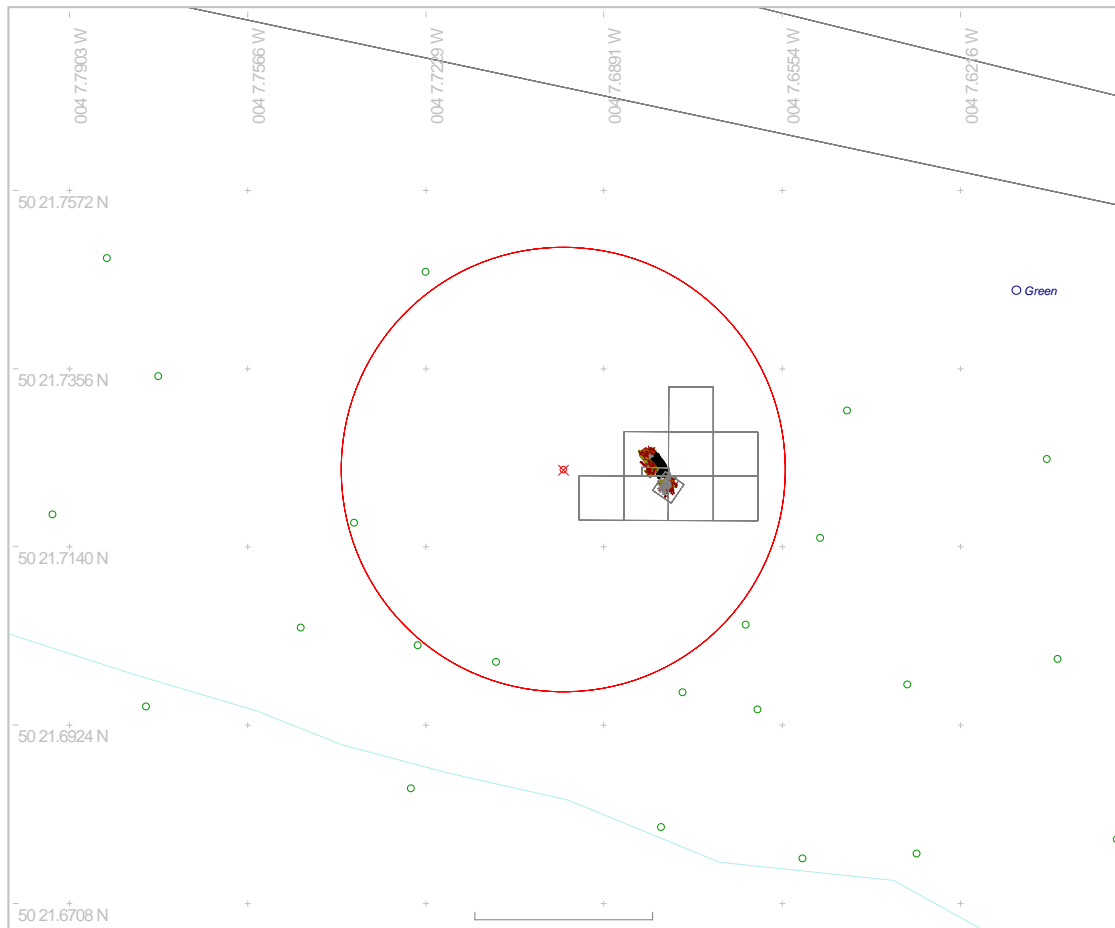


Figure 20: New estimated location for the hull

²¹ The Cattewater Wreck: The investigation of an armed vessel of the early sixteenth century

²² Pers. Comm. 2007

Cattewater Wreck Site

The location of the site on a sheltered bank, in shallow water, close to habitation and transport suggests that the ship would have been heavily salvaged at the time of loss. The ship would have also been a significant obstruction to other vessels so it is likely that the upper works would have been removed.

No anchors were found during the excavation and no geophysical targets have been detected so far that are of sufficient size to be an anchor from this vessel. Lost anchors would have been a hazard in this shallow harbour as it was not uncommon for a vessel to be holed on her own or another's anchor in shallow water. Again it is likely that lost anchors were routinely removed to avoid any hazard but also because they were work recovering.

If this is the case it is surprising that two guns were found on the site when it was first relocated in 1973, as the guns would have been worth salvaging. Being comparatively small the guns would have been easy to recover so quite why they were left behind is a mystery.

Seabed Sediment

Redknap suggests a siltation rate of 300mm per year over the Cattewater site. This appears to have reduced considerably in recent years as the site is now only buried by approximately 1m of sediment. The sediment that now exists on the site is firm, compacted clay and does not retain any of the darker, more mobile sediment reported as being found up-river in Turnchapel or on the now reclaimed Cockle Bank. Further work is needed to be able to determine if the seabed level is changing.

Target Detection

Magnetometer

One of the more interesting aspects to this project is that it has highlighted the difficulty of reliably detecting small targets on marine archaeological sites.

This site has the great advantages that at least one of the significant targets is well documented, the area it covers is small, it lies in shallow and sheltered water as well as being ideally placed for easy access. Conversely, the site is also complicated by the presence of large and very magnetic boat mooring chains and buoys.

The magnetometer targets detected during the first survey were not always detected during the second, high resolution survey, and vice versa. It could be expected that the higher resolution survey would have detected all of the targets on the first, coarser survey plus a few more but this was not the case. For example, 1310A_1349A is a clearly defined 30nT target detected on a number of passes in the first survey that was not detected at all in the second. The only explanation that comes to mind is the differences in the magnetometer sensor technology used for each survey, for the first survey an Overhauser magnetometer was used and for the second a caesium magnetometer was used. The two sensor types may be able to detect targets of different size and shapes differently so some experiments will need to be done to determine if this is in fact the cause.

Sub-Bottom Profiler

The detection of the Cattewater wreck hull by the Innomar sub-bottom profiler was not consistent and requires further investigation. The location where target 06 F11B2 was detected in run 11B (04042006103944) was also covered by runs 13B (07042006104740), 7A (04042006111532) and 3B (07042006100145).

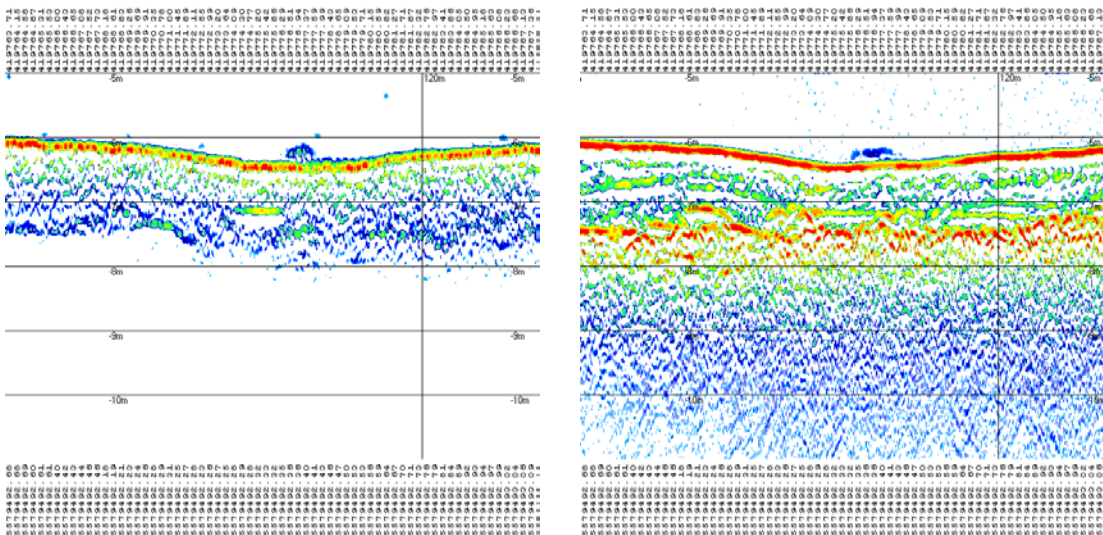


Figure 21: Run 11B 100kHz (L) 12kHz (R)

The target thought to be the hull is shown in the left hand image in figure 22 above, it is the small horizontal line with the white 'shadow' underneath it.

Other traces that repeat the same sail line are shown below and the target should be visible at the bottom of the slight dip in the seabed.

A similar target was detected on run 13B and Run 3B shows a small reflector.

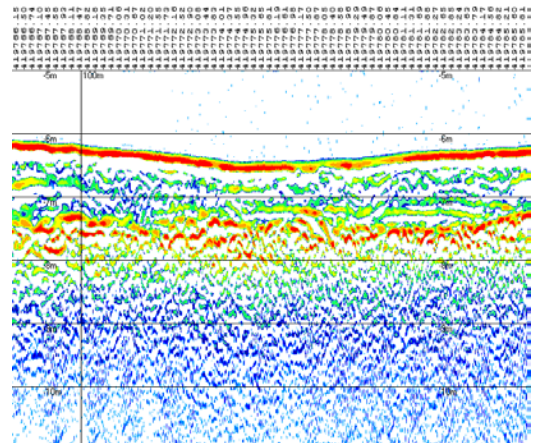
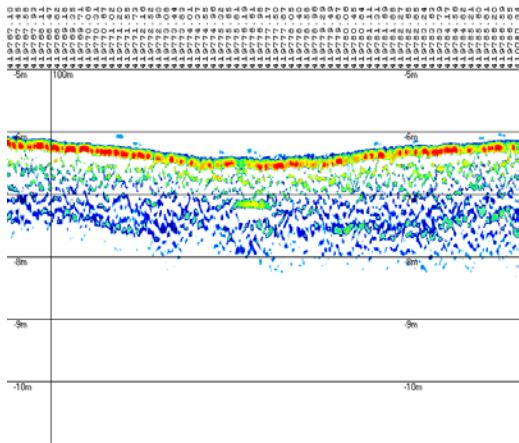


Figure 22: Run 13B 100kHz (L) 12kHz (R)

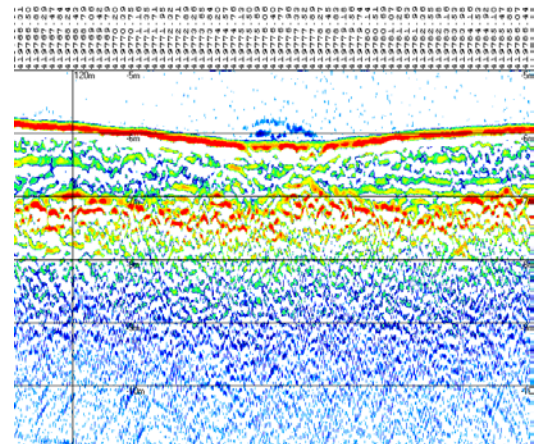
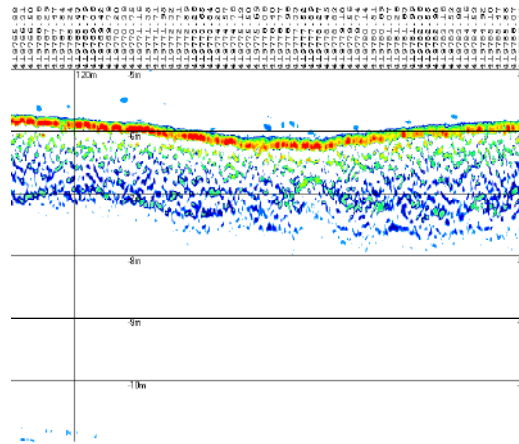


Figure 23: Run 3B 100kHz (L) 12kHz (R)

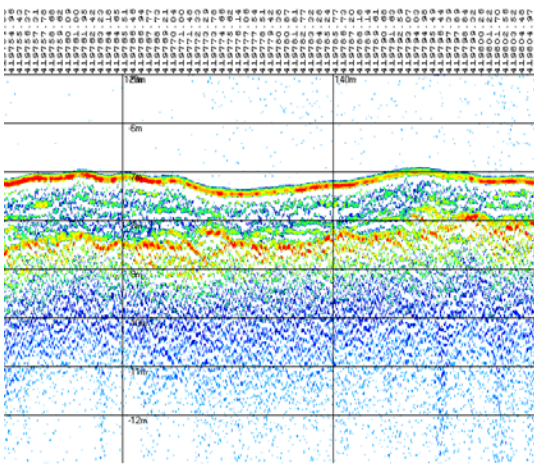
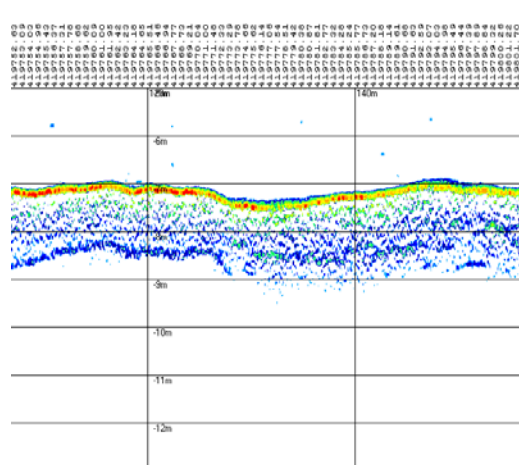


Figure 24: Run 7A 100kHz (L) 12kHz (R)

Run 7A does not show any target but this appears to have been run at a higher vessel speed so perhaps this is a contributing factor.

The first significant point to note is that the hull is detected on the high frequency (100 kHz) trace used for seabed depth measurement but is lost in the noise on the low frequency (12 kHz) trace used for sub-bottom profiling. The hull should present a target 11m long by 4m wide yet it is only shown in 2 of the 15 runs that should have imaged the hull.

Conclusions

General

The results from the geophysical survey work undertaken on the site of the Cattewater wreck between 1997 and 2007 form an unusual and perhaps unique body of work. There are few maritime archaeological sites that have been investigated by such a range of instruments as magnetometer, sidescan sonar, multibeam echo sounder and sub-bottom profiler while fewer still can claim to have been investigated by these instruments more than once.

By collating and integrating the results from the surveys we have a better understanding of the site itself and the seabed in which it lies. Previously undiscovered targets buried within the seabed may be the remains of similar vessels or parts of this same ship. There is still much to learn so only further investigation will help answer that question.

We can use the data from the surveys to help establish how the latest versions of geophysical instruments can be used for shipwreck prospection and mapping. More importantly, we have seen within the unexpected differences between the survey data sets the limitations of these instruments and how their datasets are processed. The requirements of maritime archaeology push the capability of these systems to their limits as the highest accuracy and highest target detection are demanded. The differences in the targets detected using similar equipment show that not all survey work is the same and that different methods give different results, an important factor that needs to be considered when managing this cultural resource.

We can also add the benefit that much of what lies on the site has been excavated and recorded in great detail. This site would make an ideal test location for anyone interested in the assessment or development of geophysical survey instruments and methods for use in maritime archaeology.

The process of integration of the diverse data sets into a single computer program has helped in the understanding of what will be required on other, similar projects in the future. The Site Recorder program was adapted and improved during this project so that it could be used to collate and render the data in a useful way.

Further Work

It is recommended that further work be undertaken on the site in relation to the previous geophysical surveys:

- The targets identified during the many geophysical surveys completed on this site need to be identified by divers to determine their significance. This task should be straightforward as the diving conditions and underwater visibility are often good and the water depth is shallow.
- Previous reports by divers suggest that remains of the scaffold frame used during the excavations still exist on site. These reports need to be confirmed by divers and if scaffolding is found it should be accurately positioned and used to update the current site plan.
- In addition, the area thought to be the site of the Cattewater wreck (Group 1) should be mapped in detail using metal detectors to confirm the presence of any buried steel scaffold tubing.
- The differences between the results from the two magnetometer surveys suggest that some research is required into the performance and behaviour of both caesium and Overhauser magnetometers.
- Further investigation with sub-bottom profilers is required using modern chirp profilers and high frequency parametric systems. This site is ideal for establishing the effectiveness of sub-bottom profiler systems for use in detecting buried hull structure.

The timber structure has been recorded in detail before reburial so offers an almost unique test target for these kinds of systems.

- Once a suitable sub-bottom profiler has been identified a comprehensive survey of the seabed should be completed between Mount Batten and the Cattewater shipping channel. This can be used to confirm the presence of the buried structures detected to date, to relocate the 97 Potten target and to detect any more structure or material buried beneath the seabed.
- A deep sub-bottom profiler survey of the area around the site is needed to establish the depth of sediment that lies in the paleochannel of the River Plym, sufficiently to be able to create a model of the original Plym channel before it filled with sediment. This model can then be used to help predict where and at what depth below the seabed shipwreck material may lie.
- Changes in the depth of sediment over the Cattewater wreck should be monitored to see if the seabed is scouring sufficiently to affect the stability of the site.
- The site can be promoted as a testing resource for anyone interested in the assessment or development of geophysical survey instruments and methods for use in maritime archaeology.
- The entire data set for the Cattewater wreck geophysical surveys needs to be published in electronic form on the Internet. The data will be available through the 3H Consulting web site www.3HConsulting.com

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