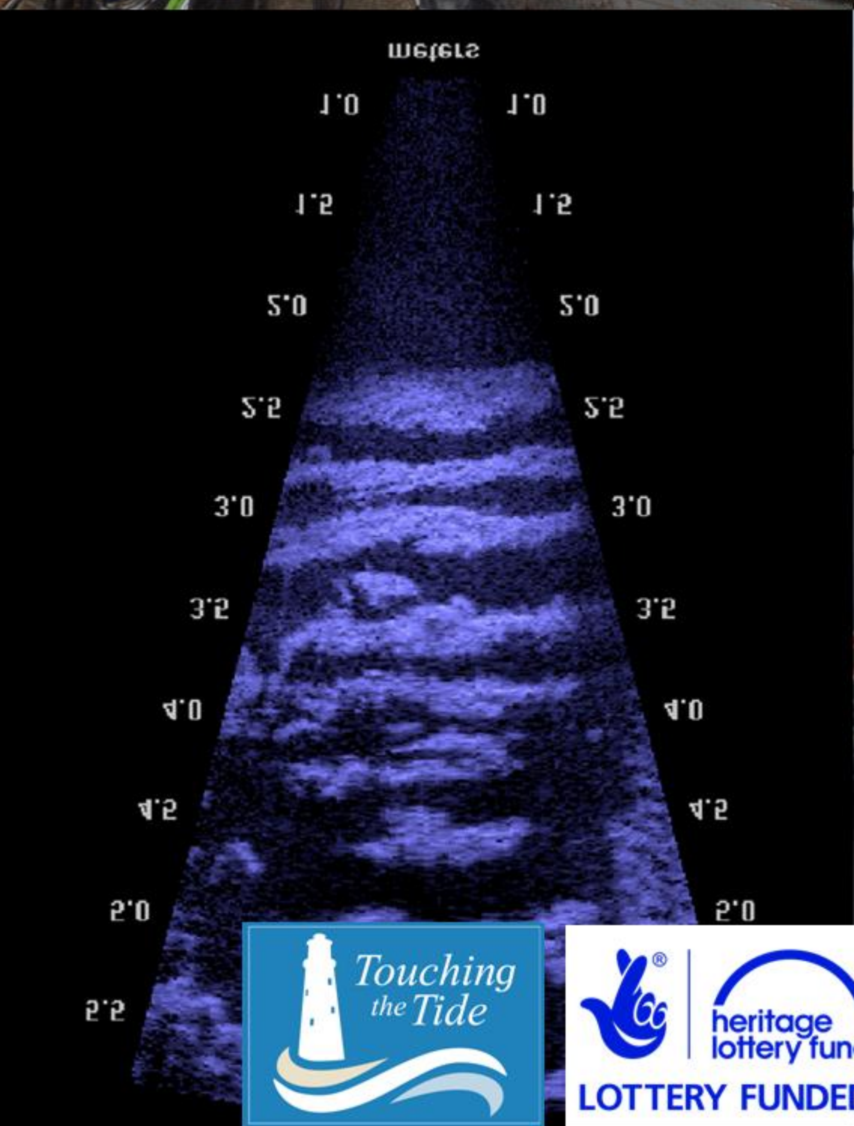
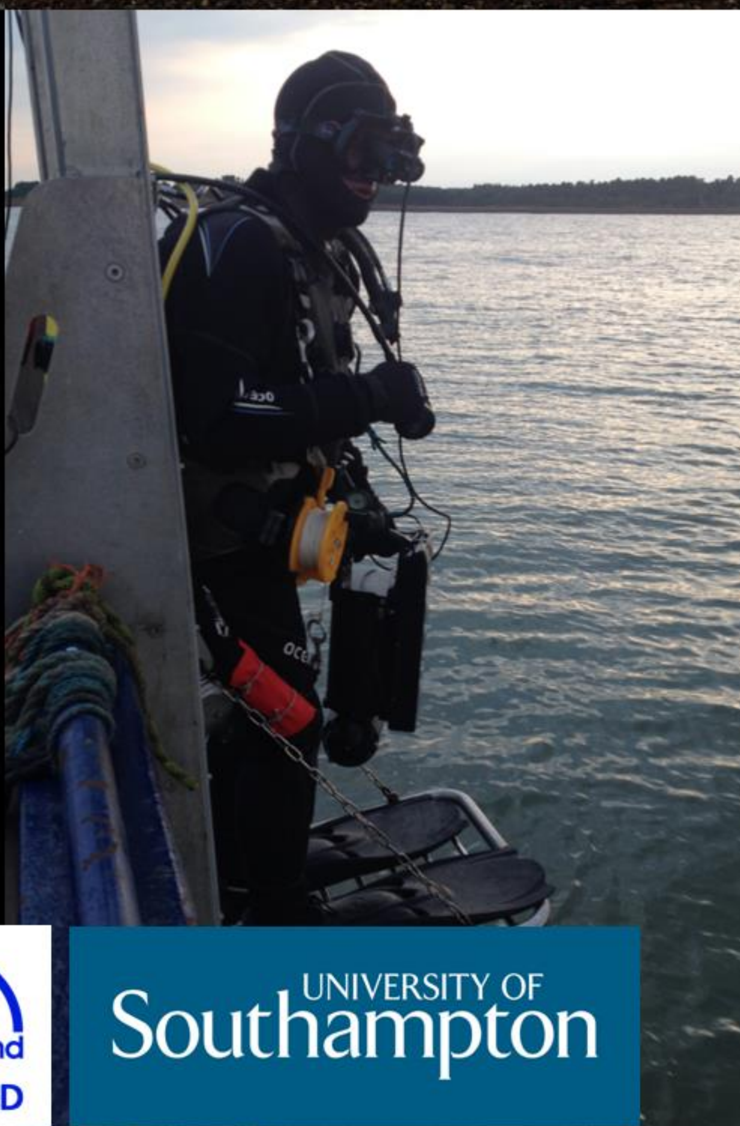
Touching The Tide Project Report

Dunwich Marine Archaeology Survey

David Sear





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UNIVERSITY OF Southampton

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Dunwich Marine Archaeology Survey

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1.0 Introduction

The fate of the medieval town of Dunwich is well documented (Gardner, 1754; Parker, 1975; Comfort, 1994; Sear et al., 2011; Sear et al., 2012). The precise size of the original town is unknown, but was sufficiently important to have once perhaps have been the seat of the first Bishop of East Anglia, and to have received Royal Charters for a market and a mint (Gardner 1754; Bacon and Bacon 1979, Chant, 1986). In 1086 Dunwich was one of the ten largest towns in England (Comfort, 1994). The wealth of Dunwich was primarily based on sea trade, fishing and ship building; with substantial investment by different religious orders and at times the Crown. Until the middle of the 14th Century, Dunwich was a nationally important seaport. By 1225 it was approximately 1.6km (1 mile) from north to south, with an area similar to the City of London at that date (Gardner 1754). The town of Dunwich contained up to 18 ecclesiastical buildings, a mint, a large guildhall and several large important houses (Comfort, 1994, Bacon 1979; Chant 1986). By 1242 Dunwich was the largest port in Suffolk. The population of Dunwich has been estimated at over 5000 at its height, with at least 800 taxable houses, and an area of c.800 acres (Comfort, 1994; Bailey 2007).

The town declined rapidly in the later 13th Century due to blocking of the harbour by the extension of a sandy gravel spit during large storms in 1287, and 1328. Sear et al., (2008) suggest that this coincided with a phase of climate change during transition from the Medieval Warm period into the Little Ice Age. Storminess increased in both frequency and magnitude during this period and continued with phases in the later 17th Century and early 18th century, and again at the end of the 19th and start of the 20th centuries (Sear et al., 2008). The result of this storm activity was a collapse in shipping trade and income from the town market, plus the physical loss of the town and its valuable infrastructure including churches, Friaries and domestic homes. Dunwich as a viable town ended in the late 17th century, with the loss of the market place and town hall (Sear et al., 2011).

Whilst much is now known about the extent and identity of the ruins on the seabed at Dunwich (Bacon 1979; 1982, Sear et al 2011; 2012), there remain areas of the site that are still poorly surveyed or whose identity remains uncertain. Thus this project represents an opportunity to fill in some important gaps in our understanding of Dunwich, through deployment of high resolution acoustic imaging sonar to try to identify specific targets on the sea bed.

1.1 Marine Archaeological Context

Large areas of coastal waters are subject to high levels of turbidity that substantially limit visibility. This is particularly the case within the lower 1-2 metres of the seabed where fine sediments (fine sands to clays) are held in suspension by tidal or wave driven currents. Such conditions are typically found in shallow coastal environments where the seabed is dominated by fine sands and silts; on eroding soft-cliff coastlines or where there is a substantial input of silts and clays from estuaries on the ebb tide. These environments are also characterised by high frequencies of wreck and non-wreck marine archaeology. Poor visibility reduces the operational capability of divers, hampering marine archaeological survey, particularly where the sites are dispersed over the seabed, or where the remains are fragmentary. Such conditions often exist in harbours and estuaries or close inshore. Such areas are often subject to development and as such require effective techniques for assessing heritage and archaeology as part of development control and planning.

Although considerable advances in side-scan sonar and multibeam echo-sounders have enabled detection and visualization of wrecks and sea-floor sediments these are still limited by resolution. Diver survey is still required to identify targets where the remains are not discrete wrecks. Recent surveys of the coastline of the UK, have highlighted the extent of non-wreck marine archaeology associated with buildings and settlements, that to date are unprotected by law, and largely unexplored (Murphy et al., 2009). A case in point is the large medieval town of Dunwich, located on the east coast of the United Kingdom. The location of this site has been well known for centuries, but the extent of the remains has remained largely unknown as a result of the poor visibility at the site. Diver surveys over the site have been undertaken (Bacon & Bacon 1979) but are frustrated by poor visibility; however they have mapped some of the ruins and confirmed the presence of some structures on the seafloor (Bacon 1979; 1982). The recent Dunwich 2008 project (www.dunwich.org.uk) and subsequent surveys in 2009 and 2012, have confirmed the locations of multiple ruins on the seabed (Sear et al., 2011). However, Sidescan sonar and Multibeam resolution is limited and whilst useful for mapping the extent of structures, they lack the detail needed to resolve individually carved or worked stones from rubble or naturally occurring geological formations. Recent diver surveys have been aided by accurate GPS positioning that enables repeat dives onto each site, but visibility is so poor that archaeological survey remains challenging. A new technology capable of high resolution imaging in turbid environments is needed for this site and the many others like it around North Sea coasts.

2.0 Project Aims

The main aim of the Marine Archaeology survey was to attempt to confirm the identity of 3 specific targets shown on the previous Sidescan and Multibeam sonar surveys of Dunwich made in 2009 and 2012. The specific aims were to use Diver held DIDSON Acoustic Imaging Sonar to:

1. Confirm the identity of potential wreck or harbour structure to the north of the town site.
2. Confirm the identity of a potential harbour structure to the north of the town site
3. Confirm the identity of a set of ruins southeast of St Peters Church that may be the remains of Dunwich town hall.
4. Conduct a survey over the site of All Saints Church

3.0 Methods

Marine survey was undertaken Monday 23rd June – Wednesday 25th June 2014 following postponement due to poor sea conditions during the previously scheduled time in August/September 2013. The survey vessel *DeHinder*, and diver team were provided by North Sea Recovery, and deployed from the port of Lowestoft. *DeHinder* was fitted out for overnight accommodation which removed the need to return to port each evening.

We used existing Sidescan Sonar and Multibeam echosounder data collected in 2009 and 2012 to identify a series of targets for which we were uncertain of their origin (natural geology, erroneous reflection or man-made structure). We then extracted their positions from the GIS, and uploaded them into the GPS of the survey vessel. We selected a series of Survey types and target priorities based on the degree of certainty of our interpretation of a target as a man-made structure (See Sear et al 2012 pg 56). The highest priority was given to sites that we were most certain that they were ruins from the medieval town, to sites that were in areas not shown on the Agas 1587 map. Figure 1 and Table 1 show the targets identified for survey, and the prioritization.

Survey Type refers to the specific deployment of the acoustic imaging camera by the diver and are:

A) Coordinate Check for accuracy. Drop Shot Line on coordinate, Send down diver & DIDSON to confirm on ruins.
B) Drop Shot Line on Coordinates. Diver & DIDSON go down and complete 360 scan at 20m, 11m Resolution to confirm presence of structures.
C) Free Dive and High Resolution Imaging of individual blocks/carved stone (1-10m resolution to ID position of blocks, then 1-3m Hi Res of individual blocks/carved stone.
D) Free Diver Drift with DIDSOn in "ROV" survey mode at 1-10m resolution over a site holding DIDSON.

Once over the Dunwich town site, we deployed a Tritech Starfish 990f XD Sidescan Sonar from the survey vessel *DeHinder* and sailed over the intended target in two directions. If the target was identified we marked its position with a shot line – a weighted line with marker buoy. We returned to the buoy and deployed the diver with DIDSON Acoustic imaging camera.

3.1 The DIDSON-DH diver held imaging sonar system

When working underwater, it is invaluable to get some form of visual feedback through cameras, for both navigation and basic inspection operations. As conventional optical systems generate blank screens in highly turbid conditions; the industry has had to resort to alternative methods of imaging. One solution is by using sonar.

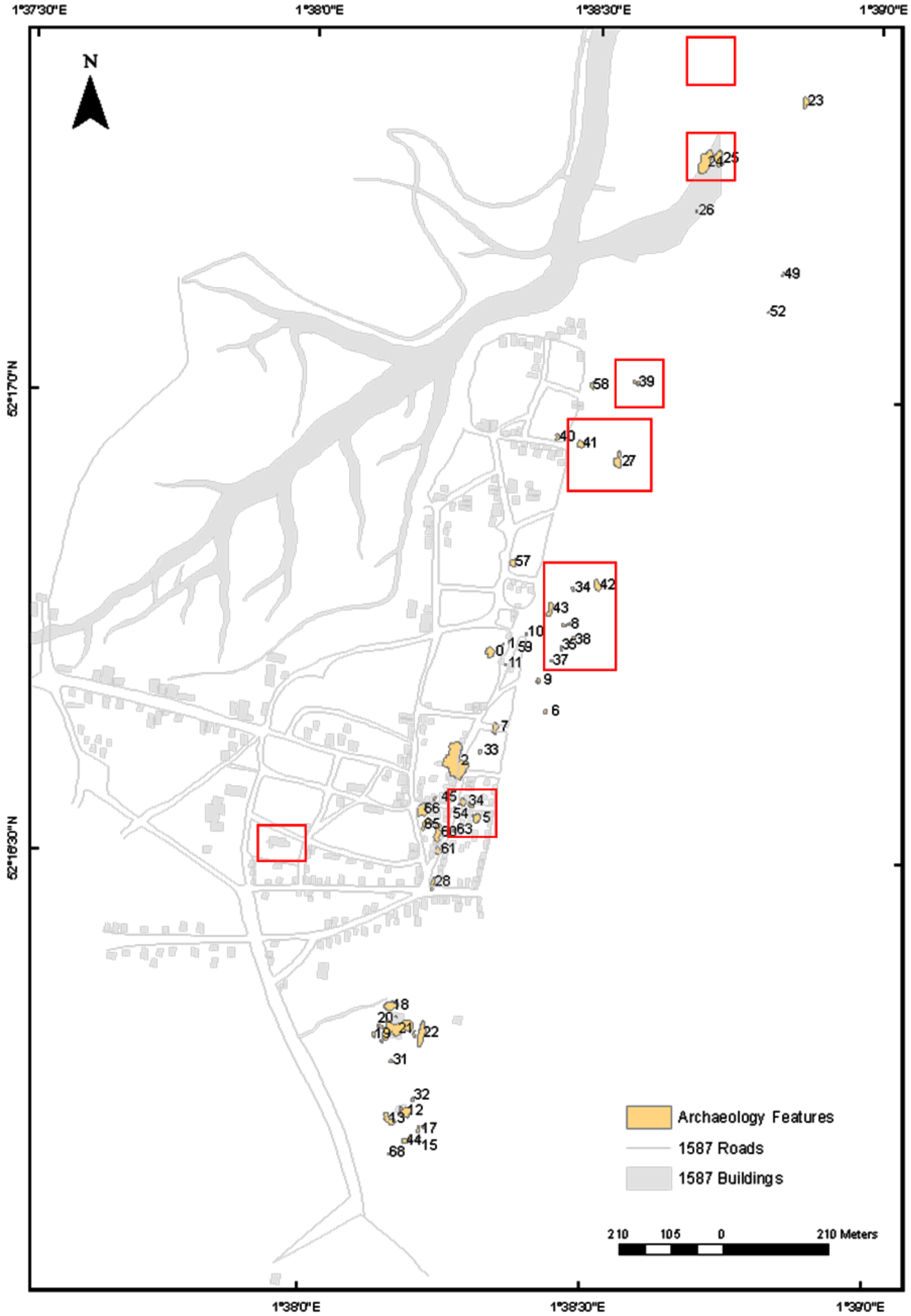

Figure 1: Archaeological targets identified for survey under the Touching the Tide project. In the event most of the sites south of the harbour area in the north of the site were inaccessible due to burial by sand.

SITE	PRIORITY	Order of Dive	Map Feature Id	Long	Lat	Survey Type	Notes
St Katherine's Chapel	**1**	**1**	0	1.638679	52.278716	A	Coordinate Check
Tollhouse/Town Hall	**2**	**2**	3	1.637955	52.275980	B, C, D	New Ruins Tollhouse
Tollhouse/Town Hall	**2**	**2**	4	1.638189	52.275934	B, C, D	New Ruins Toll house
Tollhouse/Town Hall	**2**	**2**	53	1.637843	52.275954	B, C, D	New Ruins Tollhouse
Tollhouse/Town Hall	**2**	**2**	54	1.637747	52.275884	B, C, D	New Ruins Tollhouse
Tollhouse/Town Hall	**2**	**2**	55	1.637770	52.276033	B, C, D	New Ruins Tollhouse
Unknown	**9**	**3**	28	1.637140	52.274510	B, C, D	Linear area of scour with large blocks in vicinity of Kings Street/Duck lane junction where Agas shows several large buildings.
Unknown	**8**	**4**	66	1.636787	52.275838	B, C, D	Debris field unknown
St John's	**7**	**5**	6	1.640352	52.277647	B, C	St Johns - Discrete raised block but might be part of geology. Lies in pre-Agas (1587) area of town.
St John's	**7**	**5**	9	1.640125	52.278206	B, C	St Johns Scour hole with blocks in it similar to other building sites but less extensive. Lies in pre-Agas (1587) area of town.
St John's	**7**	**5**	82	1.640441	52.277258	B, C	St Johns Depressions in seabed in 2008 MBES
Blackfriars (New)	**10**	**6**	18	1.635966	52.272277	B, C, D	Blackfriars Friary (New). Collection of smaller blocks (< 0.5m) and stones emerging from a sand rib. North west of main Blackfriars ruins. Part of Friary buildings?
Unknown	**3**	**7**	27	1.642367	52.282215	B, C, D	Area of linear straight and curved ridges, including circular 2m diameter structure (well?).
Wreck/Harbour structures	**5**	**8**	24	1.644796	52.287661	B	Wreck?peat
Wreck/Harbour structures	**6**	**9**	25	1.645192	52.287726	B	Wreck?peat
Unknown	**4**	**10**	49	1.647106	52.285641	B, C	Large partly buried block (2.2 x 0.8m) with evidence of scour around it. NE of Agas 1587 map.
Unknown	**11**	**11**	8	1.640910	52.279238	B	Depression with small blocks (0.6 x 0.4m) within it. Lies in pre-Agas (1587) area of town.
Unknown	**12**	**12**	9	1.640125	52.278206	B	Scour hole with blocks in it similar to other building sites but less extensive. Lies in pre-Agas (1587) area of town.
Unknown	**13**	**13**	10	1.639747	52.279066	B	Collection of c. 3 blocks (0.7 x 0.5m) with scour holes around them. Lies on eastern margin of Agas 1587 coast line.
All Saints	**14**	**14**		1.640534	52.278832	D	Site of All Saints Church, to be dived from beach as too shallow for boat survey.

Table 1: Targets Identified for survey together with their position (WGS 1984, UTM Zone 31°N) and Survey priority/order. Shaded sections are those that were dived using DIDSON-DH. Bold are sites that were checked using Sidescan Sonar, but were found not to be visible above the sand.

The demand for better imaging in turbid waters has fuelled the development of a new breed of sonar's which are able to provide near-video quality images with sound (sonar). In the same way that light waves can refract, sound waves have the same property. They can therefore be focused with an acoustic lens system in the same way that light is focused with optical lenses, principally by moving one of the lens elements. The result is an acoustic image with significant detail. In many ways, the acoustic camera (Dual frequency IDentification SONar - DIDSON) bridges the gap between conventional sonar's that can image a shipwreck at 300m and medical ultrasound which can image inside the womb at a range of 10cms.

Acoustic cameras operate using a combination of high frequencies, acoustic lenses and very narrow beams to increase the detail in images. The operating frequencies range up to 3MHz with the high frequency sound being more quickly absorbed in the water than low frequency sound. As a consequence, the range of these high-frequency acoustic cameras is limited to around 40m when operating at 1.1MHz and approximately 15m when operating at 1.8MHz.

The DIDSON systems can focus from as close as 1m, to its maximum range of 40m in this configuration. Its major limitation, however, is that it only has a 29 deg field of view, leading some users to call it an acoustic torch. This relatively narrow beam means that while the DIDSON is a good identification tool, it is not such a good search tool. Therefore, side scan sonar and multibeam are conventionally employed to locate the targets of interest. This leaves the DIDSON to follow up and make the positive identification. Because of the DIDSON Systems unprecedented vision in turbid waters, it has been used on a wide variety of applications. Dunwich however, is the first use of the system for Non-wreck marine Archaeology. The DIDSON DIVER-HELD (DH) system is a self-contained unit used with rechargeable batteries and a mask-mounted display (Fig 2 – DIDSON Diver Held (DH) System). It has a depth rating of 100 m. The DH DIDSON System allows divers to operate in zero-visibility conditions. The diver views the image through a mask-mounted SVGA colour display. The rechargeable, exchangeable batteries provide ~2.5 hours of operation. Further specifications are available from the Soundmetrics website http://www.soundmetrics.com/products/imaging-sonars/didson-diver-held.

DIDSON sonars operate at two discrete frequencies: a higher frequency that produces higher resolution images (Identification

Mode), and a lower frequency that can detect targets at further ranges but at a reduced image resolution (Detect Mode). The Diver Held model (DIDSON-DH) used in this study was operated in high-frequency mode (1.8 MHz) to achieve maximum image resolution.

Figure 2: Diver held DIDSON Acoustic imaging camera. Black rectangular box houses the liquid lens system used to focus the 96 beams of sound. Image is projected into the divers mask using a head up display unit. (Diver Andy Rose).

The resolution of a DIDSON image is defined in terms of down-range and cross-range resolution, where cross-range resolution refers to the width and downrange resolution refers to the height of the individual pixels that make up the DIDSON image. Each image pixel in a DIDSON frame has (x, y) rectangular coordinates that are mapped back to a beam and sample number defined by polar coordinates. The pixel height defines the down-range resolution and the pixel width defines the cross-range resolution of the image.

‘‘Window length’’ (i.e., the range interval sampled by the sonar) controls the down-range resolution of the DIDSON image. Because the DIDSON image is composed of 512 samples (pixels) in range, images with shorter window lengths are better resolved (i.e., down-range resolution=window length/512). Window length can be set to a range of lengths according to the mode of detection (see Table 2). For this study, window length is set at a range of 1-15m HF Identification mode and 1-35m in LF Identification mode. Since we used the coordinates for the centre or margins of the sites shown on MBES or SSS as drop off points for the shot lines used by the divers, the divers were always close to the structure of interest. For this reason we found that High Frequency Identification Mode at 15m gave the best compromise that allowed coverage of a reasonable distance while still operating in high-frequency mode for optimal resolution.

The down-range resolution (or pixel height) for a 10-m window length is 2 cm (1,000 cm/512) and 0.9cm for a 5m window. The cross-range resolution is primarily determined by the individual beam spacing (0.3°) and beam width (0.4°) for the DIDSON-DH at 1.8 MHz. Targets at closer range are better resolved because the individual beam widths and corresponding image pixels increase with range.Horizontal image pixel resolution ranges from 1cm at 2m range to 5cm at 10m range.

The transmitting power of the DIDSON sonar is fixed, and the maximum receiver gain (40 dB) was used during all data collection. The DIDSON-DH was enabled so that the sonar automatically set the lens focus to the midrange of the selected display window (e.g., for a window length of 15 m that started at 5 m, the focus range would be (15 m – 5 m)/2). The image smoothing feature was disabled. Image display threshold and intensity settings were selected that optimized the contrast of the image (threshold = 10, intensity = 50).

Detection Mode
Operating Frequency 1.1 MHz
Beamwidth (two-way) 0.4° H by 14° V
Number of Beams 48

Beam Spacing 0.6°
Window Length 5m, 10m, 20m, 40m
Range Bin Size (relative to window length) 10mm, 20mm, 40mm, 80mm
Identification Mode
Operating Frequency 1.8 MHz
Beamwidth (two-way) 0.3° H by 14 ° V
Number of Beams 96
Beam Spacing 0.3°
Extended Range Settings
Start Range 0.42m to 26.1m in 0.42m steps
Window Length 1.25m, 2.5m, 5m, 10m
Range Bin Size (relative to window length) 2.5mm, 5mm, 10mm, 20mm

Table 2 DIDSON-DH specifications. Most data at Dunwich were captured in Identification model operating at 10m range. Data from Soundmetrics 2013.

Four dives were made with the DIDSON-DH system. Each diver clipped on to a shot line which had been previously positioned over the ruins using GPS navigation and Side Scan Sonar data. The divers were then able to undertake circular sweeps of the sea bed around the shot line, increasing their radius of survey by extending the clip line. DIDSON filming was attempted in two formats; first by hanging over the ruins at a distance of 8-15m and secondly for specific close up visualization at 1-5m within the ruins.

DIDSON .avi files were reviewed and the best frames captured as screenshots using the DIDSON5.3 software. These capture the range of DIDSON imaging from 1-5.5m, 2 – 11m and 5 – 23m.

In addition to DIDSON imaging, the divers used a touch survey where they wanted to determine the composition of the structure they could observe. This was particularly useful where the imaging showed apparent square blocks of stone that with touch turned out to be blocks of peat.

All data was stored on hard drives and copies provided to the client.

4.0 Results

Survey Conditions during the week deteriorated with a north easterly wind and swell, reducing the survey time dues to increasing wave height which prevented the safe deployment of divers. On the Wednesday 25th June, when conditions for sea deployment were too dangerous, we dived on All Saints church from the beach using a diver attached to a safety line (Figure 3).

Figure 3: Surveying the site of All Saints church from the beach using a tethered safety line and DIDSON-DH sonar. Diver Andy Rose, Dive Master Duncan Coles. Bacon (1979; 1982) reported in a large section tower lying across the ruins in a gully just off the beach around where the diver is located in the photograph.

The dive team set up at Dunwich, and swept the site using the Sidescan sonar to check the conditions on the seabed after a winter of storm surges and high seas (November 2013 was the highest storm surge since 1953). This quickly revealed a major change in site conditions since the previous surveys in June 2012. Sand and silt had been moved over the site of the former town, burying all but the largest ruins. DIDSON imaging of the St Peter's church site, which previous surveys in 2011 had stood up to 1.2m above the seabed revealed that only the top 0.2 – 0.3m of the ruins now protrude meaning that around 1 metre of silt and sand has been deposited over this site since 2011.

Our planned survey targets were located using GPS and sidescan. This revealed that for the main central and southern areas of the site we could not detect any of the previous targets. Bacon (1979; 1982) describe the continual burial and re-exposure of sites by up to a metre of sand, often frustrating diver survey, and burying whole ruins.

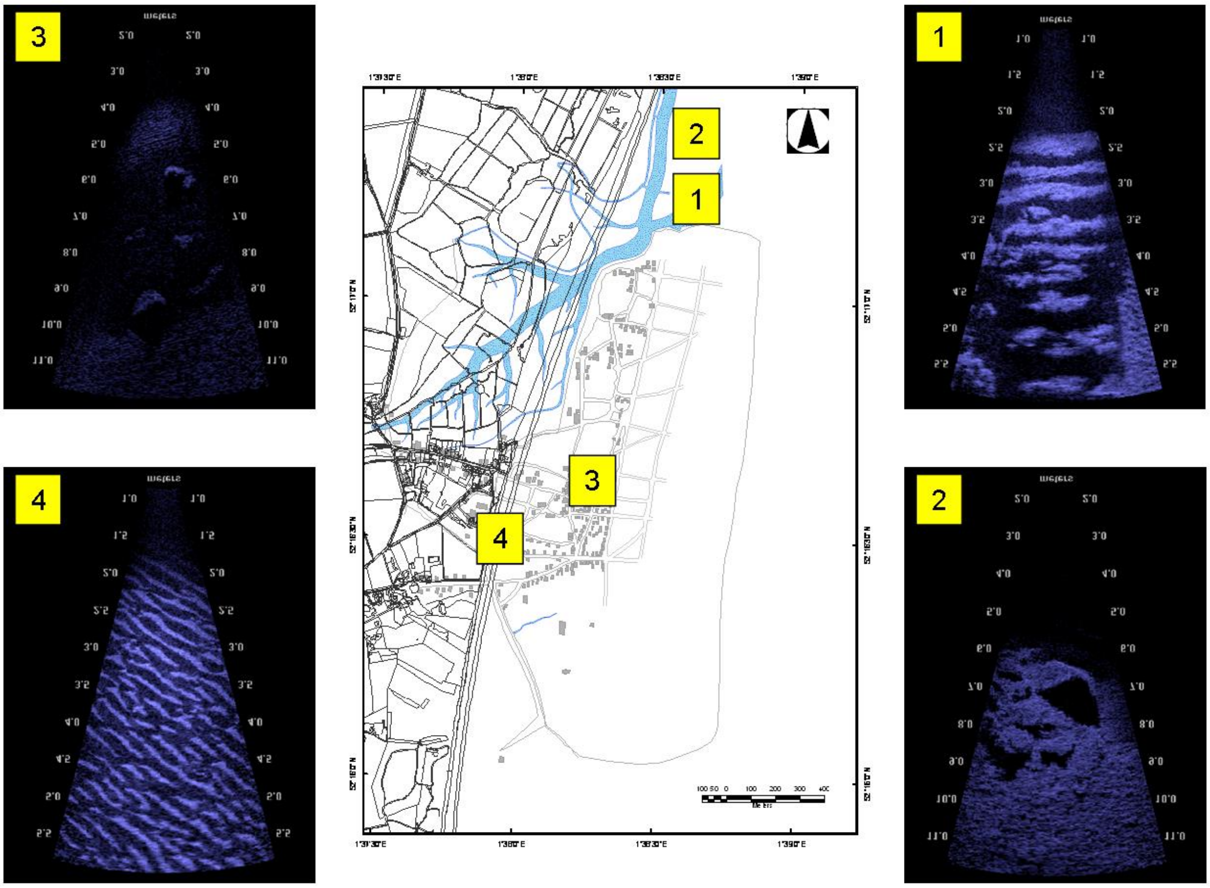

Figure 4: Survey sites identified for DIDSON sonar survey. Site 1 was a possible wreck site, Site 2 was a series of possible cut blocks associated with the harbour. Site 3 was located near to St Peters (shown in DIDON image) but was identified as the toll house. Site 4 was the site of All Saints Church and was accessed from the beach.

Further to the north of the town in the region of the old harbour, the seabed was not covered in sand, and we were able to locate the two targets of interest (See Table 1 and Figure 4 above).

All DIDSON image files are listed in Appendix 1.0. Copies of he movie files and DIDSON format files together with DIDSON software are available on the accompany DVD.

4.1 Target 1: Wreck Site

The first target dived is located north of Dunwich and close inshore, adjacent to the course of the old Dunwich/Blyth river (Figure 5). The site is a raised elliptical feature that the 2009 Sidescan sonar showed to potentially have a row of ribs or upright posts along its long axis (Figure 5), and areas of unidentified rubble. The feature measures 32m long by 12m wide and lies parallel to the coastline some 189m from the current Mean High Water.

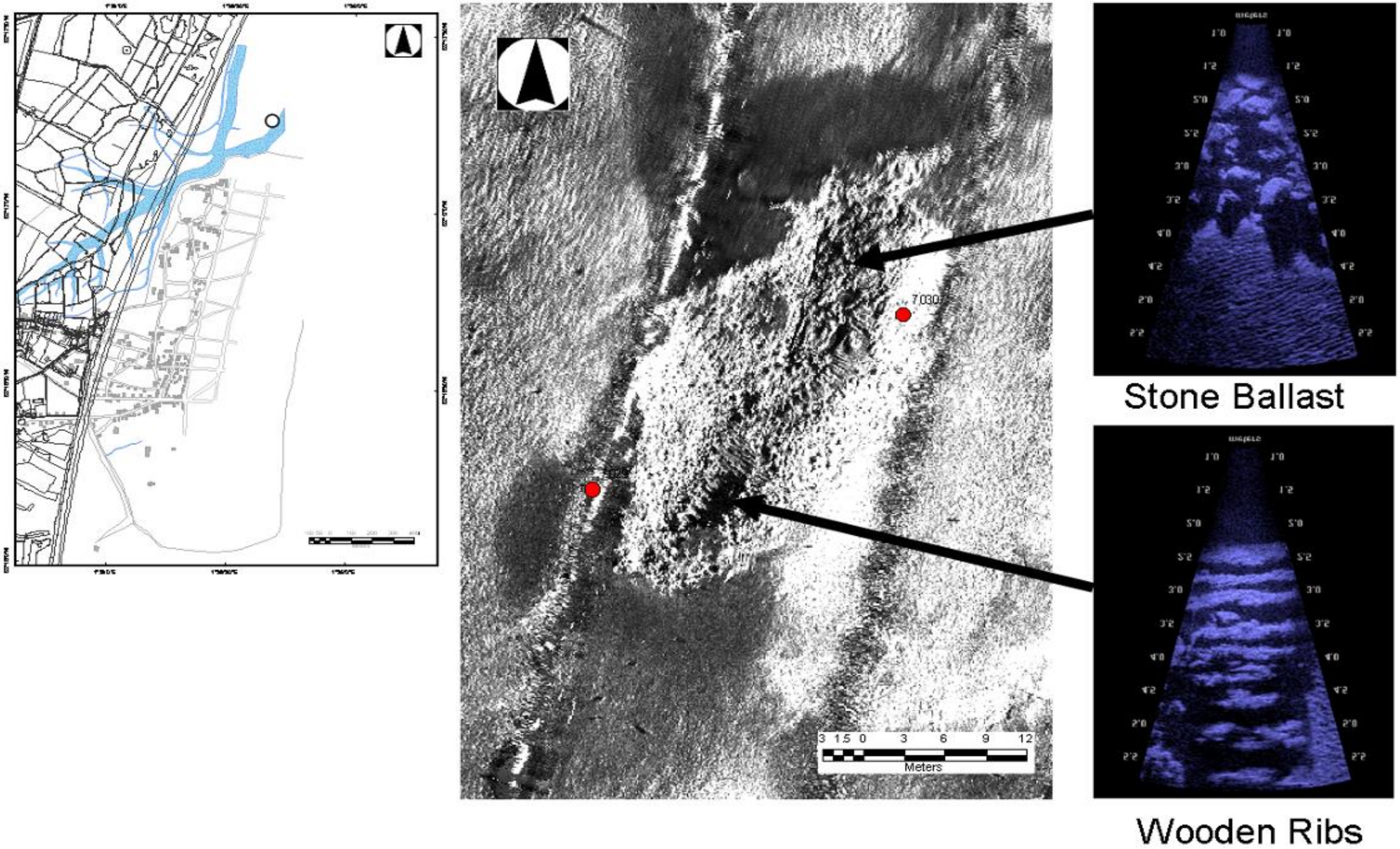

Figure 5: Target 1 Wreck site showing its position adjacent to the former Dunwich/Blyth river north of the old port and harbour area. Central panel shows Wessex Archaeology 2009 Sidescan sonar image with areas of possible wooden ribs of posts and areas of rubble shown. Red dots refer to magnetometer anomalies suggesting the presence of ferrous metal. Right hand images show DIDSON-DH 15m images of the Ribs and what is interpreted as stone ballast.

The site proved to be a shipwreck. In the DIDSON-DH images (Figure 5, Appendix 2.0), the diver could see the ribs of a wooden vessel, with piles of stone ballast lying in between each rib and in a pile on the landward side. The pile of ballast probably results from the ship leaning to landward as it was driven onto the sand bank or beach during a storm.

The diver acting on experience, felt around one of ribs, and recovered a small (5cm x 2cm) strip of thin copper sheathing. Copper sheathing was only common on merchant ships after c.1800 AD, and in Royal Navy ships after 1780AD. Muntz metal sheathing (an alloy of zinc and copper) became widespread after 1840. On this basis we suggest a date for the wreck post 1800AD. This date precludes the vessel being associated with the old Dunwich/Blyth river. Rather the location suggests it was driven on to the inner and bank which parallels the beach, at some point in the 19th century.

Potential wrecks in the area are given in a list compiled by Hancock (2009). These are listed in Table 3 below. Perhaps the most likely ship within the list is the *Request* that was wrecked to the north of Dunwich carrying a cargo of stone.

Further images of the site are given in Appendix 2, and on the DIDSON films listed in Appendix 1.0.

Year/ Date of Wreck	Ship	Notes
1770 Dec 18th	N/A	30 ships driven on to Dunwich beach on NW gale.
1814 Oct 25th	Friends	Cargo of Stone, SSE gale. Home port Selby. Master Potter.
1840, Jan 27th	Request	Brig, North of Dunwich, 10 crew, Cargo of stone. Crew of 10. Home port Newcastle, Master Baines.
1859 Dec 1st?	Raven	No data.
1887 Dec 13th	Rebecca	Brigantine, Home port Plymouth, Master A. May. Cargo of barrel hoops and sand.
1891 Oct 13th	Agatha	Snow, 187 tons, wreck marker. Home port Kings Lynn, Master T.W.Bell.
1894 Ost 24th	Nina	Barque, Off Dunwich, Cargo of firewood. Home port Christiania, Master J.P. Jorgensen.
1912 Jul 1st	Olive	Smack, driven on shore. Home port Ramsgate.

Table 3: List of potential shipwrecks for the Dunwich beach area. Source Hancock (2009).

4.2 Target 2: Peat Blocks

The second target dived was a potential area of ruins located north of the harbour area (Figure 6a,b). DIDSON images revealed flat faced blocks which visually looked potentially of man-made origin (Figure 6c). However touch survey by the diver showed them to be composed of peat. The blocks are from erosion of the peat which underlies the upper clay in the marsh sediment sequence. This layer of peat is revealed on the sea bed as the gravel barrier between Dunwich and Walberswick migrates inland. The peat breaks off in flat failure planes that resemble cut stone faces. Further images of the site are given in Appendix 2, and on the DIDSON films listed in Appendix 1.0.

The DIDSON survey enables us to accurately interpret the Multibeam and Sidescan sonar data for this area, as an exposure of former marsh peat on the seabed which is being eroded by tidal and wave driven currents.

4.3 Target 3: Toll house/St Peters Church

The third target was to have been some unidentified ruins found to the southeast of St Peter's Church which were tentatively attributed to the Toll house since this is mentioned in historic records to have been in the vicinity of the Market place, near to St Peter's church (Gardner 1754).We checked on the ruins of St Peter's using the DIDSON to confirm the sidescan sonar survey which suggested that sand had moved over the town site, burying many of the ruins that were visible in previous years. The ruins of St Peters church (see Figure 7a,b) were located on the sidecsan sonar and a shot line put down on the GPS coordinates. The diver then undertook a DIDSON sweep on the seabed around the shotline. The ruins (Figure 7c) were barely visible above the sand, protruding only some 0.2-0.3m (diver estimate based on touch). Between 2008 – 2011 these ruins had protruded up to 1.2m above a firm seabed. This confirmed that the site has been buried under c. 1m of and, and therefore explained the absence of smaller ruins in the sidescan sonar data. Further images of the site are given in Appendix 2, and on the DIDSON films listed in Appendix 1.0.

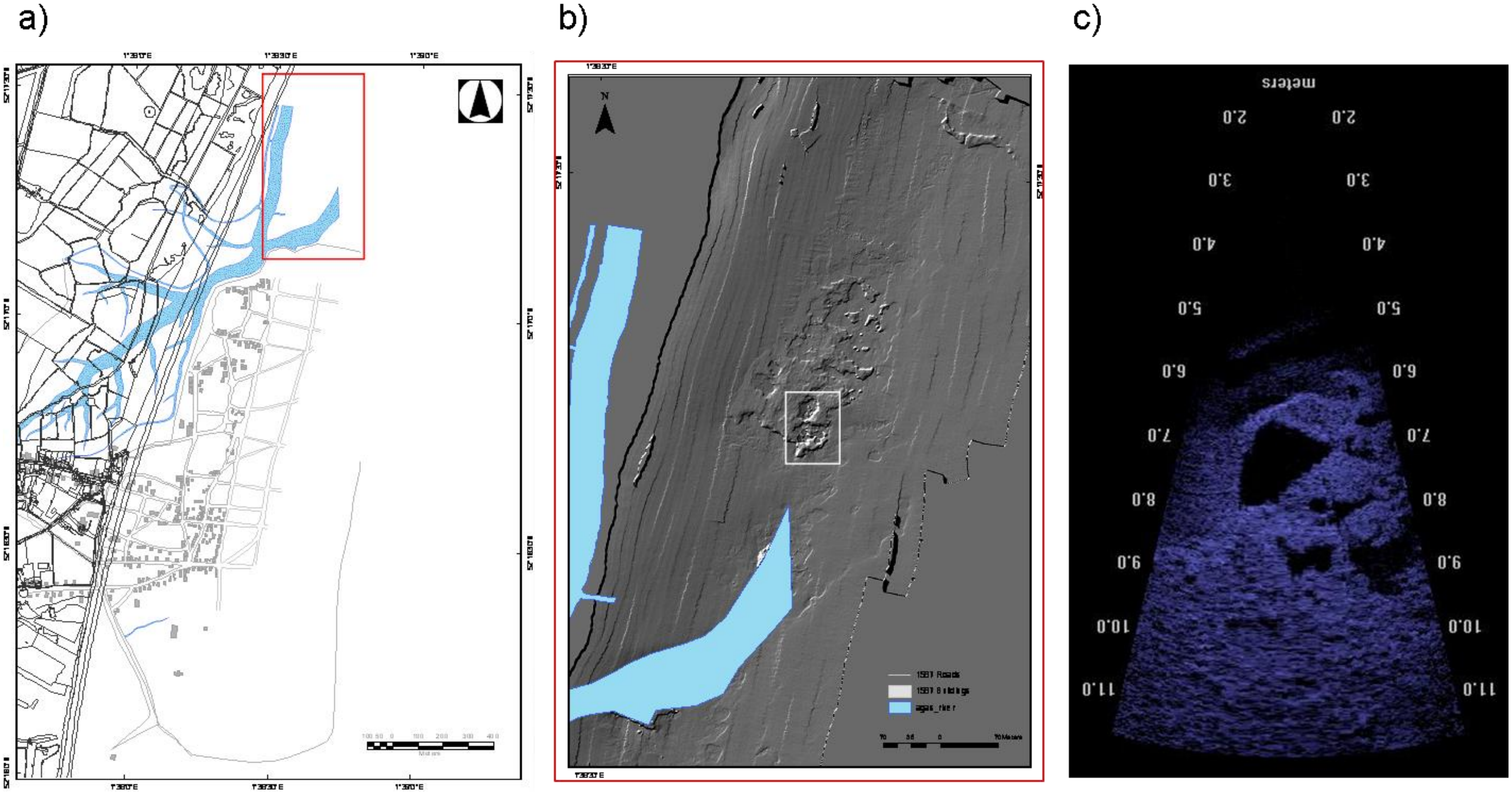

Figure 6: Survey site 2, located north of the wreck site (a) in an area of possible ruins revealed on the multibeam data collected in 2011 (b). DIDSON image c) shows square faced blocks but Diver inspection by hand revealed them to be blocks of peat. The multibeam can thus be reinterpreted as an area of peat from the former Dunwich marshes, which is exposed on the seabed and is being eroded by wave and tidal currents.

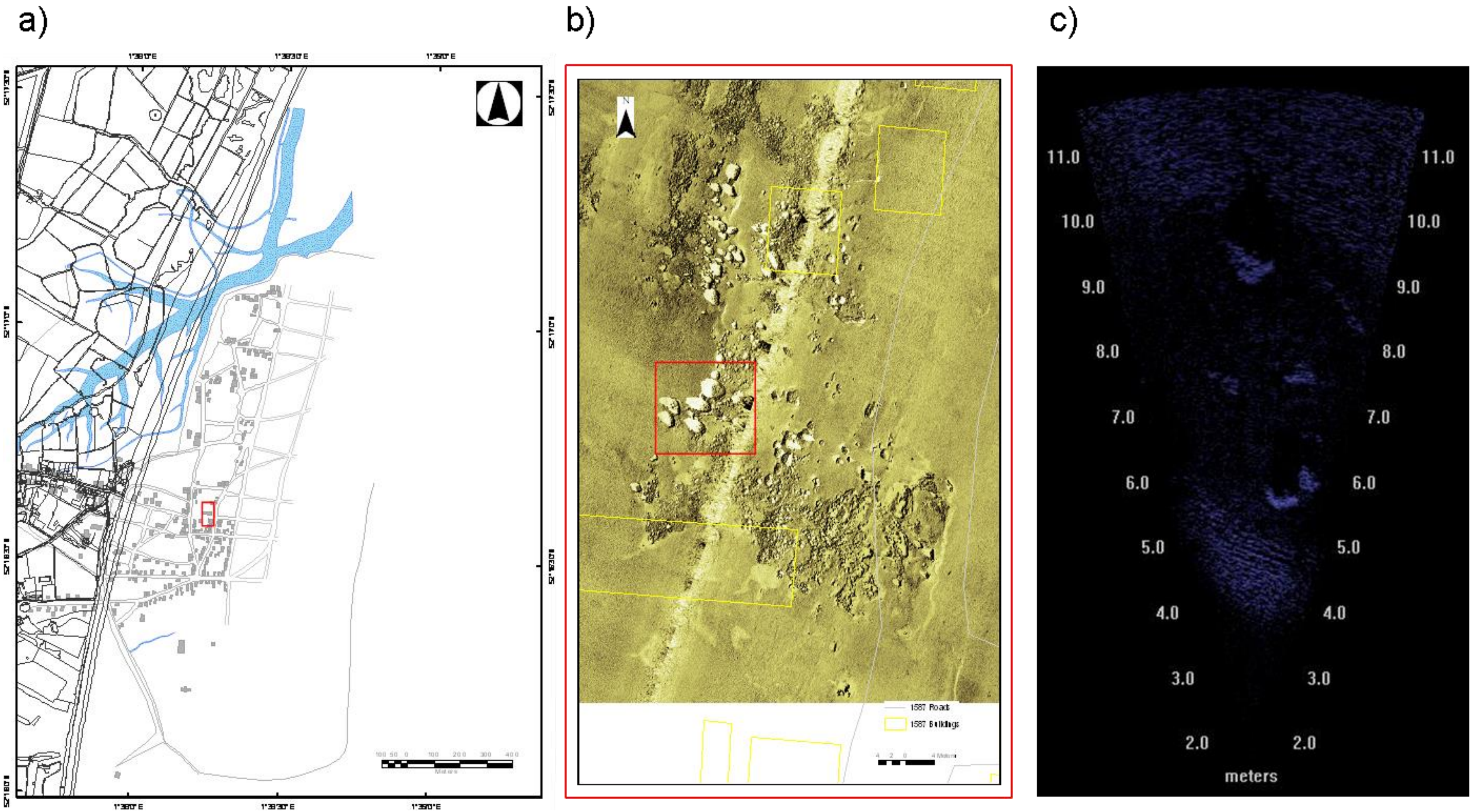

Figure 7: Survey site 3, St Peters Church located in the centre of the former town (a) was the largest area of ruins with large blocks associated with the tower in 2008-2011 surveys – 2009 Sidescan sonar data shown in (b). DIDSON image c) shows flint and mortar blocks that Diver inspection estimated at 0.2-0.3m above a sandy bed. Rippled area of sandy bed can be seen, together with scoured depression created by tidal current interaction with the ruins.

4.4 Target 4: All Saints Church

The fourth target was All Saints church, which collapsed over the cliffs between 1880 and 1923 (Sear et al., 2012). The site was extensively dived by Stuart Bacon and others during his survey of the site in 1973-1983 (Bacon & Bacon 1979; Bacon 1979; 1983). Bacon described the ruins as lying in a gully between the beach and the inner sand bank with large sections of the tower and areas of flints scattered over the bed. This gully lies immediately off the beach and is too shallow for boat access and sidescan or multibeam survey (Figure 8a,b). This provided an ideal target for DIDSON-DH as it can be accessed from the beach using a tethered free swimming diver. We identified the site using GPS and cliff markers (gravestones near the cliff edge denote the former graveyard of All Saints). The diver then swam out over the gully (which runs parallel along the beach) and drifted down across the site scanning the seafloor. The seaward (western) side of the gully is formed by the inner sandbank. DIDSON images (Figure 8c, Appendix 2) shows a sandy bed with ripples running at an angle up the face of the inner bank. In contrast, the bottom of the gully and the landward (east) toe of the beach is formed of gravels (Appendix 2). There was no evidence of any ruins protruding above the surface of either beach or sand bank. Some large stones were evident in patches in the bottom of the gully which may be derived from the ruins of the church, but this is speculative. The DIDSON survey confirms that the ruins of All Saints church are currently buried under the beach and inner sandbank.

5.0 Interpretation

The 2014 survey of specific targets at the Dunwich Town site was only partially successful due to the accumulation of sand over the site since the last survey in June 2011, and most probably resulting from storm surge and winter storms in 2013/14. This in itself reminds us of the dynamic nature of coastal archaeological sites, and confirms observations made by earlier dives at the site by Stuart Bacon. Movement of fine sediments over the site is controlled by tidal currents but also occurs during storms (IOS 1979). Sear et al., (2012) reported that the height of the Dunwich bank is becoming shallower and the bank is widening, with signs that it was already moving landward and starting to encroach over the ruins. This survey confirms that this has continued to the extend that many of the smaller ruins that were only protruding up to 0.5m above the seabed are now buried. The long term implications of this are uncertain because this sand may be swept clear by tidal currents. If not, then the ruins will be protected to some extent from the scouring action of sands and fine gravels that are mobile over the bed during strong tides and storms. However were the Dunwich bank to continue to migrate landwards, then is likely that the ruins will become buried and lost to current archaeological survey.

The survey also confirmed that the ruins of All Saints church are currently buried. These would be revealed by a) a general lowering of beach levels by c.1-2m and; b) by re-exposure on the seaward side of the narrow inner sand bank as this migrates shoreward, which will happen as the beach/cliff line retreats landward over time.

The Survey also confirmed the origin of two unidentified targets; the first of which proved to be a shipwreck dating from the 19th or late 18th century. This find adds to the overall heritage value of the site, and reminds us that coastal sites are a palimpsest of historical events. Indeed the Dunwich Town site has artefacts dating from at least Saxon through Medieval and later wrecks through to ordnance from First and Second World War gunnery and mortar practice (Sear et al., 2012). The wreck remains unidentified. Subsequent research using local historical resources may yet confirm its identity. The wreck site is to be registered with English Heritage.

DIDSON survey also clarified the origin of the blocks and complex topography to the north of the harbour site. This is exposed peat sediments caused by the recession of the gravel bank over the back barrier marsh sediments. This peat is sometimes exposed in the beach face and blocks of it are washed up after storms.

The Survey confirmed the value of Diver held DIDSON sonar as a tool for shallow marine archaeology. The technology provided access to information that was impossible or difficult to obtain by other geophysical of visual methods. It also provided clarification of the origin and layout of sites. However, samples are still required to confirm the material composition of artefacts.

6.0 Conclusions

The Survey provides evidence for the following conclusions:

- A large, new unidentified wreck dating from the late 18th or 19th century has been found to the north of the harbour area of the old town of Dunwich. The wreck was exposed at time of survey and shows evidence of copper sheathing, wooden ribs, and ballast or possible cargo stones. A more detailed investigation of the wreck is warranted, focussing on the precise metal used in the sheathing which would help date the wreck, together with a sample of the stone for confirmation of ballast or cargo. Local historical societies should be involved in identifying the vessel.

- Much of the middle and southern area of the Dunwich Town site is buried by sand and currently inaccessible to conventional geophysical survey or diver survey. This is in line with observations that the Dunwich bank is getting wider and migrating landward.

- The sites of All Saints Church and the possible Toll house ruins are buried by sand and not visible to divers or surface sonar technology.

- The northern are of the site is not so impacted by burial by sand. This area has a high diversity of seabed substrates including gravels, sands and silts and exposed areas of former marsh peat.

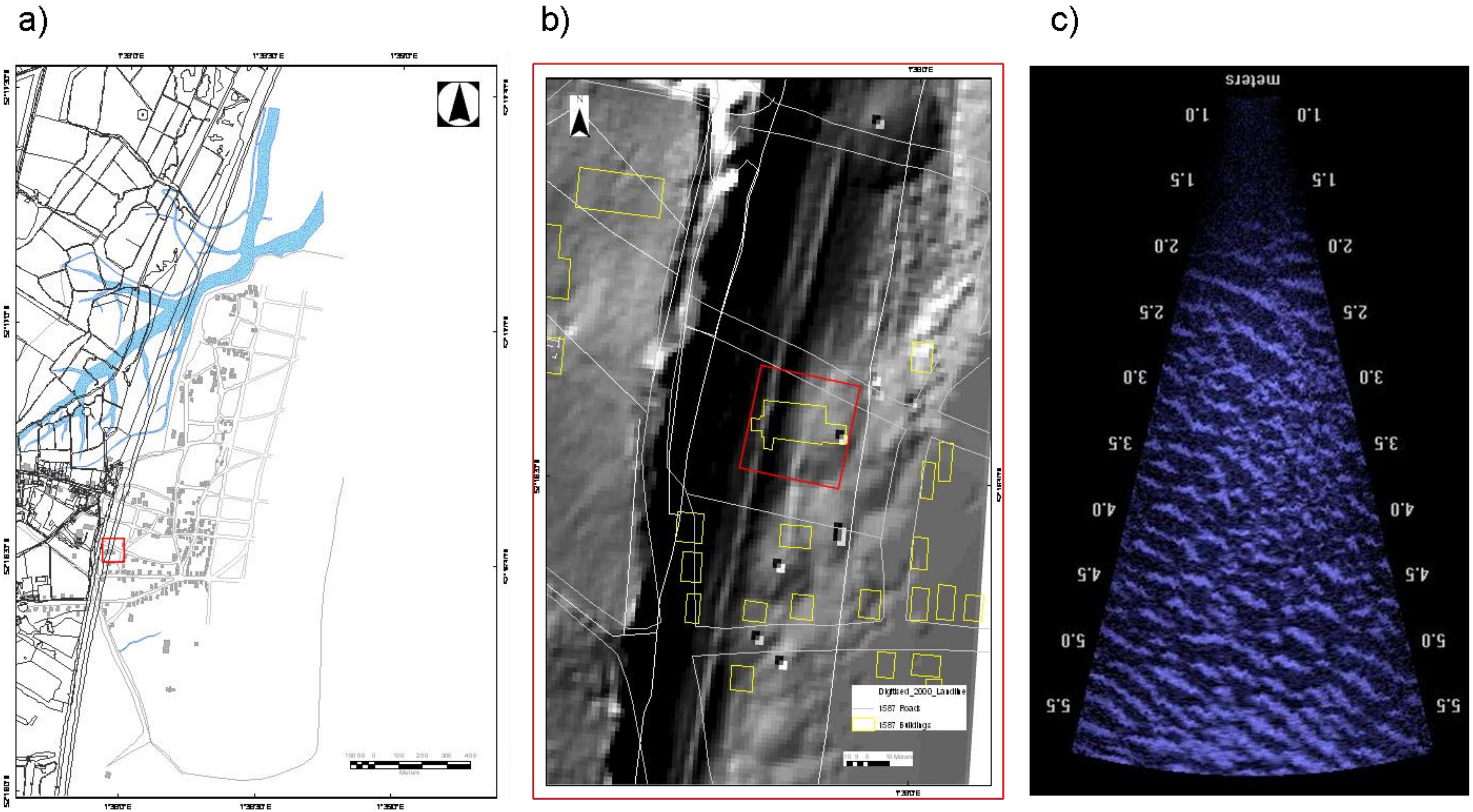

Figure 8: Target 4 survey site of All Saints Church located in close to the current beach (a, b). DIDSON survey revealed that the site is currently buried under the beach and inner sand bank with not evidence of any ruins within the gully area. The landward (west) face of the inner sand bank is strongly rippled (c).

7.0 References

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8.0 Appendix 1.0: DIDSON Files (Note that .AVI movie file formats also exist with same names)

Date / Survey	DIDSON Files	Site	Description
23/06/2014 Touching The Tide Diver: Andy Rose	2014_06-23_112812_HF.ddf 2014_06-23_042921_HF.ddf 2014_06-23_042929_HF.ddf 2014_06-23_042947_HF.ddf 2014_06-23_042956_HF.ddf 2014_06-23_043004_HF.ddf	Wreck Site	A series of DIDSON diver held files taken around the Wreck site. Shows rubble from cargo or ballast and ribs from the wooden hull.
24/06/2014 Touching The Tide Diver: Andy Rose	2014_06-24_043040_HF.ddf 2014_06-24_043049_HF.ddf 2014_06-24_043057_HF.ddf 2014_06-24_043105_HF.ddf 2014_06-24_043121_HF.ddf 2014_06-24_043122_HF.ddf 2014_06-24_043130_HF.ddf 2014_06-24_043105_HF.ddf	St Peters Church site	A series of DIDSON diver held files taken around the St Peter's church site. Shows large blocks of masonry protruding through sand rippled bed.
24/06/2014 Touching The Tide Diver: Andy Rose	2014_06-24_100248_HF.ddf 2014_06-24_100257_HF.ddf 2014_06-24_100305_HF.ddf 2014_06-24_100313_HF.ddf	Exposed marsh peat	Series of DIDSON scans of exposed marsh peat outcropping on the sea bed.
25/06/2014 Touching The Tide Diver: Andy Rose	2014_06-25_151529_HF.ddf 2014_06-25_151540_HF.ddf 2014_06-25_151549_HF.ddf 2014_06-25_151559_HF.ddf 2014_06-25_151609_HF.ddf 2014_06-25_151619_HF.ddf 2014_06-25_151629_HF.ddf 2014_06-25_151639_HF.ddf 2014_06-25_151649_HF.ddf 2014_06-25_151659_HF.ddf 2014_06-25_042929_HF.ddf	All Saints Church	Tethered diver scans in gully just off beach. First files are scans of the bottom and western (shoreward) gravel bed of the gully. Later files are seaward (eastern) side of gully showing riffles on inner sandbank

9.0 Appendix 2.0 DIDSON Images for survey sites

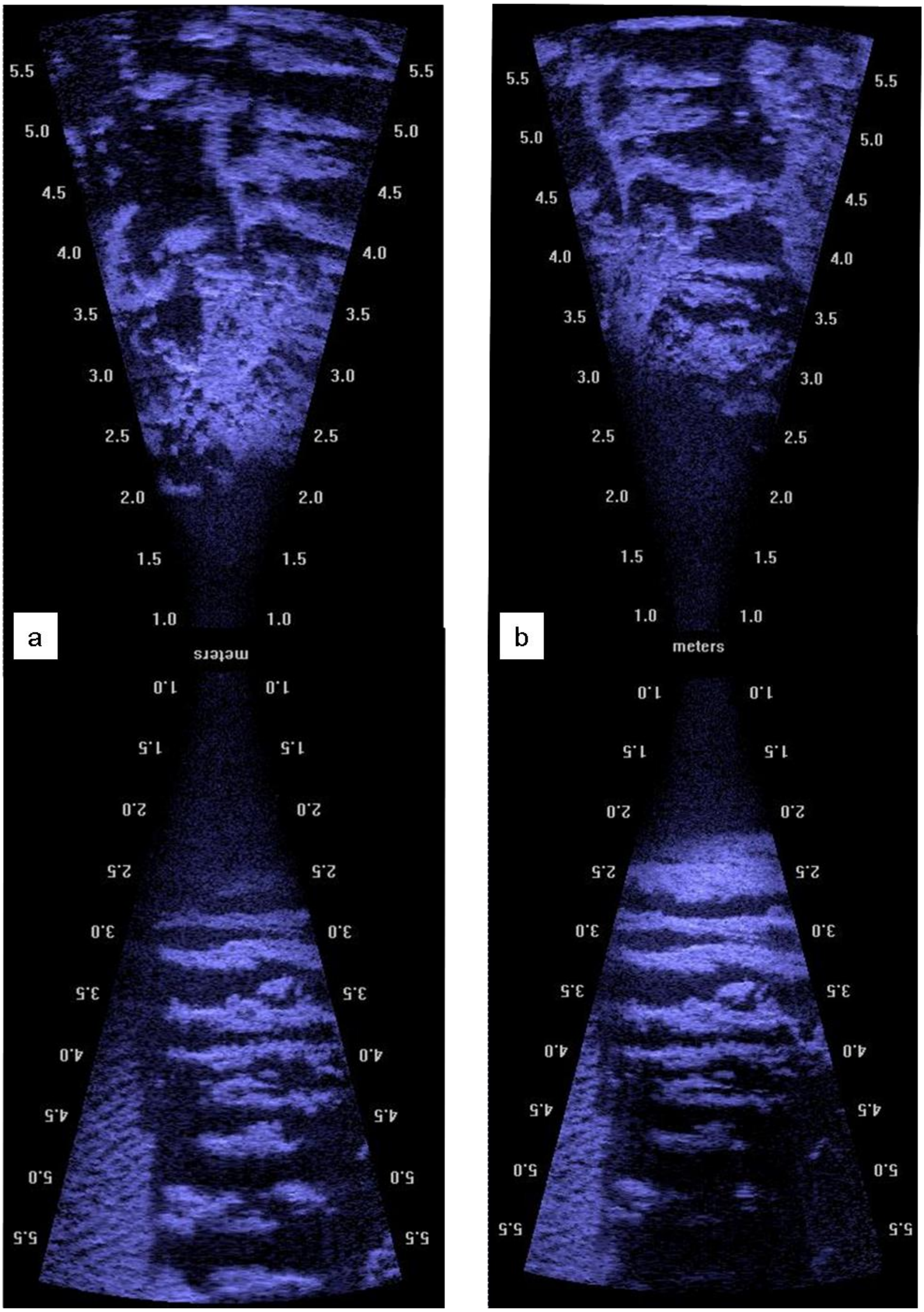


Figure A1: Wreck site mosaic. Diver stood in the centre and did a 360 scan. These two mosaics of two DIDSON screen shots are looking along the axis of the vessel (SW-NE). Ribs can be seen in the bottom half of the image and the top half together with ballast / cargo stones scattered around the upper (northern) part of the vessel.

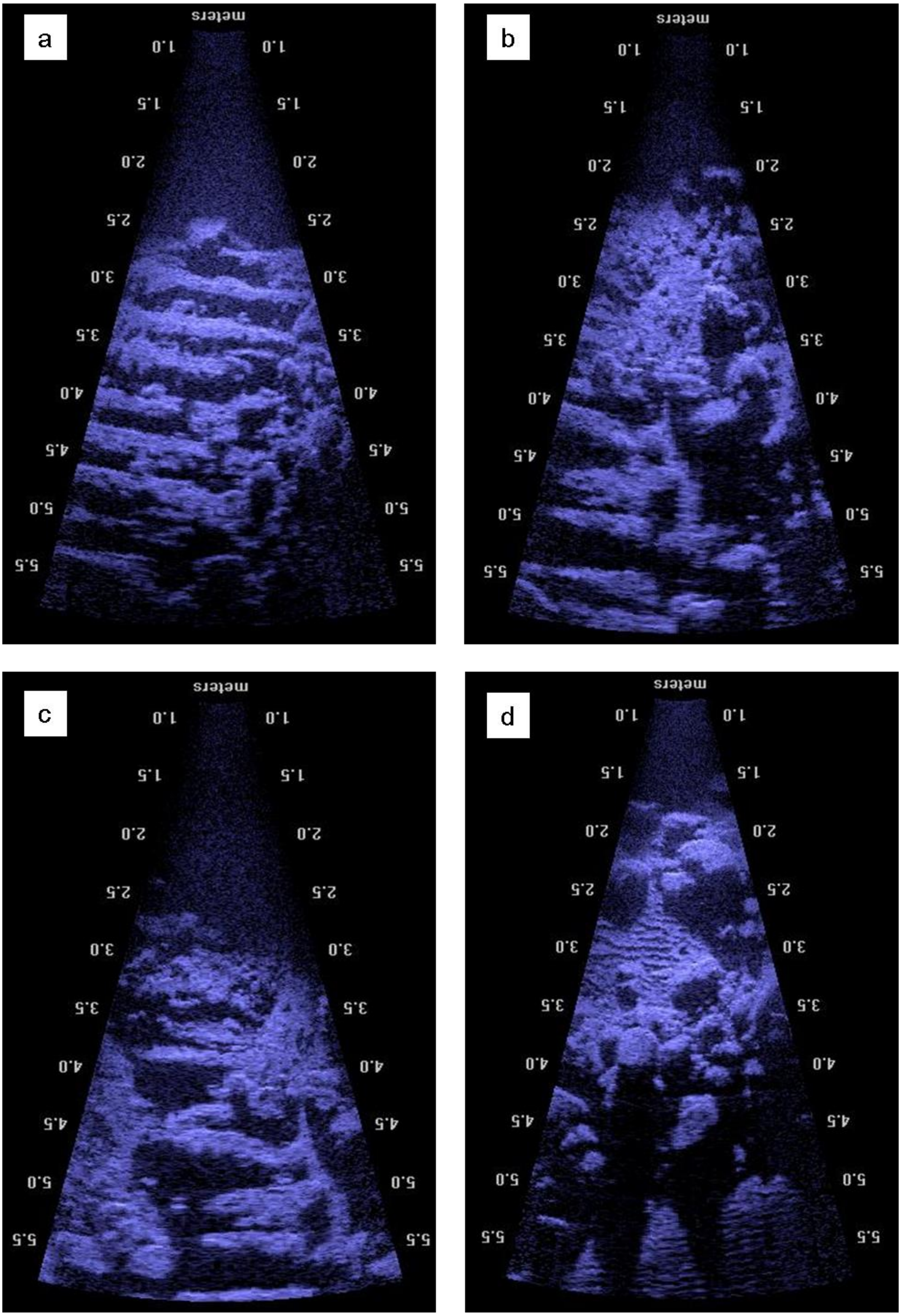
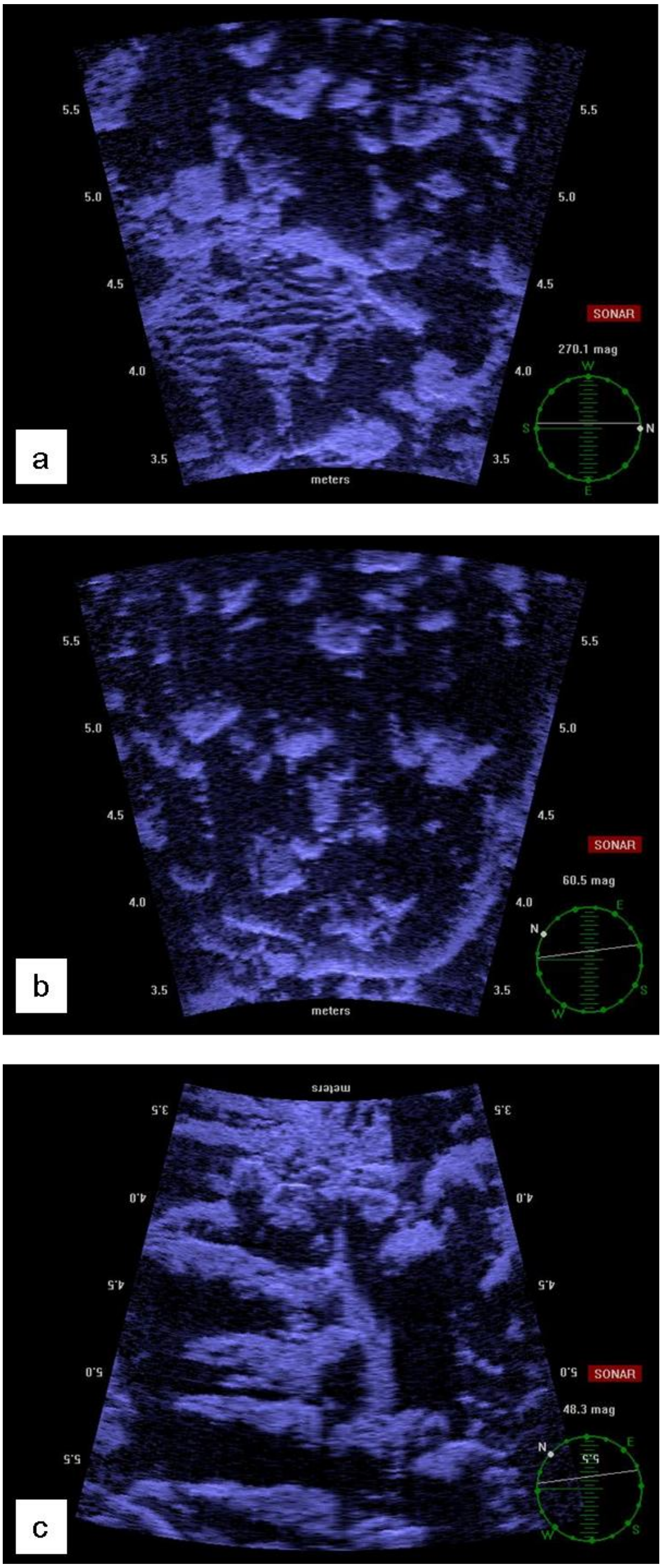
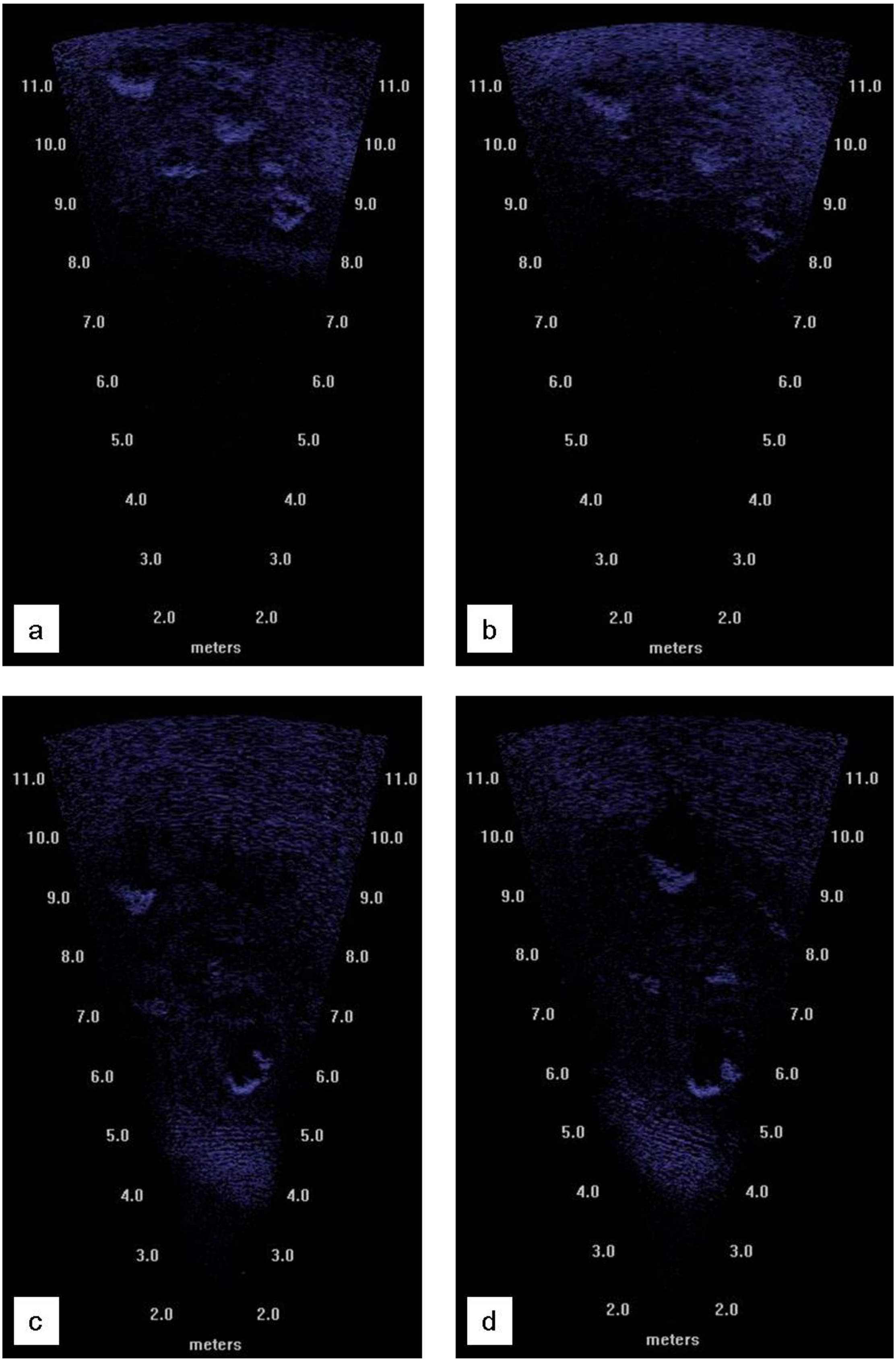


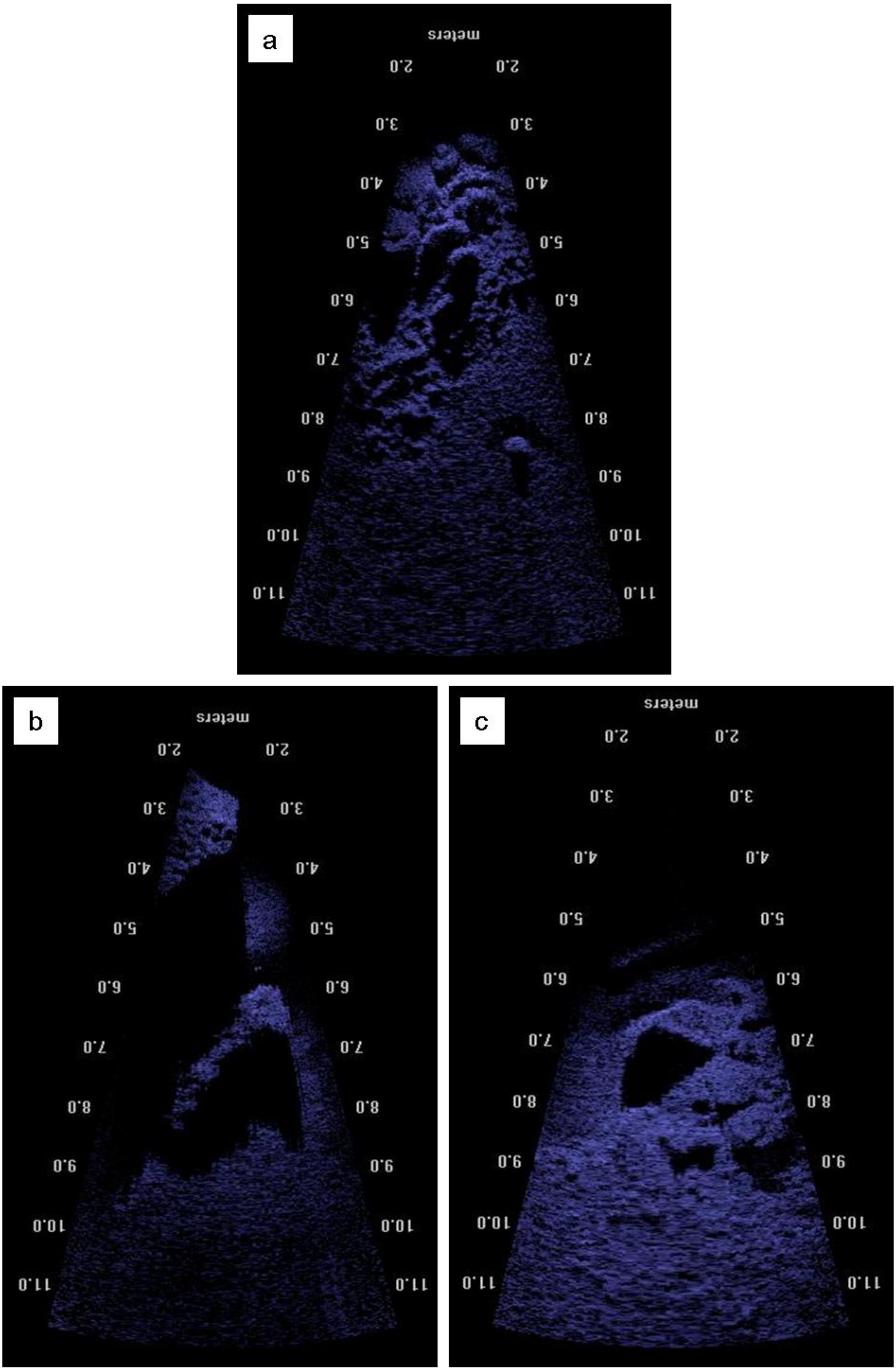
Figure A2: Wreck site a & b) Ribs clearly visible with ballast/cargo stones scattered over the site; c & d) shows ribs and larger (up to 0.35m) stones (cargo?) with sand ripples of the surrounding seabed (d)



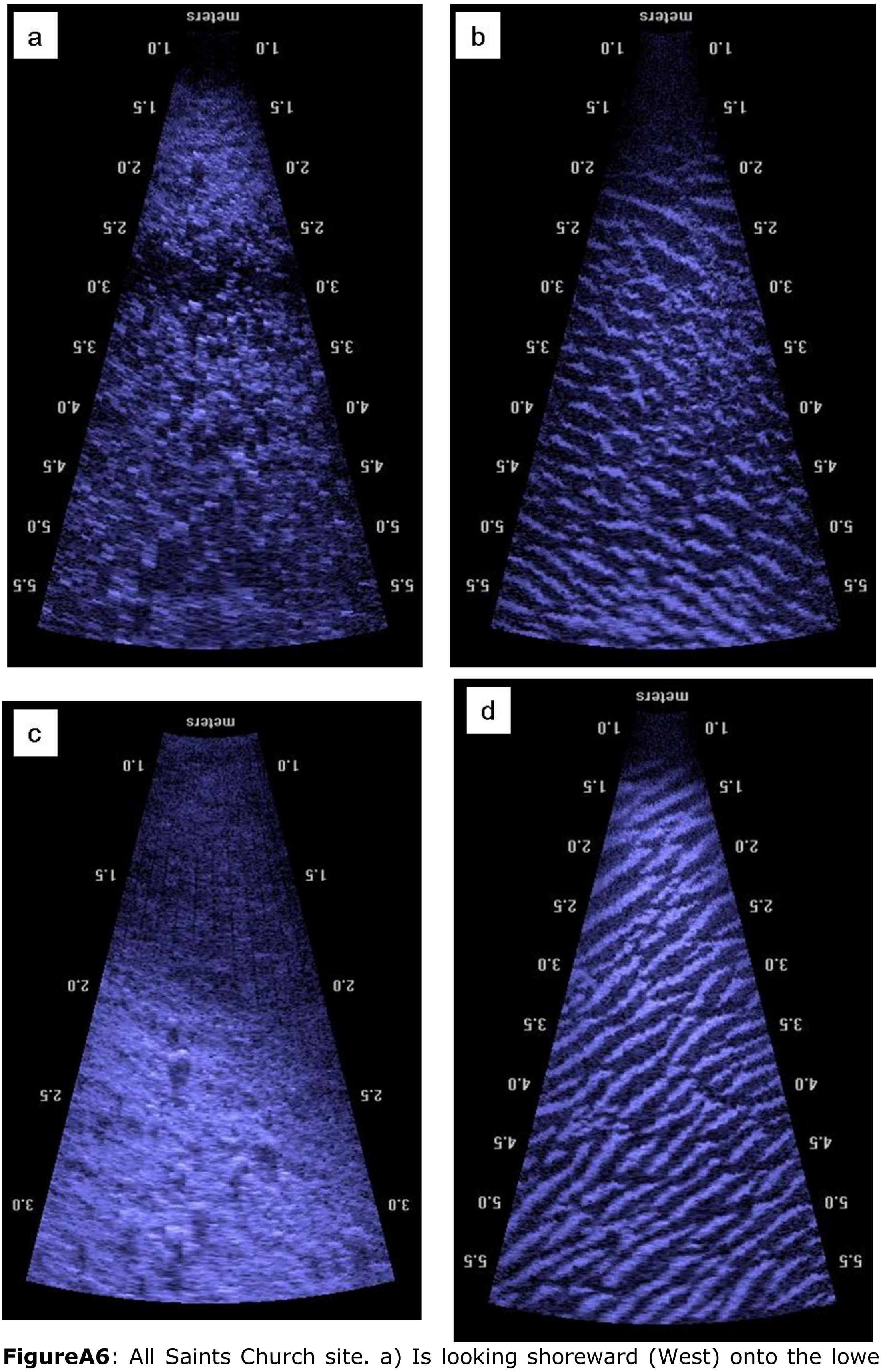
FigureA3: Wreck Site at higher resolution (3.5-5.5m) showing a) scattered stones with rippled sand bed. B) shows a curved rib (right of image) lying over stones. c) Shows detail of wooden ribs with ballast/cargo of stone lying over them. Ribs are approx. 0.25-0.3m width.



FigureA4: St Peter's Church site showing the tops of larger masonry blocks from the region of the tower. The sea bed is mainly sand and silt washed into rippled. Clocks have generated a depression through tidal scour around the blocks (Sear et al .,2012).



FigureA5: Peat blocks and eroded peat surface exposed on the sea bed. Coastal recession of the gravel barrier over the marsh sediments scours off the top of the marine clay revealing the lower peat layer in the seabed. The peat breaks off into flat faced blocks that are sometimes washed up onto the beach. Figure b) shows acoustic shadows cast by large blocks. c) shows a square faced series of peat blocks.



FigureA6: All Saints Church site. a) Is looking shoreward (West) onto the lower beach and shows a gravel bed with at 2.5m a low berm. C) Is a view along the gully bottom parallel to the beach. Larger flints probably from decay of All Saints church can be seen. B) and c) are looking seaward (East) along the inner sand bank that borders the gully. Gravel being covered by sand ripples (b) and sand/silt ripples (d). No sign is evident of any ruins from All Saints demonstrating how ruins exposed in the past, (Bacon 1979) are rapidly buried under the beach and inner sandbanks.