Maritime & Coastguard Agency

SS Richard Montgomery: Survey Report 2020

Contents

Abbreviations

CD	Chart Datum
DfT	Department for Transport
EAG	Expert Advisory Group
GPS	Global Positioning System
IHO	International Hydrographic Organization
MBES	Multibeam Echo Sounder
MCA	Maritime and Coastguard Agency
MOD	Ministry of Defence
NEQ	Net Explosive Quantity
PPK	Post-Processed Kinematic
SSRM	SS Richard Montgomery
VORF	Vertical Offshore Reference Frame
VTS	Vessel Traffic Monitoring Service

1 Executive Summary

1.1 Background

1.1.1 The SS Richard Montgomery (SSRM) was a US Liberty Ship which went aground in the Thames Estuary in August 1944 whilst carrying a cargo of munitions. Although immediate efforts were made to salvage the cargo, the vessel broke in two, flooded and sank before the salvage operations could be completed.

1.1.2 The wreck lies adjacent to the Medway Approach Channel and is approximately 1.5 miles from the town of Sheerness and 5 miles from Southend. Around 1,400 tons of explosives remain on board the wreck which is designated under section 2 of the Protection of Wrecks Act 1973.

1.1.3 Surveys of the wreck are undertaken to provide information on its condition, to identify any changes or deterioration and to inform future management of the wreck. This report details the results of the 2020 survey.

1.2 Survey Overview

1.2.1 The 2020 survey data was gathered from the area identified by the black dotted box in Figure 1.

1.2.2 In general, the two surveys of August 2019 and September 2020 agree very well within the required specification (+/- 5cm of each other). All 96 ID features were compared with the Cloud Compare and apart from ID 15, 51 and 86 no changes were detected on any of the IDs outside of the 5cm threshold.

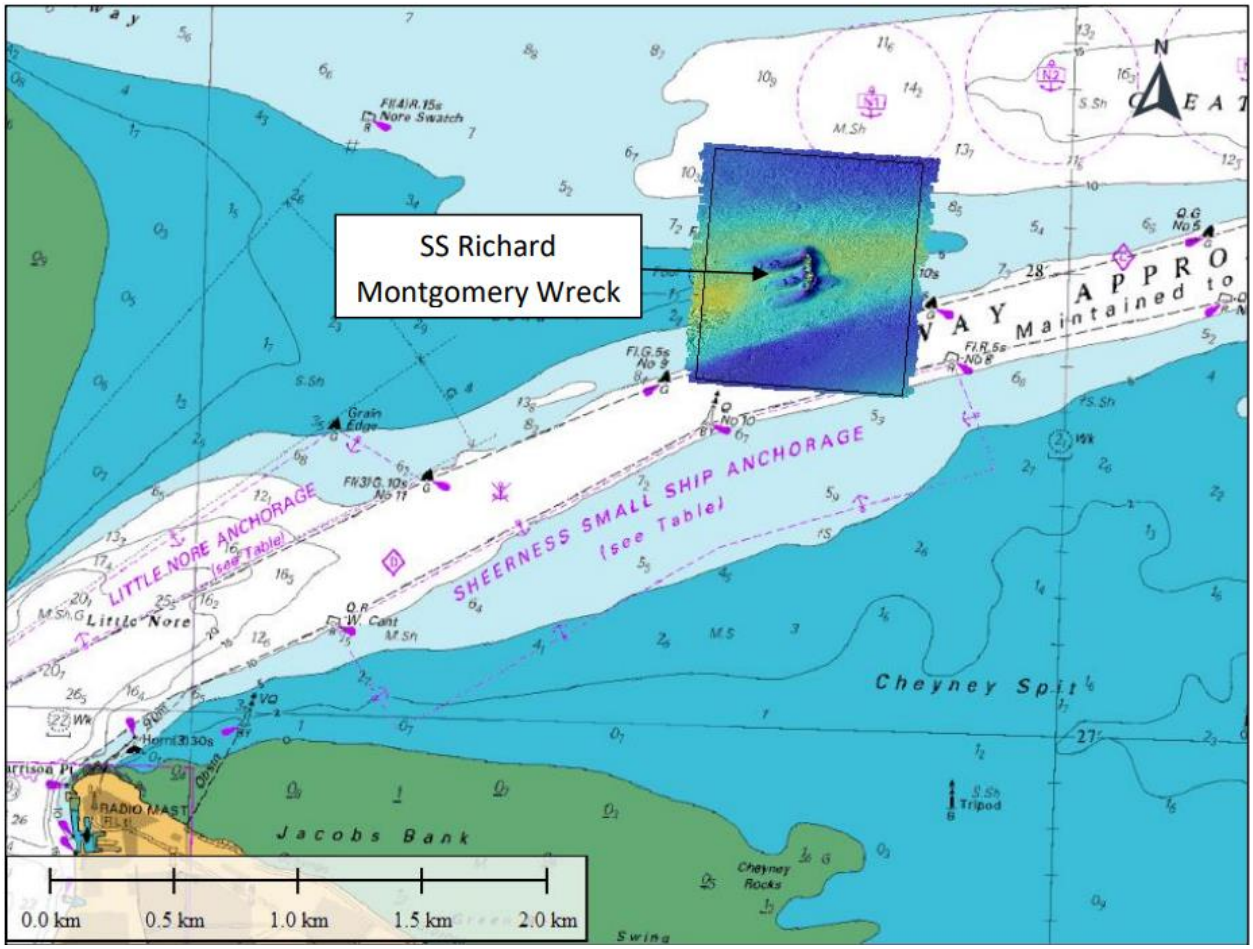

Figure 1 - SSRM 2020 survey location and extent.

1.3 Key Results

1.3.1 As in previous years, the 2020 survey covered the entire wreck and surrounding seabed in detail.

1.3.2 There are very few and minor differences discernible on the wreck between the August 2019 survey and the September 2020 survey.

1.3.3 In general, the two surveys agree very well within the required specification (+/- 5cm of each other). All 96 ID features were compared with the Cloud Compare and apart from ID 15, 51 and 86 no changes were detected on any of the IDs outside of the 5cm threshold.

1.3.4 The seabed depths measured during the September 2020 survey were compared to the depths measured during the 2019 survey. There is little change with the only area of significant change being to the east of the wreck. Here the seabed has shoaled (become shallower) by over 1m. The cause of this is the westerly migration of the shoal bank leaving the seabed to its west shoal bank.

1.3.5 Of the 68 previously identified seabed contacts, 54 were seen in the current survey, 4 were possibly seen (but were too indistinct to be positive), 10 were not seen and 16 new contacts were identified.

2 Introduction

2.1 Background

2.1.1 The SS Richard Montgomery (SSRM) was a US Liberty Ship of the EC2-S-C1 class, constructed by the St. John's River Shipbuilding Company in Jacksonville, Florida in 1943. In August 1944, the ship left the US with a cargo of munitions and travelled across the Atlantic in convoy bound for the UK and then on to France.

2.1.2 On arrival in the Thames Estuary on 20 August 1944, orders were received to anchor off Great Nore. Unfortunately, the water was too shallow for the heavily laden vessel and, as the tide fell, the SSRM dragged its anchor and ran aground on Sheerness Middle Sand, a sandbank running east from the Isle of Grain and to the north of the Medway Approach Channel. By that evening, the vessel was already reported to be badly hogged (curved-up in the centre and sagging at the ends) and an explosive-like sound was heard. This sound was the steel hull plates splitting forward of the bridge.

2.1.3 On 23 August, stevedores from Gravesend were engaged to discharge the cargo. However, on the afternoon of the following day, the ship's hull cracked even further, and the bow holds flooded. By 8 September, the ship broke its' back completely. Divers reported that the crack extended down both sides of the hull, with the vessel clearly open on the starboard side, but the cargo discharge continued. Royal Navy personnel were brought in to finish the cargo removal, but they were hampered by deteriorating weather and safety fears as the vessel gradually sank. The salvage operation was abandoned with approximately 1,400 tons Net Explosive Quantity (NEQ) of munitions remaining within the forward section of the vessel in holds 1, 2 and 3.

2.1.4 The vessel remains on Sheerness Middle Sand, lying in two sections in its own scour pit and sitting on exposed bedrock which is believed to be London Clay. The SSRM lies across the tide and all three masts are visible above the water at all states of the tide.

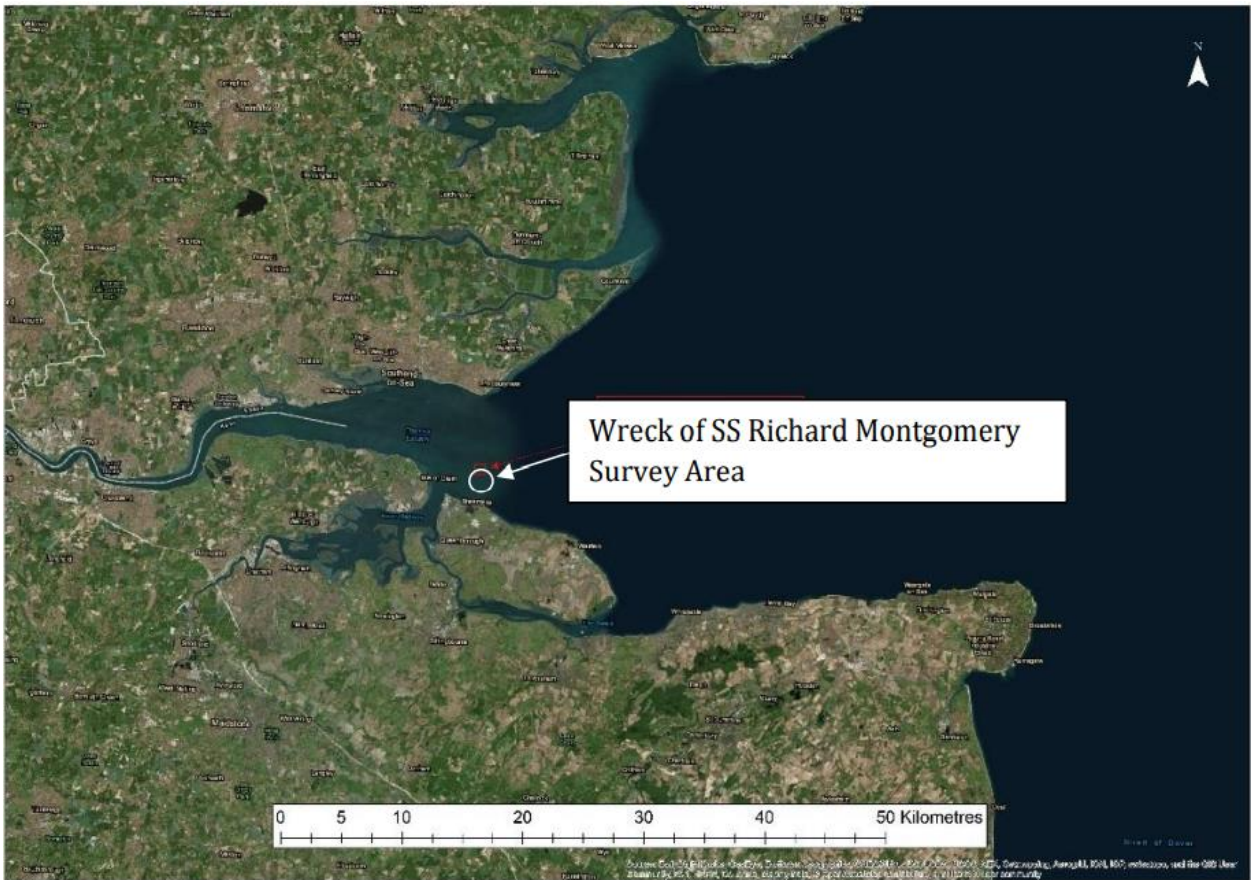

Figure 2 Position of the SSRM.

2.2 Management

2.2.1 The Maritime and Coastguard Agency (MCA) has a requirement to survey the wreck of the SS Richard Montgomery in the Thames Estuary. The location of the wreck is illustrated in Figure 2.

2.2.2 The SSRM wreck is designated as a dangerous wreck under section 2 of the Protection of Wrecks Act 1973. There is a prohibited area around the wreck, and it is an offence to enter within this area without the written permission of the Secretary of State for Transport. The wreck is marked on Admiralty Charts, the prohibited area being delineated by four lit cardinal buoys and twelve red danger buoys. The wreck is also under 24hr surveillance by Medway Vessel Traffic Monitoring Service (VTS).

2.2.3 Although the wreck is thought to be stable if left undisturbed, it is routinely monitored. Regular surveys of the wreck are undertaken to provide information on its condition, to identify any changes or deterioration and to inform future management strategy. The survey results are shared with the independent Expert Advisory Group (EAG) formed in 2017 to advise the DfT on managing the SSRM.

2.2.4 A variety of methods have been used to monitor the wreck. Since 2002, multibeam sonar technology has been the favoured method of survey, along with the laser scanning method. Although occasional diving operations are carried out on the wreck (most recently in 2013), multibeam sonar is faster, more cost-effective and provides greater levels of detail, repeatability and reliability than diver surveys. This is in part due to the very poor visibility and high tidal range in the Thames Estuary which makes diving operations very challenging.

2.3 This Report

2.3.1 This report is a summary of the September 2020 SSRM survey findings, including a comparison with the 2019 survey dataset. The year-on-year comparisons of survey data are used to help identify and quantify any deterioration of the wreck and it provides a longer view of the condition and rate of deterioration of the wreck structure.

2.3.2 The data analysis covers the entirety of the wreck and identifies 96 features on the wreck which have been used in successive surveys as markers for

measuring levels of change. Of these, there are six areas which have repeatedly demonstrated levels of accelerated deterioration and are therefore a specific focus of each survey. Figure 3 below shows the six Key Areas of search.

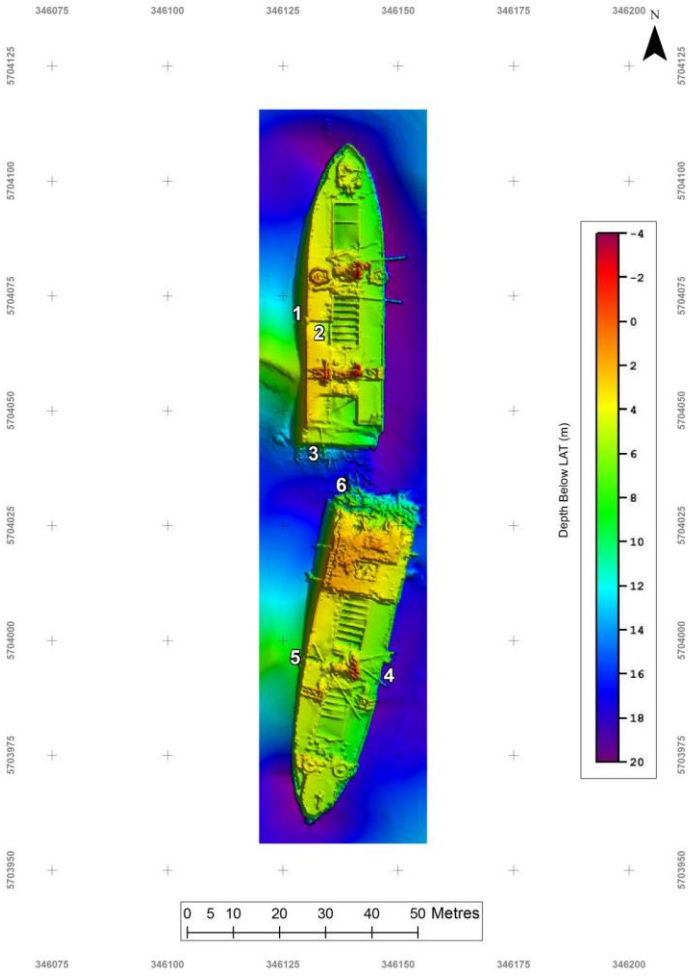

Figure 3 Six Key Areas monitored through SSRM annual surveys.

2.3.3 This report also includes the results of the surrounding seabed survey. The seabed survey aims to identify changes in the local seafloor topography that may have implications for the wreck's stability or for the neighbouring Medway Approach Channel. It also aims to locate items of debris on the seabed within the survey area, including debris that may have originated from the wreck and debris from other sources.

3 The Survey

3.1 Survey Requirements

3.1.1 The Scope of Work included the following objectives:

a) A Multibeam Echosounder (MBES) survey of the entire wreck.

b) A MBES survey of the seafloor in the immediate vicinity of the wreck.

c) Laser scan survey of the masts and other structures which are visible above the waterline.

d) Process the data and directly compare it to previous survey data (from January 2020) to identify and highlight any areas of structural change or deterioration.

e) Produce a detailed survey report which includes details of any changes noted and comparisons with results from the previous survey.

3.2 Survey Area

3.2.1 The survey area is shown by the black box in Figure 1.

3.3 Survey Operations

3.3.1 The multibeam survey of the entire wreck and seabed, along with the laser scanning took place on 21, 22 and 23 September 2020 taking advantage of the spring tides.

3.3.2 On Monday 21 September surveying started at 07:45 and continued until 17:15. The laser data was collected between 10:10 and 10:45. On Tuesday 22 September surveying started at 10:05 and continued until 13:55 when a mechanical problem with the port engine required the vessel to return to port.

3.3.3 The MBES survey was concluded on Wednesday 23 September after the fault on the engine had been rectified. Surveying started at 10:55 and continued until 18:40 after which the survey vessel transited back to Gillingham to demobilise MBES and mobilise the SBP system.

3.4 MBES

3.4.1 The MBES data was collected at high tide using the equipment described below.

Table 1 List of survey equipment.

Equipment Specifications	
Primary Horizontal & Vertical Positioning	1 x Integrated V5 Applanix POS MV Wavemaster II
Primary Heading Sensor	1 x Integrated V5 Applanix POS MV Wavemaster II
Acquisition / Processing	1 x Norbit WBMS GUI 1 x QPS QINSy acquisition/processing software 1 x BeamworX AutoClean processing software 1 x Caris HIPS/SIPS processing software 1 x Cloud Compare point cloud visualisation software
Multibeam echosounder (MBES)	1 x Norbit iWBMS MBES
MBES Motion reference unit	1 x V5 Applanix POS MV Wavemaster II
Sound Velocity Measurement	1 x Integrated AML SV Xchange SVS Sound Velocity Sensor 2 x Valeport Mini SVP Sound Velocity Profiler
Laser Scanner System	1 x Norbit iWBMS iLIDAR Laser
Acquisition	1 x Norbit WBMS GUI

3.4.2 Although a Kongsberg EM2040CMBES and positioning system are permanently mobilised on board the EGS Watchful, a Norbit MBES system was used for this survey. The decision to use the Norbit was based on its ability to gather data higher up the submerged portion of the masts (and so to close the gap between MBES data and laser data) and its higher operating frequency (700kHz) which, although not able to provide the density of data as the Kongsberg twin head system, was expected to provide higher resolution which would be of great use when assessing the possible degradation of the wreck and the seamless integration of the laser and MBES systems.

3.4.3 The Norbit was mounted on an OEM made pole located on the portside of the Watchful. The IMU is integrated with the MBES head, and the laser and the two GPS antennae were fixed on an upward extension making the entire unit self-contained. Consequently, none of the permanently fitted equipment was used for this survey.

3.4.4 Originally it was intended to use the Norbit for the wreck and the Kongsberg for the seabed survey to take advantage of the greater swath width afforded by the dual head Kongsberg. However, as the Norbit provided sufficient coverage on the seabed it was decided to gather all data with a single system and the Kongsberg was not used. As the SSRM wreck lies close to shore,

positioning for the Norbit MBES and Laser was provided by using the Smartnet NRTK system. This system provides for real time centimetric accuracy without the need to post process although it needs a 3G connection for the corrections so can only be used close to shore. This allowed data collected during each day to be assessed each evening rather than having to wait for 24 hours as with the POS Pac Smart Base Post-Processed Kinematic (PPK) solution.

3.4.5 The vertical survey datum used during processing, interpretation and reporting is Chart Datum. The single value of 41.845m was used for consistency with previous surveys for comparison purposes.

3.4.6 GNSS data was acquired using the POSMV Wave Master which is integrated with the Norbit iWBMS system. The POSMV Wave Master received RTK corrections from the HxGN SmartNet service via an NTRIP caster. The RTK corrected horizontal and vertical positions, relative to ETRS89, were combined with the UKHO Vertical Offshore Reference Frame (VORF) model to reduce the bathymetry data to chart datum in real time to a centimetre accuracy. QPS QINSy was set up to receive the corrected ETRS89 GNSS positions and project the data in UTM31N. There was no dropout of the SmartNet service throughout the survey, therefore, no post-processing was required.

3.4.7 When used with the RTK corrected horizontal positions, the Applanix POS MV provides positions for each sounding in the swath with uncertainties better than ±0.05m.

3.4.8 Vertical positions from the Applanix POS MV were combined in QINSy with the single point VORF separation value allowing tidally reduced elevations to be output directly from QINSy.

3.4.9 An overview of the seabed surrounding the wreck of the SSRM is illustrated below. Changes to the seafloor are fairly limited with the majority remaining stable (+/-0.1m) between the 2019 and 2020 surveys. The sand bank to the east of SSRM has migrated slightly west (towards the wreck).

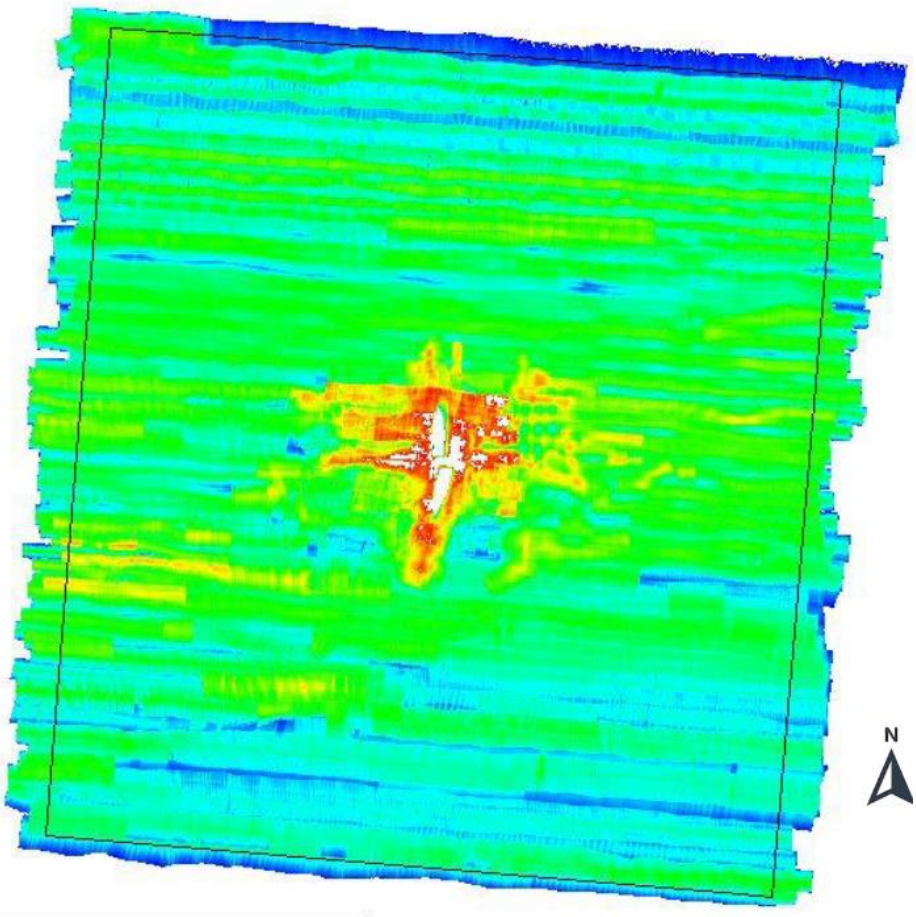

Figure 4 Density plot of surrounding seabed MBES survey for SSRM.

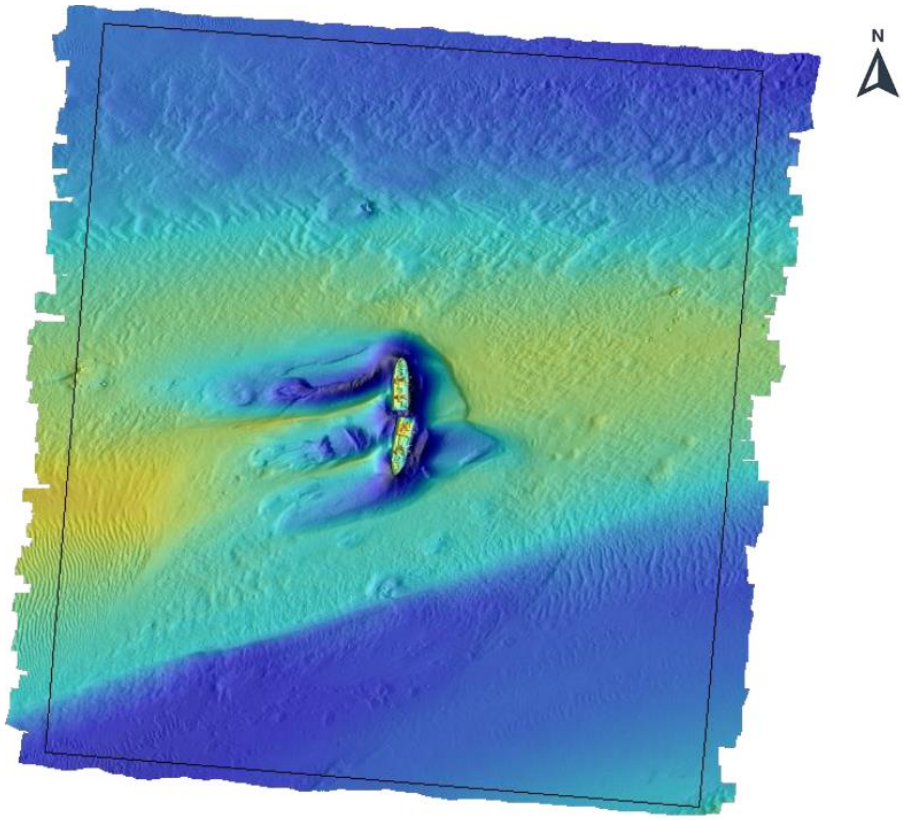

Figure 5 Overview of the seabed surrounding the SSRM.

3.5 Laser Scanning

3.5.1 The laser scanning was conducted at low tide using a Norbit iWBMS iLIDAR Laser, and the data was acquired by Norbit WBMS GUI. Multiple lines were run in various directions within the vicinity of the wreck to achieve full coverage and data density around the masts. The laser data was also reduced using a PPK solution and exported to a separate georeferenced full density point cloud (the results are shown at section 4.8).

3.5.2 In addition to laser scan data, photographs were taken to add to the available information on the condition of the exposed masts.

4 Results – The Wreck

4.1 Overview

4.1.1 This section of the report details the output of the survey data acquired from the wreck. It combines the results of the survey data and uses various tools to analyse the data and identify areas of change. This includes cross-sections through the data and surface difference analysis.

4.1.2 Using the six key areas of analysis, the results of the survey demonstrate that, in general terms, no significant changes have been identified on the wreck between the September 2020 survey and the August 2019 survey conducted. The only area of change is on the rear gun platform where it appears that a section of the platform has dropped.

4.1.3 The SSRM wreck survey was conducted from 21 to 23 September by the EGS Watchful. Multiple passes were run across the wreck, in all practicable directions to ensure as complete a coverage as possible. The Norbit was operated in 700kHz mode for much of the wreck survey although the frequency was reduced to 400kHz for the masts as this allowed the Norbit to operate with a wider swath allowing data to be collected higher up the submerged portion of the masts. The dataset is of very good quality, allowing a thorough comparison with previous survey datasets. Historically there are certain areas on the starboard side of the wreck where full coverage is difficult to achieve due to the acute angle of the hull and this has proved to be the case on this survey also, however, sufficient data has been obtained over all the key areas of the vessel. Throughout this report, all point cloud images, and comparison profiles have been generated in Cloud Compare.

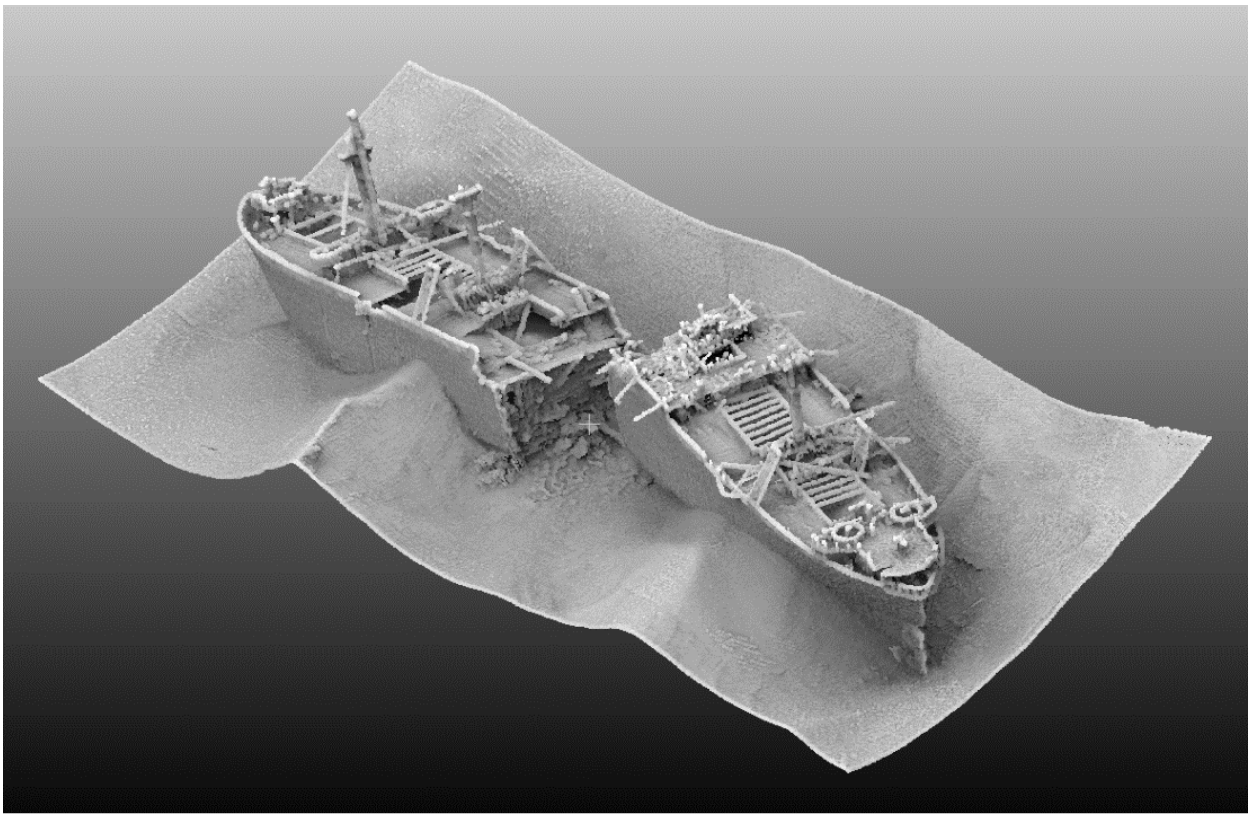

Figure 6 2020 Overview of port side of SSRM.

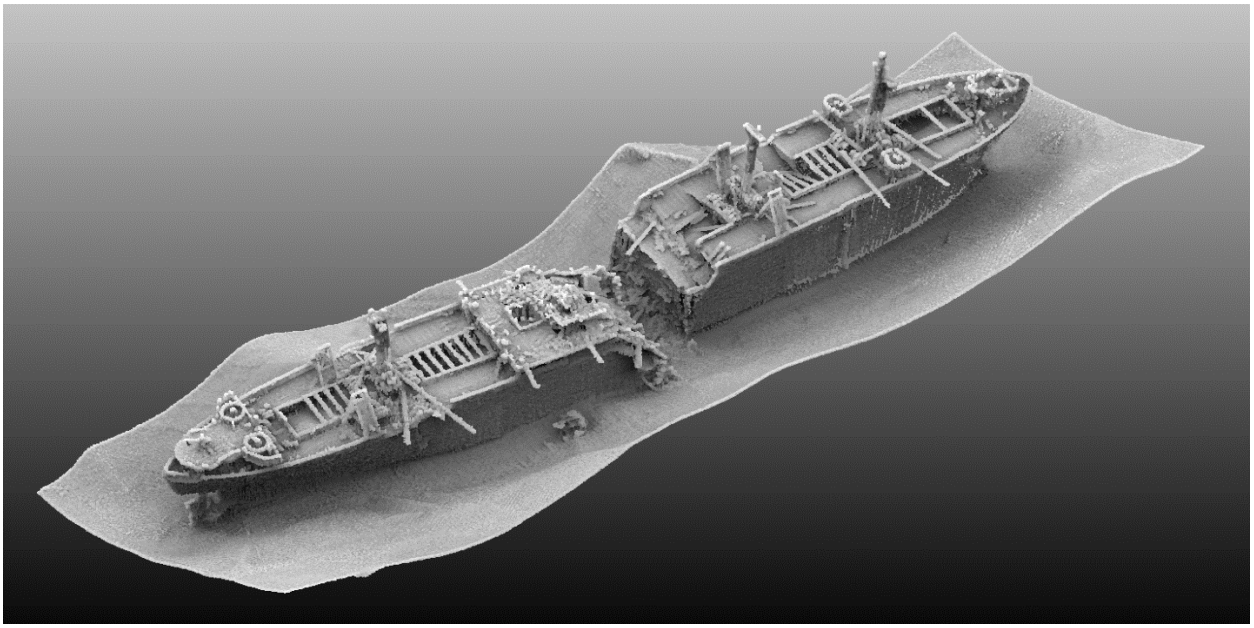

Figure 7 2020 Overview of starboard side of SSRM.

4.2 Wreck Profiles

4.2.1 Profiles of the hull were reviewed to monitor for any wreck movements or listing which may have occurred since the previous surveys.

4.2.2 The data shows good correlation between previous datasets with no change observed in the various profiles of the wreck. This suggests that the SSRM has remained stable in all planes of attitude and position, and any minor changes are attributed to small scale feature changes only.

4.2.3 **Bow Section**

4.2.4 In Figure 8 a cross section through the SSRM wreck overlaid on a sectional plan shows the extreme bulging outward of the hull plates on the starboard side of the bow section. Although this bulging does seem to have remained stable over the last few surveys, its extent is a cause for possible concern, and it is recommended that this area is included in all future reports as an area for particular study. Note that the starboard side is distorted in as well as out and the port side is also distorted in this area.

4.2.5 The bulge is limited to No. 2 hold and the form of the hull returns to normal at the bulkheads at either end, potentially due to the greater strength afforded to the hull by the presence of the bulkheads.

4.2.6 The forward hull appears to be buckling at the crack in No. 2 Hold with two distinct levels to the forward hull. Firstly, the rear part from the bulkhead at Frame 88 (the rear of No. 3 Hold) to the crack mid-way along No. 2 Hold (see Figure 9 below). Secondly, from the crack forward (see Figure 10).

4.2.7 It is likely that the crack, bulge and distortion to the ship’s upper deck all happened some time ago and no new movement has been apparent. As there is no indication of subsidence at the bow or stern it can be concluded that the split in the hull is not getting larger and the wreck seems to be stable.

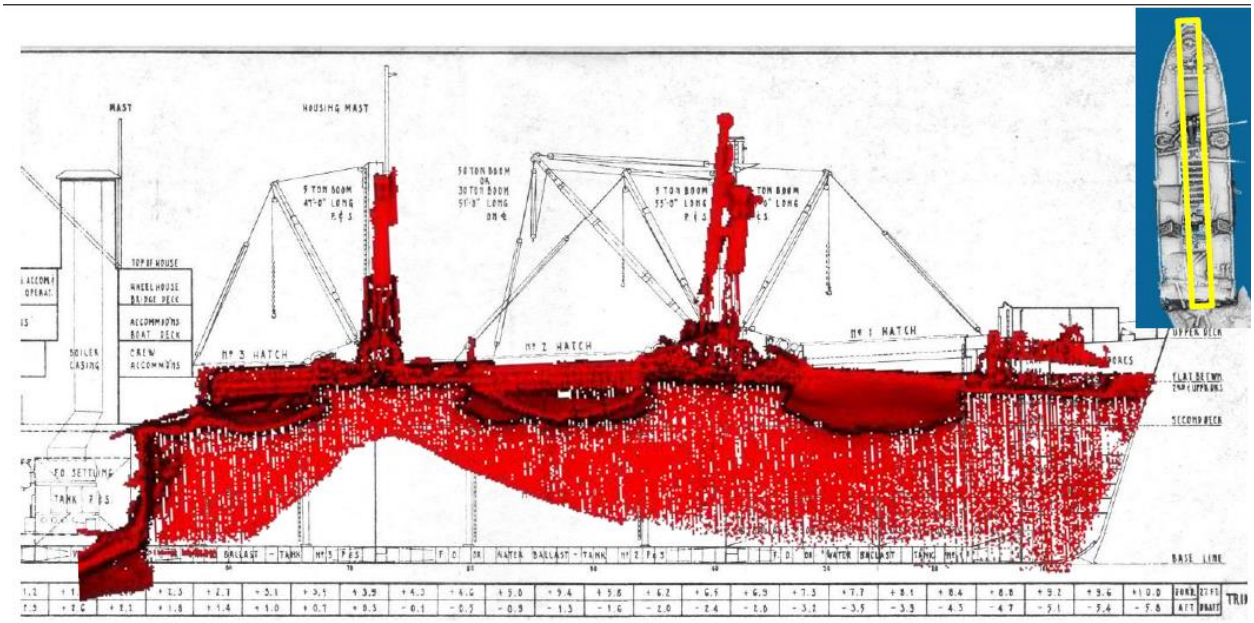

Figure 8 September 2020 Data overlain on ship's plan and oriented – rear alignment.

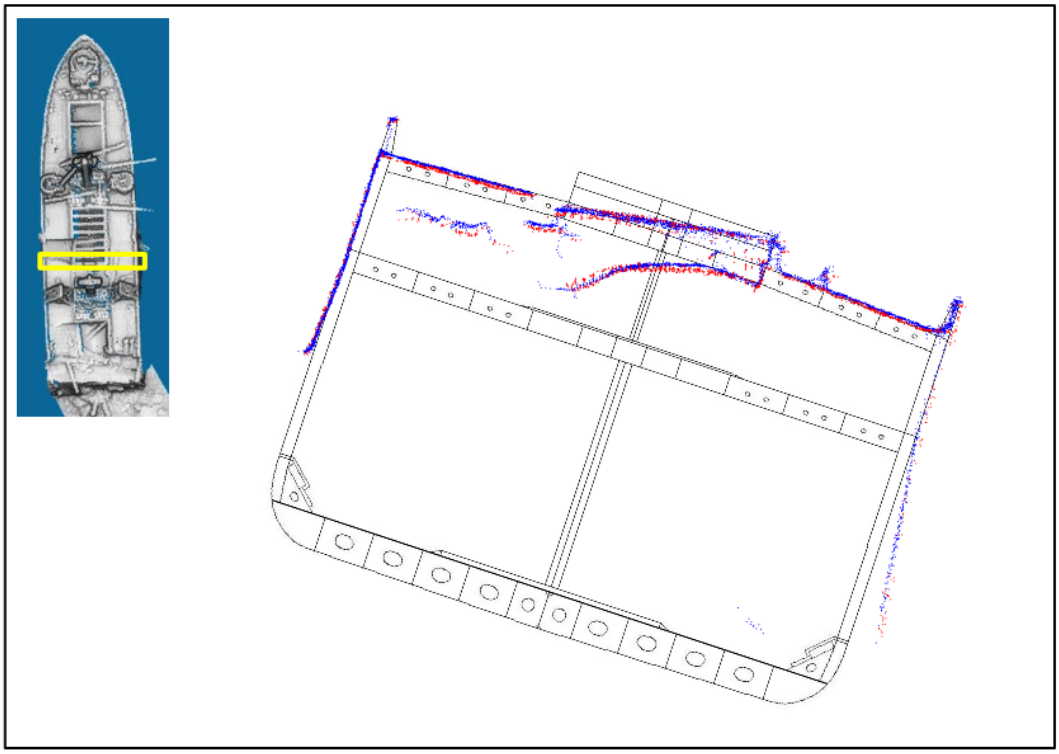

Figure 9 Cross section through the hull at frame 60, the aft end of No. 2 hatch. Blue 2017, red 2020.

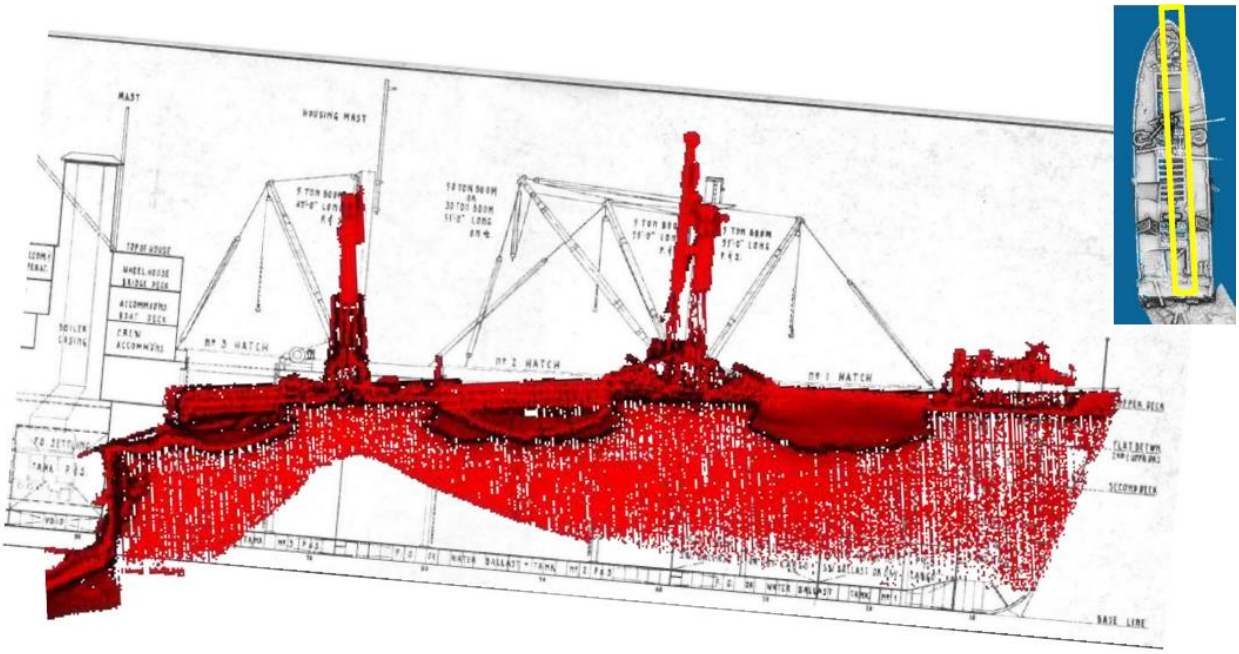

Figure 10 September 2020 Data overlain on ship's plan and oriented – front alignment.

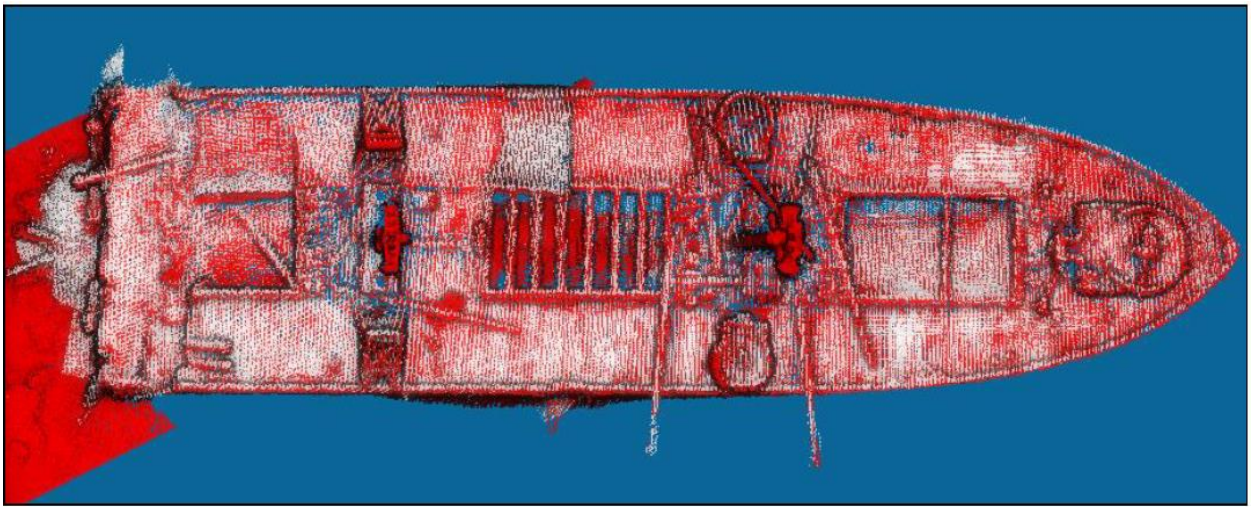

Figure 11 2020 data (red) and 2010 data (white) of the forward part of the wreck.

4.2.8 Stern Section

4.2.9 Like the forward section, the rear section is hogging and potentially breaking in two about halfway along its length. The split appears to be occurring just forward of the mast with the mast remaining upright with respect to the stern part as it drops away from the forward part (Figure 10). This observation, made in the last report is upheld by the current survey's data, with no appreciable change to how the wreck is lying.

4.2.10 In Figure 13 below, the 2020 survey data is presented with the 2010 survey data. The speckled red/white indicates that the two data sets agree, and that no movement has occurred. Areas of movement are the forward section of the superstructure (to the right of the image) which has collapsed quite a bit over the 10-year gap. Also, the section of decking adjacent to No. 4 Hold. This indicates that this section of decking has subsided over the 10 years probably related to the crack in the hull just forward of the mizzen mast. The crack in the hull was present in 2010 and seems not to have altered much.

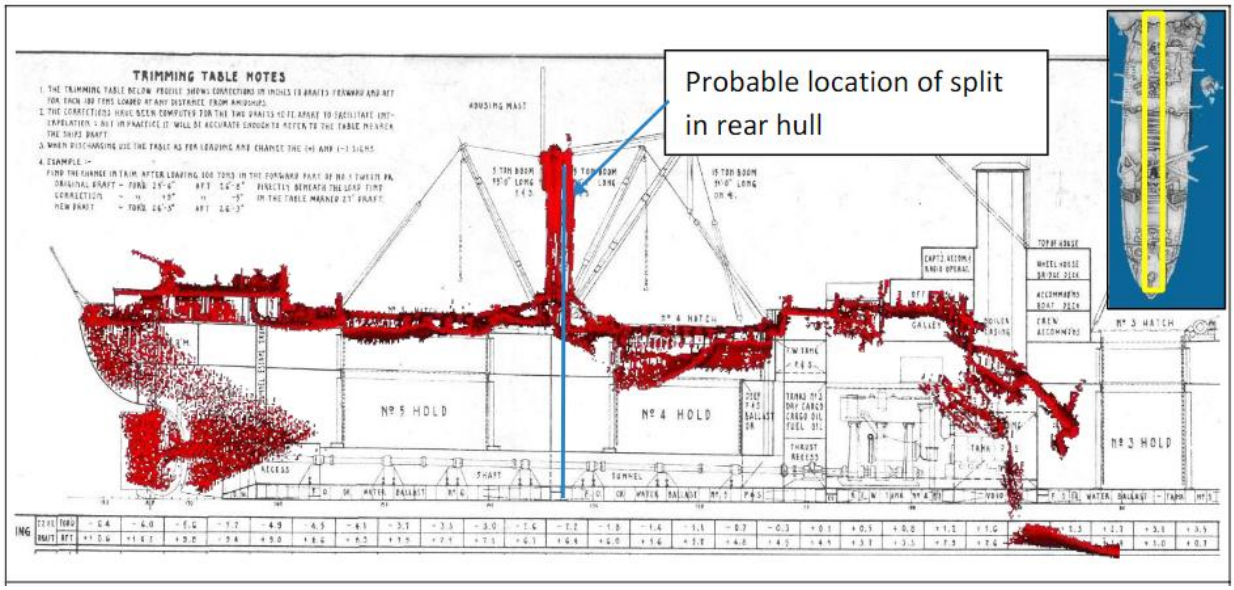

Figure 12 Image of Key Areas 4 and 5: severe splitting of hull showing a slight dip of the stern and the mast.

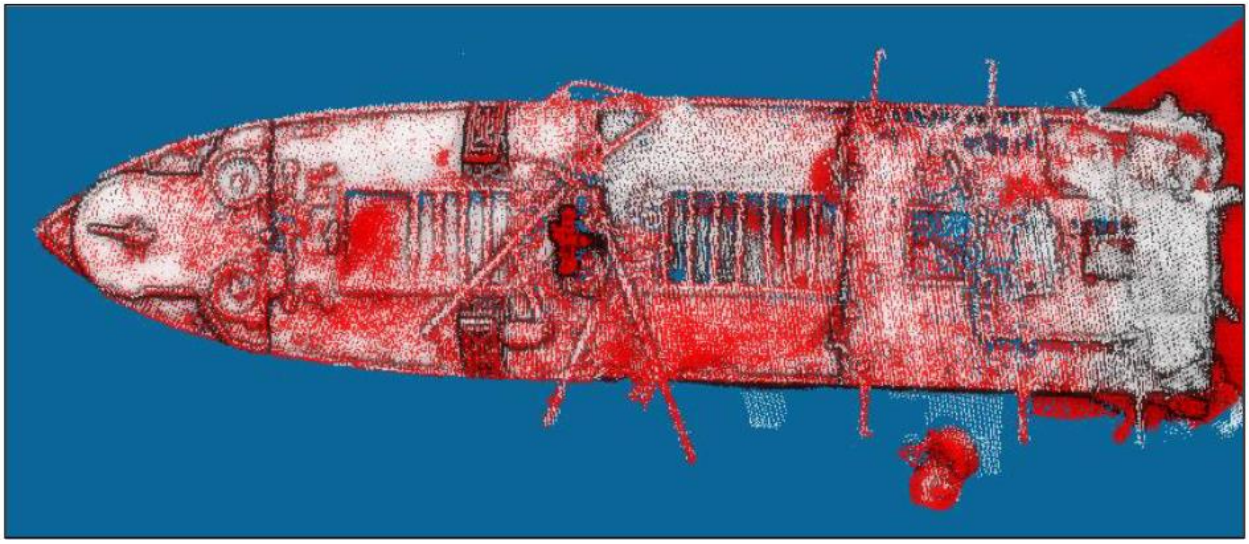

Figure 13 2020 data (red), 2010 data (white) of the stern part of the wreck.

4.3 Surface Difference

4.3.1 Surface differencing provides a useful tool in quickly assessing the general deterioration of the wreck. As described in Section 8.1, the accuracy of final processed data sets has been considered and the scale is graduated to reflect this by discounting any values less than +/-0.05m. No major areas are assessed to have undergone change between the August 2019 and September 2020 surveys.

4.3.2 The red and dark blue areas (indicating significant changes) occur only in areas of great height difference (e.g., the masts, ships sides and life raft support). These areas yield a large vertical difference due to small horizontal changes or the existence of noise in the data, not actual vertical change.

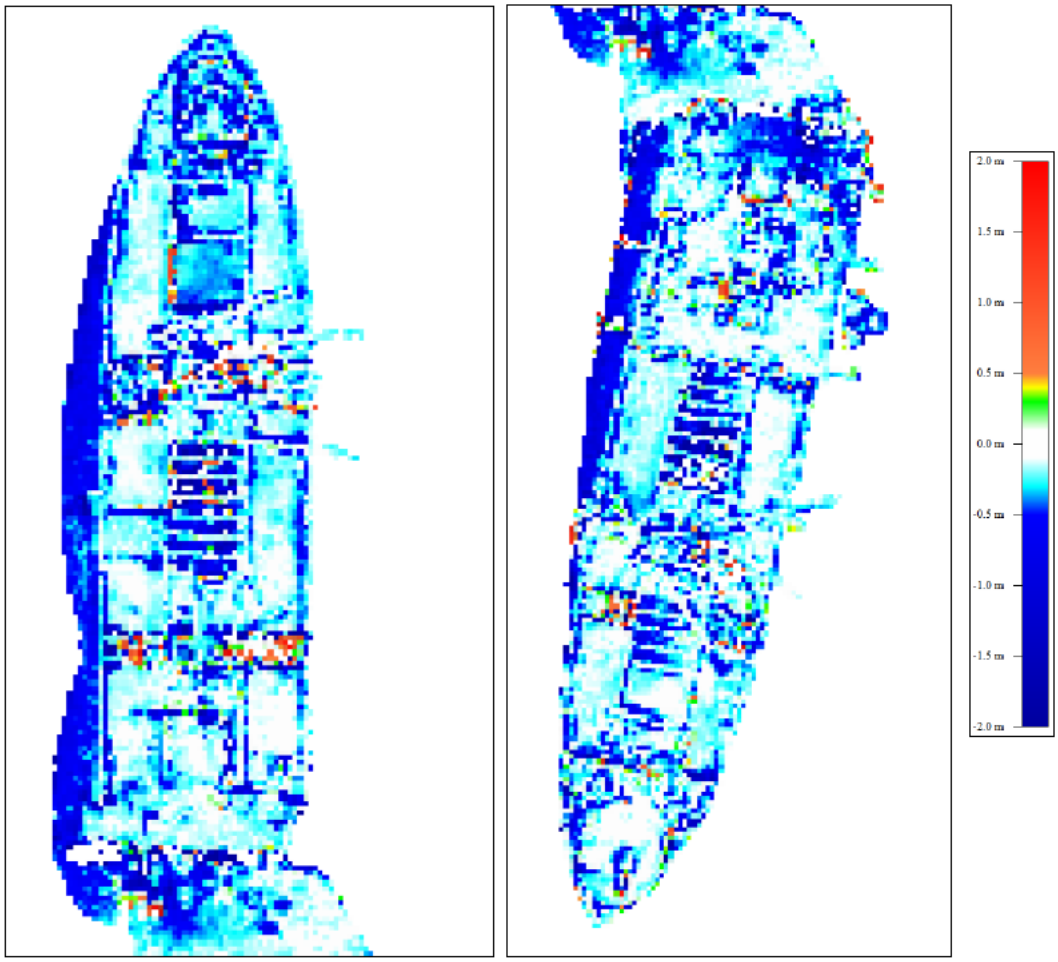

Figure 14 Forward section (L) and stern section (R) surface difference results September 2020 - August 2019.

4.4 List of Features

4.4.1 Over the whole of the wreck, 96 specific features have been used in successive surveys as comparison points for quantifying change and deterioration (*Table 2 List of features*). The location of these features is given in Figure 15 and Figure 16.

4.4.2 All feature IDs detailed in this report are consistent with those from previous survey. Three features showing change have been identified at ID15, ID51 and ID 86 between the August 2019 survey and the September 2020 survey These are described in detail below.

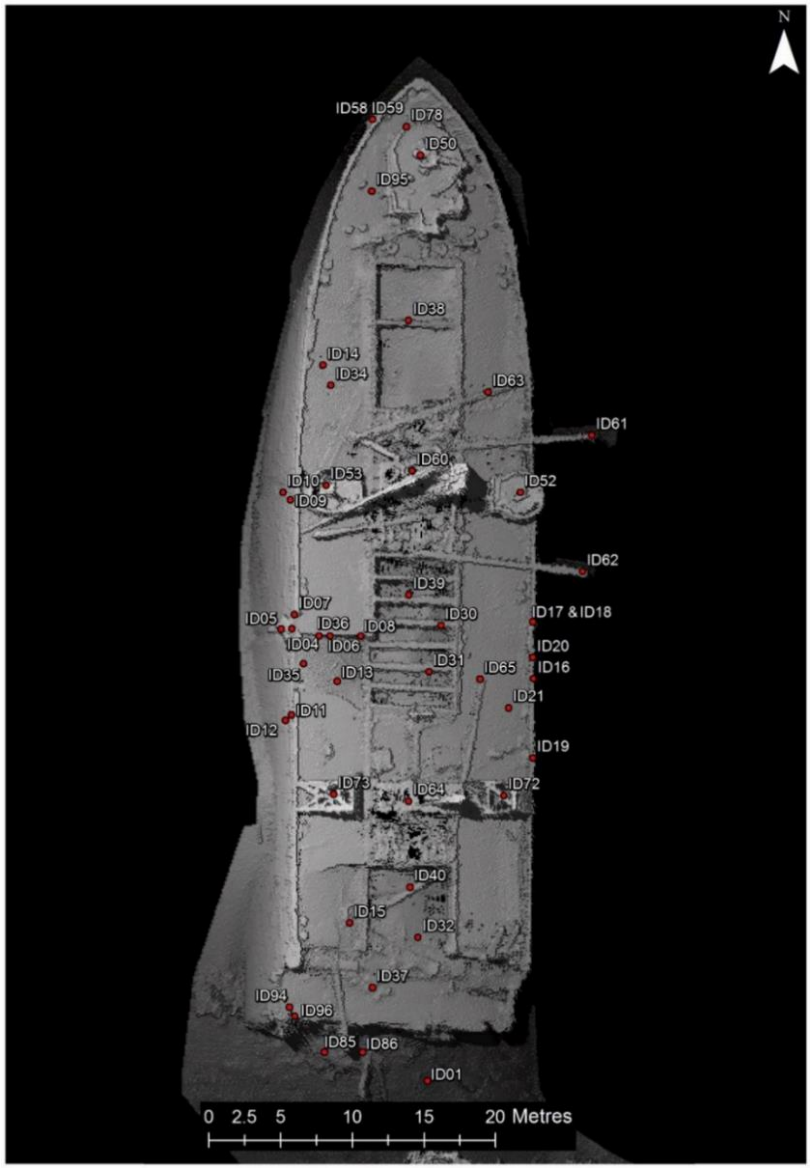

Figure 15 ID features on forward section.

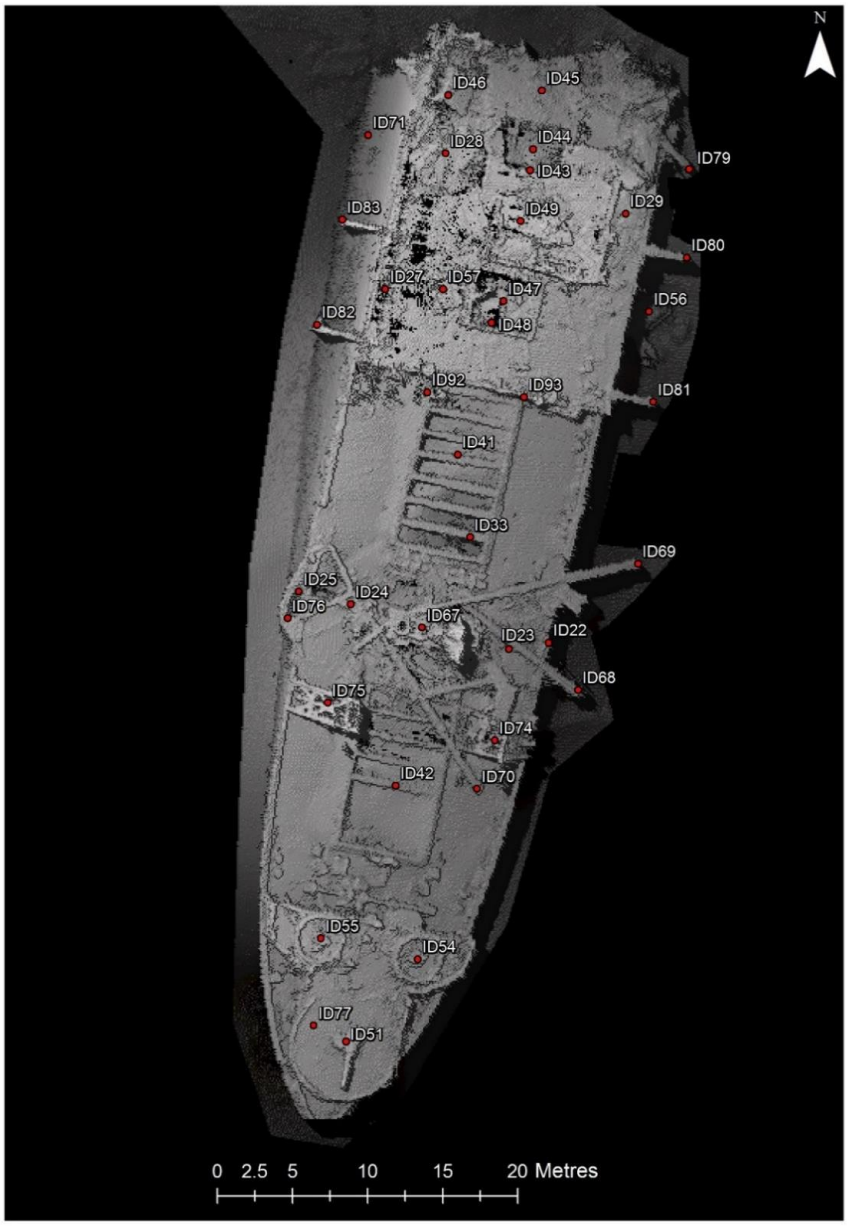

Figure 16 ID features on aft section.

Table 2 List of features.

Number	Feature	Location	2019 Status
ID01 ID02 ID03	Separation of the hull in two sections Forward section Aft Section	Wreck site	No change observed
ID04	Crack in hull (Key Area 1)	Port side, forward section	No change observed
ID05	Severe buckling of hull plating	Forward end, port side near Hold 2	No change observed
ID06	Split in deck	Forward end, port side near Hold 2	No change observed
ID07	Break in gunnel	Portside Hold 2	No change observed
ID08	Collapse of Hold 2 deck (Key Area 2)	Port side, forward section	No change observed
ID09 ID10	Severe buckling of hull plating Buckling of hull plating	Port side Hold 2	No change observed
ID11	Hole in hull plating	Forward section, port side	No change observed
ID12	Buckling of hull plating	Port side Hold 2	No change observed
ID13	Holes in deck plating	Portside Hold 2	No change observed
ID14	Holes in deck plating	Port side Hold 1	No change observed
ID15	Collapse of deck and hatch coaming	Portside Hold 3	Port side of hatch coaming has dropped by approximately 0.6m since 2017
ID16	Horizontal crease in hull plating	Stbd side Hold 2	No change observed
ID17	Hole in hull plating	Fwd side, by Hold 2	No change observed
ID18	Severe vertical discontinuity of hull plating	Fwd side, by Hold 2	No change observed
ID19	Severely horizontal buckling of hull	Stbd side Hold 2	No change observed
ID20	Large hole in hull plating	Fwd side, by Hold 2	No change observed
ID21	Bends in deck plating	Stbd side Hold 2	No change observed

Number	Feature	Location	2019 Status
ID22	Split in hull (Key Area 4)	Starboard side, aft section (near aft mast house)	No change observed
ID23	Split in deck plating	Aft section, starboard side	No change observed
ID24 ID25	Split in deck Split in hull (Key Area 5)	Aft section, port side.	No change observed
ID26	Holes in bulwarks		No change observed
ID27	Holes in boat deck	Port side aft section	No change observed
ID28	Collapsed boat deck	Starboard side aft mast	No change observed
ID29	Boat deck missing above walkway	Stbd side, aft section, (forward end)	No change observed
ID30 ID31	Hole in lower hold cover Collapse of lower hold cover	Hold 2	No change observed
ID32	Collapse of lower hold cover	Hold 3	No change observed
ID33	Collapse of lower hold cover	Hold 4	No change observed
ID34	Indications of tween deck cargo	Stbd side, Hold 1	No change observed
ID35 ID36	Indications of tween deck cargo	Port side, Hold 2	No change observed
ID37	Indications of tween deck cargo	Hold 3	No change observed
ID38	Hold 1 catch supports	Hold 1	No change observed
ID39	Hold 2 catch supports	Hold 2	No change observed
ID40	Hold 3 catch supports	Hold 3	No change observed
ID41	Hold 4 catch supports	Hold 4	No change observed
ID42	Hold 5 catch supports	Hold 5	No change observed
ID43 ID45 ID46	Boiler room casing Collapsing bridge deck (Key Area 6) Collapsing boat deck	Forward end, aft section	No change observed

Number	Feature	Location	2019 Status
ID47 ID48	Engine room skylight & casing	Central Superstructure	No change observed
ID49	Gunnery officer's cabin	Aft section, central bridge block	No change observed
ID50	Forward gun & gun tub	Bow	No change observed
ID51	Stern gun & gun tub	Stern superstructure	Collapse of small section of stern gun deck approximately 0.9m wide by 2.5m long.
ID52 ID53	20mm gun tubs	Adjacent to fore mast	No change observed
ID54 ID55	20mm gun tubs-stern superstructure	Stern superstructure	No change observed
ID56	20mm gun tubs – laying on seabed	Starboard side aft section	No change observed
ID57	20mm gun tubs-upturned on boat deck	Central superstructure	No change observed
ID58	20mm gun tubs	Aft	No change observed
ID59	Port anchor	Port side, bow	No change observed
ID60	Foremast and mast house	Forward section	No change observed
ID61 ID62 ID63	Foremast cargo and handling booms	Forward section	No change observed
ID64 ID65 ID66	Main mast and mast house	Forward section	No change observed
ID67 ID68 ID69 ID70	Mizzen mast & mast house	Aft section	No change observed
ID71	Bilge keel	Port side, forward and aft sections	No change observed
ID72 ID73 ID74	Life raft racks	Adjacent to main mast Adjacent to Hold 5	No change observed
ID76	Anti-torpedo net cage	Port side, mizzen mast	No change observed

Number	Feature	Location	2019 Status
ID77	Propeller and rudder	Stern	No change observed
ID78	Forefoot	Bow	No change observed
ID79	Lifeboat davit	Stbd side, aft section (forward end)	No change observed
ID80 ID81	Lifeboat davits	Starboard side, aft section	No change observed
ID82 ID83	Lifeboat davits	Portside aft section	No change observed
ID84	Lifeboat davit		No change observed
ID85 ID86	Debris on seabed	Gap between forward and aft	Pipes sticking out from bulkhead have dropped a small amount
ID87	Debris on seabed		No change observed
ID88	Debris on seabed		No change observed
ID89	Debris on seabed		No change observed
ID90	Small targets to west		No change observed
ID91	Scour pattern to west		
ID92	Port and starboard lighting towers	Central superstructure	No change observed
ID93	Starboard side lighting tower	Aft rail of boat deck on accommodation block	No change observed
ID94	Aperture in Hold 3 exposing cargo of bombs	At the aft end of the forward section	No change observed
ID95	Bow section	Bow	No change observed
ID96	Aperture (Key Area 3)	Aft end, forward section	No change observed

4.4.3 **ID 15 Collapse of Deck and Hatch Coaming**

4.4.4 The port side coaming of the No. 3 hold hatch has collapsed a short way, the movement is shown in Figure 17 below and indicated by the red oval. The collapse is approximately 0.6m between the 2017 and 2020 surveys and seems to be caused by the coaming rotating clockwise (when viewed from the stern).

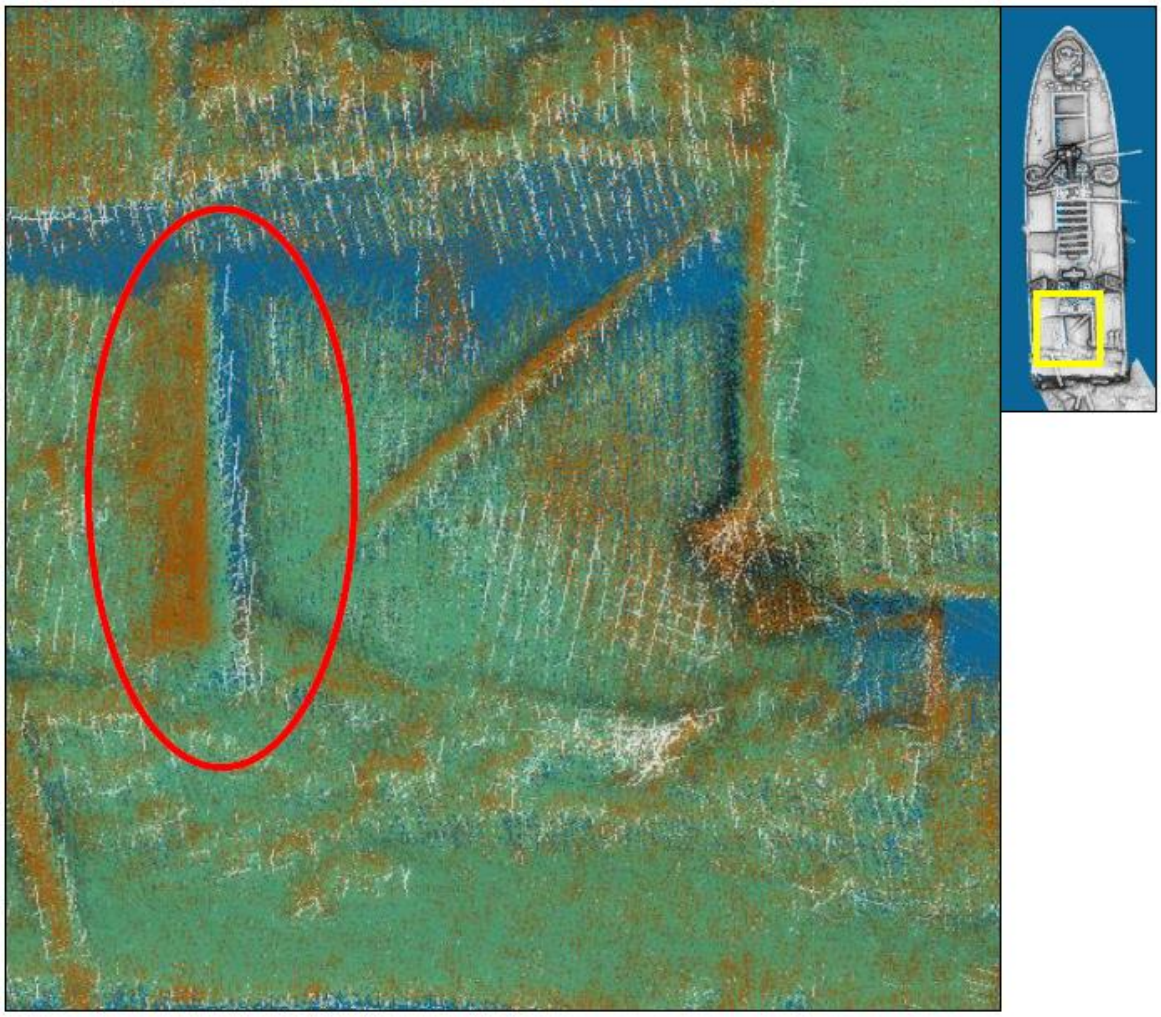

Figure 17 No.3 hatch showing movement of hatch coaming. Brown 2017, green 2019, white 2020.

4.4.5 **ID51 Stern Gun and Gun Tub**

4.4.6 A small section of the rear gun deck has collapsed. The section is approximately 0.9m wide by 2.5m long. This is a new change from the 2019 survey. The 2019 and 2017 surveys showed no change. The small section that has dropped remains attached at its inboard edge, but the outboard edge has dropped so it rests on the lower deck and now forms a ramp up to the rear gun deck. It is indicated by the red oval in Figure 18 below.

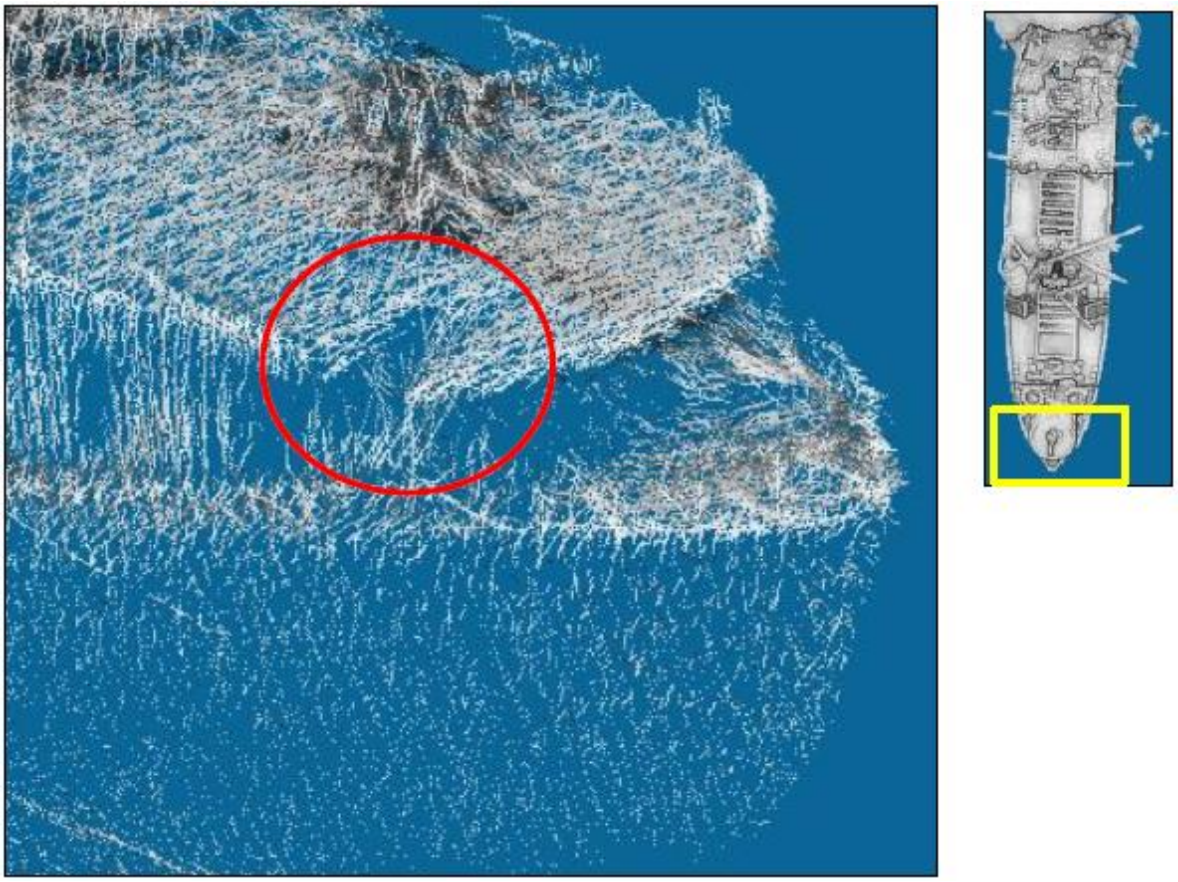

Figure 18 Small collapse on the rear gun deck. 2020 data.

4.4.7 ID86 Debris on Seabed

4.4.8 Two suspected pipes that stick out from the bulkhead at the rear of No. 3 Hold have tilted down a short distance. The pipes were very well ensonified in the 2017 survey and again in the 2020 survey. However, they were only partially detected in the 2019 survey. The lower of the two pipes is slightly indistinct so has been highlighted with solid lines in Figure 19 to show how it has moved. Again, the 2019 survey only partially ensonified the pipe.

4.4.9 The upper pipe, which extends approximately 2.5m out from the bulkhead, appears to have rotated about its forward end so the unsupported rear end has dropped by approximately 1m.

4.4.10 The lower pipe, which is of similar dimensions, has also apparently rotated about its forward end so the unsupported rear end has dropped by approximately 0.5m. Both of these measurements are between the 2017 and 2020 surveys.

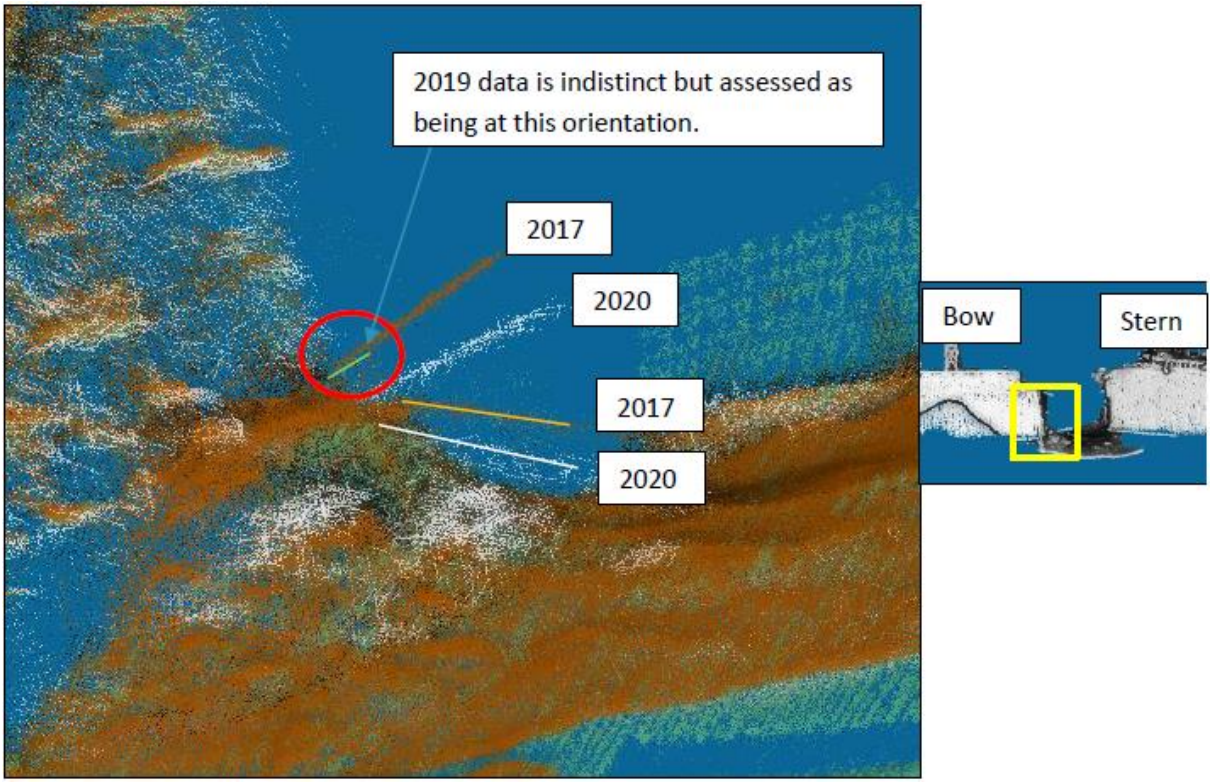

Figure 19 The 'pipes' in the gap between bow and stern sections. Brown 2017, green 2019, white 2020.

4.5 Key Areas

4.5.1 In addition to the 96 features, six Key Areas that have been highlighted in previous surveys as areas of significant structural change are monitored in each survey (Figure 20).

4.5.2 No changes were identified in any of the Key Areas, however these areas are further described below.

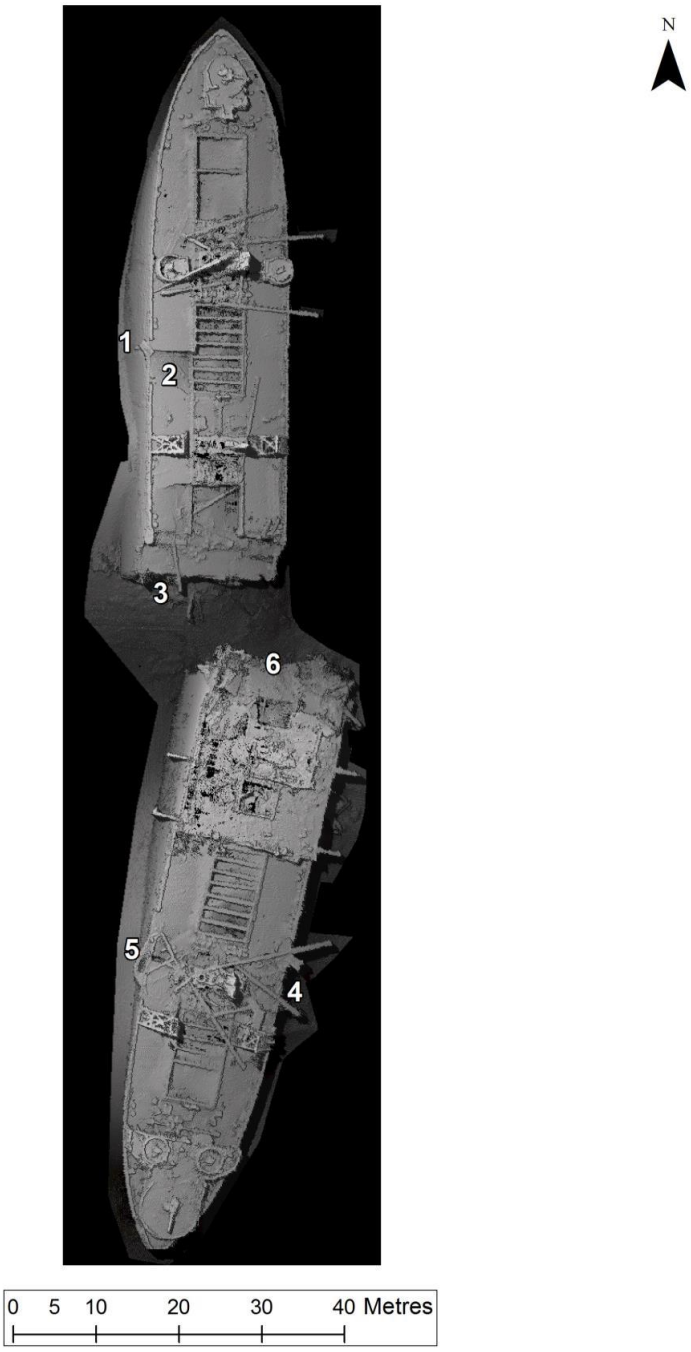

Figure 20 Location of the 6 Key Areas described in this section.

4.5.3 Key Areas 1 & 2 (ID04 & ID08) – crack in hull and partial collapse of cargo hold deck (port side)

4.5.4 The forward section of the SSRM is hogging around frame 53 almost exactly halfway along the No. 2 Hold Hatch. This hogging has resulted in a crack appearing on the upper part of the port side while the lower part of the starboard side is significantly buckled giving the appearance that the forward

part of the wreck is splitting in two and pivoting about the starboard rim of Hold 2 on both the port and starboard sides as well as significant deformation of the hull sides, particularly on the starboard side. The flexing of the upper deck has caused a portion of the upper deck and half of the No. 2 hatch cover supports to collapse through into the ‘tween deck space. (Figure 21 and Figure 22)

4.5.5 There is no change in these areas between the 2019 and 2020 datasets.

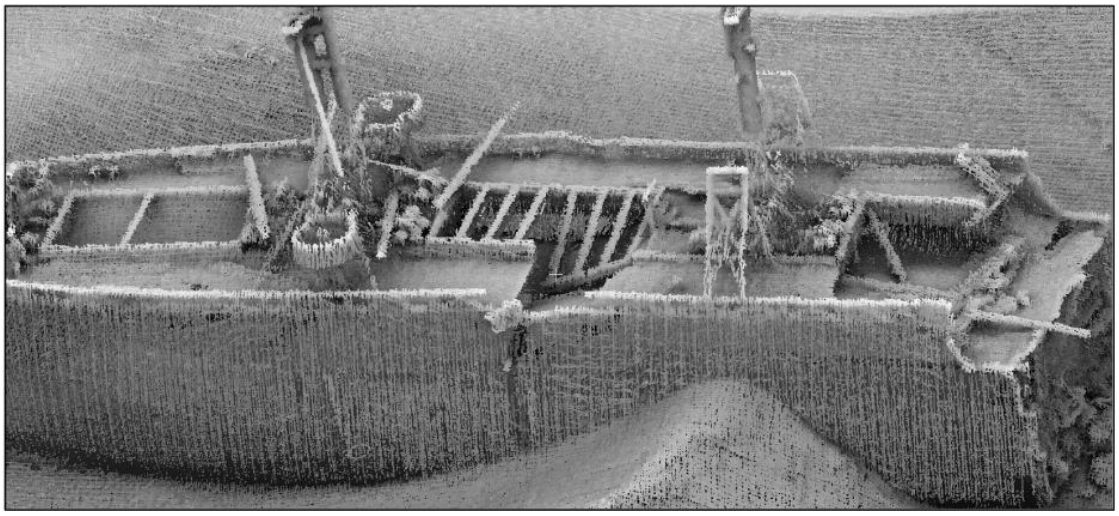

Figure 21 Crack in Hull (ID04) and collapsed upper deck (ID08) overview in the 2020 dataset.

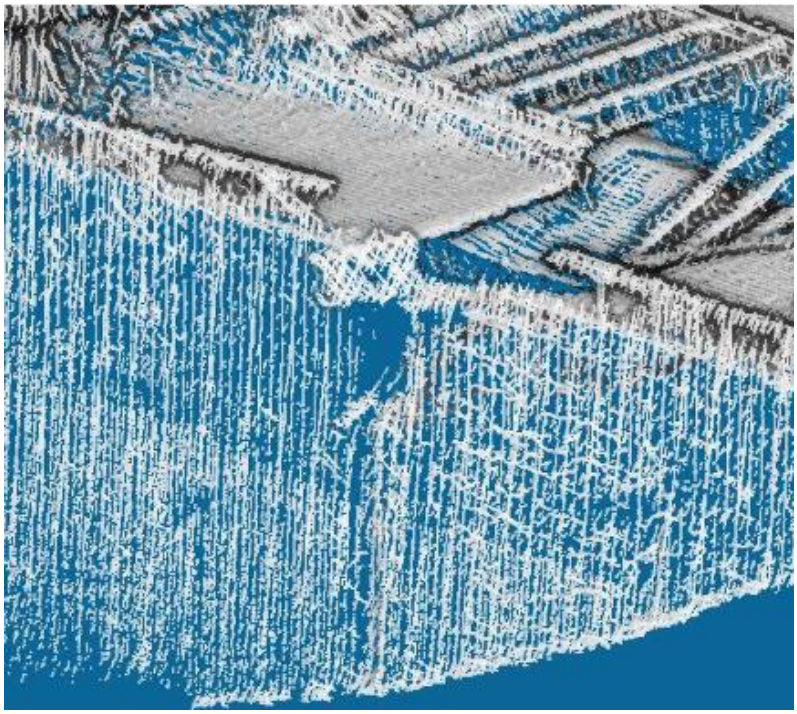

Figure 22 Image of Key Area 1, crack in hull.

4.5.6 **Key Area 3 (ID96) – Port side aperture**

4.5.7 The port side apertures are located at the aft part of the forward section of the SSRM. The apertures on the bulkhead at frame 88 at the aft end of the forward section are clearly visible in the 2020 dataset although there are no appreciable differences between this survey and the 2017 data (Figure 23).

4.5.8 A Cloud Compare profile, illustrated in Figure 24, shows the September 2020 and August 2019 data overlaid on a plan of the oil and watertight bulkhead at frame 88 (the rear of No. 3 Hold). The apertures in the bulkhead occur where the plates have corroded away but frequently leaving the stringers in place (the dashed vertical lines in the plan). Note that the second stringer from the left has fallen away. Also note the absence of the upper part of the bulkhead that would have formed the rear end of the No. 3 Hold ‘tween deck storage area. This was carried away with the stern section of the wreck when the two halves separated.

4.5.9 Whilst returns were obtained from objects through the aperture the quality of the returns is poor, so it is not possible to identify what the objects are. The data collected during September 2020 shows very similar dimensions to what was gathered during 2019. However, whether the returns are from cargo in the hold or sediment surrounding them cannot be ascertained.

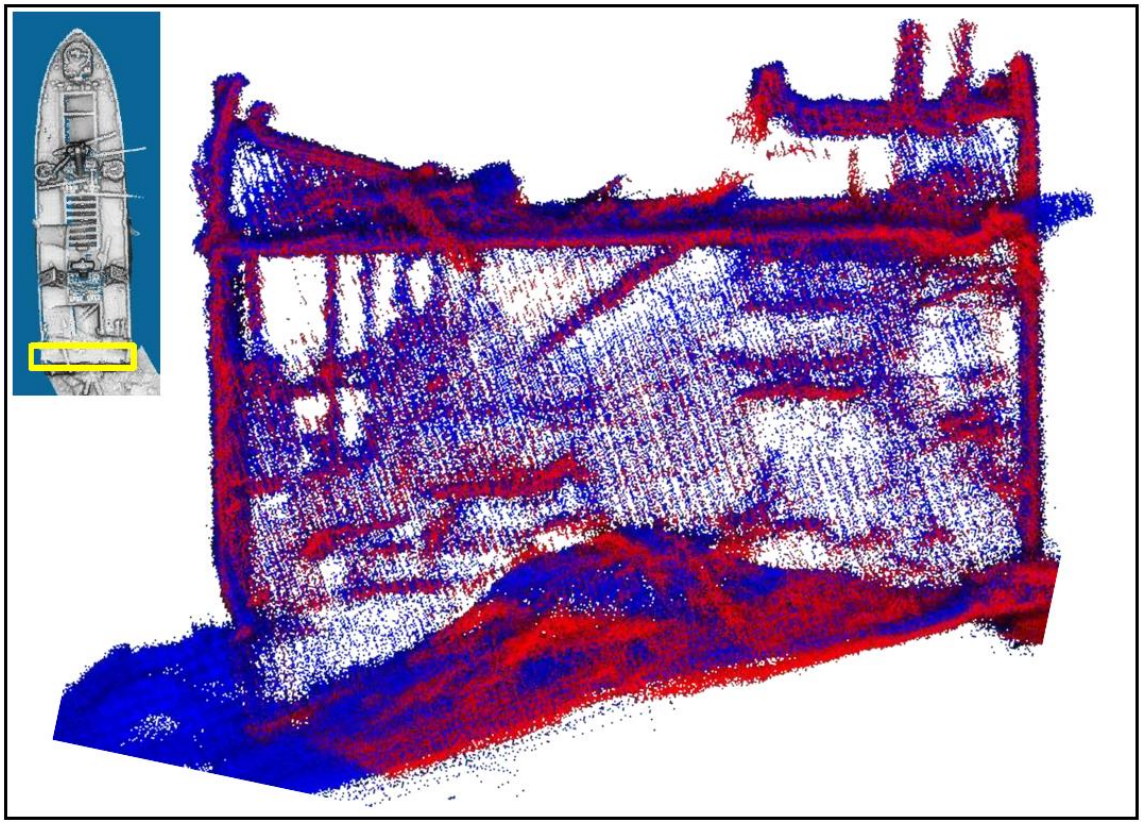

Figure 23 Aperture in the bulkhead to rear of No. 3 Hold. Blue 2017, red 2020.

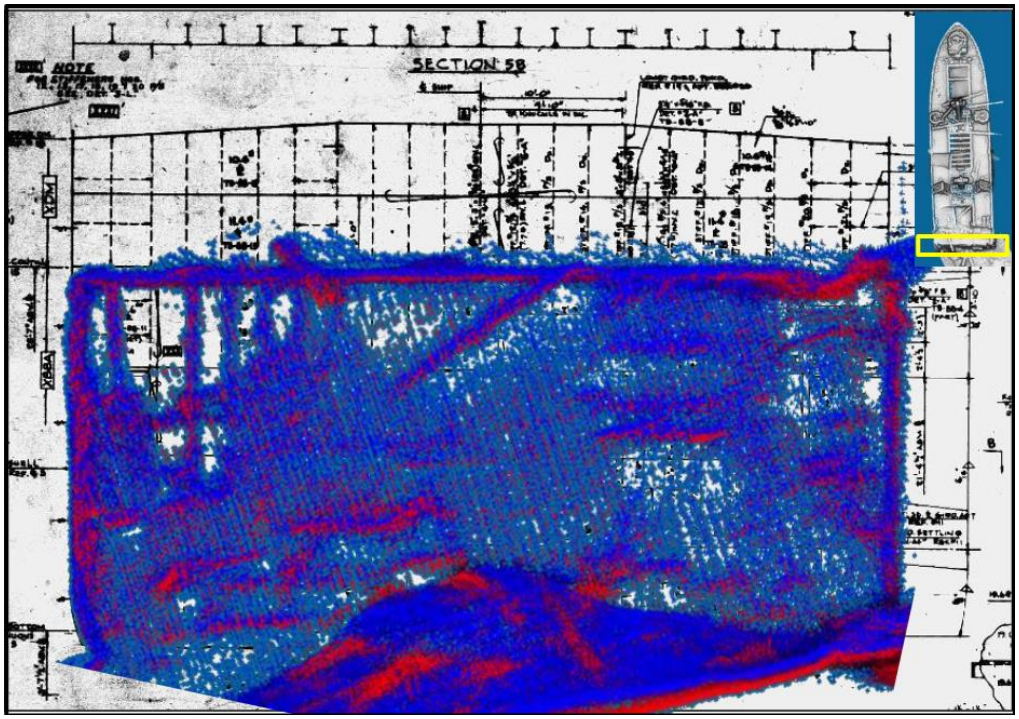

Figure 24 2019 and 2020 data on plan of the bulkhead at frame 88 (rear of No. 3 Hold) blue 2017, red 2020.

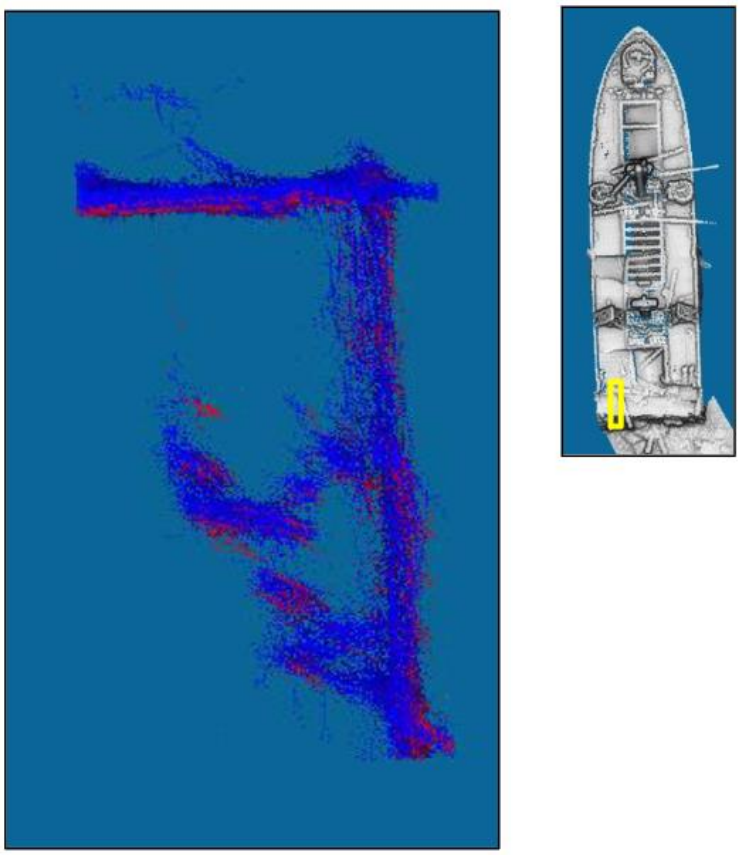

Figure 25 Returns of content through hold aperture, blue 2017 red 2020.

4.5.10 **Key Areas 4 & 5 (ID22 and ID24 & ID25) – Splitting of hull, and split in deck and hull.**

4.5.11 Key Areas 4 and 5 represent the two ends of the same feature, namely a transverse crack across the rear hull section at about frame 134, the bulkhead between Nos. 4 and 5 holds.

4.5.12 The crack just forward of the mizzen mast has resulted in a large part of the deck plating subsiding into the ‘tween deck space over time. This subsidence appears to be continuing slowly with a small difference noted between the August 2017 survey and the September 2020 survey as can be seen in Figure 26 below. However, no change has occurred between the August 2019 and September 2020 survey.

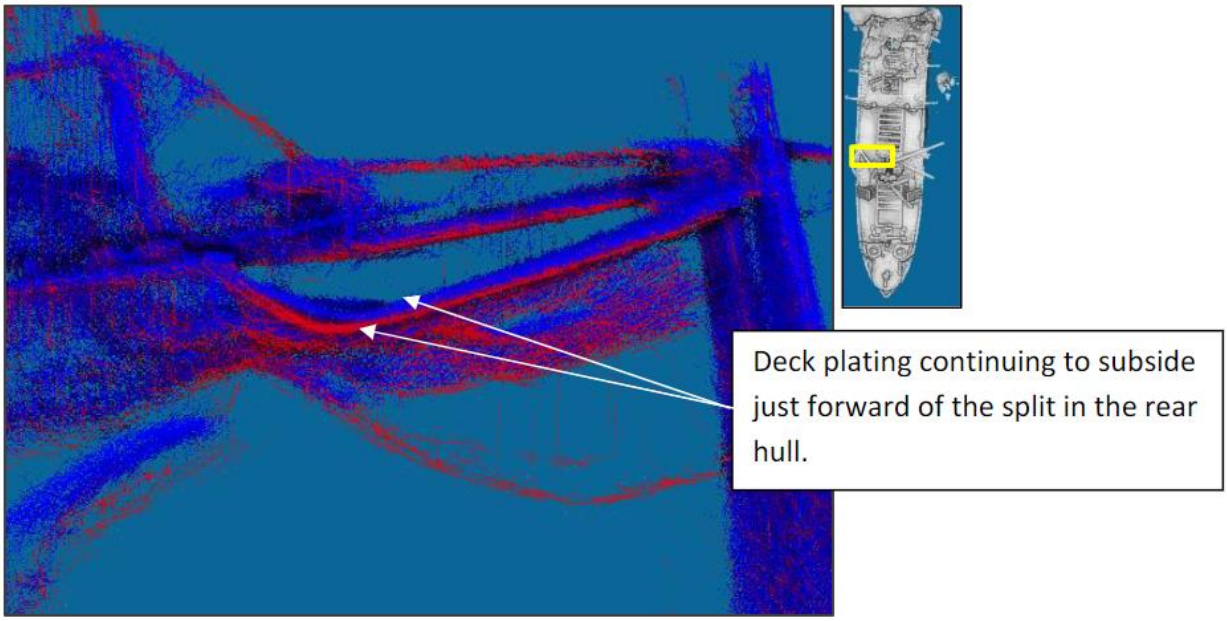

Figure 26 Looking rearward at the crack, 2020 (red), 2019 (blue).

4.5.13 **Key Area 6 (ID43, ID45, ID46) – Collapsing bridge deck.**

4.5.14 The collapsing bridge deck area. This area was left unsupported when the ship broke in two back in 1944. Consequently, it has been badly affected by wave and current action and is steadily collapsing and falling into the gap between the two halves of the vessel. This area has showed significant degradation in earlier surveys. However, although there is some evidence of continued collapse, the difference between the September 2020 data and the August 2019 data is only very minor.

4.5.15 The area is difficult to survey accurately as the large number of angular protrusions create numerous echoes and multi path returns, creating a large amount of noise which makes discrimination of real features hard. For this reason, the presence, or absence, of a given feature, especially internal structures within the void, are not conclusive of the actual feature existing or not. The main upper surface is more robust, and it is this area that has been used to assess the change in this region.

4.5.16 Figure 27 below shows a transverse profile across the bridge deck area. Although the 2020 data is slightly deeper than the August 2019 the change is minimal.

4.5.17 Figure 28 below shows a longitudinal cross section through the collapsing bridge deck area. The white (2010), blue (2019) and red (2020) points along

the long unsupported section of deck show how this section has collapsed over the 10 years. The variations within the void may be artefacts created by the very complex environment in this area for MBES data acquisition.

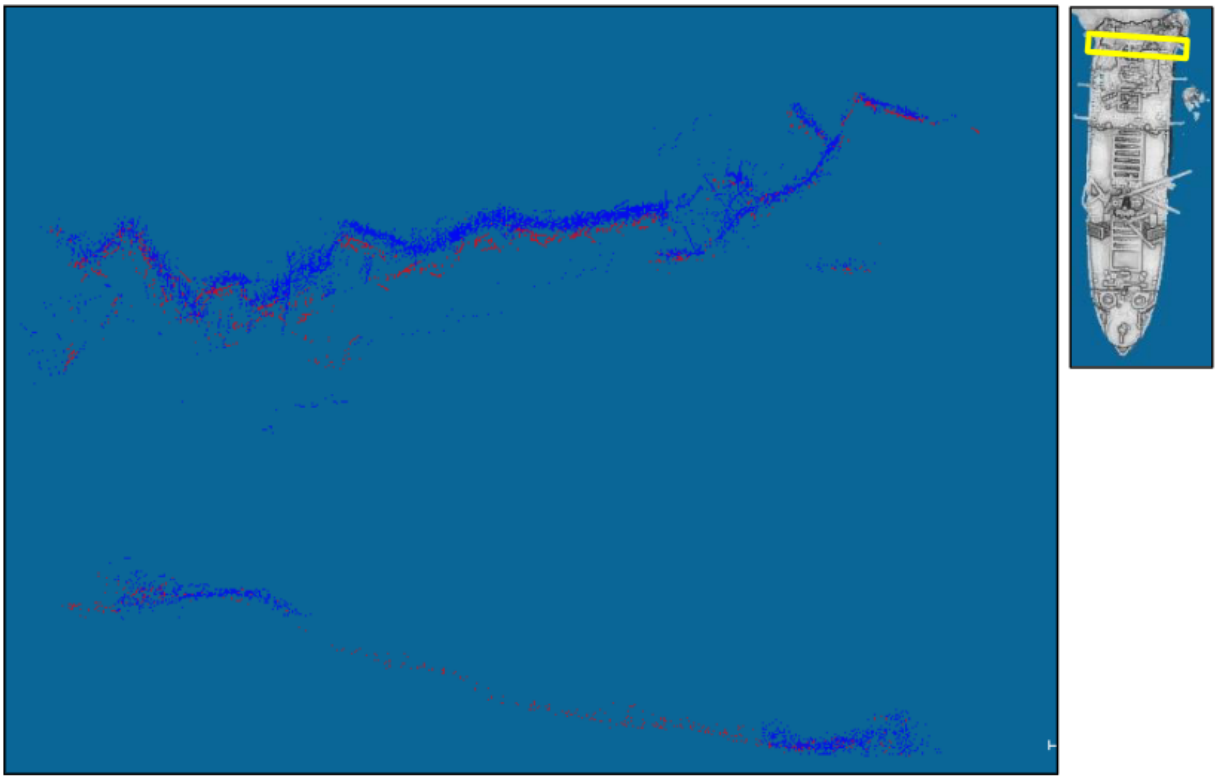

Figure 27 Key Area 6: collapsing bridge deck area. 2020 (red) 2019 (blue).

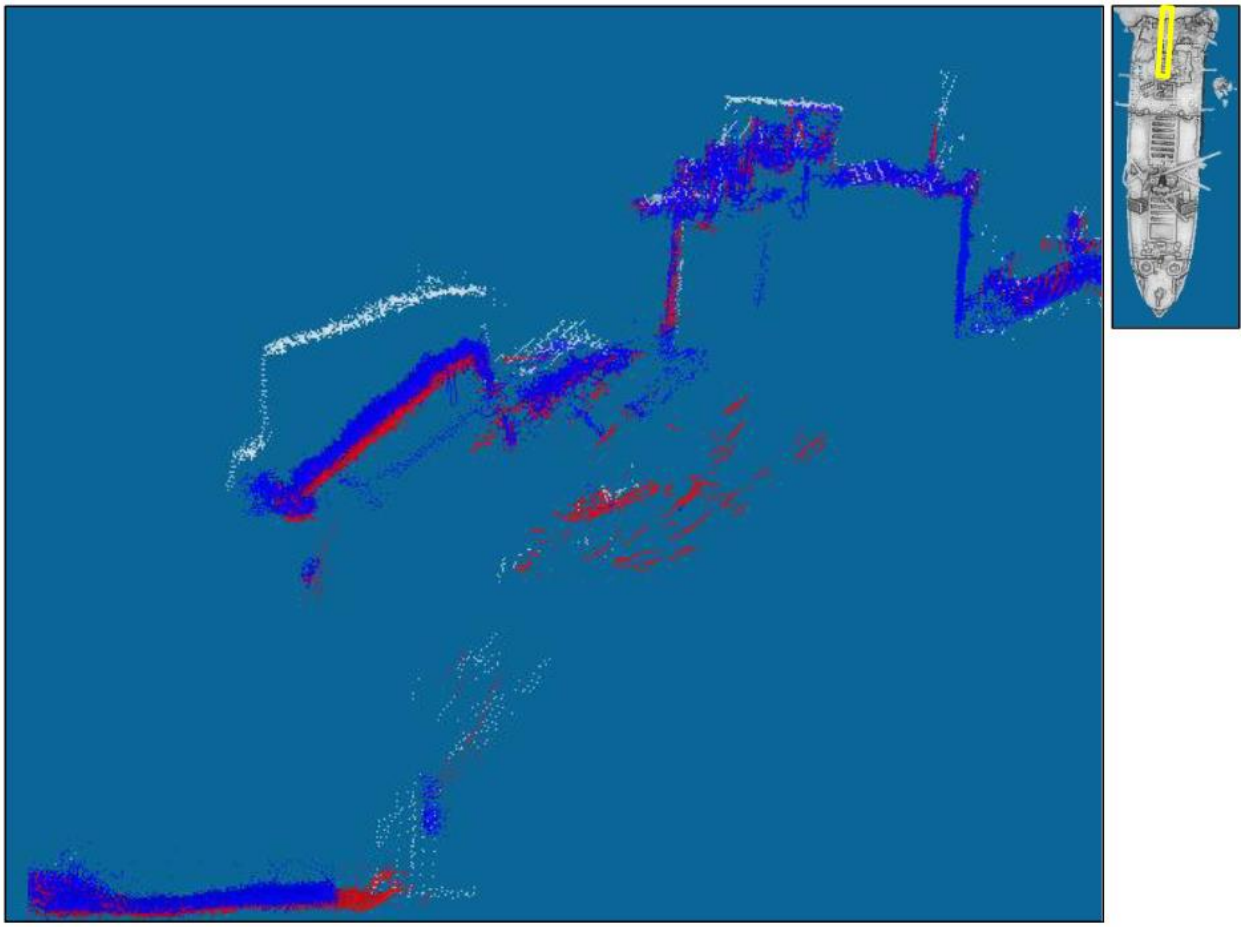

Figure 28 Longitudinal cross section through forward end of rear section. White 2010, blue 2019, red 2020.

4.6 Debris Between Hull Sections

4.6.1 Apart from the changes to the two pipes sticking out from the bulkhead at the back of No. 3 Hold there are no appreciable differences between the August 2019 and September 2020 data sets in this area.

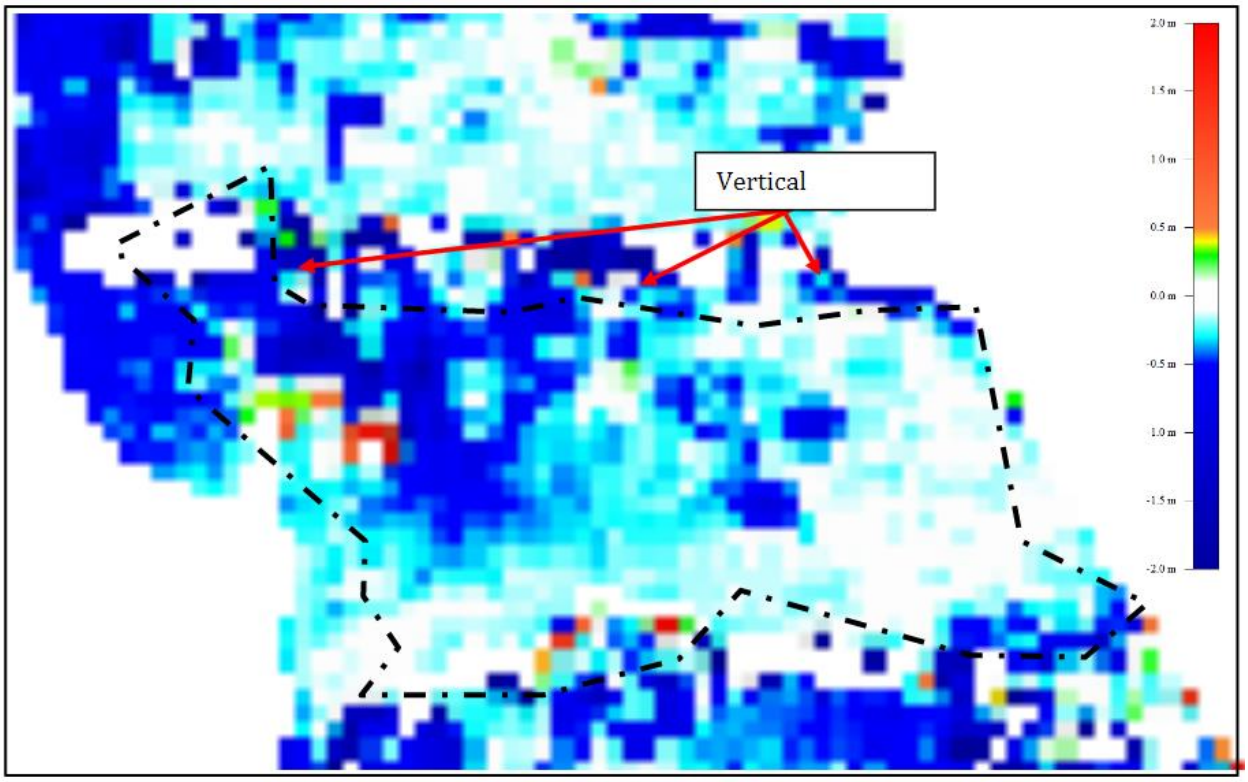

Figure 29 - Surface difference between September 2020 survey and August 2019 data.

4.7 Cargo Holds

4.7.1 When the SSRM grounded, it was carrying some 6,127 imperial tons of cargo, mainly munitions. Of these, 2,954 tons were salvaged from the rear two holds (Nos 4 and 5 Holds) and a small portion from the No 3 Hold ‘tween deck space.

4.7.2 The small portion salved from the No 3 Hold ‘tween deck space was the 2 tons of bursters leaving 86 tons of fuses in 1,522 wooden cases and 117 tons of fin assemblies in 11,230 metal crates in this space. It is likely that the cylindrical debris seen in this area in previous surveys are some of the metal crates holding the tail fin assemblies.

4.7.3 All the holds on Liberty Ships are divided into a ‘tween deck area located between the Upper Deck and the Second Deck and the Lower Hold underneath the Second Deck. Hatch covers cover both the hatch on the Upper Deck and the opening through the Second Deck into the Lower Hold. Except for No. 4 Hold, all the sediment visible through the hatch openings is in the ‘tween deck space and not the lower hold.

4.7.4 Cargo was carried in the Lower Holds, in the ‘tween deck spaces and also on the Upper Deck. Contemporary records indicate that the SRRM held cargo in all holds and all ‘tween deck spaces but only carried a very small amount on the Upper Deck.

Hold 1:

4.7.5 Hold 1 is the forward most of the five holds on the Liberty Ship and, in addition to the ‘tween deck space and the Lower Hold, Hold 1 also contained a third layer of storage at the bottom of the Lower Hold known as the Deep Tanks in which additional cargo or ballast could be carried.

4.7.6 The hatch cover is missing as are all but one of the hatch cover supports. Sediment has settled in the ‘tween deck space to a considerable depth, filling the starboard side to the top of the starboard side hatch coaming. The port side remains clear above the horizontal from the hatch coaming. Apart from some undulations in the sediment surface this is indicative of all the sediment visible in the data as imaged through the open hatch.

4.7.7 Notably there is no indication that the second deck has collapsed. There is no indication that the second deck hatch covers have collapsed, although it is an unlikely possibility, they have and that sediment has filled both the ‘tween deck area and the Lower Hold.

4.7.8 No appreciable difference is evident between the data sets for the 2017 and September 2020 surveys. The sediment level to the front of Hold 1 is remarkably similar. At the rear end there has been a small amount of erosion to the sediment in the ‘tween deck space although the general profile of the sediment remains the same.

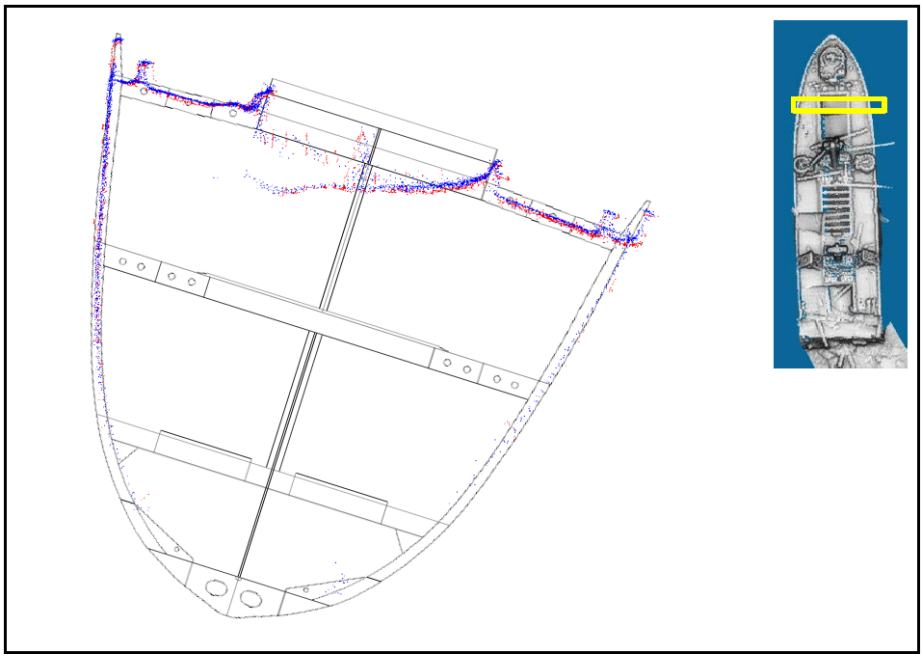

Figure 30 Cross section through the hull at frames 17-18 at the forward end of No. 1 hatch. Blue 2017, red 2020.

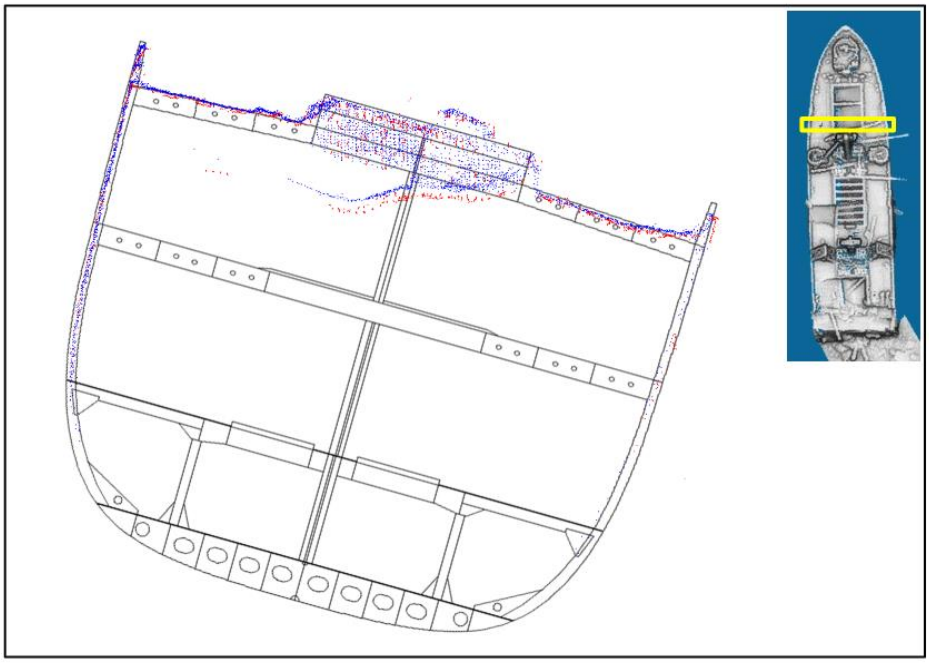

Figure 31 Cross section through the hull at frame 32, the aft end of No.1 hatch. Blue 2017, red 2020.

Hold 2:

4.7.9 The second from forward hold. As with Hold 1, the outer hatch cover is missing although all the cover supports are in place. The forward section of the wreck is splitting at frame 54, nearly mid-way along No. 2 Hatch, and this has resulted in part of the Upper Deck collapsing into the ‘tween deck space bringing the connected hatch coaming and hatch cover supports with it. Sediment is visible through the open No. 2 Hatch and similarly to hold 1, the sediment has filled the ‘tween deck space to a considerable depth. Again, there is no indication that the second deck or the lower hatch covers have failed as there is no indicative slump in the sediment. (Figures 32, 33 and 34).

4.7.10 There is a large bulge in the lower hull of the ship’s side around frame 54.

4.7.11 The sediment in the holds has remained relatively stable over the last several years. Small fluctuation in the depth occurs but essentially the ‘tween deck space is filled to the same extent, seemingly limited by the sediment reaching the height of the lower hatch coaming after which, presumably, it is washed away. Note the deformation of the hull side to the right of Figure 34. This is part of the bulge mentioned earlier that extends for the entire length of hold 2. This is also the location of the maximum hull deformation on the starboard side. However, this deformation currently seems to be stable, not having increased over the last several years.

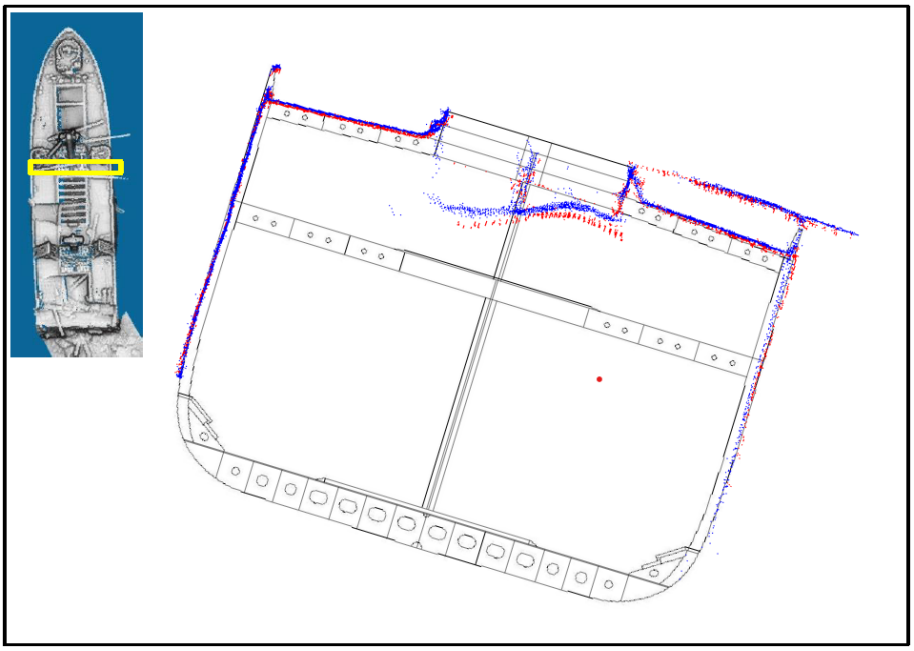

Figure 32 Cross section through the hull at frame 46, the forward end of No.2 Hatch. Blue 2017, red 2020.

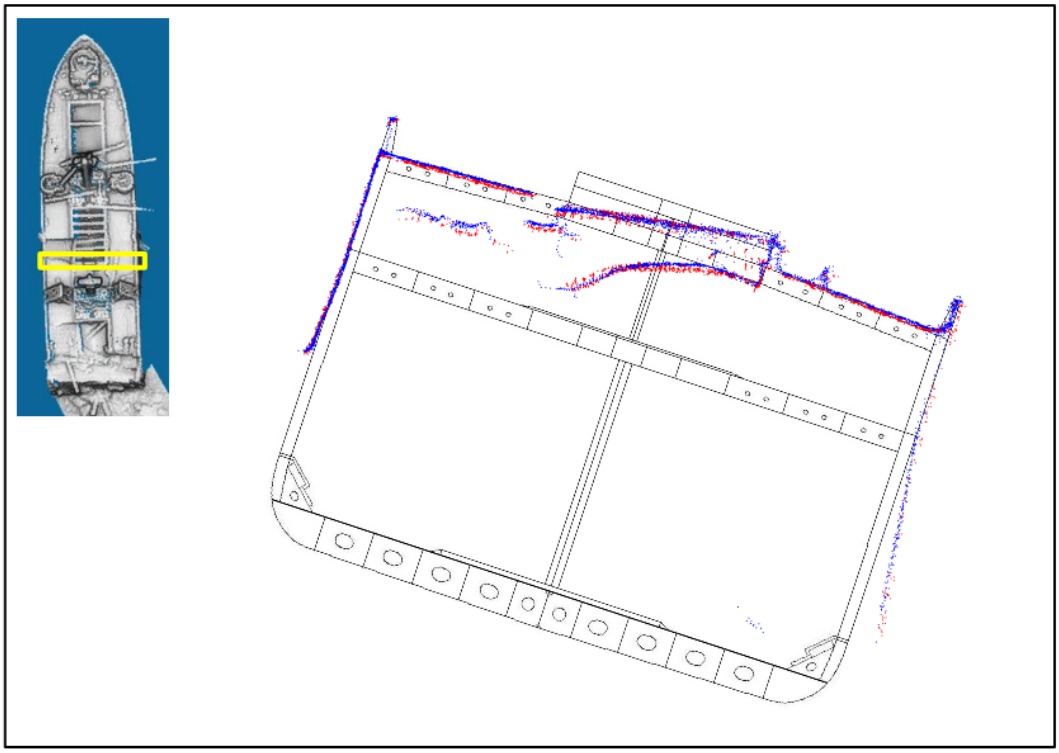

Figure 33 Cross section through the hull at frame 60, the aft end of No. 2 Hatch. Blue 2017, red 2020.

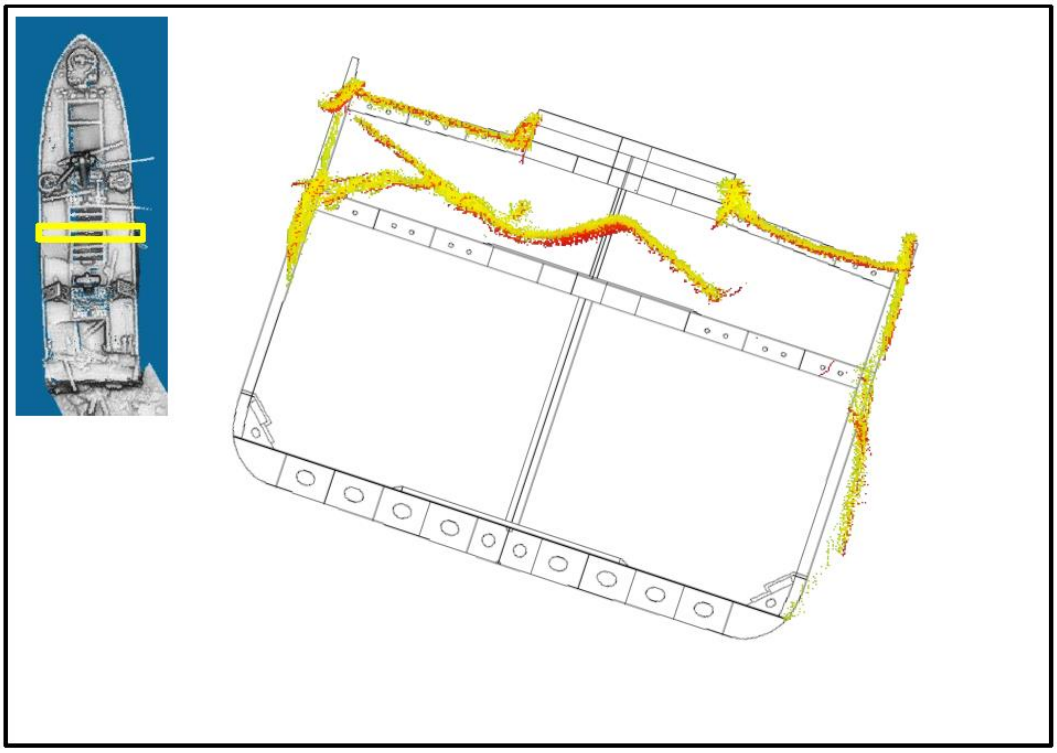

Figure 34 Cross section through the hull at about frame 54 where the forward section is cracking. Yellow 2019, red 2020.

Hold 3:

4.7.12 The rearmost hold of the forward section. The rear bulkhead of this hold forms the rear of the forward section, the vessel having broken in two immediately aft of that bulkhead. Although the lower hold remained with the forward section, the bulkhead at the rear of the ‘tween deck space and the section of the upper deck above it were carried away leaving this area open. The outer hatch cover has gone as have all the cover supports although there is a beam – possibly a cover support or part of the coaming lying on the starboard side. (Figure 35).

4.7.13 Sediment accumulation is largely limited to the forward part that still retains the protection of the Upper Deck and, in common with all the forward holds there is no evidence that the Second Deck or the cover leading to the lower Hold have collapsed. All sediment layers are higher than the second deck with no indicative slumps.

4.7.14 The rear end of No. 3 Hatch shows very close agreement between the last few surveys. The only difference (although not readily visible in the data above) is the port coaming of No. 3 Hatch (to the left in the image above) which has fallen away from the deck and now lies a small distance below where it was in 2019.

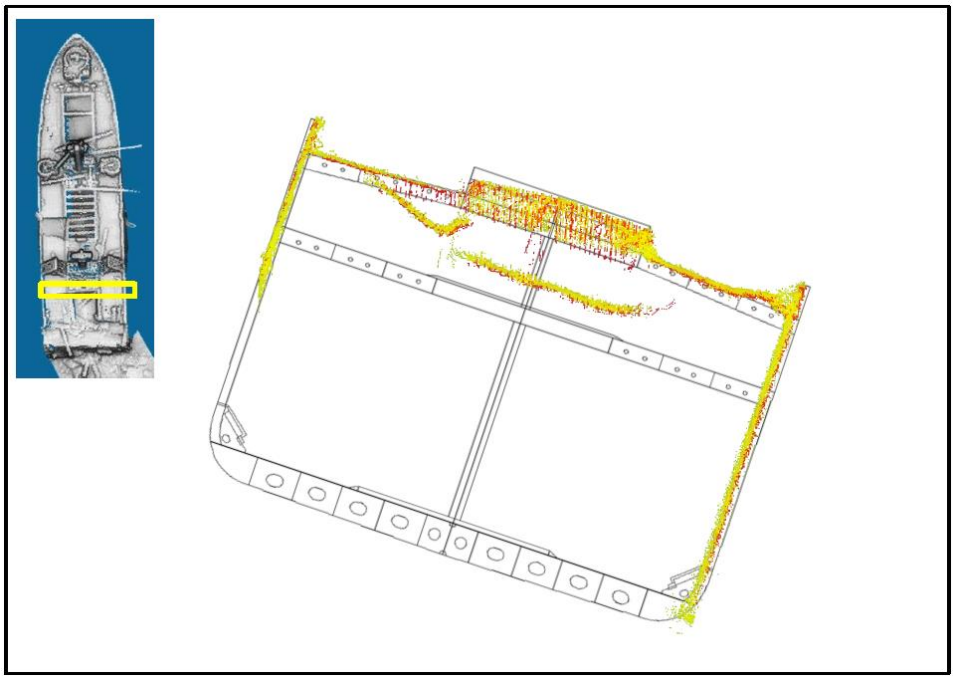

Figure 35 Cross section through the hull at frame 73, the forward edge of No. 3 Hatch. Yellow 2019, red 2020.

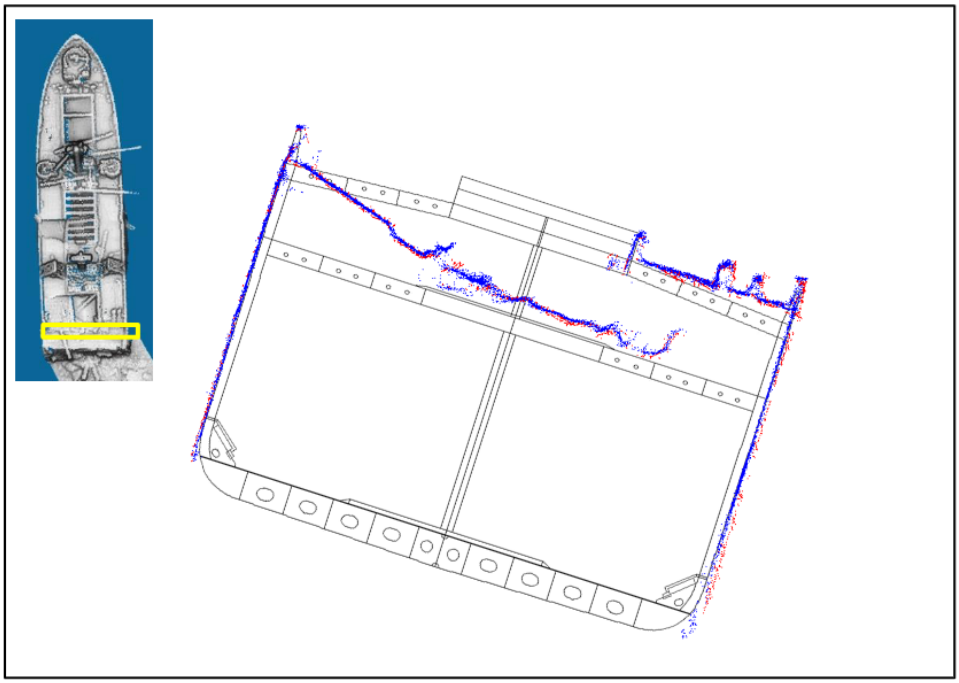

Figure 36 Cross section through the hull at frame 82, the aft end of No. 3 Hatch. Blue 2017, red 2020.

Hold 4:

4.7.15 The most forward of the two holds in the stern section. Since the two stern holds are reported to have been emptied during salvage operations conducted soon after the grounding, it is not known if the lower hatch covers were replaced. However, since the upper hatch supports are in place it seems likely that the salvors did replace the covers once they were finished.

4.7.16 The sediment in the forward part of No. 4 Hatch shows distinct similarities with that in Nos 1 and 2 Hatches with the starboard side of the 'tween deck space being filled and the port side remaining clear above the horizontal to the top of the hatch coaming (Figure 36). However, the rear of the hatch area shows a different story with the first (and only) indication that the Second Deck or the lower hatch covers have failed. Here the sediment layer descends below the level of the Second Deck (Figure 37) confirming some form of collapse, probably a partial collapse of the lower hatch cover. This has happened at some time between 2010 (where the survey showed the sediment above the Second Deck) and the 2017 survey where the sediment is just below the second deck. The sediment deepened slightly between the 2017 survey and the August 2019 survey but has remained largely static between August 2019 and September 2020.

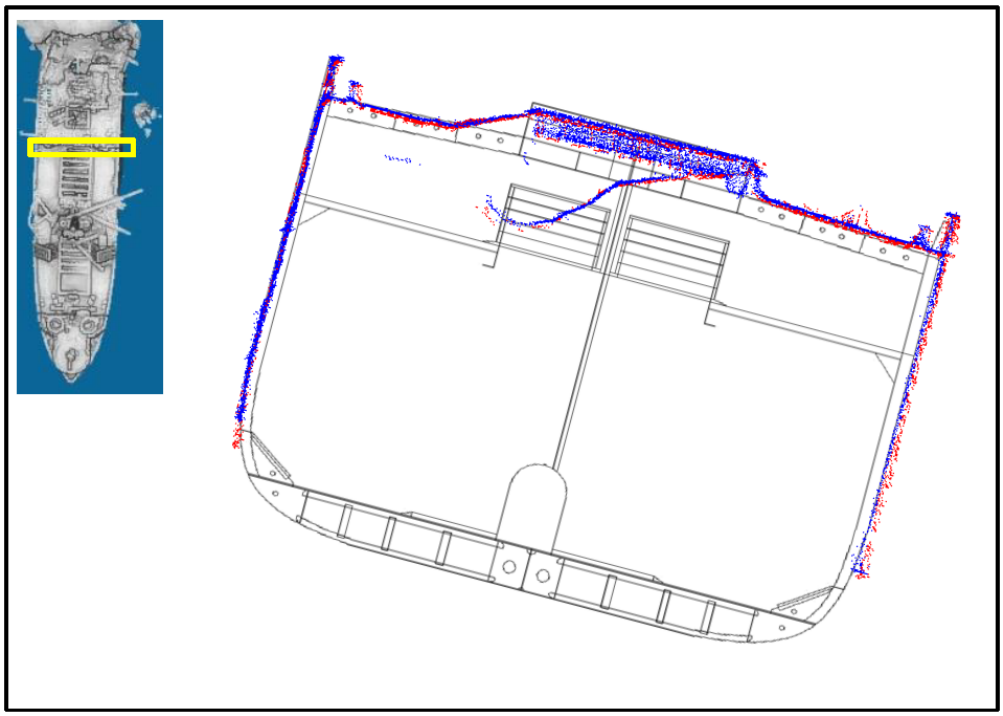

Figure 37 Cross section through the hull at frame 114, the forward end of No. 4 Hatch. Blue 2017, red 2020.

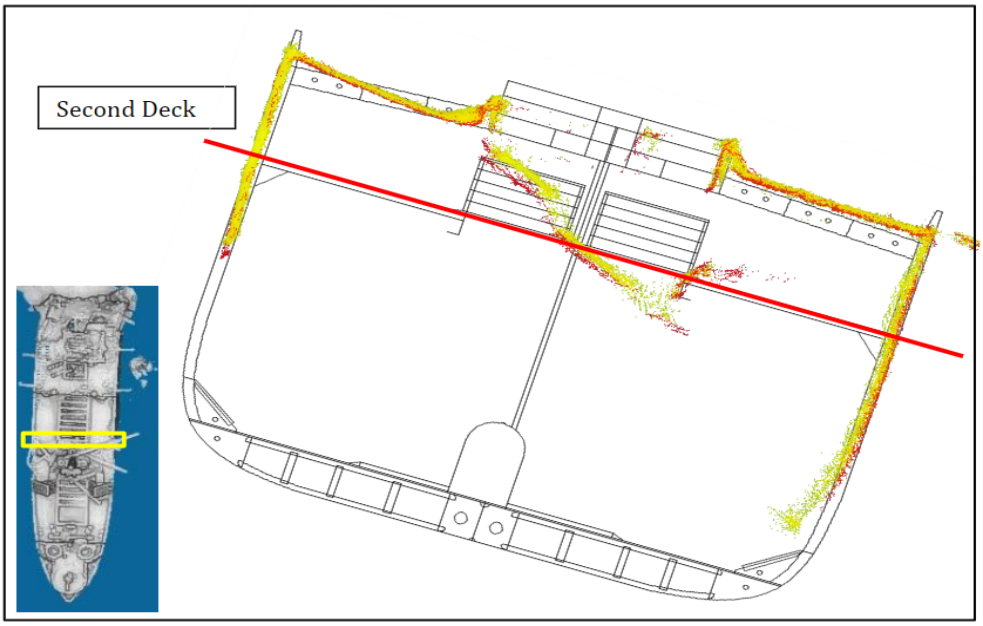

Figure 38 Cross section through the hull at frame 114, the rear of No. 4 Hatch. Yellow 2019, red 2020.

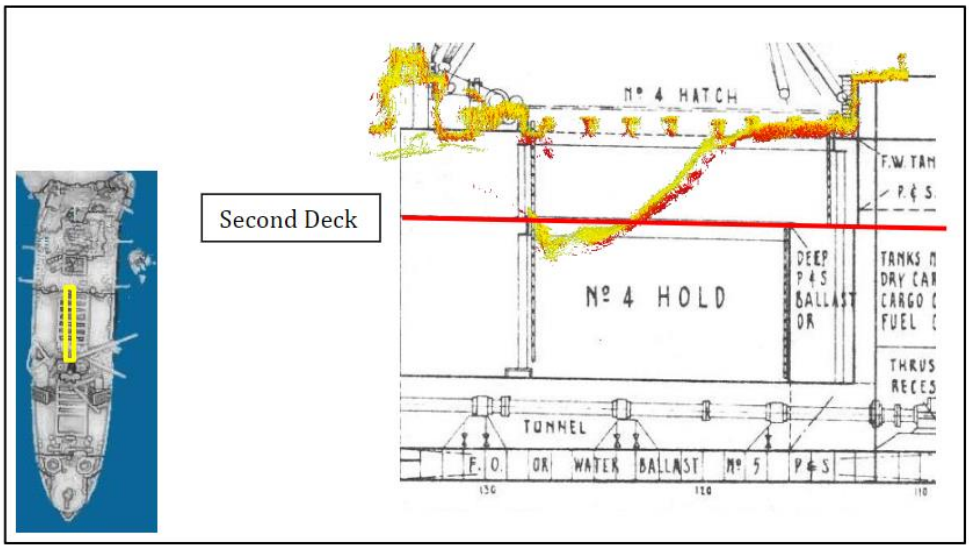

Figure 39 Longitudinal cross section through No. 4 Hold. Yellow 2019, red 2020.

Hold 5:

4.7.17 The rear most hold. The forward four of the six hatch cover supports remain in place. Sediment levels in the ‘tween deck space again follow the pattern of the other mainly intact holds, in that the starboard side is filled while the port side remains clear above the level of the horizontal from the top of the hatch coaming. As with the other holds, except Hold 4, there is no indication that the Second Deck or the lower hatch cover have collapsed.

4.7.18 The sediment levels appear to have been stable for several years and the 2017 to 2020 surveys are shown below.

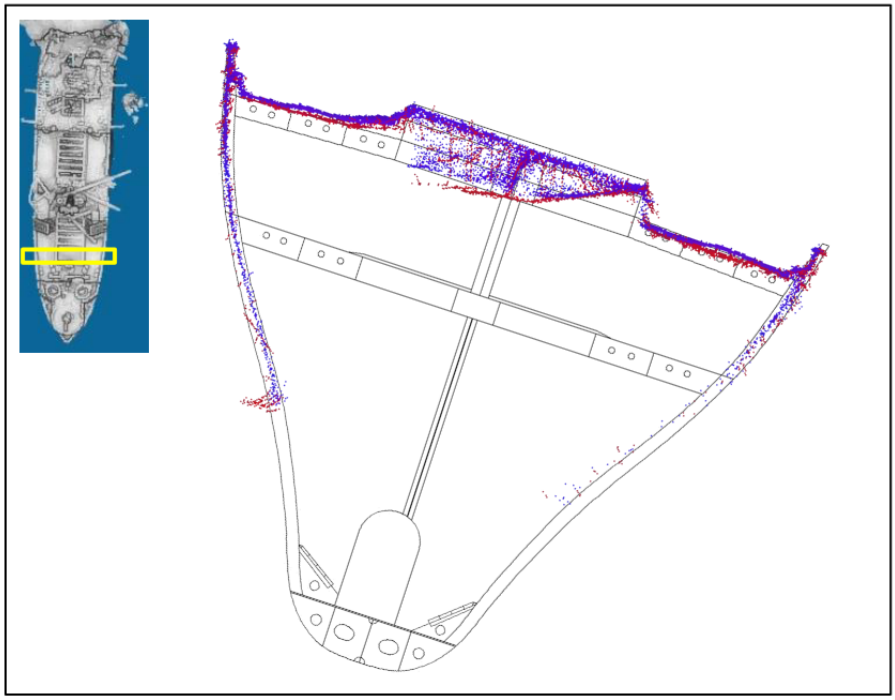

Figure 40 Cross section through the hull at frame 154, the aft of No. 5 Hatch. Blue 2017, red 2020.

4.8 Laser Survey

4.8.1 No changes are apparent on the masts between the August 2019 survey and the September 2020 survey. In fact, no changes are apparent between 2017 and 2020.

4.8.2 The laser data from the August 2019 survey was combined with the 2020 laser data to create a set of cross sections (one per mast). These show excellent agreement between the data from the two surveys (see Figures 41 to 43).

4.8.3 As an additional check, the 2017 data was combined with the 2020 data. Again, the two data sets show very close alignment indicating that there has been no movement since 2017 (see Figure 44 to Figure 47). By extension, the lack of movement in the masts implies that the wreck has not settled or moved as the masts, which are firmly fixed to the wreck, would also have done so.

4.8.4 Photographs of the masts from the August 2019 and September 2020 surveys are also included in Figure 47 to Figure 49. These also indicate that there have been no changes since August 2019.

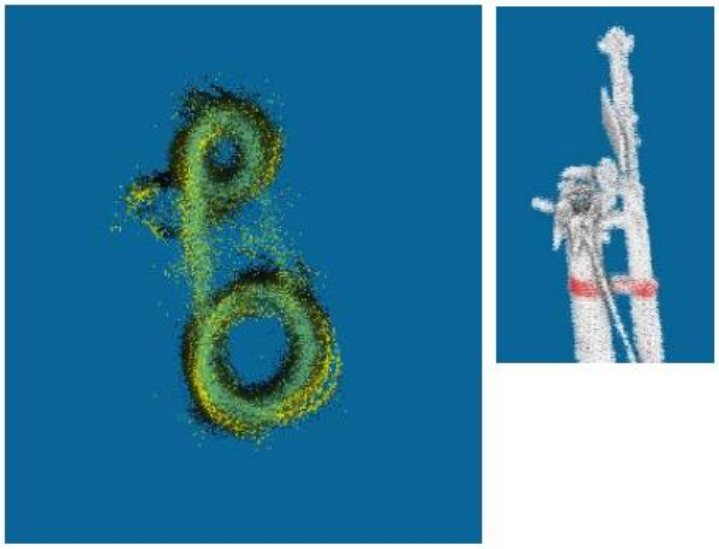

Figure 41 Cross section through fore mast. 2020 Yellow, 2019 green.

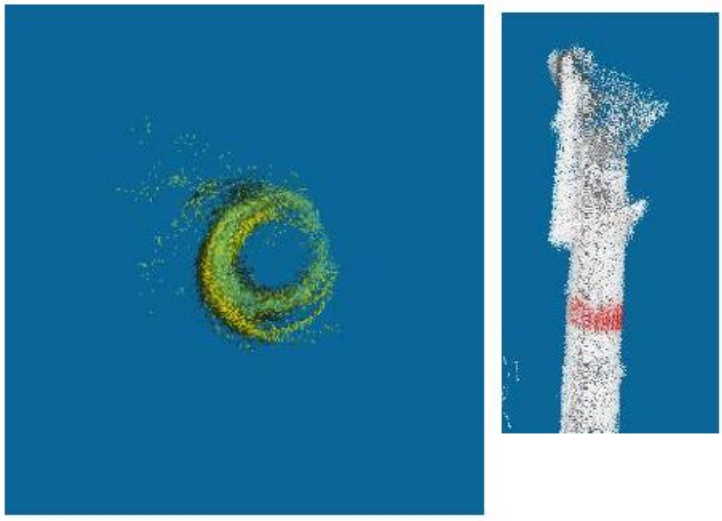

Figure 42 Cross section through main mast. 2020 Yellow, 2019 green.

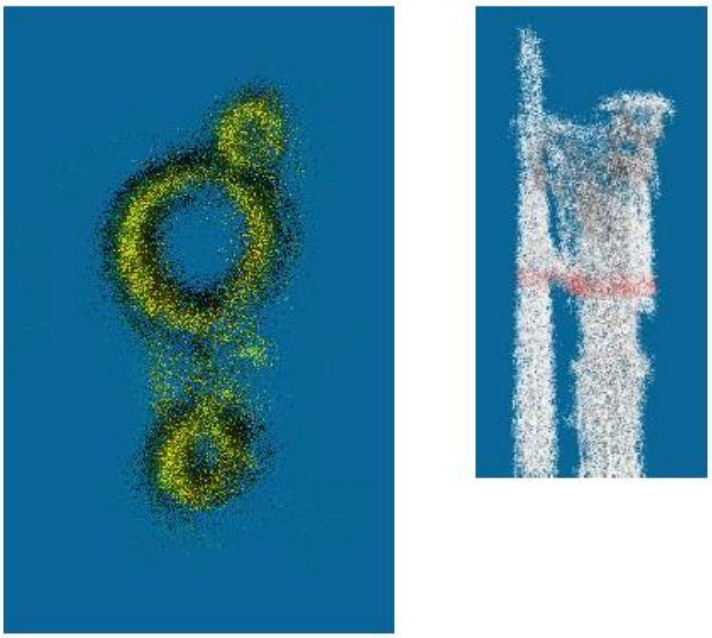

Figure 43 Cross section through mizzen mast. 2020 Yellow, 2019 green.

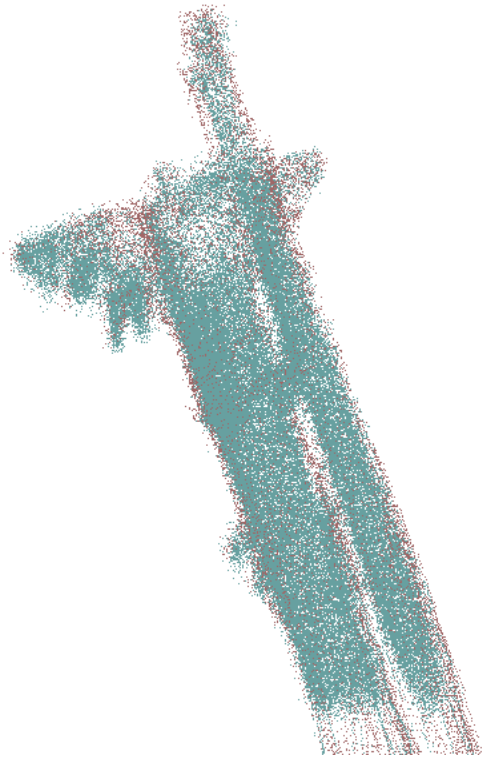

Figure 44 Mizzen mast. 2017 Red, 2020 blue.

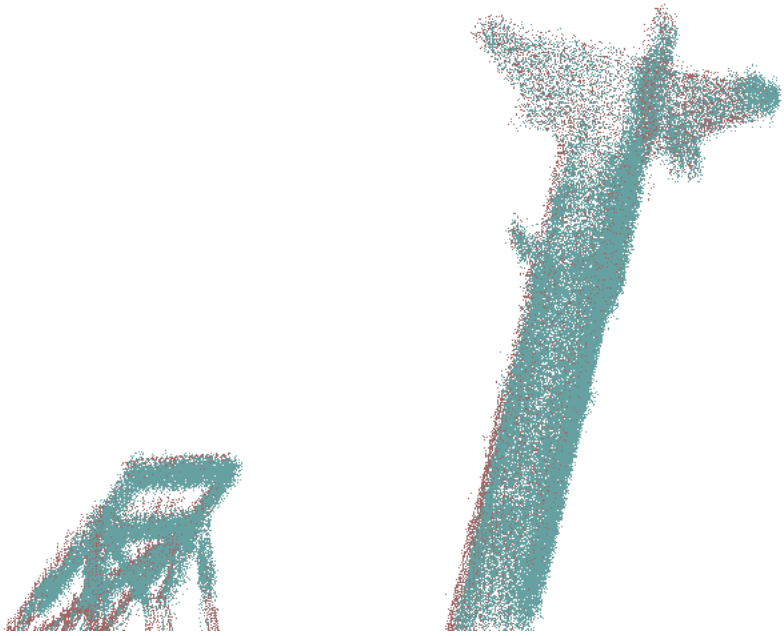

Figure 45 Main mast and life raft support. 2017 Red, 2020 blue.

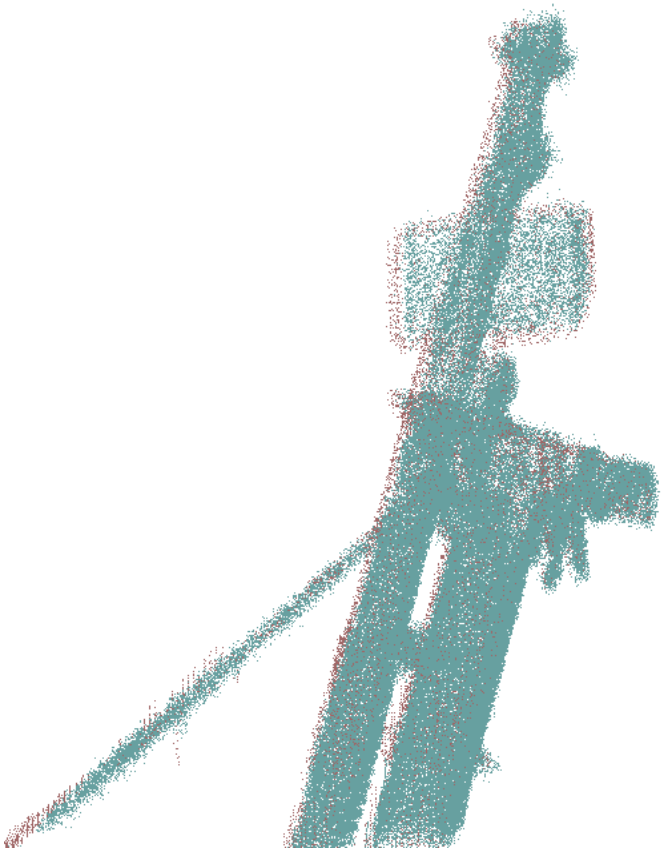

Figure 46 Fore mast. 2017 Red, 2020 blue.

Figure 47 Mizzen mast in August 2019 (L) and September 2020 (R).

Figure 48 Main mast and life raft support in August 2019 (L) and September 2020 (R).

Figure 49 Fore mast in August 2019 (L) and September 2020 (R).

5 Results - Seabed Survey

5.1 General

5.1.1 The seabed data collected is of high quality and adheres to IHO Special Order as per requirement. Previously identified seabed targets from the gazetteer of observations were overlaid and the presence of the targets noted and any new targets added.

5.1.2 A difference plot was made between the August 2019 and September 2020 surveys. The results of this are shown in Figure 50 below. In general, there are only minor changes in the depths. However, a sand bank to the west of SSRM wreck has extended slightly to the west making the general depth in this area about 2m shallower. Similarly, the sandbank to the east of the wreck has also extended to the west again making the general depth some 2m shallower. This continues a trend reported on in previous survey reports or a general westerly migration of the sand bank.

5.1.3 Overlaying the difference plot on the bathymetry (Figure 51) shows the relative location of the sediment loss to the latest bathymetry.

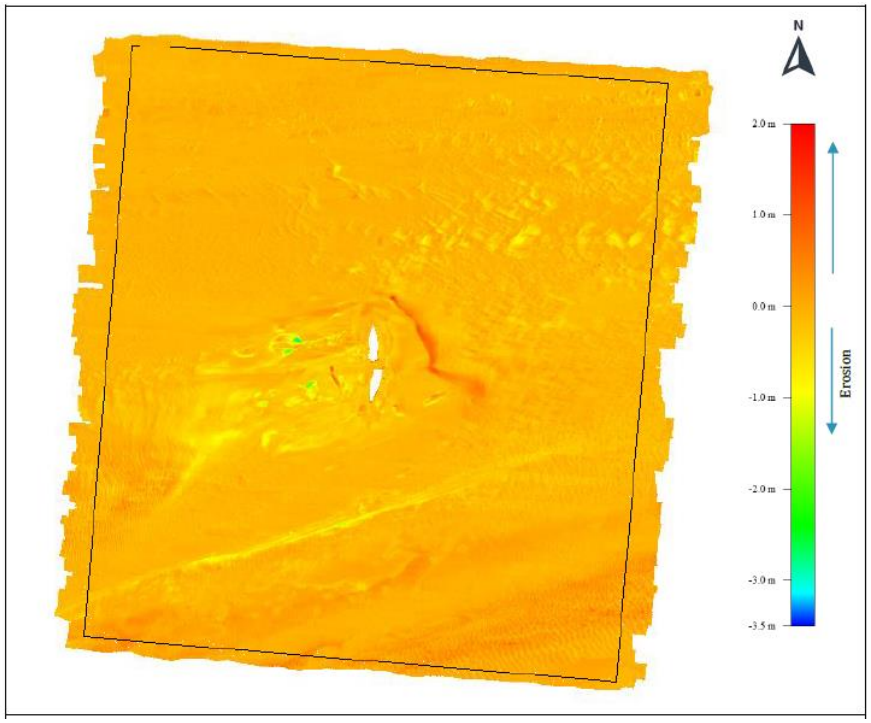

Figure 50 Surface difference results September 2020 – August 2019.

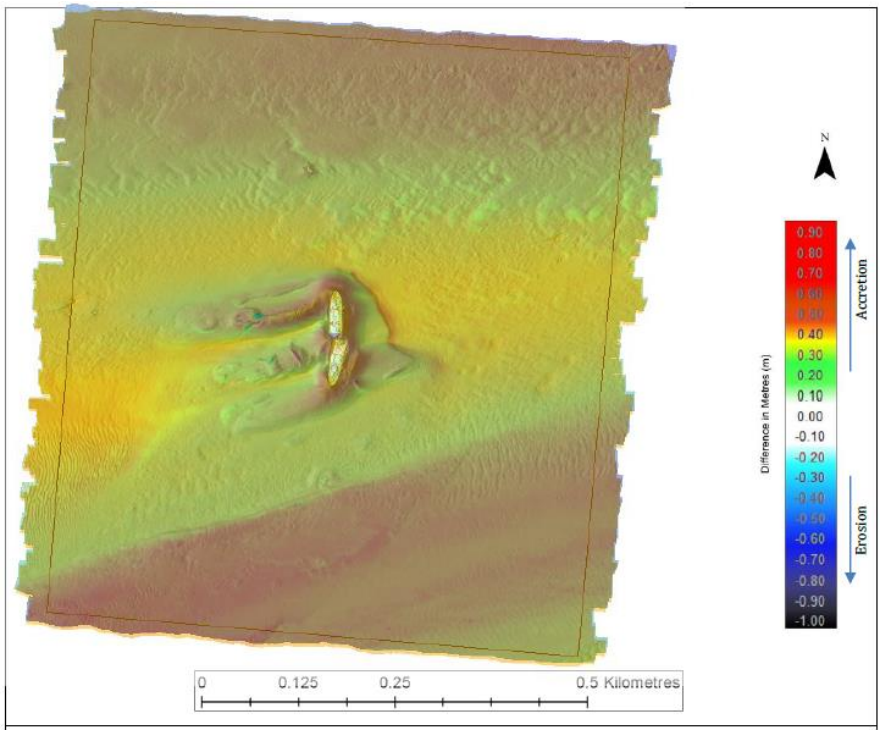

Figure 51 Overlay of difference plot on the bathymetry.

5.2 Seabed Contacts

5.2.1 The seabed contact list from 2019, with a total of 68 contacts, was compared against this year's bathymetry. Analysis of the 2020 dataset has added a further 16 targets to the contact list, while 12 items from the 2017 contact list are not apparent on the 2019 data.

5.2.2 Seabed contacts are shown in Figure 52. Although the image does not cover the full extent of the survey, no identified contacts exist outside the area shown.

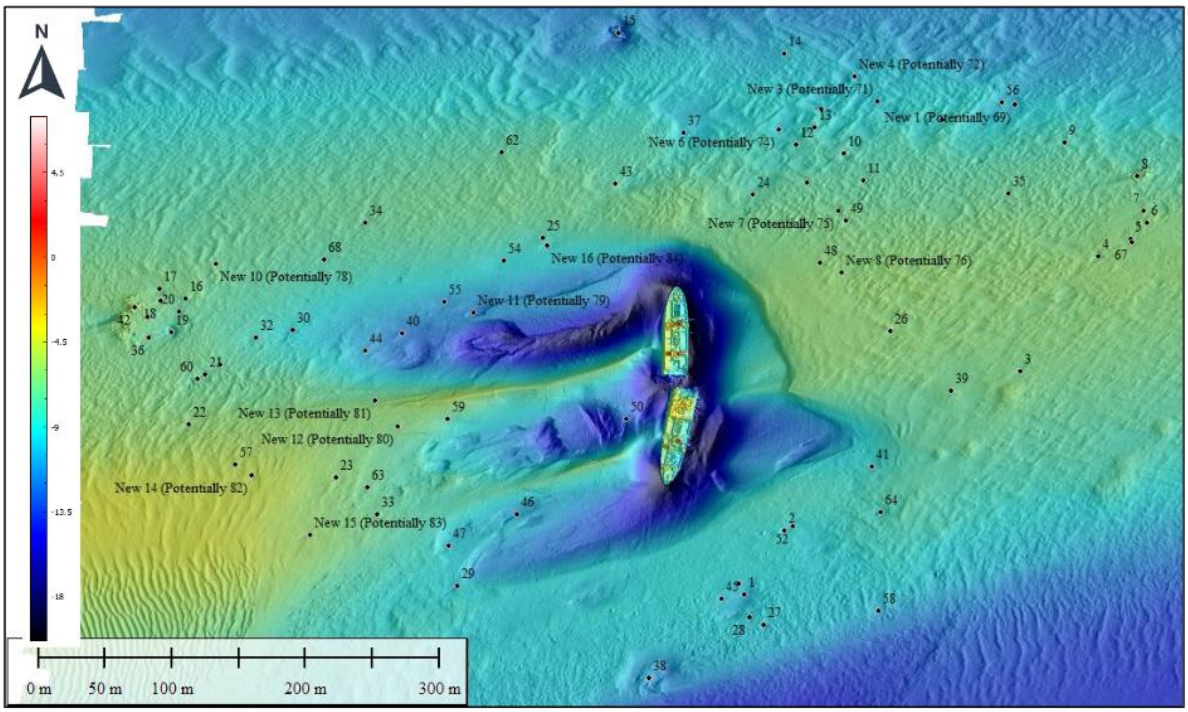

Figure 52 Seabed contacts overlain on 2020 bathymetry.

6 Conclusions

6.1.1 The August 2020 survey successfully covered all significant portions of the wreck with high quality MBES data. Although not completely ensonified, the overhanging portion of the wreck (starboard side of hull) was covered adequately. The MBES also successfully covered the masts and achieved overlap with the laser data.

6.1.2 Comparison between this survey's data and preceding surveys (August 2019 survey, 2017 survey and 2010 survey) indicates that only minor changes have occurred between August 2019 and September 2020.

6.1.3 It is recommended that the 6 Key Areas of change identified in previous reports are modified since several of these are parts of the same degradation feature and should be studied together to gain an understanding of how the wreck is deforming as it continues to degrade.

6.1.4 It is recommended that Key Areas 1 and 2 are combined and joined by all IDs across the hull to the gap in the port hull at ID 20 and the bulge on the port side adjacent to this. This collection of IDs will then represent the significant split in the hull at approximately frame 53, which should be monitored as a single entity.

6.1.5 Secondly, it is recommended that the split on the rear hull is also monitored as a single entity by combining Key Areas 4 and 5 as well as all IDs between.

6.1.6 Monitoring the bulkhead at the rear of hold 3 (Key Area 3) and the forward end of the rear section (Key Area 6) remain valid points to consider.

Maritime & Coastguard Agency

ww.gov.uk/mca

@MCA_media

@MCA

/maritime-and-coastguard-agency