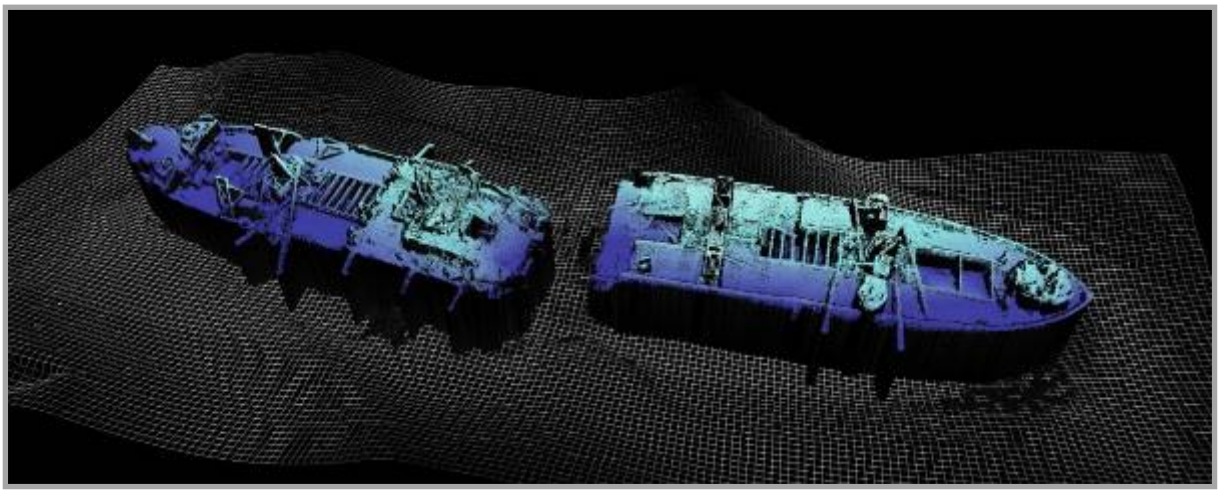
Maritime & Coastguard Agency

SS RICHARD MONTGOMERY

SURVEY REPORT 2012



Maritime and Coastguard Agency
October 2013

1. Executive Summary

1.1 The wreck of the SS Richard Montgomery is designated as a dangerous wreck under section 2 of the Protection of Wrecks Act 1973. The vessel grounded and sank in 1944 and, since that time, it has been subject to regular surveys using a variety of methods.

1.2 The 2012 survey of the SS Richard Montgomery took place on the 4th and 5th of October 2012 and was undertaken by NetSurvey Limited using survey vessels belonging to the Port of London Authority.

1.3 The scope of the survey encompassed a full sonar survey of the wreck of the SS Richard Montgomery, survey of the prohibited area out to a distance of 400m from the wreck, location and identification of debris and objects within the prohibited area, analysis of the survey results and comparisons with previous survey data. The survey also included details of the sediment build up immediately adjacent to the wreck and focus on particular points on the wreck where deterioration has been noted in the past.

1.4 The 2012 survey of the SS Richard Montgomery provided improved clarity and definition over the structure itself when compared to the data produced in 2011. The data has shown that, as a whole, the wreck site appears to remain stable, with the majority of the features identified in the data showing no evidence of deterioration. Areas of change and deterioration are to be expected and the following bullet points list the main features noted in the survey data.

- The crack on the port side of hold 2 shows a vertical increase of approximately 16cm since 2011. The horizontal measurement remains unchanged.
- The deck plating at hold 2 has dropped by 30cm since 2010 (2011 survey data could not be accurately measured in this area, although a small drop in deck plating was noted in the 2011 Report).
- No change noted in the aperture in the bulkhead at hold 3.
- Buckling of the hull plating on the port side of hold 2 remains in a similar condition to that found in 2011.
- One of the two stays on the forward mast is now detached at deck level but remains suspended from the masthead.
- Scour on the port (west) side of the wreck has shown a gradual increase in size.
- The orientation, list and pitch of the wreck remain unchanged.
- Over much of the wreck, no changes were noted.
- As recommended in 2011, a smaller survey vessel was used to survey the wreck and this has resulted in much improved data.
- The seabed survey re-located all 38 seabed features that have previously been identified.

2. Background

2.1 The SS Richard Montgomery was a US Liberty Ship built in 1943. In August 1944, the ship left the US with a cargo of munitions bound for the UK and then on to France. After arriving in the Thames Estuary, the SS Richard Montgomery dragged anchor and, on the falling tide, foundered on Sheerness Middle Sand, a sand bank running east from the Isle of Grain and to the north of the Medway Approach Channel. Almost immediately, the vessel hogged and the hull plates forward of the bridge began to split. An operation began to discharge the cargo. However, the ship broke its back, the forward section became completely flooded and, eventually, in September 1944, the salvage operation was abandoned.

2.2 Although the stern section of the wreck was cleared during the salvage operation, approximately 1400 tons (NEQ)[1] of munitions remain in the forward section. The wreck lies in two sections across the tide and close to the Medway Approach Channel. Her masts are clearly visible above the water at all states of the tide and the seabed around the wreck has gradually scoured away to leave the wreck sitting on a bedrock which is believed to be London Clay.

2.3 The wreck is designated under section 2 of the Protection of Wrecks Act 1973[2]. 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. The wreck is clearly marked on the relevant Admiralty charts, the prohibited area around the wreck is ringed with four cardinal buoys and twelve red danger buoys, and the wreck is under 24 hour surveillance by Medway Ports (under contract to the Maritime and Coastguard Agency).

2.4 Whilst the risk of explosion is considered to be low, the wreck is regularly monitored. Surveys of the wreck are undertaken in order to provide information on its condition, identify any changes and to help inform future management strategy. Since 2002, multibeam sonar technology has been utilised for these surveys. Multibeam sonar is used because it is faster and provides a greater level of detail, accuracy, repeatability and reliability than could be achieved through a diving survey. This is in part due to the very poor visibility and high tidal range in the Thames Estuary.

[1] Net Explosive Quantity
[2] Text of the Protection of Wrecks Act 1973 Protection of Wrecks Act 1973

3. The Survey

3.1 The requirement was for a complete multibeam sonar survey of the wreck of the SS Richard Montgomery and the surrounding area. The results of this were then to be analysed and compared with previous survey results in order to identify any areas of change or deterioration. Any changes or deterioration were to be quantified and particular attention was to be paid to areas where greater levels of deterioration had been noted in the past. This includes the area around Hold 2 and the bulkhead aft of Hold 3.

3.2 As well as surveying the wreck itself, an area of 400m around the structure was to be covered by the multibeam. The objective of this was to identify loose or isolated wreckage and highlight the level of sediment build up immediately adjacent to the wreck.

3.3 The 2012 survey of the SS Richard Montgomery was undertaken on the 4th and 5th of October 2012. The survey was carried out by NetSurvey Ltd using survey vessels from the Port of London Authority (PLA). These were the MV Galloper, a 7.9m catamaran and the MV Yantlet, a 13.4m Catamaran. Each vessel was fitted with a single head Reson Multibeam system, these were a 7125 on the MV Galloper and an 8125H on the MV Yantlet. Both vessels have been used in previous SS Richard Montgomery surveys and provide a reliable and repeatable survey platform.

3.4 Once the survey was complete, NetSurvey Ltd processed the data using a number of software packages so that a 3-dimensional point cloud could be produced and compared with previous survey data. The combination of processing techniques and software packages allowed for direct analysis of the wreck structure and also assist in providing an understanding of its influence on the surrounding seabed.

3.5 Survey Methodology

3.5.1 One of the recommendations from the 2011 survey was that a smaller survey vessel was used for the wreck survey in order that data could be gathered from directly over the wreck. Therefore, the 2012 survey was conducted using both the survey vessel Yantlet and the Galloper. The larger vessel, Yantlet, was used to survey the seabed area around the wreck while the Galloper, having a shallow draft of only 30cm, was able to survey very close in to the wreck and directly over the top. Survey lines were run north/south parallel to the wreck and east/west and, at selected points, survey lines were run across the structure in order to achieve the best possible coverage. When surveying the surrounding seabed, a line spacing of 20m was used in order to ensure that data density was achieved across the site and to allow for small objects on the seabed to be identified in the multibeam data.

3.5.2 The 2012 data resulting from the dual vessel survey is of a much higher clarity and sharper detail than was achieved the previous year.

3.6 Survey Equipment & Software

3.6.1 NetSurvey Ltd used a Reson 7125 to survey the wreck structure and a Reson 8125H system for the seabed survey.

3.6.2 On both vessels, Applanix POS-MV 320 inertial systems were used to output real-time position, attitude and heading data. The sensor outputs heading and attitude to an accuracy of 0.02° and 0.01° respectively. The POS-MV was integrated with both the Reson 7125 and 8125H to apply time stamp information to the swath data. As well as real-time data, the raw inertial and GPS data was recorded as raw sensor files. This meant that the data could be post-processed using POSPAC MMS software and imported into the multibeam data at a later stage.

3.6.3 For data acquisition QINSy was installed on the survey vessels. QINSy is an integrated navigation system software package that allows for the combination of multiple sensors to produce accurate XYZ data. A GPS tidal solution was used to compute the depths of the wreck in relation to Chart Datum.

3.6.4 Raw data was logged in the XTF format by QINSy, these files were then converted into Caris HIPS format for post processing. As well as the raw bathymetry data, positional data was also logged from the POSMV. The raw data files from the POSMV could be post processed so that any inaccuracies in the online navigation solution could be removed and a positional solution, with an accuracy of >5cm could be produced in the form of an SBET (Smoothed Best Estimate of Trajectory).

3.6.5 With the Bathymetry data converted into the Caris HIPS format, the SBET file could then be used to overwrite the online positional / height data. A GPS height/tide solution was computed, the data was reduced to Chart Datum and merged with the vessel configuration data.

3.6.6 A BASE surface was then generated and used to highlight any errors (height or positional) within the data.

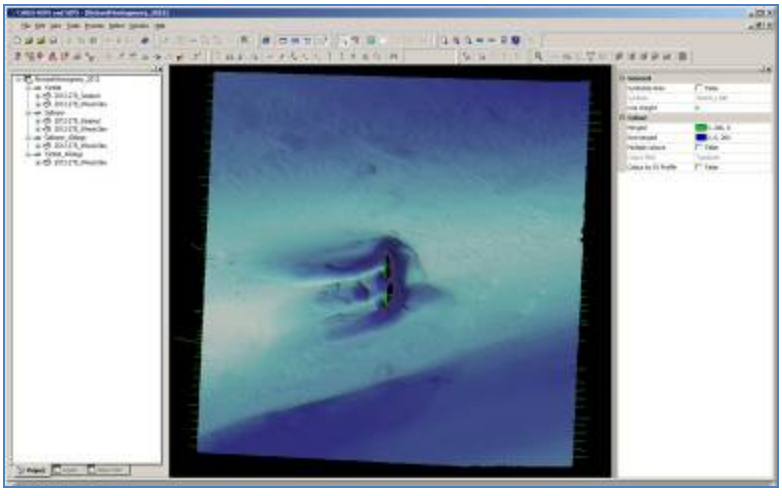


Fig.1 Caris BASE Surface coloured by height

3.6.7 Once the data had been taken through Caris HIPS it was then loaded into Dmagic and from that a PFM structure was built. The PFM was loaded into Fledermaus which allowed the data to be opened in 3D so that it could undergo cleaning and editing procedures. Once cleaning had been completed a point cloud could then be exported that would be used in the analysis of the wreck structure.

4. Survey Results

4.1 The wreck data collected during the 2012 survey demonstrates an improvement in terms of clarity on that collected in 2011. This is due to a number of factors but principal among these is that a smaller, more manoeuvrable vessel was used to survey directly over the top of the wreck structure.

4.2 In general terms, the data shows that, as a whole, the wreck site remains stable with the majority of the features identified in previous surveys showing little or no visible evidence of further deterioration. Highlighted in 2009 and carried through to the 2011 survey report were three key factors that would affect the future stability and deterioration of the site. These were the strength of the hull structure, the local environment around the wreck site and the condition of the munitions within the forward section. These three factors will be expanded upon to give an overall conclusion with regards to the status of the SS Richard Montgomery. However, it should be noted that, although the mulitbeam sonar survey can give us some information about the munitions cargo, it cannot assess the condition of the cargo (see 4.6).

4.3 The Hull Structure

4.3.1 The main body of the wreck structure remains in two sections, with only the forward section showing evidence of deterioration. The vessel has not changed its list or orientation.

4.3.2 In previous surveys, particular attention has been paid to four key areas which have repeatedly shown the greatest change over time. These are the crack at Hold 2, the collapsed deck plating at Hold 2, the aperture in the bulkhead aft of Hold 3 and a split in the starboard side of the stern section. The survey results for these sections of the wreck will be covered first, followed by the results for the rest of the wreck.

4.3.3 Area around Hold 2 continues to show levels of deterioration. This area has shown slow but continual deterioration across previous surveys. Data from the 2012 survey shows that the crack at Hold 2 has increased in length by 16cm since 2011 although the width remains unchanged. The dimensions of the crack were measured as 2.53m vertical and 1.22m in width from the 2011 survey. From the 2012 survey results the crack has increased to 2.69m in the vertical and remains almost unchanged in its horizontal measurement at 1.29m.

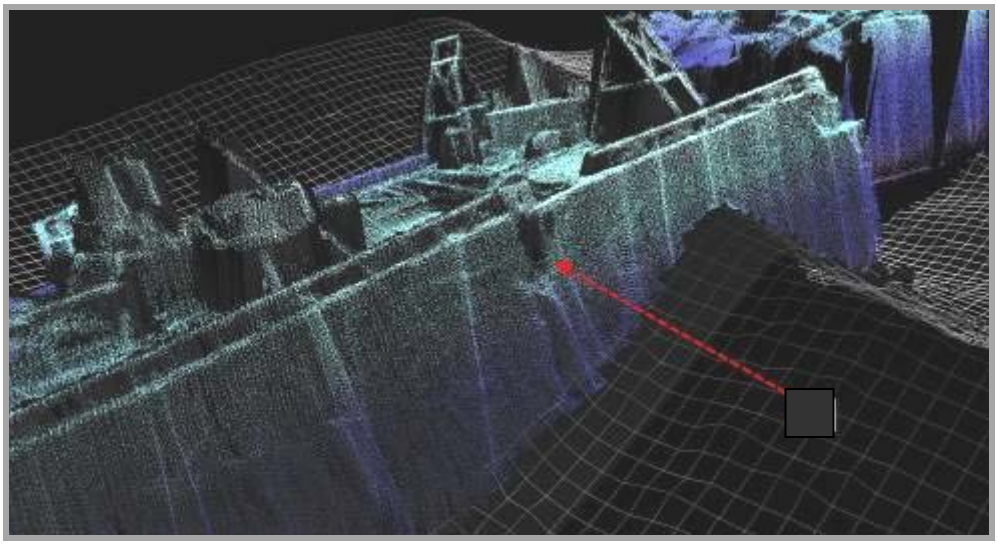


Fig. 2 Crack at Hold 2 – 2012 data

4.3.4 The deck plating at Hold 2 has also shown evidence of gradual collapse over previous surveys. It was not possible to accurately measure the 2011 survey data from this area, therefore, the 2012 data has been compared to that collected in 2010. Over this two-year period, the deck plating has dropped by 30cm. In total, the distance between the two deck levels can be measured at 1.5m.

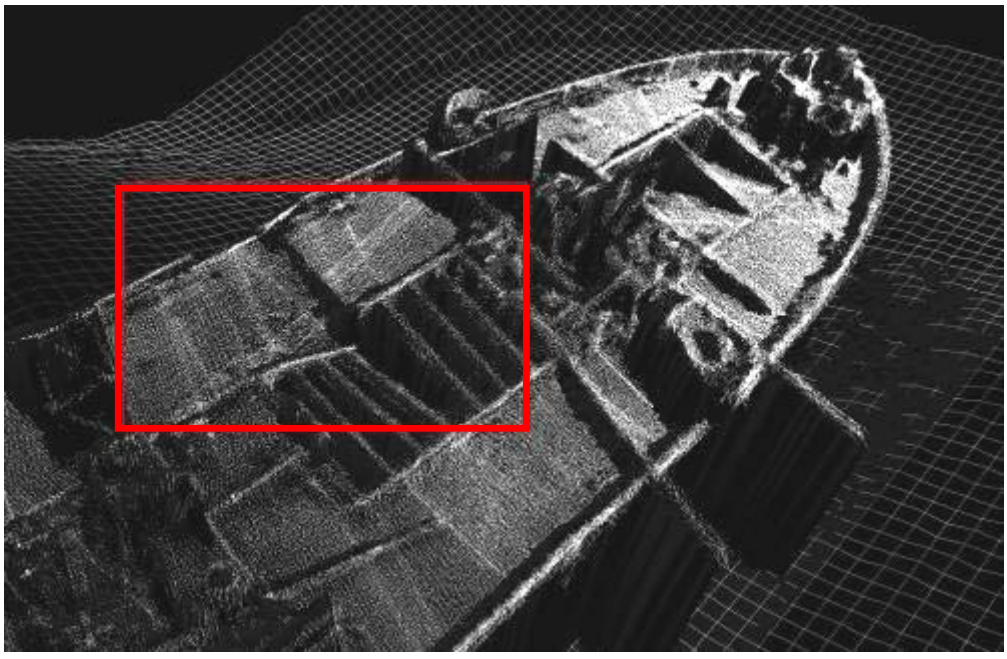


Fig. 3 Collapsed deck plating at Hold 2 – 2012 data

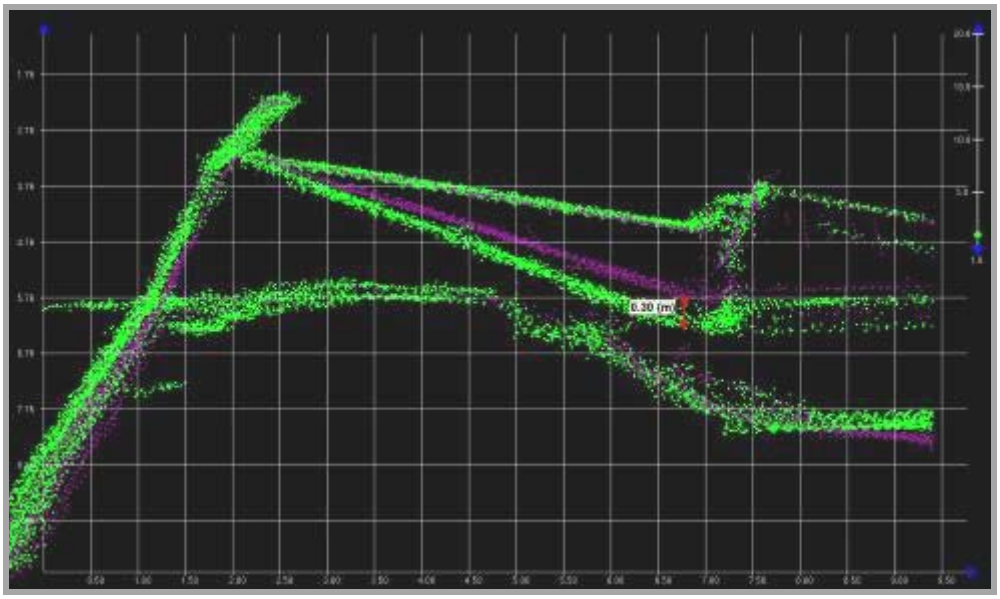


Fig. 4 Difference in height between 2010 [purple] and 2012 [green] data sets

4.3.5 The third key area is the bulkhead aft of Hold 3. On one side of this bulkhead was the engine room and on the other side is Hold 3. This bulkhead is where the vessel broke in two. The bulkhead remains predominantly intact but there are known to be apertures in it. One large aperture was first noted in the 2008 survey data and this has been monitored since that time. The 2012 survey data indicates that there is no visible change in this section.

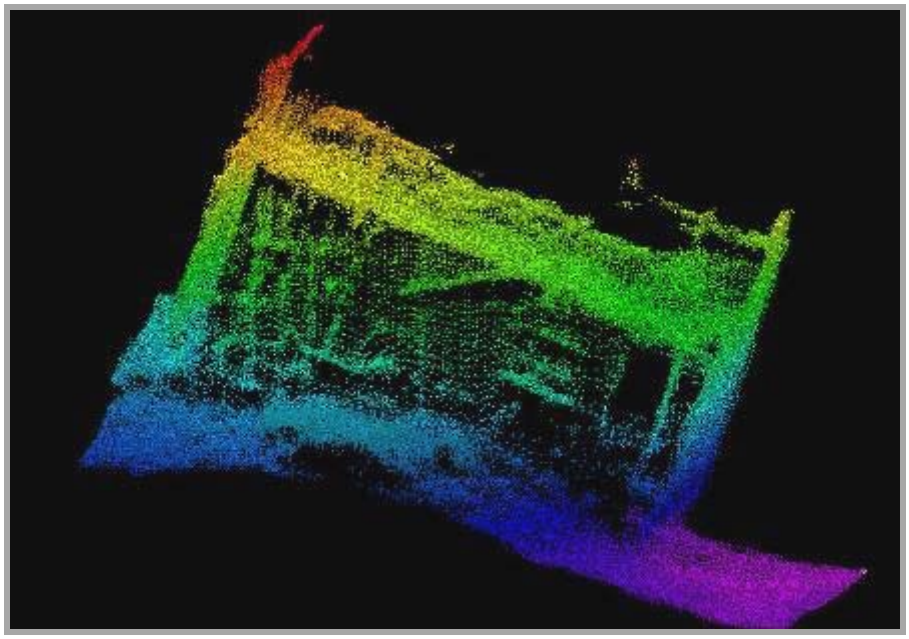


Fig. 5 Bulkhead aft of Hold 3

4.3.6 The final key area has been previously described as severe splitting of the hull located on the starboard side of the stern section. This feature was identified in 2009, however it was not found in survey data from 2010 and 2011. It was thought likely that this

feature was caused by shadowing of the multibeam by overhanging debris which gave the appearance of a split in the hull. The angle of list and overhanging debris at this section of the hull present a challenge for multibeam systems and it has yet to be insonified to any significant level of detail. However, the data from 2012, similar to 2009, indicates the presence of a feature in this location and, from some angles, the multibeam data indicates there could be holes in the hull. However, it is difficult to analyse and, as such, it remains inconclusive.

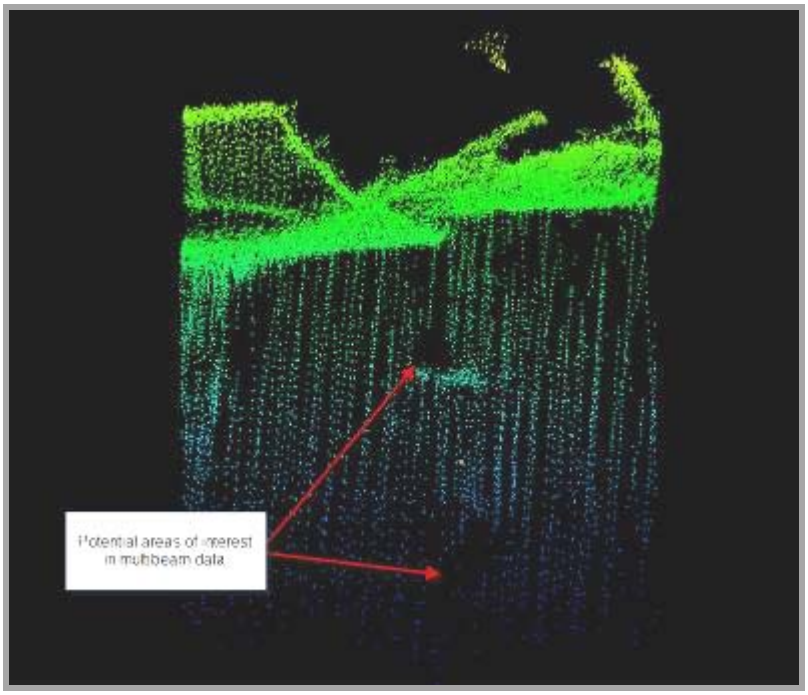


Fig. 6 Severe splitting in Aft section - side view

4.4 Deformation of the hull (hogging)

4.4.1 The vessel reportedly showed signs of hogging immediately that it went aground in 1944, and successive surveys have noted evidence of deformity in the hull. However, the level of deformity and any increase is difficult to measure. For the 2011 survey report a surface of the hull was generated and gridded at 5cm and the profiling tool was used to ascertain the level of deformity in the hull directly below the crack at Hold 2. Data from 2011 indicated that the hull was bending inwards by 15-20cm beneath the crack and outwards by approximately 40cm closer to the seabed. The gridded data from 2012 shows that the level of deformity of the hull remains similar to that found in 2011. Directly underneath the crack at Hold 2, a bend of approximately 20cm is evident, whilst nearer the base of the hull the profile remains unchanged at 40cm

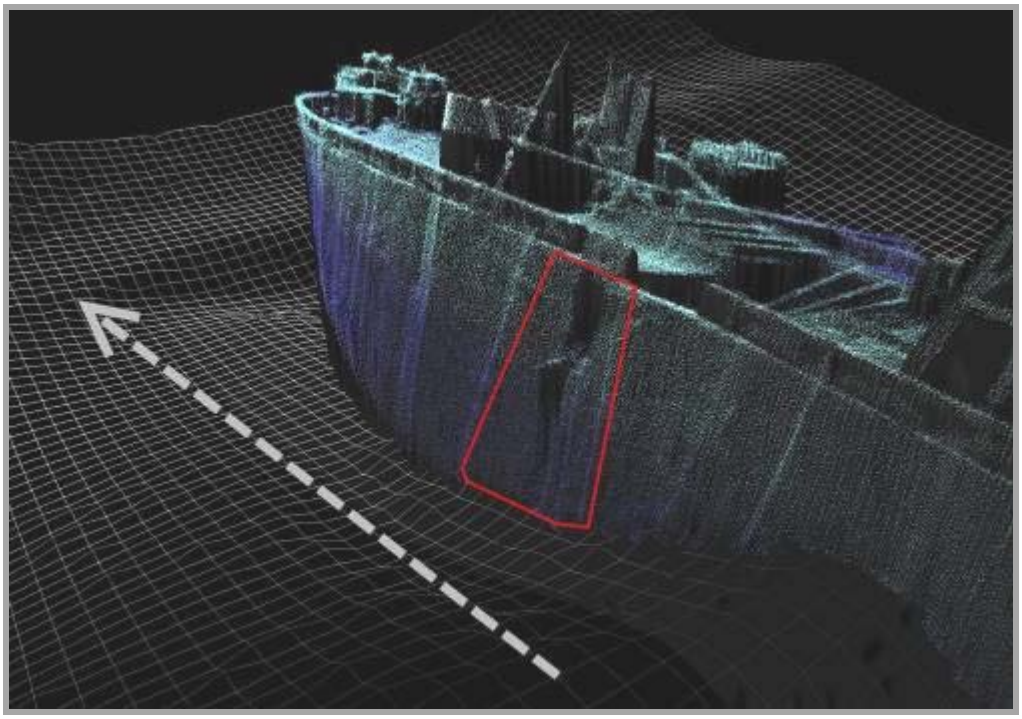


Fig. 7 Section of hull that has been gridded into a surface

4.5 Masts & Booms

4.5.1 All three masts on the SS Richard Montgomery are still in place and are visible above the waterline at all states of the tide. These are surveyed with a combination of multibeam sonar for the areas below the waterline and photography for the areas above the waterline. Laser scanning has also been used for the masts above the waterline, but was not part of the 2012 survey.

4.5.2 The fore mast cargo handling booms can be easily seen in the point cloud data. One boom is lying across the deck and the point cloud data shows that it protrudes over the starboard side by 4.5m. Another extends over the side of the wreck by 3.6m and the third boom appears from the data to by lying across the corner of Hold 1. This feature remains constant when compared with historical point cloud data and is approximately 10m in length. The fore mast and mast house are clearly visible in the 2012 data. There are no visible signs of deterioration in the multibeam data, but the photographic survey revealed that one of the two mast stays on the forward mast has become detached at deck level since the 2011 survey.

Fig. 8 2011 – fore mast, both stays attached

Fig. 9 2012 – fore mast, one stay attached

4.5.3 The main mast house is clearly defined in the 2012 data and shows no sign of change when compared to historical data sets. Similarly, the main mast cargo handling boom is clearly visible in the 2012 point cloud data and shows no signs of deterioration.

4.5.4 Mizzen mast house is well defined in 2012 data set. The feature is supporting the mast situated on top. Point cloud data from 2012 shows all 3 booms in good detail. One lies across the deck and two extend over the side of the hull. All three remain in the same position and show no sign of change from previous data sets.

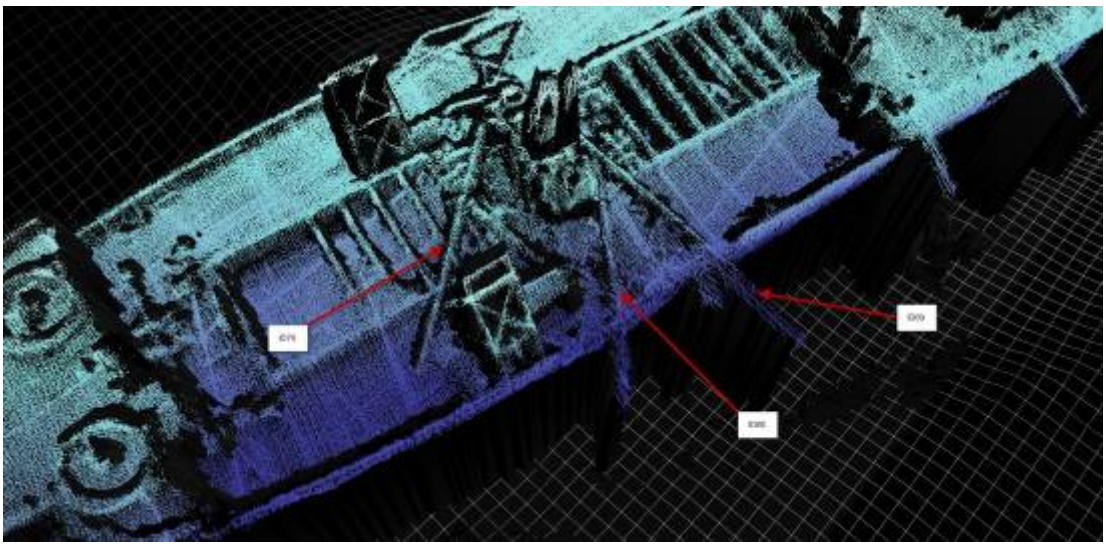


Fig. 10 Mizzen mast booms - 2012

4.6 Areas with no detectable change

4.6.1 The 2012 survey shows that, in general, the majority of the features identified on the wreck show no detectable evidence of further deterioration since 2011. If any changes have occurred, they are not visible in the multibeam data. The following section lists examples of features surveyed and showing little or no change:

1. Holes in deck plating from the crack at Hold 2 to the aft end of Hatch 2 - this section of the wreck structure was poorly insonified in 2011 but the 2012 data shows this section clearly and there are no visible signs of holes in this area.
2. Holes in deck plating by Hold 1 – the 2012 data shows that there are some holes present, but they remain in a similar condition to the data produced in 2010 and do not appear to have changed in dimensions.
3. Collapse of deck and hatch coaming at Hold 3 - the data from 2012 shows no further signs of deterioration. Cross-section images from 2010 and 2012 data sets placed one on top of the other show that no additional movement has taken place.
4. Hole and deformity in the hull plating on the starboard side at Hold 2 - There is evidence of these features in the data from previous surveys as well as the current data set. Due to the angle of list it is difficult to make solid assessments, however, measurements obtained using a gridded surface suggest a deformity of 25cm close to deck level and 80cm closer to the seabed. These values are the same as those obtained in 2011.
5. Splits in the deck plating on the port and starboard sides of the mizzen mast – data from the 2012 survey relocated these features and, when compared with data from both 2010 and 2011 they appear to remain in the same condition.
6. Holes in the boat deck – holes were noted in both the 2010 and 2011 data sets with dimensions measuring approximately 80cm. The data from 2012 shows that these holes remain in the boat deck, have not eroded further and retain the same dimensions.
7. Aft port side collapsed boat deck - the 2012 data shows that this section remains in the same condition seen in both 2010 and 2011. No further deterioration of the boat deck is evident from the point clouds.
8. Lower hold cover at Hold 4 - data from 2012 survey shows no signs of deterioration from the 2010 data.
9. Hold 1 hatch cover support - no change is seen in this section of the wreck and the hatch support remains the same when compared to the 2010 data.
10. Hold 2 hatch cover supports - data from 2012 shows that all the hatch supports remain in good condition; however they are being affected by the collapsing deck.
11. Hold 3 hatch cover supports - data from 2012 improves upon the point cloud taken from 2011. Debris from the cover supports remain in this area.
12. Hold 4 hatch cover supports - from the 2012 data all 6 of the cover supports remain intact.
13. Hold 5 - four supports remain over this hatch. The multibeam data is of good quality and no changes were noted.
14. Collapsed bridge deck - due to the complex surroundings in this section it is difficult to ascertain the state of the bridge deck.

15. Engine room casing/skylight – this casing can be seen clearly in the 2012 data set and is in an advance state of deterioration, as noted in previous surveys.
16. Aft boat deck gunnery officer's cabin - this has been defined well in the 2012 data and shows no sign of deterioration when compared to both 2010 and 2011 data.
17. Gun tubs – almost all of the gun tubs were clearly defined in the survey data and show no signs of deterioration when compared to the 2011 and 2010 survey data, including one of the aft gun tubs which is lying on the seabed off the starboard side. One gun tub is upside down on the aft starboard boat deck in an area of complex structures and debris and it is difficult to determine what level of change, if any, may have taken place.
18. Propeller, rudder and port anchor – all of these features are clearly defined in the 2012 data set and show little or no sign of change over time.
19. Lifeboat racks and davits - Point cloud analysis shows that these features remain present on the wreck structure and show no visible signs of deterioration since 2010 and 2011.

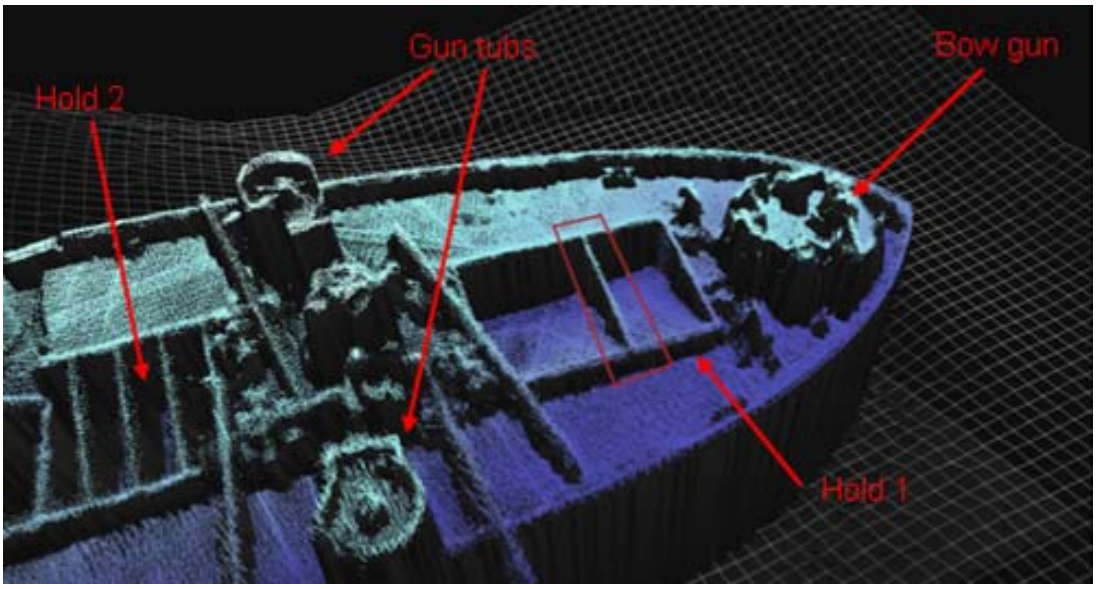


Fig. 11 Hold 1 hatch cover support and other features - 2012

4.7 Condition of the Munitions Cargo

4.7.1 The surveying techniques used to collect data on the wreck structure cannot be used to accurately predict the amount and state of the munitions cargo. However, there are some areas on the wreck where previous survey data may have shown indications of the cargo.

4.7.2 The 2012 multibeam data acquired in the area of Hold 1 shows no detail of the 'tween deck cargo. There are small holes in the deck plating on the port side of Hold 1, but these are too small to allow for visualisation of the cargo underneath.

4.7.3 The point cloud produced in 2012 shows good definition around the area of Hold 2. However, multibeam sonar cannot penetrate through metal and it is difficult to make out the cargo inside the vessel at this location. Some evidence from previous surveys which reported on cargo visible in this area may in fact have been collapsed decking giving the impression of cargo inside the wreck.

4.7.4 The area around Hold 3 is where the break between the two sections of wreck occurred. Although the bulkhead at Hold 3 remains predominantly intact and is containing the munitions, the deck, hatch and 'tween deck area of Hold 3 were heavily damaged when the vessel broke in two and this area is full of debris. The multibeam data shows this debris and shows no signs of deterioration since 2011. Previous survey data has been interpreted as showing outlines of cargo material through an aperture in the bulkhead. This is not visible in the 2012 survey data.

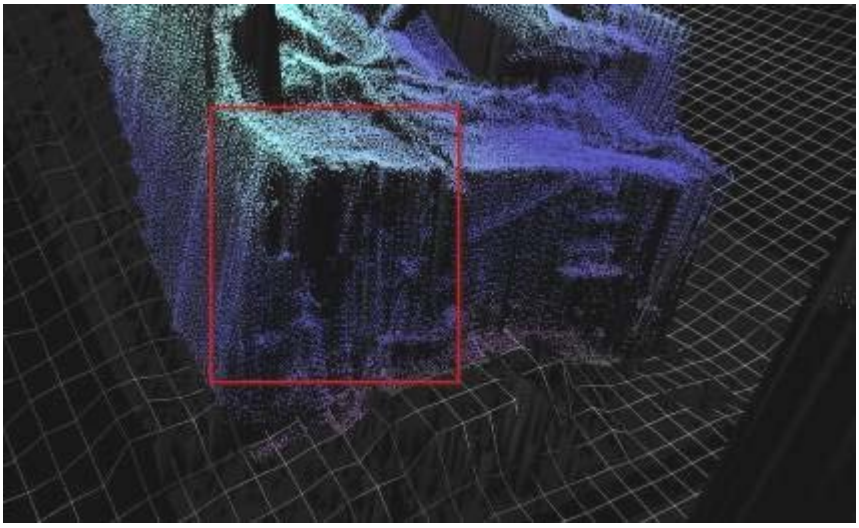


Fig. 12 Bulkhead at Hold 3 - 2012

4.8 Vessel List and Orientation

4.8.1 In previous survey reports measurements have been taken from selected locations on the hull in order to inspect for any signs of change in the vessel's list and orientation. For the 2012 survey report, imagery has been taken instead to show the alignment of key features such as masts, mast house and A-frames, so that a more visual representation can be made with regards to the wreck's orientation on the sandbank. Imagery taken from selected locations across the wreck show that the most recent point cloud aligns with historical data sets on these key features.

4.8.2 As can be seen from the images below, comparisons of the 2012 point cloud with data from the 2010 and 2011 surveys show that the vessel has not moved in terms of its relative vertical axis. This alignment gives confidence that the wreck has not changed its list or orientation over the course of the last three surveys.

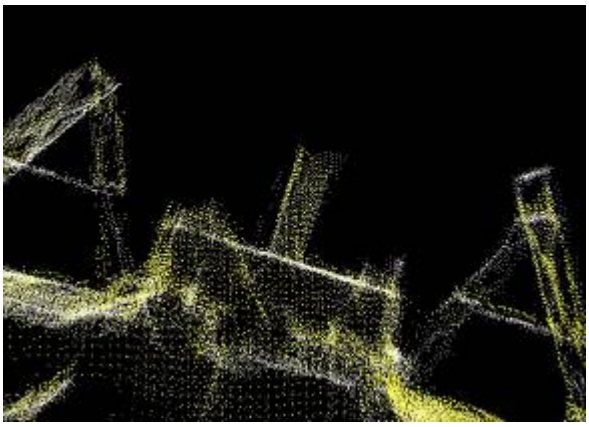


Fig 13 2012 data (white) -2011 data (yellow) – main mast area

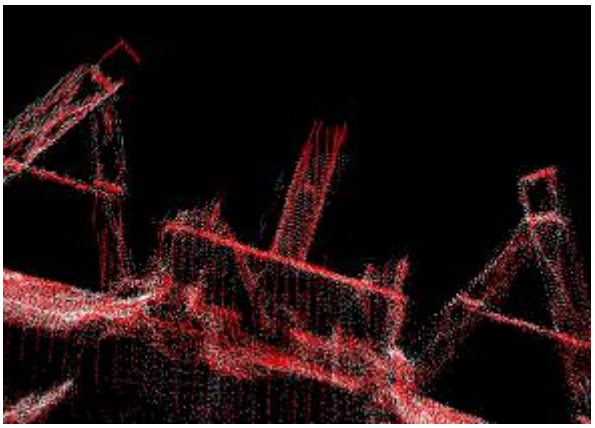


Fig. 14 2012 data (white) -2010 data (red) – main mast area

5. Seabed Comparisons

5.1 The survey of the SS Richard Montgomery encompasses both the wreck itself and the surrounding seabed out to approximately 400m distant from the wreck. The objectives of this seabed survey are to assist in determining the level of seabed support particularly around the bow of the vessel, to identify any build-up or scouring of seabed sediment adjacent to the wreck, to determine whether any cargo material has escaped from the wreck and to locate and identify any other debris within the prohibited area.

5.2 For the purpose of evaluating the 2012 survey data, the seabed that surrounds the wreck was split into three distinct areas. These are areas A, B and C. Area A is the dredged channel to the south which has remained apparently unaffected by the wreck structure. Area B is the scours that have developed to the west of the wreck structure. These have been shown in this and previous surveys to change over time, mainly due to the relatively shallow depths of the water and strong tidal streams that pass around the wreck. Area C is the immediate area of the wreck site itself which surveys suggest is subject to changes in sediment levels.

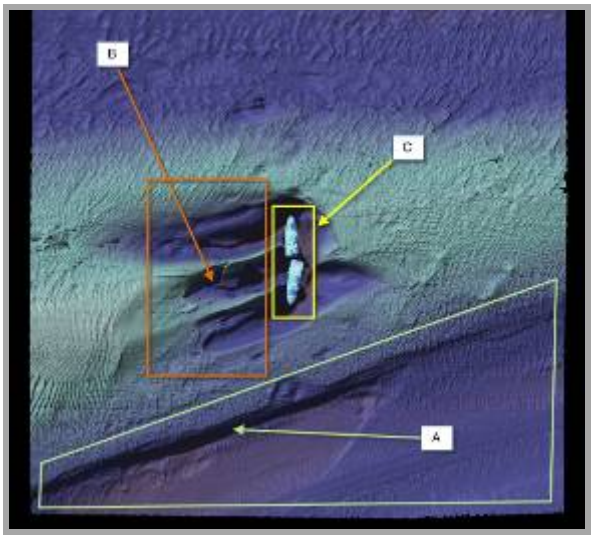


Fig. 15 Seabed areas A, B & C

5.3 Area A - Survey data from the edge of the dredged channel indicates that there has been a small reduction in sediment deposits. There is no evidence to suggest that the wreck is having an influence on this area and the channel is surveyed and dredged by the port authority.

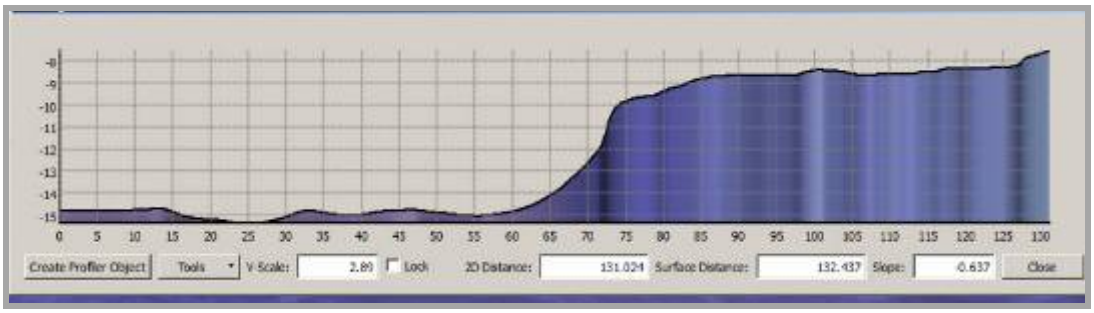


Fig. 16 Profile of edge of dredged channel

5.4 Area B – The scour around the wreck retains its same general shape year on year but the sediments are mobile and some changes are to be expected. From the 2012 data, it can be seen that the scour marks to the west of the wreck appear to be growing in size and scour marks that were previously two distinct shapes have, over time, merged in to one. Analysis of the scour to the west of the wreck shows that, although the scour mark retains the same depth along the profile length, it has changed in dimensions in north-south and east-west directions. In 2010 the scour was measured as 45m x 35m. In 2011 the survey data measured the dimensions of the scour as 48m x 40m and the 2012 data shows the dimensions of the scour as 51m x 45m. The scour is measured at a distance of 40m away from the wreck and data analysis indicates that it has extended towards the wreck at a rate of approximately 1 metre per year since the 2009 survey.

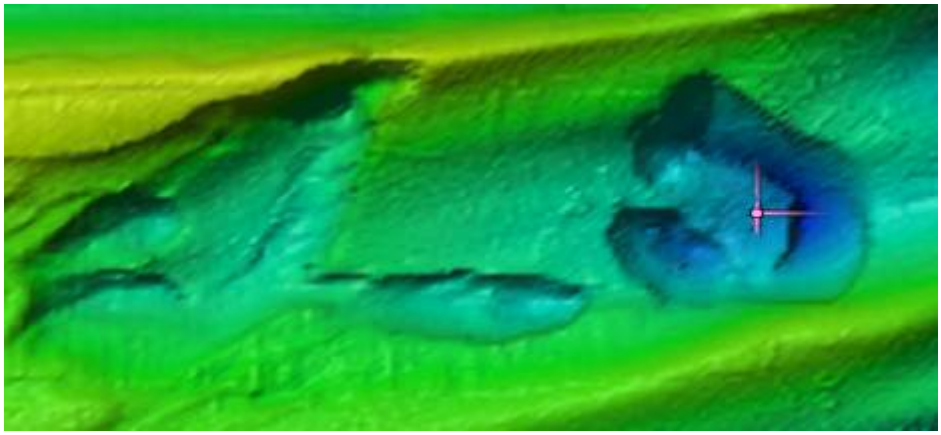


Fig. 17 Scour to west of wreck - 2010

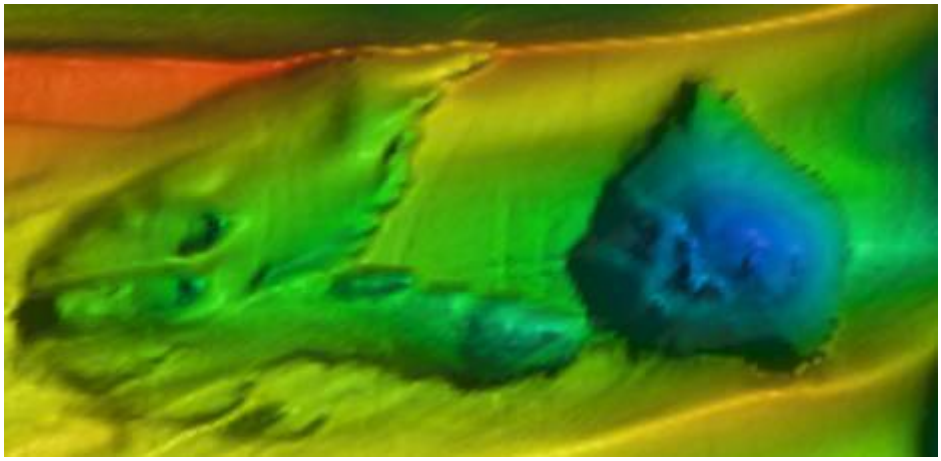


Fig. 18 Scour to west of wreck - 2011

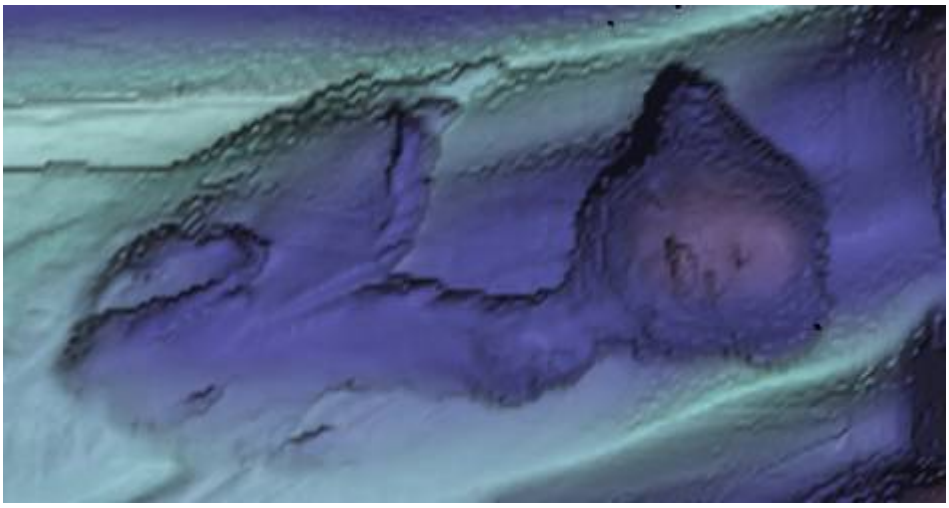


Fig. 19 Scour to west of wreck - 2012

5.6 Area C - Surface differencing indicates that, in the area immediately surrounding the wreck, there has been a small removal of sediments. As highlighted in previous reports, it is likely that the scouring of the sand around the wreck, caused by the increased speed of water as it flows around the vessel, has gradually allowed the structure to settle onto the bedrock of London Clay, and it is now likely that there is no significant quantity of sand under the wreck itself.

5.7 Across the whole site, the average surface difference is 0.13m, an element of which is due to the tolerance levels of the equipment used to collect and process the survey data. Looking at the seabed contours around the wreck, these remained consistent between 2009 and 2011. The contours generated in 2012 are again consistent with previous surveys, with only small deviations visible on closer inspection. The overview of the surrounding seabed suggests that the dredged channel directly to the south remains unaffected by the presence of the wreck on the sandbanks.

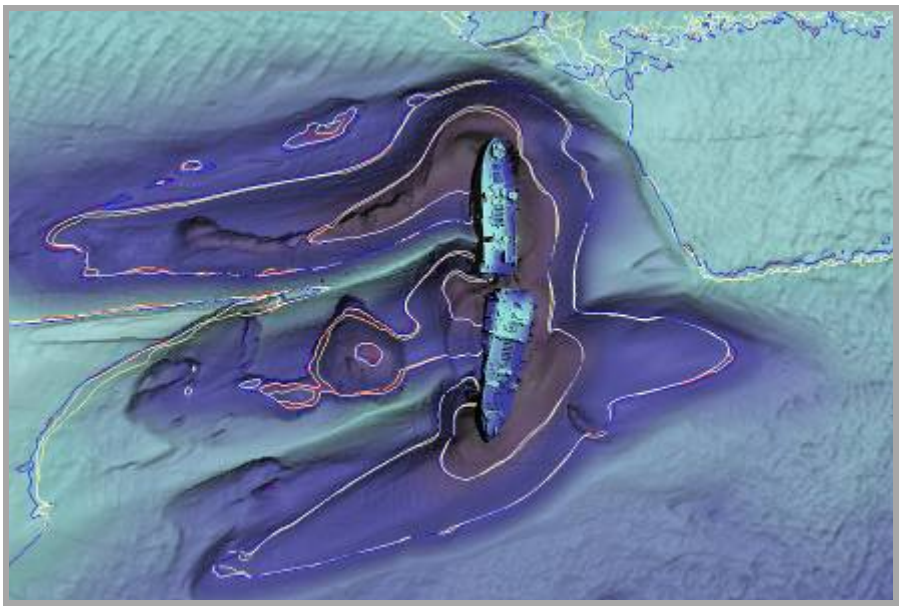


Fig. 20 Survey Contours: 2009= Yellow, 2010 = Red, 2011 = White, 2012= Blue

5.8 In previous surveys, a total of 38 seabed contacts have been catalogued within the survey area. These range from 0.2 m high pieces of debris to a possible Thames barge measuring 10m x 4 m x 2.5 m in size. These targets were also located within the 2012 survey data.

6. Conclusions & Recommendations

6.1 The 2012 survey of the SS Richard Montgomery produced good quality survey data, with improved clarity and definition over the structure itself when compared to the data collected for the 2011 survey. The data has shown that, as a whole, the wreck site appears to remain stable with the majority of the features identified in previous surveys showing no visible evidence of further deterioration.

6.2 Highlighted in 2009 and carried through to the 2011 survey report were three key factors that would affect the future stability and deterioration of the site. These were the strength of the hull structure, the local environment around the wreck site and the condition of the munitions within the forward section.

6.3 Hull structure - structural changes

6.3.1 The majority of the wreck structure appears to be stable. The main body of the wreck structure remains in two distinct parts, with only the forward section showing evidence of deterioration. Areas around the Hold 2 section of the wreck continue to show levels of deterioration. The crack on the port side has increased in its vertical length by 16cm and the deck plating has dropped by a further 30cm when compared to the 2010 data set. These two features have shown gradual and continual change from the 2009 report.

The vessel has not changed its list or orientation. Imagery taken from selected locations across the wreck show that the most recent point cloud aligns with historical data sets on key features.

6.4 Local environment - seabed movement

6.4.1 The seabed that surrounds the wreck site remains relatively stable. Across the site there are areas of changing sediment levels but this would be expected in an area that is subject to strong tidal / wave conditions. The scour marks that are located to the west of the wreck have shown signs of change, with two smaller scour marks being amalgamated into one. Analysis of the data indicated that the scour marks have slowly moved towards the wreck at an approximate rate of 1 metre per year. The dredged channel to the south of the wreck remains apparently unaffected by the presence of the wreck.

6.5 Condition of the munitions

6.5.1 The surveying techniques used to collect data cannot be used to accurately predict the amount and state of the cargo in the vessel. Where there are larger breaks in the hull structure the munitions appear to be contained. The 2009 survey report includes a more in-depth analysis of the munitions by Wessex Archaeology.

6.6 Recommendations

6.6.1 Key recommendations from previous survey reports have highlighted the need for a smaller vessel to be used for survey operations over the wreck. The 2012 survey is a testament to this, with resulting data from the smaller vessel being of a much higher clarity and providing sharper detail directly over the wreck structure on the key features. This recommendation is carried through to this report, with a strong emphasis being placed on getting directly above the wreck structure to provide the best results. Using two survey vessels, survey operations can be conducted in one day but it has proved sensible to allow for two days on site in order to ensure that the wreck and surrounding area has been fully insonified before demobilising equipment.