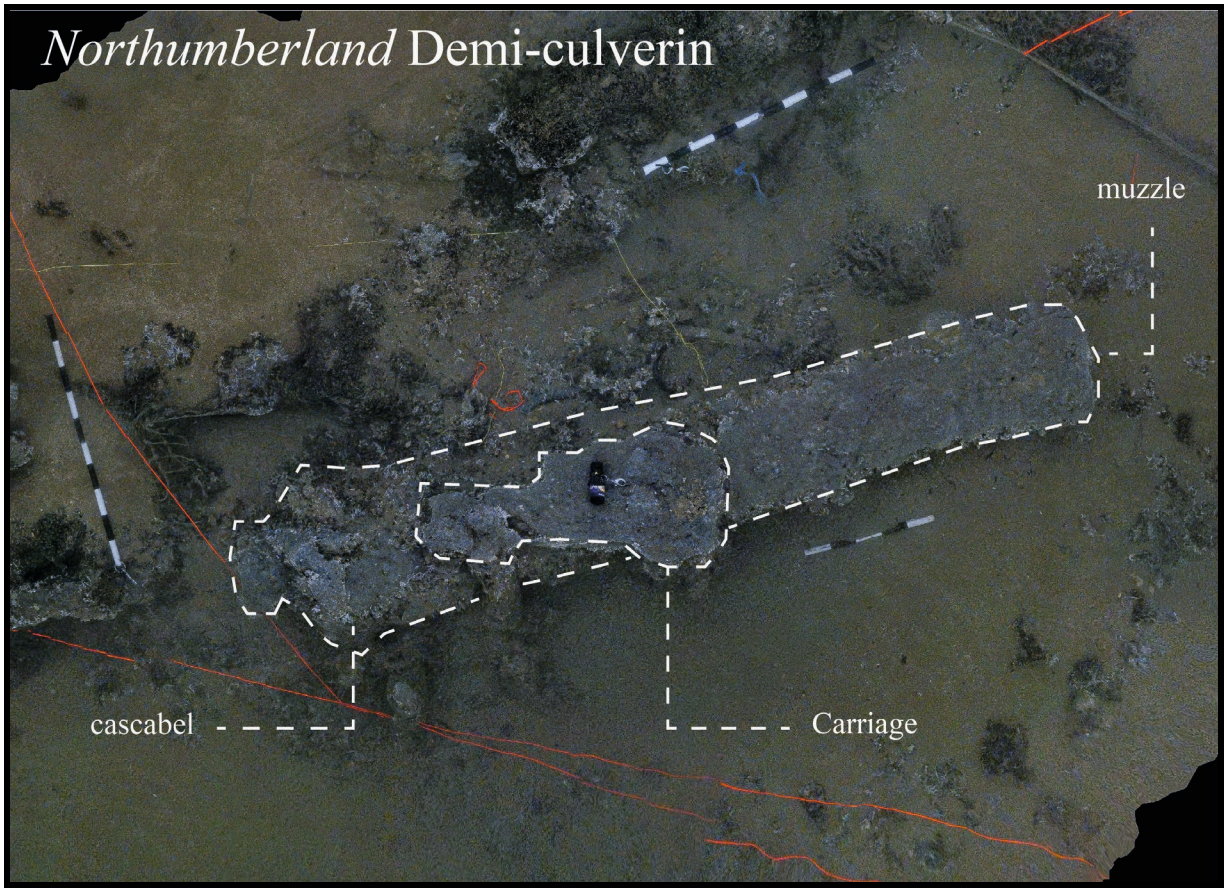
ARCHAEOLOGICAL ASSESSMENT AND NET REMOVAL FROM THE DESIGNATED WRECK OF THE *NORTHUMBERLAND* ON THE GOODWIN SANDS

PROJECT REPORT
2022



New gun with carriage recently emerged from the sands.

PASCOE ARCHAEOLOGY

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PROJECT REPORT

Prepared by:

Pascoe Archaeology
7 Castle Road
Southampton
SO18 1QP

Prepared for:

Historic England
Fort Cumberland
Fort Cumberland Road
Eastney
Portsmouth
PO4 9LD

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ARCHAEOLOGICAL ASSESSMENT AND NET REMOVAL FROM THE DESIGNATED WRECK OF THE *NORTHUMBERLAND* ON THE GOODWIN SANDS

Summary

The *Northumberland*, a third-rate man-of-war, was lost on the Goodwin Sands during the Great Storm of 26-27 November 1703. The wreck was discovered in 1980 and shortly after designated under the protection of Wrecks Act 1973. The *Northumberland* is currently one of only four protected wreck sites in England that are on Historic England's Heritage at Risk Register as High[1]. The stage 1 geophysical surveys conducted in November 2020 identified its huge archaeological potential with a depth of stratigraphy on the site of up to 3.5m deep but with the immediate threat to its future preservation from the migration away of local bedforms (PA 2021). This work led Historic England to commission Pascoe Archaeology to conduct stage 2, the removal of hazardous fishing net and the underwater archaeological assessment of the wreck.

The fieldwork was conducted between the 1-7 July 2021, by a collaborative team led by Pascoe Archaeology. MSDS Marine acted as the diving contractor and diving operations were conducted from the Dive Support Vessel (DSV), *Predator*, of Predator Charters Marine Ltd. The dive team consisted of members of Pascoe Archaeology, MSDS Marine and Bournemouth University.

The current fieldwork has led to new archaeological features being identified, as well as an increased understanding of the archaeological remains in general. Diving observations recorded that there had been further loss of seabed sediments on the wreck since the 2020 geophysical surveys. This has resulted in more archaeological features being exposed and a greater amount of visible fishing net covering the wreck. Guns complete with carriages are now emerging from the wreck mound, along with the ship's structure, rigging and other fragile finds such as, a complete chest, onion bottles, muskets, swords and copper cauldrons. This rich assemblage has the potential to provide a unique insight into life on board a Royal Navy ship of the Queen Anne period.

[1] https://historicengland.org.uk/advice/heritage-at-risk/protected-wreck-sites-at-risk/ assessed 08/12/2021

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Acknowledgements

The author gratefully acknowledges the funding received from Historic England (HE); without it this project would not have been possible. The assistance provided by Hefin Meara and Jenni Butterworth was most gratefully received.

The fieldwork was carried out by Dan Pascoe of Pascoe Archaeology (PA), Mark James and Tom Harrison of MSDS Marine, Tom Cousins Bournemouth University, Rodrigo Ortiz-Vazquez, Mark Hobbs and Michael Pitts. The survey vessel, *Predator* from Predator Marine was skippered by Stuart and crewed by Daniel Poppy. The project was led by Dan Pascoe and the results of the assessment and the report have been produced by Dan Pascoe.

Copyright Statement

1. INTRODUCTION

1.1.1. This report has been prepared by PA for HE. It comprises an Archaeological Assessment Report for the designated wreck of the *Northumberland* on the Goodwin Sands.

1.1.2. The programme of work was conducted in accordance with the Project Design agreed by HE. The archaeological assessment took place through underwater diving investigations over one week from the 1-7 July 2021. PA directed the fieldwork and MSDS Marine acted as the dive contractor. The 2020 multi-beam bathymetry data was used to target exposed archaeological features on the seabed.

1.1.3. Following the fieldwork PA has analyzed the results gathered and interpreted the archaeological remains currently exposed on the seabed that form the basis of this report. Exposed archaeological features described in the report were either recorded photogrammetrically or details recorded in divers' logs and illustrated with film and photographs.

2. PROJECT AIMS AND OBJECTIVES

2.1. PROJECT AIM

2.1.1. There were three project aims. To remove the fishing gear from the wreck of the *Northumberland* that is a danger to divers and the archaeology; to complete unfinished objectives from the 2018 fieldwork; and to record and identify recently exposed areas of the wreck and features and features cleared of fishing net.

2.2. PROJECT OBJECTIVES

2.2.1. Remove all fishing gear which an entanglement hazard to divers.

2.2.2. Remove all fishing gear that is damaging or obscuring archaeological features and artefacts.

2.2.3. Record features that have previously been obscured by fishing nets.

2.2.4. Record timber sizes, dimensions and types to help identify which parts of the ship are surviving on the seabed.

2.2.5. Record the number of guns (cannons) exposed and their sizes.

2.2.6. Identify any exposed artefacts, ships fittings and fixtures that may help to determine the identification of areas of the ship.

2.2.7. If showing on the 2020 bathymetry ground-truth anomalies to the north of the main wreck mound. This was an objective left over from the 2018 fieldwork.

2.2.8. Collect pH reading from the seabed. This was an objective left over from the 2018 fieldwork.

2.2.9. Collect biological trial test pallets for analysis.

3. METHODOLOGY

3.1. DIVING

3.1.1. MSDS Marine acted as the diving contractor during the fieldwork. All diving works were undertaken in adherence to the Diving at Work Regulations 1997 (DWR97) and following the guidance laid out in the Scientific and Archaeological Diving Projects Approved Code of Practice (ACoP). The Scientific and Archaeological Diving Projects ACoP allows for the use of professional divers, volunteers and students and has been used successfully on a wide range of projects undertaken by the diving contractor.

3.1.2. All diving was undertaken using SCUBA diving equipment with Full Face Masks (FFM) fitted with through-water communications to allow two-way communication with the divers. All divers were suitably qualified and experienced to undertake the proposed tasks.

3.1.3. Alongside the professional core dive team were volunteer divers. The volunteers dived according to the rules and regulations of their certifying organisations but under the supervision of the diving supervisor.

3.1.4. Diving operations were conducted from the MCA accredited diving support vessel (DSV) *Predator*, a 12m catamaran and licensed to carry 12 divers.

3.1.5. At the beginning of each day the project team were briefed on the dive plan, survey and recording methods, and health and safety. The team members were then divided into buddy pairs for diving and given survey tasks to carry out underwater.

3.1.6. A buoyed shot was deployed on the site, which the divers descended. When at the bottom divers clipped onto the bottom of the shot and reeled-out to their chosen areas to survey. This method ensured that divers never got lost from the shot and could always return safely to the surface to be picked up by the dive vessel.

3.2. Survey and Recording Methods

3.2.1. The methodological approach to carrying out archaeological work underwater followed the procedures and guidelines set out in 'Underwater Archaeology: The NAS Guide to Principles and Practice' (Bowen 2008).

3.2.2. The recording of the site was carried out following procedures and guidelines set out in the 'Institute for Archaeologists Standards and Guidance for Nautical Recording and Reconstruction' (CIFA 2014).

3.2.3. Initial site assessment and recording involved observational survey and sketch plans of potential areas of recently exposed material. These were supplemented by digital photographs and HD video. The observations were recorded by the diver onto survey boards using digital cameras and GoPro HD cameras.

3.2.4. Photographic and video surveys were taken to record key constructional features and exposed artefacts.

3.3. Photogrammetry

3.3.1. Exposed archaeological features were identified and several 1m scales were placed around the feature prior to survey. The scales ensure the results of the surveys can be scaled accurately during the processing phase.

3.3.2. A Gopro Hero 9 with an Inon UFL-G140 semi-fisheye dome port was used to conduct the surveys.

3.3.3. During diving operations, teams of two were sent down onto the wreck and tasked to survey specific areas. Areas were assigned during the dive briefings at the beginning of each day and teams were shown on a site plan the area to be covered. Divers were equipped with the available cameras: typically dive teams were either assigned the Nikon with the attached GoPro with flat lens, or the standalone GoPro with the dome port. Divers covered their designated areas in a 'lawnmower' pattern with the intent to ensure overlap between photo rows and columns.

3.3.4. During dives, the cameras were set to automatic white balance settings and set to automatic capture at one image per second. This workflow was designed to eliminate user error and the need for a comprehensive understanding of camera theory among the team.

3.3.5. The images were collected as JPEGs and brought into Adobe Lightroom for colour correcting. Following image correcting the images were loaded into Agisosft Photoscan for processing.

3.3.6. Images were then aligned using Photoscan's medium accuracy setting. Medium was chosen due to both high processing times observed when attempting alignment of larger datasets on the 'high' and 'highest' settings, as well as occasional highly confused models generated due to the high sensitivity of the setting attempting to highlight water particles as features of interest.

3.3.7. After chunks of photos were aligned, dense point clouds were generated using high or medium settings. If successful, interpolative meshes and textures were generated from the dense cloud. Once full models were created, the models were scaled in Photoscan. Textures were rendered as orthophotos and Depth Elevation Models (DEM) were also produced. Once scaled the orthophotos and DEMs can be georeferenced onto the appropriate bathymetry of the site. Unfortunately, the sections of the site recorded during the current fieldwork were not visible on the 2020 bathymetry. They may, however, be visible on future bathymetry of the site.

3.4. BIOLOGICAL TRIAL – TEST PANEL DEPLOYMENT IN 2018

3.4.1. Three sets of test panels containing elm, oak and pine were placed on the site. Each set had 5 x elm, 5 x oak and 5 x pine panels. The individual panels are 200x75x25mm in accordance with EN275 (1992) standards.

3.4.2. The test panels consist of timed sets, in which the first set will remain on the site for 12 months, the second for 18 months and the third for 24 months. When the panels are retrieved, they will be analysed to determine the type of wood boring species living, breeding, and eating the wood.

3.4.3. The test panels were arranged in rows of three in accordance to their species and secured using polypropylene rope threaded through a 10mm hole in the middle of each test panel. An additional 1m of rope was left at each end of the row to secure the panels directly to the wreck. A different colour and number of cable tie combinations were secured to the rope to help identify the test panel groups on retrieval.

4. PROJECT RESULTS

4.1. INTRODUCTION

4.1.1. The *Northumberland* was a third-rate man-of-war of 70 guns built in 1679 in Bristol. She was lost on the 27th November 1703 during the Great Storm. The wreck lies at a chartered depth of 14m, 9.5km southeast of Ramsgate on the Goodwin Sands between North Sands and South Sands Head. The exact position is 51º15.4802'N 001º30.0161'E WGS 84 with a designated area with a 300m radius. The National Record of the Historic Environment (NMHR) monument number is 1082118 and the National Heritage List for England (NHLE) number is 1000058.

4.1.2. The multi-beam echo-sounder survey (MBES) conducted over the site during stage 1 of this project in November 2020, revealed significant changes to the site and the surrounding area. The large subaqueous dunes which have been covering the site have continued to migrate northeastwards. This has led to a reduction in seabed

sediments resulting in new exposure of wreck material and the site situated on the very edge of a migrating dune. (PA, 2021, 21) (Figure 1). Sub-bottom data identified a depth of stratigraphy of up to 3.5m on the wreck but only 0.5m on the seabed to the west, north and south. Therefore, there is an insufficient burial environment should the dune migrate further to the northeast (PA, 2021, 32-33). These findings demonstrated the urgent need for stage 2 diving fieldwork to go ahead.

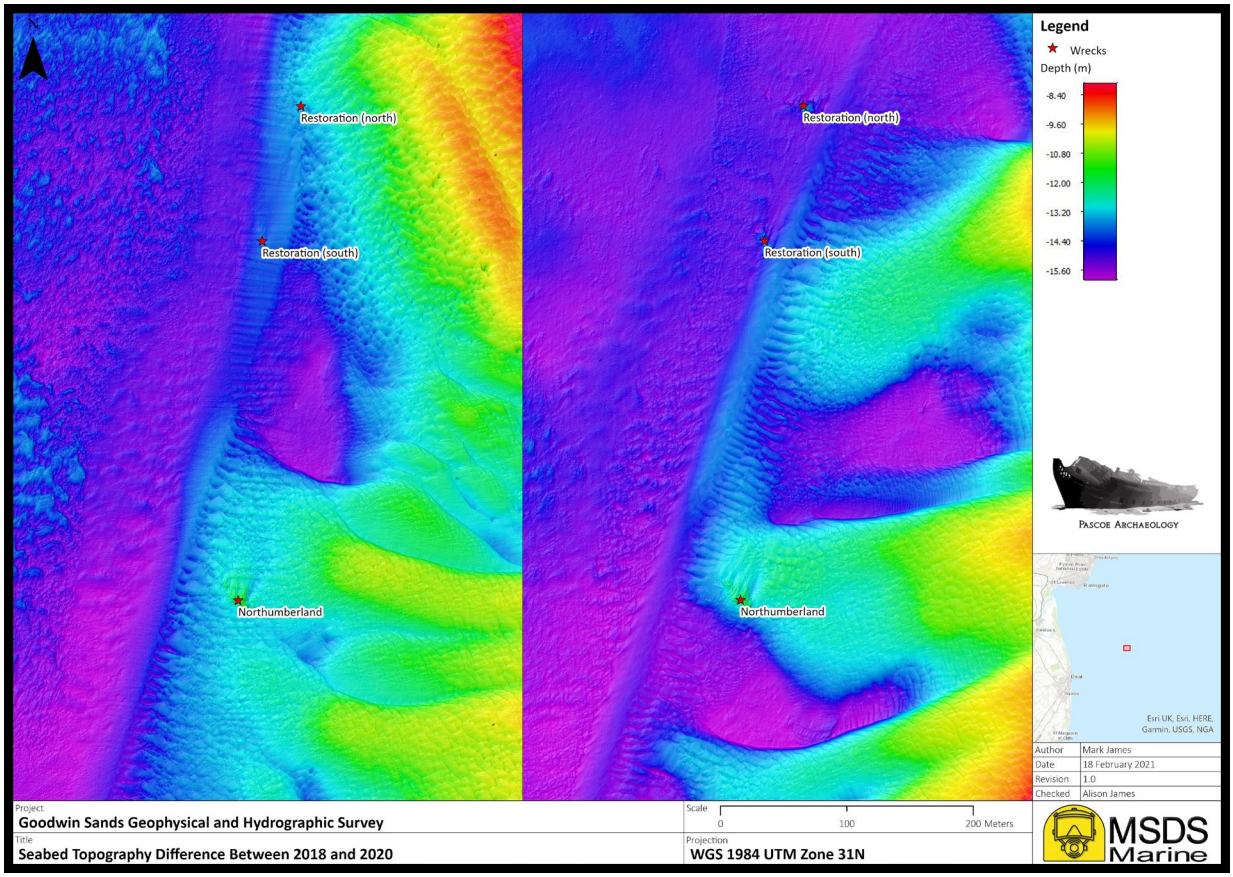

Figure 1: Comparison between the 2018 and 2020 MBES data, showing significant changes to the topography on the site.

4.1.3. Five days of diving were conducted over the wreck of the *Northumberland* on the Goodwin Sands between 1- 5 July 2021, during a period of neap tides. It was not possible to dive on the last two scheduled days (6 and 7 July) due to adverse weather conditions. A total of 28 individual dives were undertaken by 6 divers, with a total bottom time of 21 hours and 35 minutes.

4.1.4. Despite the very good tides and fair weather for the five diving days, underwater conditions were extremely challenging. The visibility for the first three days was pitch

black on the seabed without a torch and under 1m with and less when seabed sediments were stirred up when working. On the fourth day the visibility improved to a good 3-4m with ambient light present on the seabed. By the fifth day visibility had deteriorated to a milky 1-2m with ambient light. The generally poor visibility was attributed to north and north easterly winds, albeit light, dominating local conditions prior to our arrival. These conditions tend to hold off clearer water from the Channel and keep the siltier water stirred up on the Goodwin Sands.

4.1.5. Due to the underwater conditions on the site expectations with what could be achieved were lowered to ensure tasks were carried out safely. The removal of fishing net is dangerous at the best of times but in poor visibility it is even more so. As such the divers tasked with removing net prioritised areas where the net could be removed without endangering themselves or the other divers in the water.

4.2. ARCHAEOLOGICAL RESULTS

4.2.1. The 2020 MBES identified exposed features within a main wreck mound 45m long by 22m wide. The mound is orientated northwest-southeast, and it lies directly on bedforms that are migrating in a northeast direction (PA 2021, 21) (Figure 2). All divers, however, observed that there was greater exposure of wreck material than was visible on the 2020 bathymetry.

4.2.2. Divers observed scouring along the entire length of the western side of the site and continuing round the large concretion at the southeast end. Several more guns were observed on the northeastern side of the wreck mound demonstrating a general reduction in sediments over the whole site. These guns were not visible on the 2020 bathymetry and are just one indicator of the change to the site in just eight months. Diver depth gauge measurements recorded 19.5-18.5 in the areas of scour compared to 17-16m at the top of the wreck mound. At the southeast end the mound sloped quite steeply with structures, guns with carriages, smaller artefacts and human remains protruding from the slope. These structures and artefacts are layered extending from the bottom of the slope to the top of the mound demonstrating the entire depth of stratigraphy contains archaeological material.

4.2.3. The interpretation of the exposed remains will start at the southeast end of the site and work systematically backwards to the extent of exposed features at the northwest end. The described features will be annotated on the 2020 bathymetry, however, many of these features were not visible when the bathymetry was recorded in November 2020. This demonstrates changes are continuous on site and considerable in a relatively short period of time. (Figure 2).

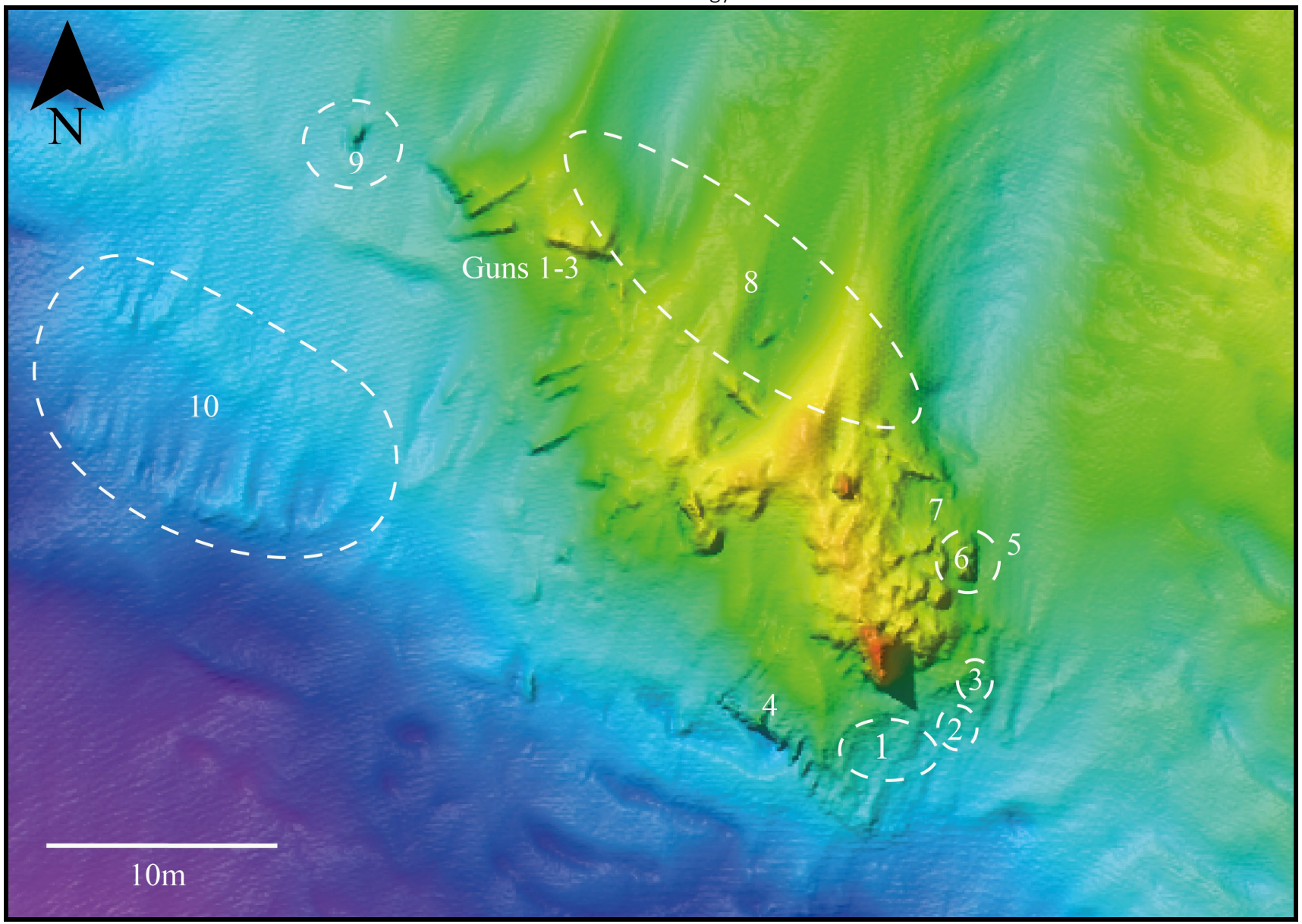

Figure 2: The 2020 multi-beam bathymetry of the wreck mound with annotations. 1. Rope area, 2. Gun with carriage, 3. Chest, 4. Keel and hull structure, 5. Cauldron, 6. Gun 4, 7. Cascabel of gun, 8. Area of guns, 9. Hand weapons, 10. Structure and netting.

Southeast end

4.2.4. This end of the site was unrecognizable with the 2020 bathymetry with a much greater area of exposure extending southeast from the large concretion mound. Diver observations recorded an area of exposed wreck material 8m long by 8m wide. All of the exposed features were covered in a thick layer of juvenile mussels.

4.2.5. The mussels camouflaged much of the archaeology making identification difficult. Removal of small areas of mussels was necessary to identify the archaeology. This revealed that a significant proportion of the area consisted of coils of cordage still in a remarkable condition (Figure 3 and label 1 in Figure 2). The location of the cordage coincided with the previous licensees site plan, which shows a mixture of different sizes of rope in neat coils southeast of the large concretion (Figure 4).

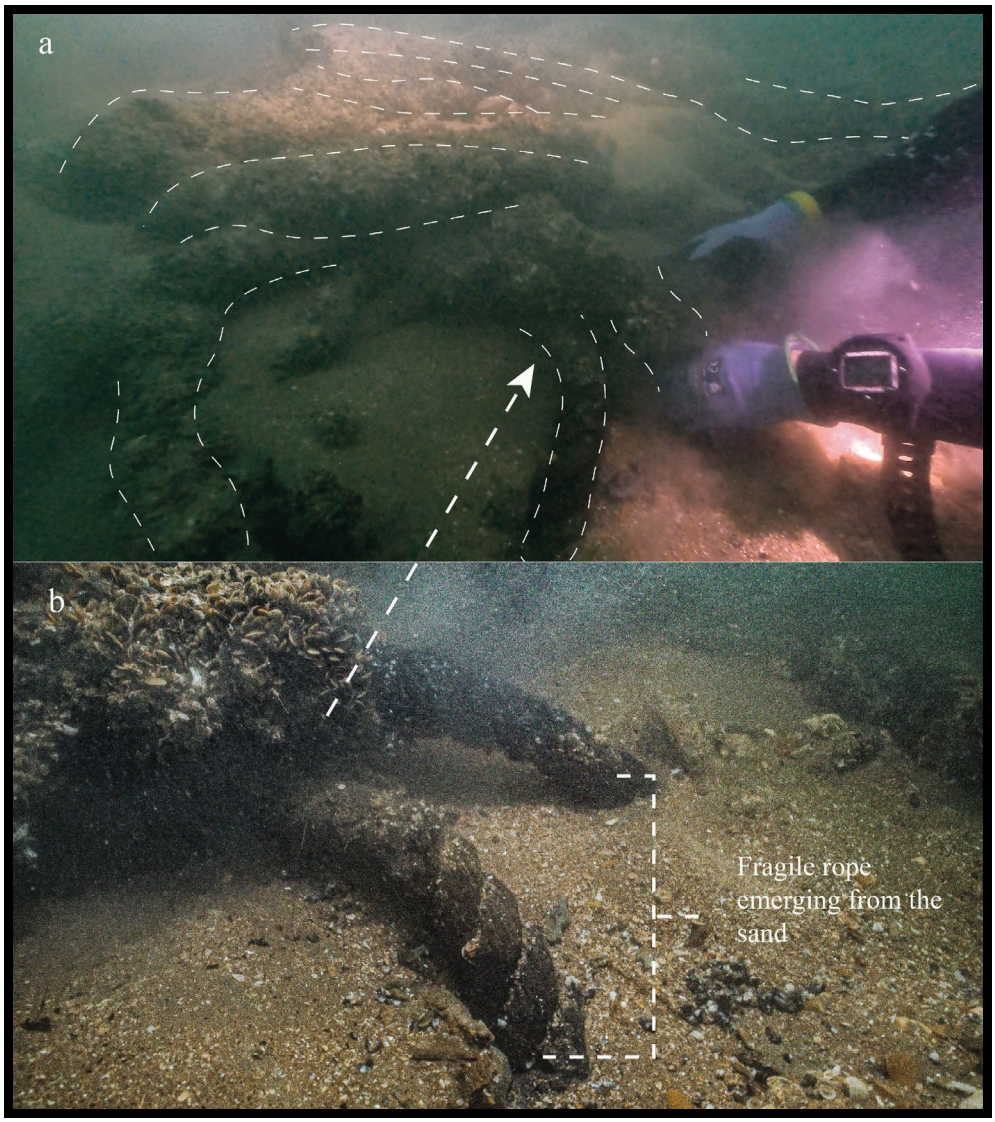

Figure 3: Image **a** partly shows the extent of the rope and how it is covered in mussels. Image **b** shows how small sections of mussels were removed to reveal well-preserved sections of rope.

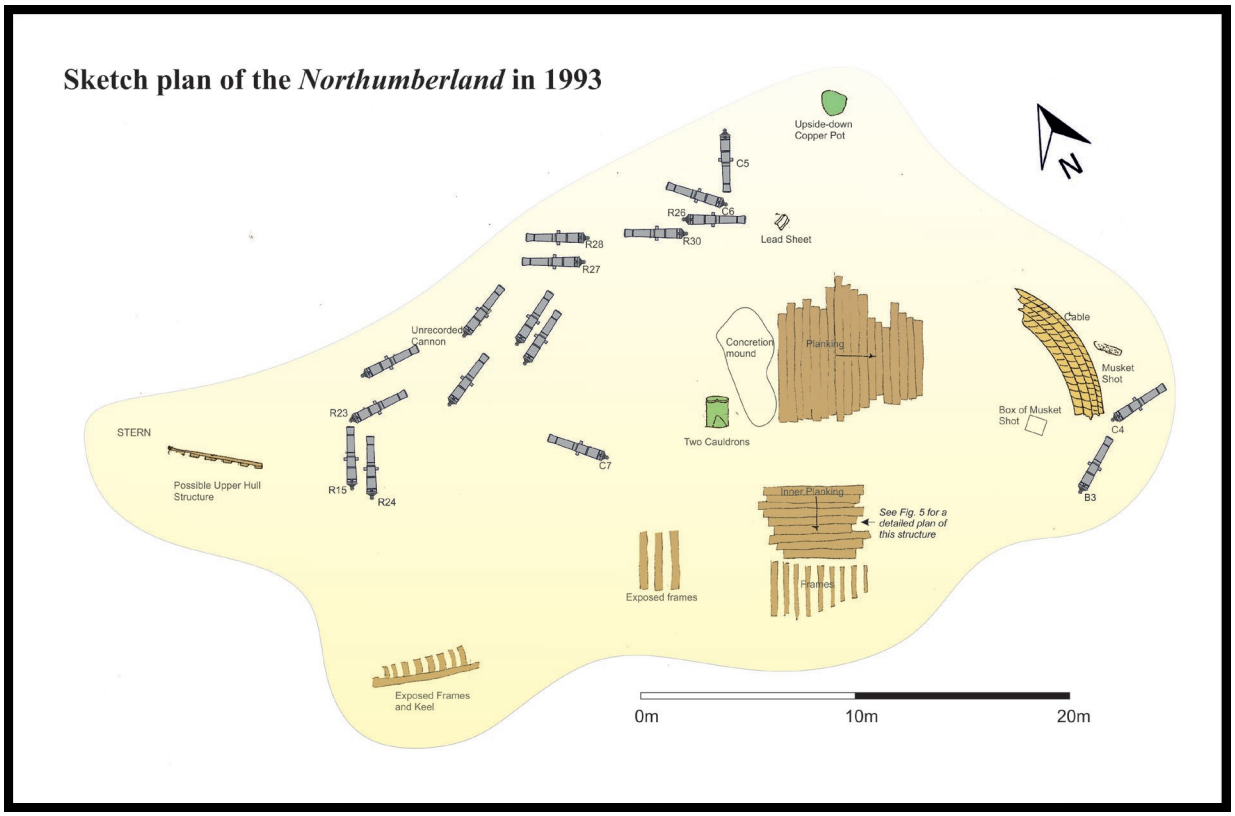

Figure 4: The 1993 site plan showing area of cordage forward of concretion mound.

4.2.6. Heading just a few metres northeast of the area of rope was a gun heavily covered in mussels and it had part of its carriage still surviving (Figure 5 and label 2 Figure 2). The gun was lying on its side with the muzzle pointing roughly southwest and therefore its left cheek was exposed. This gun was not visible on the 2020 bathymetry and must have become exposed sometime between the November 2020 and July 2021. The gun was observed during an inspection of the whole site and the intention was to return the next day to record dimensions, however, poor visibility the following day hampered this task. From the quick inspection it would appear to be of a smaller type, possible demi-culverin or saker. Its location would appear to be slightly north of guns B3 and C4 illustrated on the 1993 sketch plan, so it is potential a gun that has not been seen before.

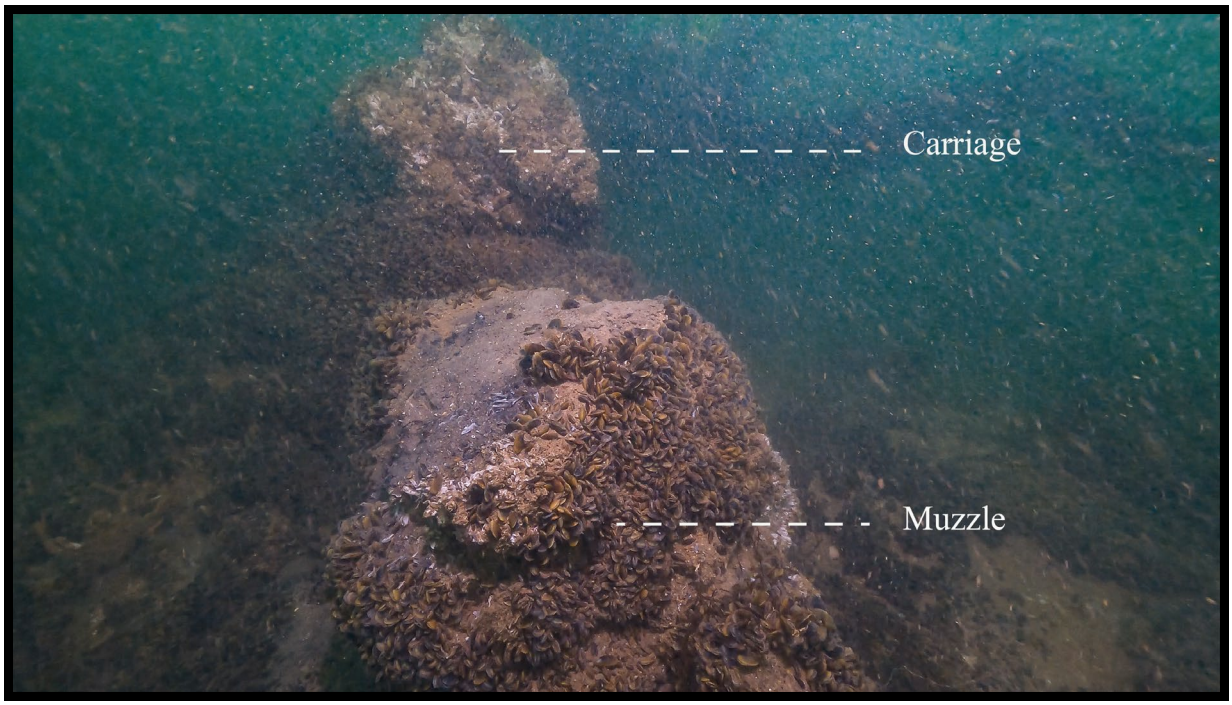

Figure 5: Exposed gun at southeast end of site from the view facing the muzzle.

4.2.7. Within 1m of the breech end of the gun and towards the large concretion was a concreted chest. As well as being concreted it was covered by a thick layer of mussels. Although concreted and covered in mussels its form was perfectly rectangular. The top side was approximately 500 x 250mm with its sides predominantly buried (Figure 6 and label 3 Figure 2).

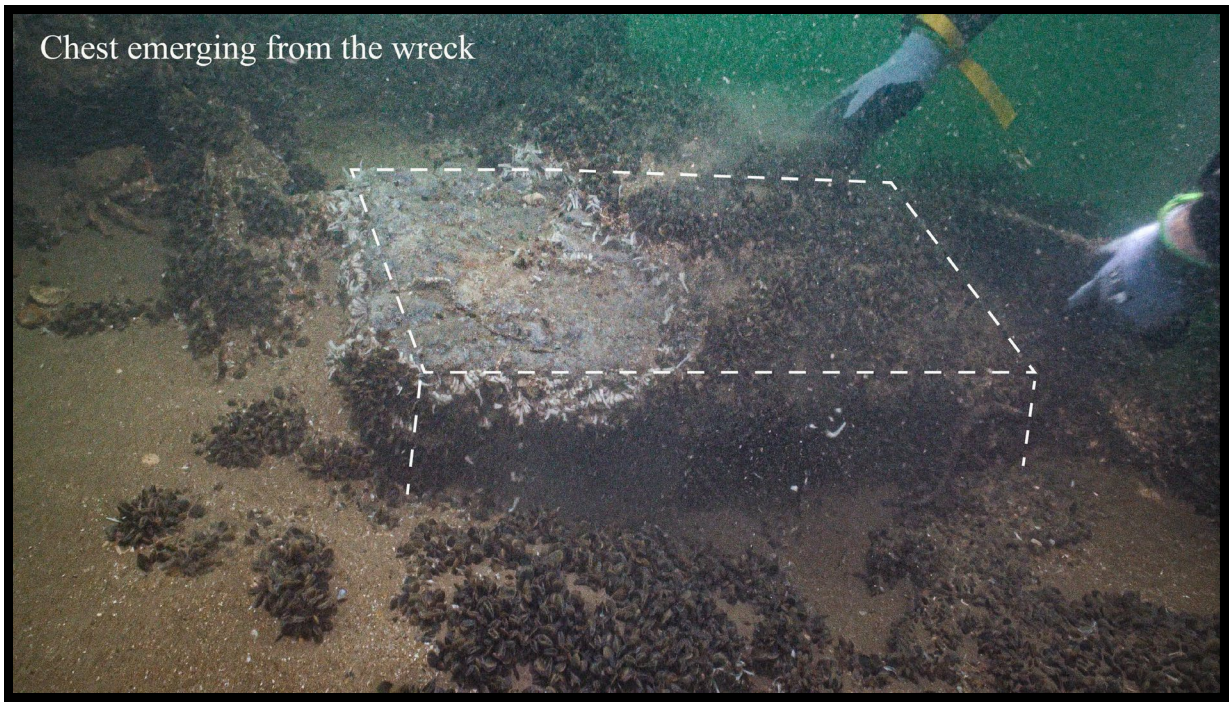

Figure 6: Concreted chest at the southeast end of the site.

4.2.8. Back over to the southwest side of the site is a large section of exposed structure. This was clearly visible on the 2020 bathymetry but since then has increased in size. The structure consists of a row of floor timbers, with their broken ends protruding over the top of the keel. In between the floors are the second futtocks which butt close to but not against the side of the keel (Label 4 Figure 2).

4.2.9. This section of structure is exposed for approximately 10m. The keel is orientated NW/SE and rises out of the sand at the northern end (Figure 7). The floors and futtocks are orientated NE/SW and were seen extending back to the large concretion (Figure 8). All of the exposed structure is heavily covered with fishing net and mussel growth. The level of netting and mussel growth meant it was not possible to gain measurements in the time available but much of it has been recorded in 2008.

Figure 7: Diver adjacent to the keel at the end of exposed lower hull structure.

Figure 8: The broken end of floor timbers protruding from the sand.

4.2.10. On the eastern side of the large concretion and near the bottom of the slope was a complete copper cauldron (Label 5 Figure 2). It was on its side with the base on the outside of the wreck mound. It was slightly squashed around the sides and open end. The sides of the cauldron were riveted to a separate base piece and its approximate diameter across the base was 700mm (Figure 9). Its location is consistent with the copper pot shown on the 1993 sketch plan (Figure 4). It is very similar to examples recovered from the wreck of the *Hazardous*, lost in 1706 off the coast of Bracklesham (Figure 10).

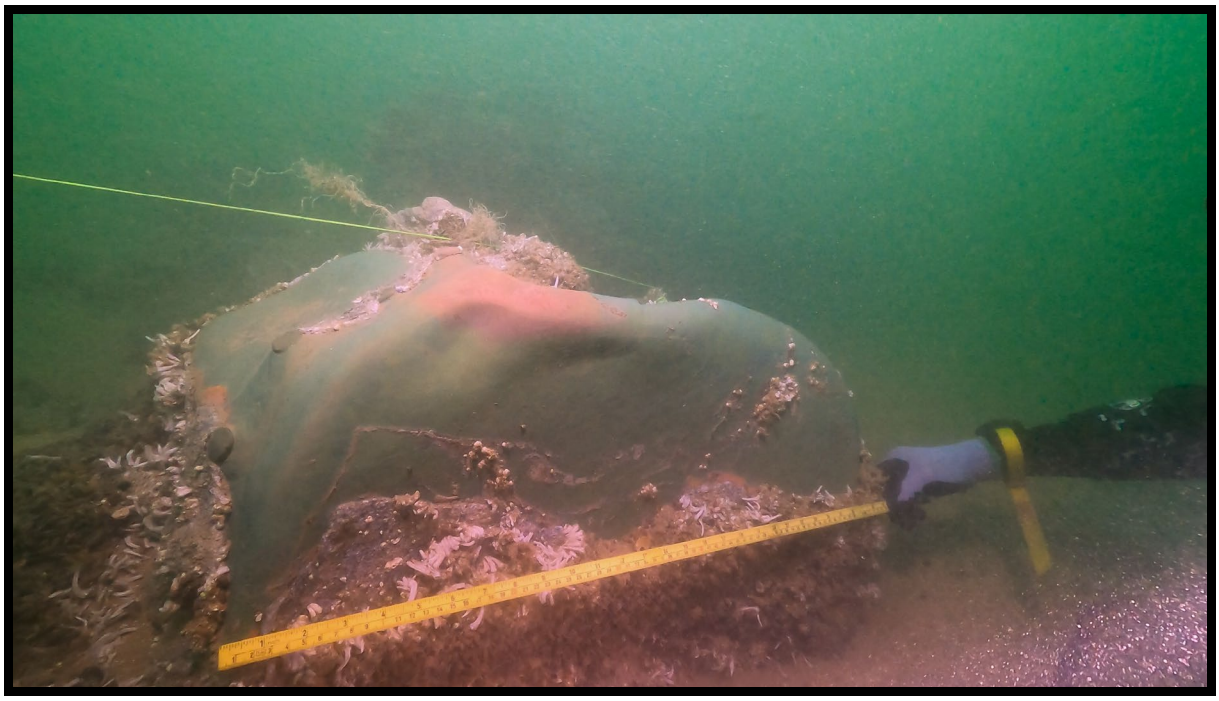

Figure 9: Copper cauldron found on the east side of the large concretion.

Figure 10: A similar type of copper cauldron recovered from the wreck of the *Hazardous,* lost 1706.

4.2.11. Roughly 3m up slope and to the north of the copper cauldron was the first of a series of guns that extend in a line up to the northwest end of the site. It lies on its side with the muzzle pointing in a northerly direction (Label 6 Figure 2 shows an approximate position). The right cheek of its carriage survives on top with two iron through bolts extending down below the underside of the gun to the buried left cheek (Figure 11). Although this gun is fully exposed its exact location of the 2020 bathymetry is not clear and this suggest it has appeared sometime after the 2020 survey. As this gun was recorded in detail it will be referred to as Gun 4 but as yet it is not possible to georeference its exact position as its shape does not match the features showing on the 2020 bathymetry.

4.2.12. Gun 4 and its carriage are both heavily concreted and therefore dimensions are only an approximation. The muzzle and the button at the cascabel end are clearly discernable but the location of the base ring less so. The length from the end of the muzzle to the approximate location of the base ring is 2.95m (9ft 7in). If one takes into consideration the thickness of the concretion then this would suite a 9 ½ ft gun. According to the guns on board the *Northumberland*, recorded during the great ordnance survey of *c.* 1696, guns of 9 ½ ft included all her main gundeck demi-cannon and eight out of 26 upper deck demi-culverins (TNA WO55/1736).

4.2.13. The gun is so heavily concreted around the breech with other concreted objects that it is difficult to take a reliable measurement. The clue which suggests which type of gun this one is can be seen from the remains of its carriage. It's clear that the carriage was constructed with two iron through bolts to brace the two cheeks and support the weight of the gun (Figure 12). The evidence from a recovered demi-cannon with carriage, from the wreck of the *Stirling Castle*, identified that the cheeks were braced by three iron through bolts (McElvogue 2008, 42). The demi-cannon being a heavier gun would require the carriage to have extra support and therefore the identification of only two from the *Northumberland* gun carriage suggests a lighter gun, such as one of the demi-culverins.

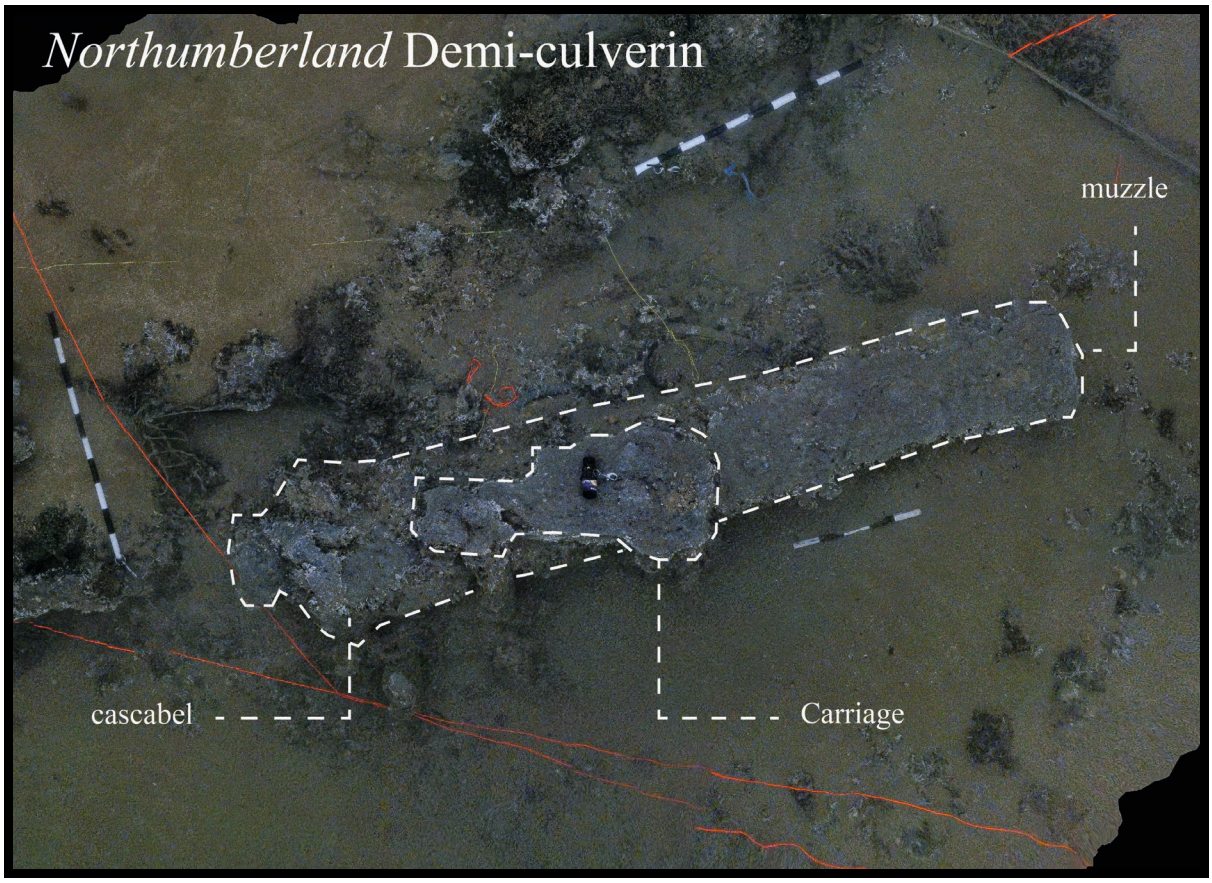

Figure 11: Annotated orthophoto mosaic of demi-culverin and carriage (Gun 4).

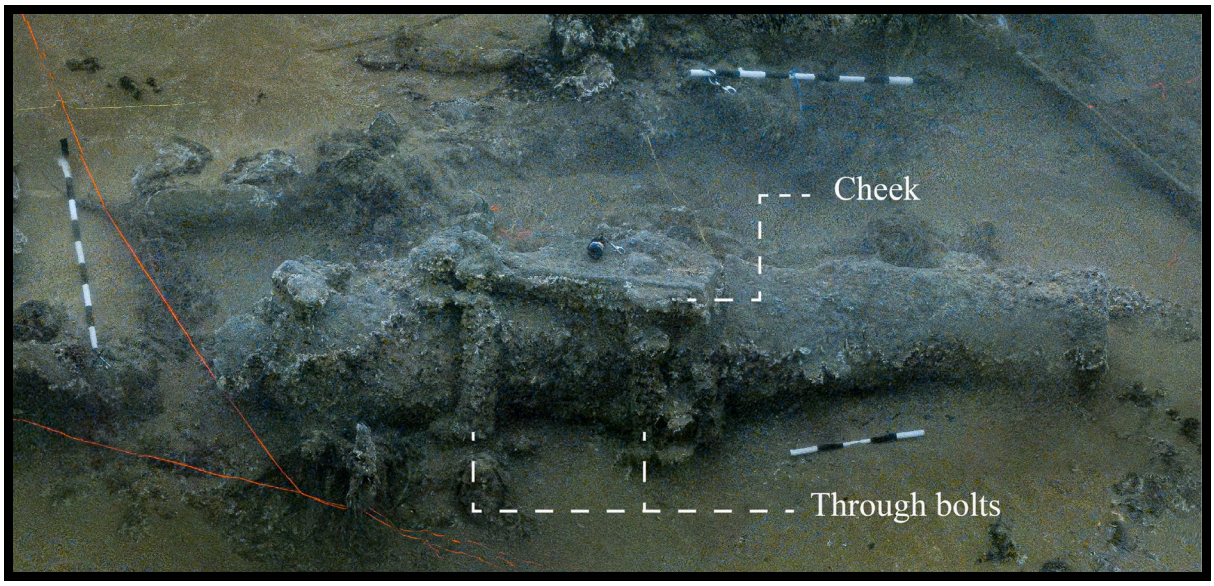

Figure 12: Annotated orthophoto mosaic of the demi-culverin from the view of the underside of the gun.

4.2.14. Also clear is the position of the gun within the carriage. The muzzle is elevated, demonstrating that it was run in with the muzzle lashed above the inside of the port (Figures 12 and 13). This was a standard procedure when housing the guns in

preparation for rough seas, so gunports could be closed to keep the vessel as watertight as possible (Harland 1984,210).

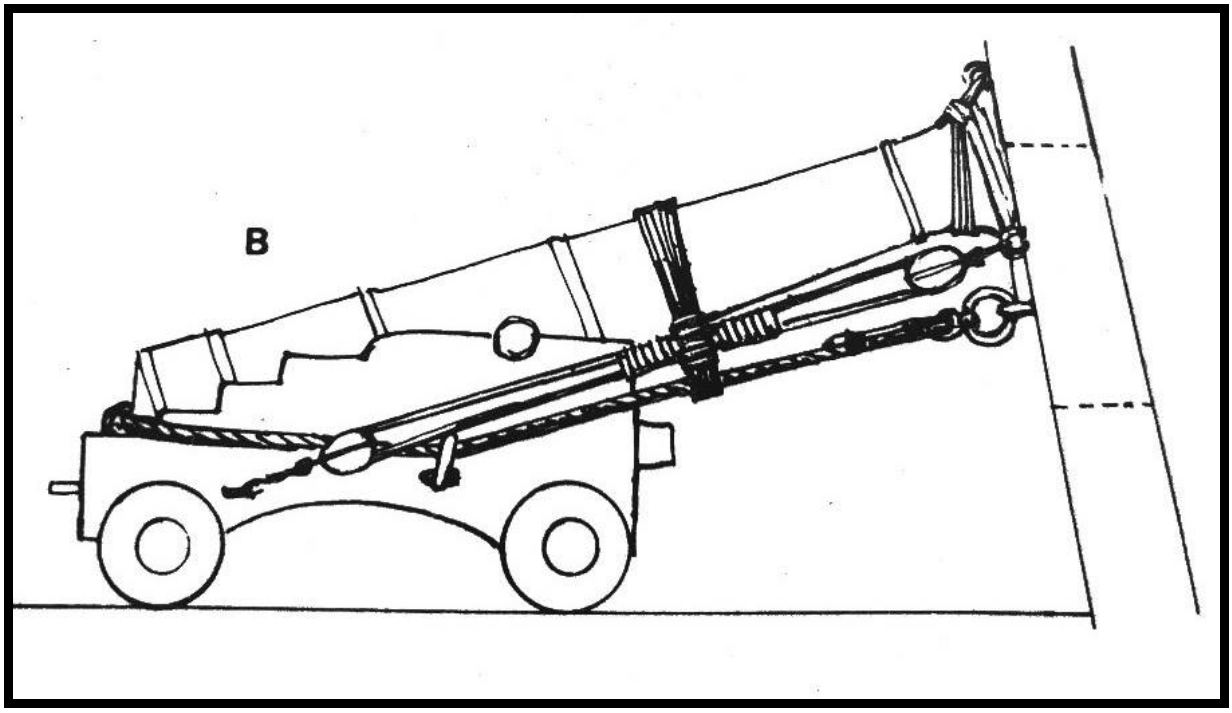

Figure 13: Illustration showing gun housed with muzzle secured above the inside of the port (From Harland 1984,210).

4.2.15. Less than 2m north of the muzzle of Gun 4 is another gun. This gun is exposed at the cascabel end and buried from the trunnions to the muzzle (Figure 14 and label 7 Figure 2). This gun was not recorded in detail but from diver Mark Hobbs hat cam footage it would appear to be a gun of one of the smaller calibres. Its location roughly coincides with gun C6 on the 1993 sketch plan. If this is C6 then it was recorded as 2.7m (8.85ft) in length and has tentatively been identified a possible demi-culverin (Pascoe and Peacock 2015, 139). This gun does not appear to be present on the 2020 bathymetry and therefore is another indication of the reduction in seabed sediments.

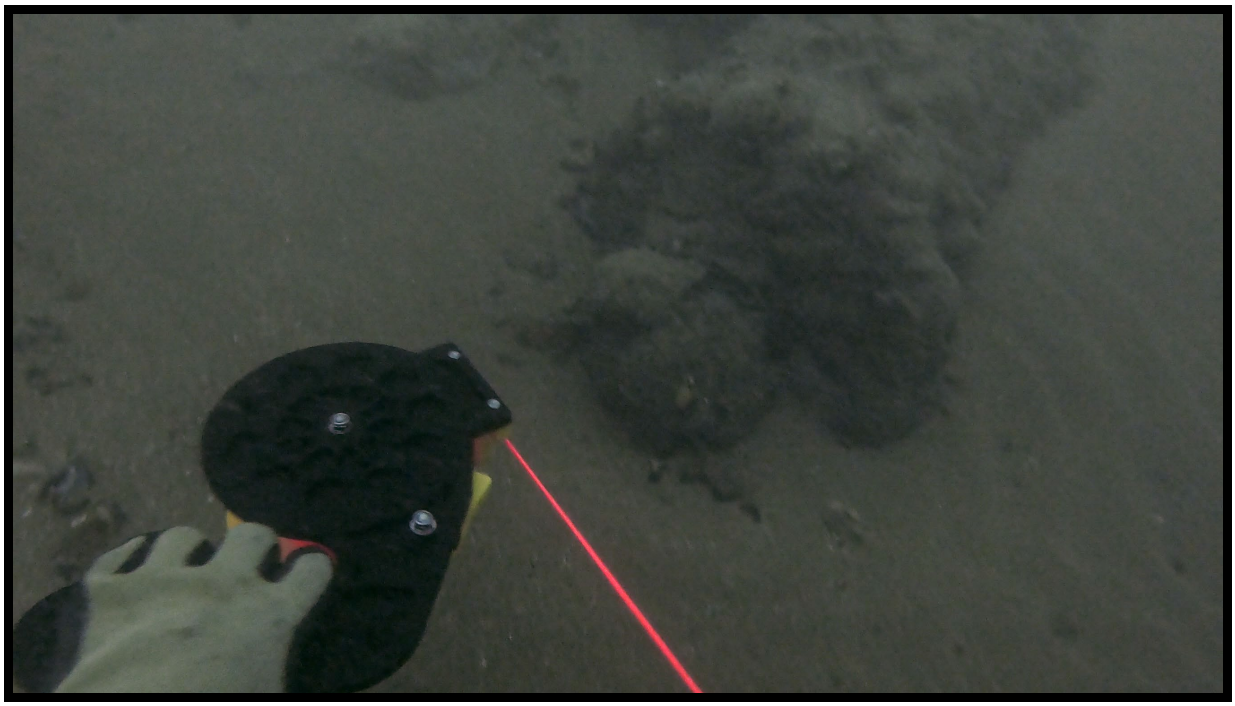

Figure 14: Frame grab from hat cam footage showing the cascabel end of another demi-culverin, potentially gun C6 shown on the 1993 site plan.

4.2.16. There are several other guns just emerging from the sand from the gun described in section 4.2.15 leading up to the assemblage of swords at the northwest end of the site. Several of these guns appear to be directly north of Guns 1-3 (Label 8 Figure 2). They were only briefly observed and not recorded in any detail. Their general positions and alignment are consistent with the group of guns positioned on the 1993 sketch plan (Figure 4), but they are not visible on the 2020 bathymetry. These guns had no mussel growth suggesting they had recently become uncovered and were not exposed during the 2020 bathymetry.

4.2.17. The guns recorded during the 2018 diving fieldwork and labelled guns 1-3 were much more exposed than they were in 2018. There was a distinct reduction in seabed sediments along the western side of the guns. This had fully exposed gun 2 which was only partially exposed in 2018 (Figure 15). The guns, as well as surrounding structure and concretions, were all heavily covered in mussel growth.

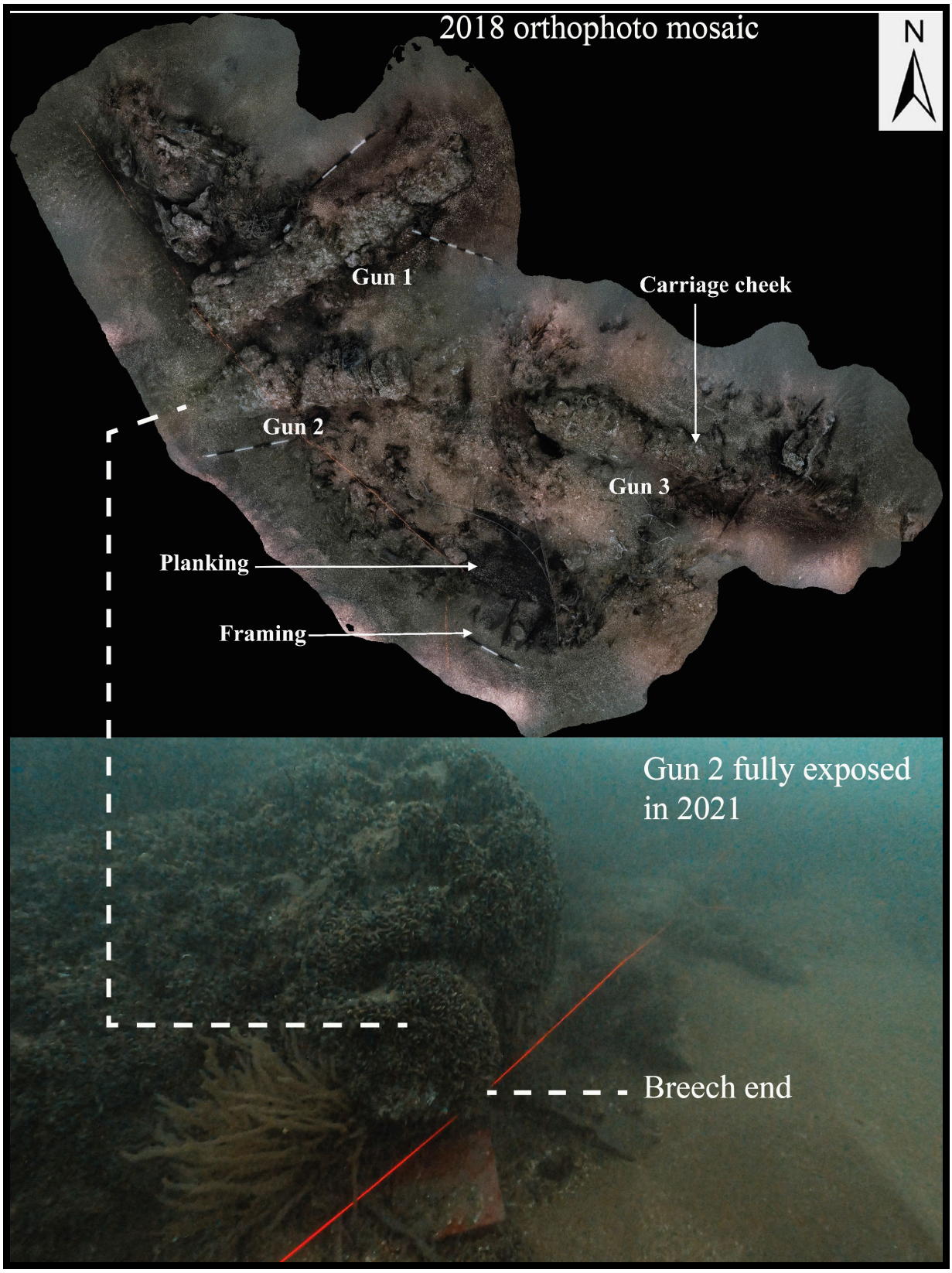

Figure 15: Images showing the comparison between 2018 and 2021. The loss of sediments has fully exposed Gun 2 from breech to muzzle. Gun 2 is now covered in a thick layer of mussels where it was not in 2018.

4.2.18. Coherent timber structure can be seen extending underneath Guns 1-3 (Figure 16). A section of this structure was observed below Gun 3 in 2018 but with the further loss

of sand it now can be seen extending under Guns 1 and 2. The structure looks like it is likely to the inside of the hull structure. Guns 1 and 2 are demi-cannon and 3 is a possible culverin, therefore the structure is possibly associated with the level of the main gundeck.

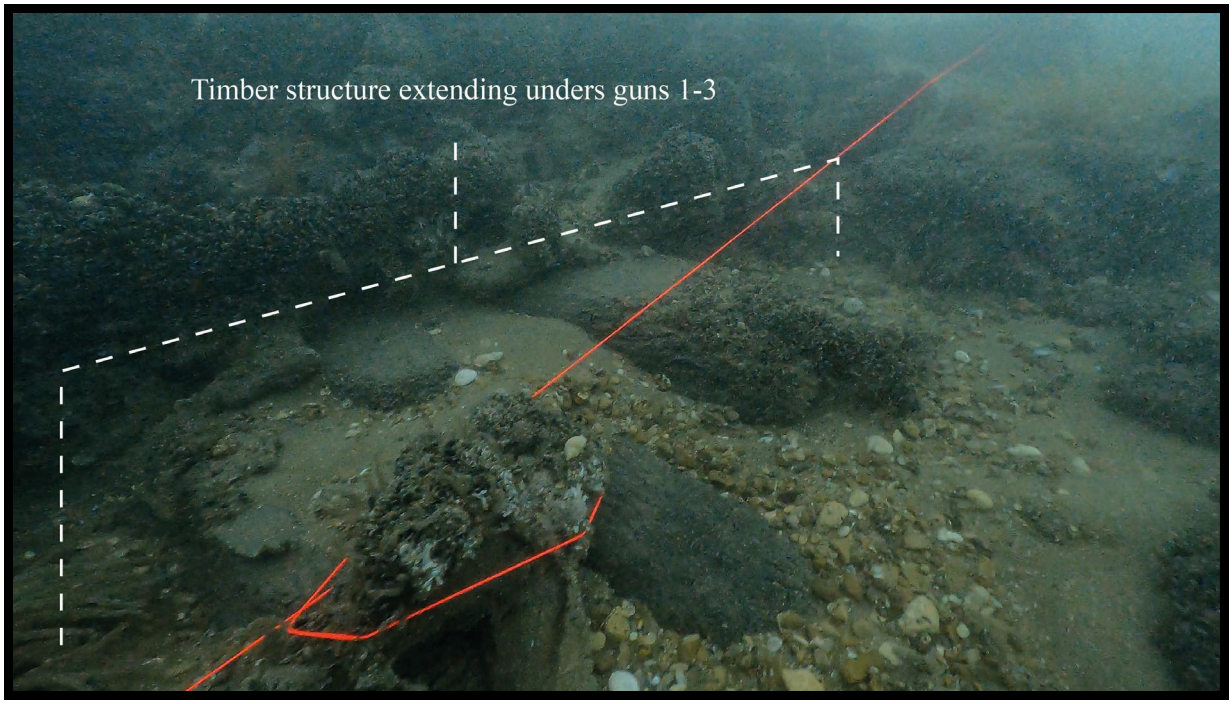

Figure 16: Image showing a section of the timber structure extending underneath Guns 1-3.

4.2.19. Six metres northwest of the cascabel of Gun 2 is the assemblage of swords, which was identified during the 2018 diving investigations. This area of the site has changed considerably since both the 2018 diving and the 2020 MBES survey. The sand levels have dropped dramatically revealing a much larger assemblage of swords but what appears to be a large assemblage of muskets too (Figures 17 and 18 and label 9 Figure 2). The muskets are on the north side of the swords and appear connected via concretion.

4.2.20. When comparing the 2018 photogrammetry model of the swords with a photograph with scale taken in 2021 it identifies a drop in sand of 0.7m in this area alone (Figure 19). The area of loss extends much further than the swords and muskets. It extends 6m southeast to Guns 1-3 with further large concretions now currently exposed between the swords and guns. There are possible further concreted small arms directly east of the swords too.

4.2.21. The general topography of the northwest end of the site is not recognizable with the 2020 bathymetry. The 2020 bathymetry showed this end of the site consisted of a gentle sandy slope with the swords as an isolated feature (Figure 2). This was not the case in July 2021. There are now currently many exposed archaeological features including several guns to the northeast and large concretions and timber structures between those guns and the swords.

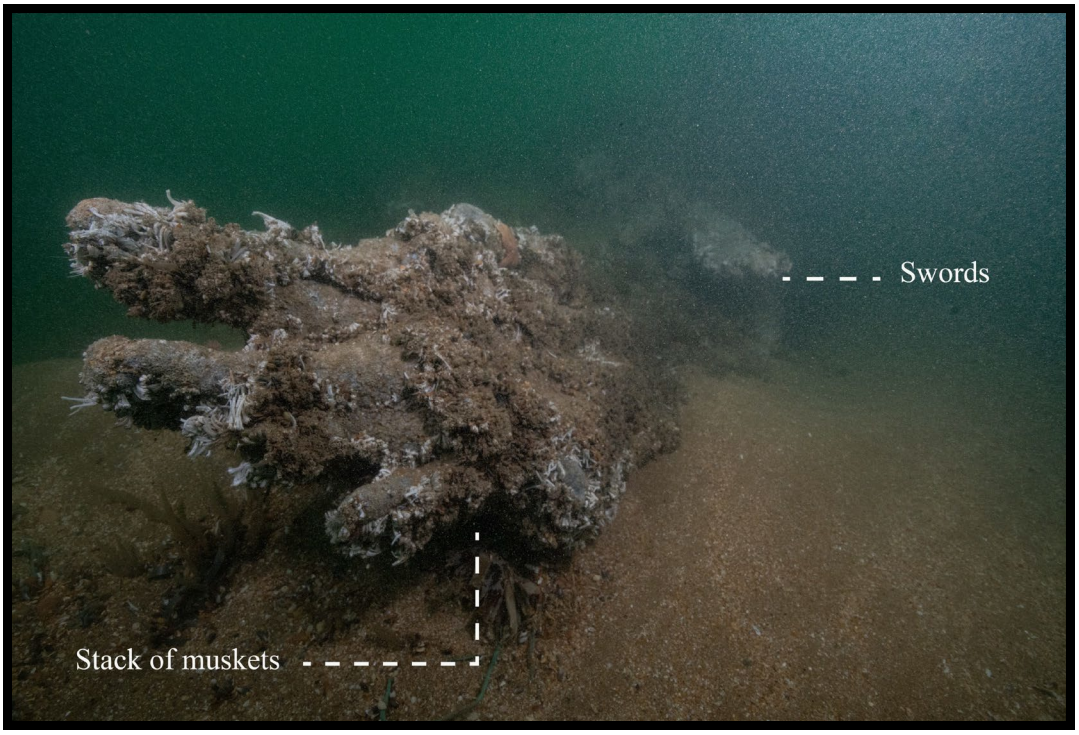

Figure 17: Annotated photo showing assemblage of muskets lying directly north of the swords.

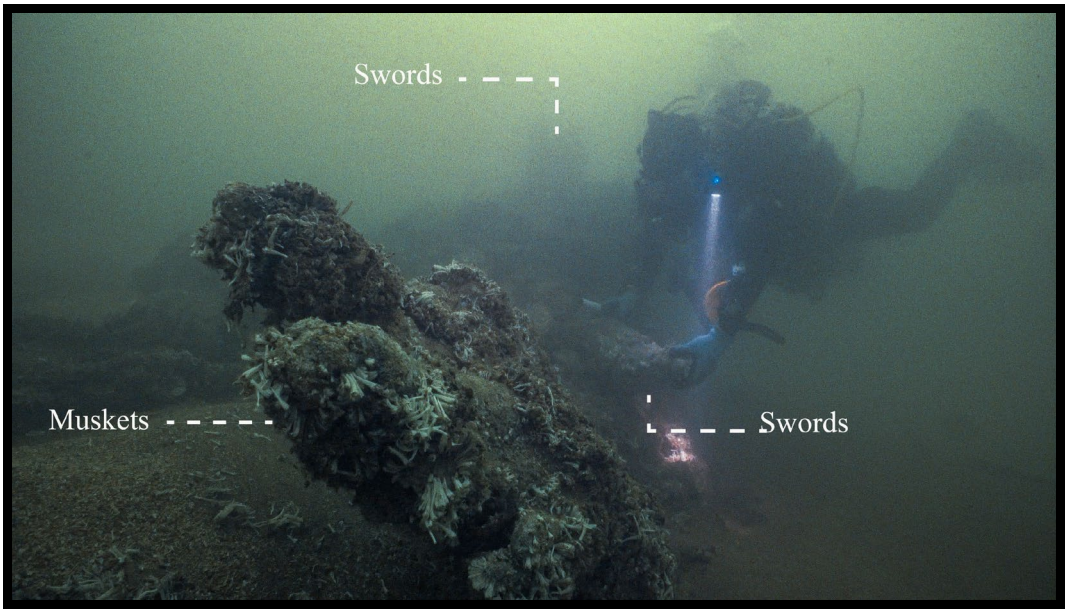

Figure 18: Annotated image showing diver inspecting concretions of muskets and swords. Also note the concretions behind the muskets and swords which look like more concreted small arms.

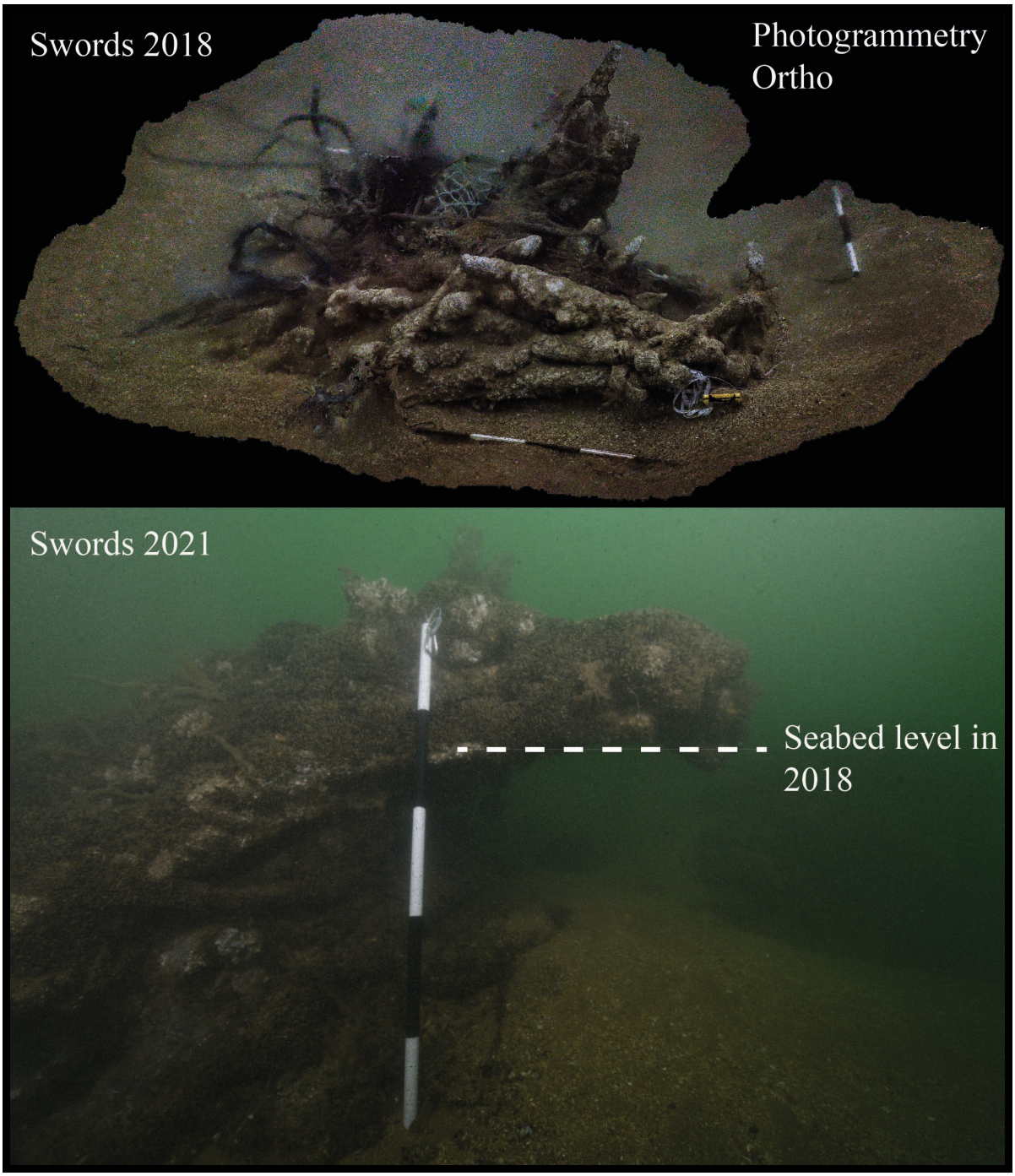

Figure 19: Comparison between the 2018 and 2021 images of the assemblage of swords which identifies a loss of 0.7m sand.

4.2.22. Approximately 13m south of the assemblage of hand weapons is an area consisting of two parallel lines of exposed structure (Label 10 Figure 2). This area was barely showing in the 2020 bathymetry but divers' observations from 2021 confirm it consists of coherent structure and concretions emerging from the sand, but which is covered in fishing net. This was only observed on the last day and therefore there was not the opportunity to return to it and record the structure in detail. It's location

away from the main wreck mound suggests it is possibly starboard side hull structure that has collapsed outwards.

4.2.23. Due to two days lost to weather there was insufficient time to ground-ruth the anomalies to the north of the site.

Biological trial

4.2.24. The three sets of timber test panels were deployed on site and secured to the large concretion at the southeast end of the site in 2018. This area of the wreck was chosen as it is robust and above the current level of the seabed. Therefore, the movement of mobile bedforms will not displace or bury the test panels.

4.2.25. It was not possible to return to the site in 2019 or 2020 due to a combination of bad weather and the Covid pandemic. When we returned to the site during the current project there was no evidence of the test panels apart from the blue nylon rope that was used to attach them to the wreck.

4.2.26. The fact that the rope survived but not the test panels would suggest that the timber was totally degraded by wood borers and probably physical erosion too.

The extent of fishing net on site and its removal

4.2.27. Due to poor visibility net removal was very focused around a manageable feature where net could be removed relatively safely and away from other divers. In 2018 the assemblage of swords at the northwest end of the site was found to be tangled in a variety of fishing gear (PA 2018, 11). Due to the uniqueness and importance of this assemblage of artefacts it became the focus for net clearance.

4.2.28. The divers assessed the area around the swords and found the swords were part of a much larger feature due to the loss of seabed sediments. As well as being a larger feature there was a lot more evidence of entangled fishing gear, which included a whole trawl net. The net was far too large to tackle in the poor conditions, but the divers conducted a video survey to demonstrate the size and the challenge of removing nets in the conditions encountered during the fieldwork. The net starts at the base of the upstanding swords and extends down the slope for approximately

10m. It appeared to be snagged on other concreted features protruding from the sand. The survey can be seen here https://youtu.be/D3jUml9AG3A.

4.2.29. In addition to the whole trawl net there was a mix of trawl and gill net wrapped around the swords from the top to the bottom of the feature. This net was successfully removed, placed into a bag and recovered to the surface. This link shows the net being removed and the challenges in doing so https://youtu.be/ncHdZJI5T30

4.2.30. The extent of fishing net covering the wreck wasn't fully realised until the fourth day when the underwater visibility improved to 3-4m. The improved visibility enabled a full assessment of the whole site and it showed that with a greater exposure of archaeological remains there was greater quantity of fishing net.

4.2.31. The fishing net which was observed in 2018 draping over much of the large concretion at the southeast end of the site was seen to extend west to the lower hull structure. The net is of the gill variety and although ripped and broken it covers the keel and end of frames (Figure 20).

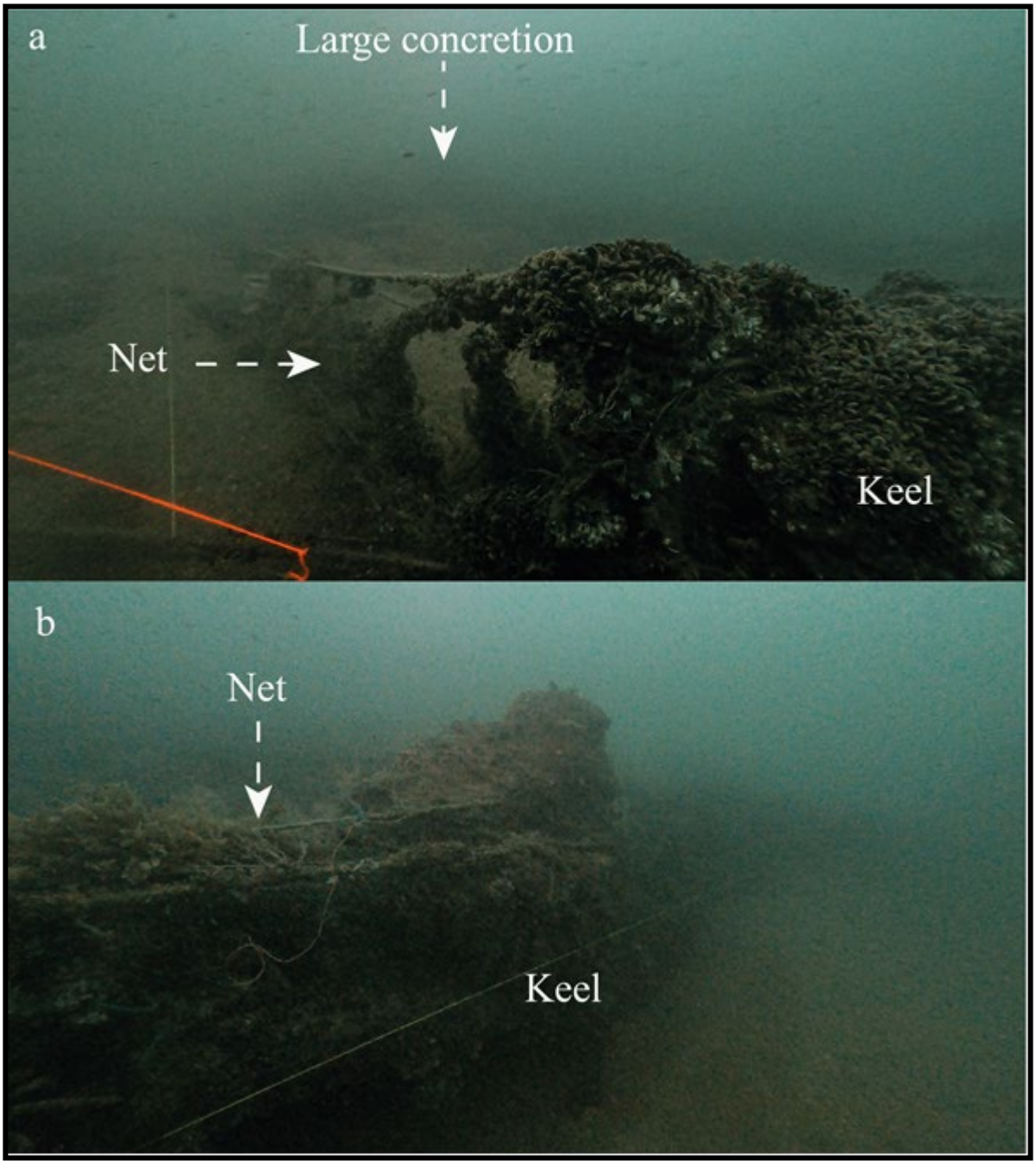

Figure 20: Image **a** shows a gill net snagged on the section of exposed keel on the west side of the wreck and extending up to the large concretion towards the centre of the site. Image **b** shows the gill net is covering the exposed keel and much of the structure along the west side of the site.

4.2.32. As mentioned in section 4.2.22 diver observations recorded that the exposed area of structure 13m south of the hand weapons and guns 1-3 was all heavily covered in fishing net. This was seen on the last dive but no images were taken.

4.2.33. The quantity of fishing net on site, and its predominantly intact nature, suggests it has been abandoned after it has been snagged, as opposed to being lost elsewhere and drifting in. To support this theory one can look to the 2020 bathymetry of the

wider area around the wreck (Figure 21) and the general understanding of the seabed topography of the Goodwin Sands. The seabed around the site, and across the Goodwin Sands in general, is made up of sand waves. The only obstructions on the seabed for nets to snag comes from wrecks or other types of manmade obstructions. Wooden wrecks are not as easy to detect on vessel's echo-sounders (depth indicators), so, despite sites being marked on charts, trawlers may be unaware of their presence, resulting in the snagged and abandoned nets seen here.

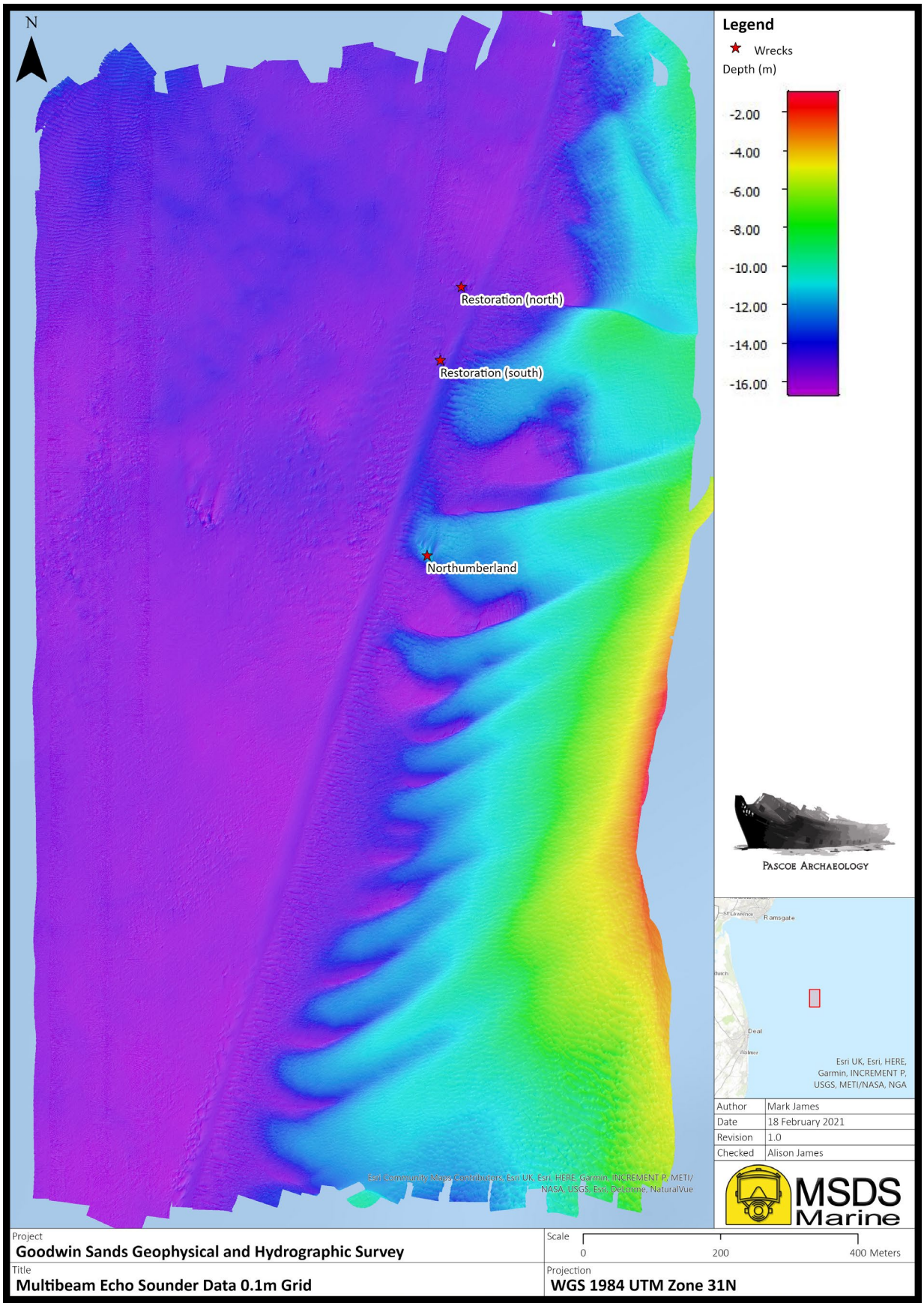

Figure 21: Showing the 2020 bathymetry of the *Northumberland, Restoration* and the surrounding region. There are no other obstructions for nets to snag other than the wrecks themselves.

4.2.34. Another indicator that the nets on site have been abandoned following snagging on the wreck is that a significant proportion of the nets have the floats attached (Figure 22). These are gill nets and they have a very fine nylon mesh. The floats are attached to the top of the net to keep it upright and off the seabed. If these were broken nets which drifted in from elsewhere the likelihood is they would be floating near the surface and therefore passing over the wreck.

Figure 22: Showing gill net with floats still attached.

4.2.35. The large trawl net described in section 4.2.27 was assessed by the divers as a complete net due to its size and weight. Its weight would have made it less likely to have drifted in and therefore more likely that it snagged the wreck during a trawl.

4.2.36. It is very difficult to determine the age of the nets and therefore when they would have become snagged on the site. The nets are all made of nylon or plastic and therefore do not degrade. In a very short period of time, though, they become colonized by marine growth. We know this happens quickly because when a camera was lost on site, by the time it was recovered 24 hours later, mussels had become attached to the lens and housing. From the quantity and different types of fishing net and gear, however, it is likely that there has been an accumulation over many years. Some of the net is partly buried which suggests it occurred some time ago but

how long is impossible to say. Equally, it cannot be ruled out that some of the net has accumulated more recently.

4.2.37. There is little visible evidence that the net is offering any significant protection to the exposed archaeology. This is especially the case for the gill net as, with its fine nylon mesh, it does not have the ability to collect and hold sediment. It is, however, very good at collecting and trapping marine life and this was evident through the large number of spider crabs entangled in the net. The trawl net with its thicker mesh and greater weight does allow sediment to collect, and, as such, does offer some protection to the archaeology lying directly underneath. The problem, however, is that the bulkier net also increases the height of exposed archaeological features, causing scour beneath the feature and cancelling out any positive effects.

4.2.38. From both an archaeological and environmental point of view the net is having a negative impact on the site, but it is extremely difficult to remove it during short periods of fieldwork. The current project has demonstrated that there is too much net to recover during one week of diving and it would probably take several weeks before a visible difference was achieved. A better approach would be to leave net where it is until the need comes to record what lies beneath it. Having the ability to remove manageable sections of net during future phases of fieldwork would be a better approach than trying to remove it all at once.

4.2.39. The net should not cause any major issues to potential excavation plans as it could be removed when required. It does, however, remain a risk to inexperienced or visiting divers who are not familiar with the site and the hazards.

pH tests

4.2.40. Environmental recording, and in particular pH testing has become a standard requirement associated with diving work on protected wreck sites. Such testing forms part of a series of techniques used to monitor wreck site environments, as they face threats from climate change and increasing ocean acidification. Decreases in the pH values of the ocean as it becomes more acidic directly affect the preservation environment of our marine heritage, and as the oceans absorb ever-

increasing levels of carbon dioxide from the atmosphere, acidification will continue to increase, further threatening marine heritage.

4.2.41. In response to these threats Historic England has begun to compile a database of pH values recorded on the seabed during diving works undertaken in English waters. The methodology set out below follows that which is set out in the paper, Climate is what we expect, weather is what we get: Managing the potential effects of oceanic climate change on underwater cultural heritage (Dunkley, 2015).

4.2.42. Our team recorded pH values on the site. Recording was undertaken using a Hanna Instruments Piccolo® Plus pH meter, capable of taking values with an accuracy of ±0.01. Relevant contextual data was also recorded, such as date, and in particular the depth and state of the tide at the time the sample was taken, as this information is thought to affect pH values (Dunkley, 2015, p. 225).

4.2.43. The samples were taken on two separate days, a single sample was collected from the main wreck mound, off site to the east and from the surface (Table 1).

Date of sample	Location	Depth	State of tide	pH value
02/07/21	Wreck mound	16m	3.5 hours after HW	7.72
04/07/21	Surface	Sea level	3.5 hours after HW	7.85
04//07/21	Off site to the east	19m	3.5 hours after HW	7.75

Table 1: pH sample results.

4.2.44. These results will feed into Historic England's wider study in this area (relating to pH), to enable future strategies to be developed allowing for the protection and management of marine heritage within English waters, in the face of global threats such as climate change.

Social media engagement

4.2.45. PA believes it is extremely important to demonstrate the importance of the site and the work being conducted with the archaeological community but also the wider public. One way of doing this is through social media platforms and each day posts were updated onto the *Northumberland* Facebook page and on twitter. This has led to the engagement with hundreds and sometimes thousands of the public. However, these posts are generally capturing a particular moment of the day and are very

short lived and easily forgotten. PA wanted to find a platform which had the potential for greater longevity and that could be repeated to keep the importance of the *Northumberland* and the work being conducted on site at the forefront. In 2018 PA experimented with video diaries, show casing underwater footage and top side interviews. These were uploaded onto the Pascoe Archaeology YouTube channel and were reasonably successful but were relatively short lived. This time PA decided on a longer single film which is currently under production.

4.2.46. Each day work on the site was documented by cameraman and producer Michael Pitts. The footage is currently being edited to produce a short film. The film will demonstrate the importance of why we are investigating the site, it's high archaeological potential, as well as the daily challenges of diving on the Goodwin Sands. A trailer has been released via the Pascoe Archaeology YouTube channel as a teaser for the forthcoming film https://youtu.be/rorRX-wI-bE

4.3. DISCUSSION

4.3.1. The main point of discussion arising from the 2021 diving fieldwork is how different the site appeared compared to how it looked in the November 2020 bathymetry. The observations made during the diving fieldwork and described and illustrated in section 4.2 demonstrated that within just eight months significant areas of the site were unrecognizable due to the increased exposure of the site. This was not limited to certain areas but all over the wreck mound.

4.3.2. It should also be stated that this has not come as a surprise as it was predicted following the analysis of the 2020 geophysical surveys. The 2020 bathymetry showed the site was on the edge of large subaqueous dune, which was migrating away from the site (PA 2021, 21). The sub-bottom results identified that there was not a sufficient depth of stratigraphy behind that dune to provide an appropriate burial environment to preserve the 3.5m depth of stratigraphy on the site (PA 2021, 34). The full extent of the change since November 2020 can only be visually appreciated through another MBES survey.

4.3.3. Greater exposure of the wreck has also revealed a greater amount of fishing gear. The quantity of net was too much for a small dive team to safely deal with during five days of diving, three days of which were in complete darkness. The quantity of net has also demonstrated that a charted and protected wreck is not a deterrent for fisherman. Much of this net is historic and has accumulated over many years but it is also possible that some of it is more recent. The entanglement of nets does cause harm to the exposed archaeology, the marine environment, as well as being a dangerous hazard to divers. Finding a way to deter fishing over the site to stop the accumulation of more net should be a point of discussion regarding the future management of the site.

4.3.4. Returning to specific features of the wreck the assemblage of small arms at the northwest end of the site poses some interesting questions. For example, what types and how many did the *Northumberland* carry? Where were they stored? The study of ordnance inventories for third-rates shows that they carried a variety of bladed and gun powder hand weapons. The inventories show the *Northumberland* would have been equipped with 40 hangers and 40 swords, 80 flint lock muskets, five blunderbusses, five musketoons and 16 pairs of pistols (HCCA,109M91/SW1). The weapons would have been distributed between members of the crew during close quarter action and boarding.

4.3.5. The master gunner was responsible for the organisation and maintenance of the small arms. The master gunner had at least one store at the forward end of the orlop, known simply as the gunner's store. However, if the current interpretation of the orientation of the wreck is correct then this assemblage of weapons is towards the stern. This suggests a significant proportion of the hand weapons were not stored in the gunner's store.

4.3.6. The master gunner was known to have his living quarters in the gunroom. The gunroom was found at the very aft end of the gundeck (Lavery 1986,147). With guns on either side, as well as the entry point for the tiller, this was already a cramped location. The location of the assemblage of hand weapons on the site suggests the gunroom may have been a possible location for large proportion of these weapons.

4.3.7. Several musket components were found on the wreck of the *Stirling Castle* and their location was recorded across the length of the site (Perkins 1980, 9-10 and Whitewright 2020, 174). This suggests the potential for hand weapons to be distributed in different locations around the ship. However, one can not assume each ship is the same despite the two ships being the same rate. Ships were commanded by individuals and as such Captains may have had different approaches to the organisation of their ship. This is what makes studying the wrecks as a collective so important as one is not only able to track the changes in maritime culture over time but also identify the unique differences between individual ships of the same period.

4.3.8. The discovery of such a large assemblage of hand weapons in one distinct location also suggests this is not a scattered and dispersed site but one that has remained predominately in one place. There is, therefore, high potential that there is other objects and structures surviving nearby that are associated with their use and organisation, which may answer the questions relating to how and where they were stored on board.

4.3.9. With regard to the great guns on the site there is still a very small proportion of the *Northumberland's* full arsenal that are currently exposed. This is surprising considering the degree of current exposure. The 2020 magnetometer data confirmed the site has a high magnetic signature with much of it extending beyond the exposed extent of the site (PA 2021, 56). Thus, the guns are all there, but most are not currently visible. As previously mentioned the sub-bottom data recorded up to 3.5m depth of stratigraphy within the main wreck mound. The lack of exposed guns is another indication of the potential for intact and well-preserved areas of the ship to survive with guns and their associated carriages.

4.3.10. The current interpretation of the site indicates a wreck lying over on its port side with the bow towards the southeast and the stern towards the northwest (Pascoe and Peacock 2015, 142). As such what is currently visible is a selection of guns from the starboard side of the ship and the port side battery could potentially be

complete lying adjacent to their gun stations, along the intact port side, at the bottom of the wreck's stratigraphy.

4.3.11. The survival of significant parts of the carriage of Gun 4, which is located near the top of the wreck mound, on the northeast edge of the site, reiterates the potential for even greater preservation of gun carriages lower down within the stratigraphy of the wreck.

4.3.12. The discovery of a complete chest, along with the area of rope forward (southeast) of the large concretion, again is another positive indicator for the widespread survival of fragile organic remains. These types of artefacts do not tend survive intact and in such a good state of preservation, unless they have been shielded from dispersal by intact and coherent sections of surviving hull structure. If this is the same rope recorded by the previous Licensee Robert Peacock and its location is certainly consistent with that of the rope recorded in the 1993 sketch plan, then there is also well-preserved deck structure surviving below it (Pascoe and Peacock 2015, 140).

4.3.13. The evidence of scouring along the western edge and SE end of the site, along with a greater number of exposed guns on the northern side it would appear that the large subaqueous dune has continued to migrate north-eastwards leading to a significant reduction in seabed levels across the whole site. Due to poor visibility and the loss of two days diving it was not possible to fully comprehend the magnitude of the new exposure. However, the discovery of more fragile material, such as onion bottles, cauldrons, rope, chests and human remains heavily suggest the site is now in a more vulnerable and unstable condition than before.

4.4. RECOMMENDATIONS

4.4.1. Due to the precarious position of the wreck recorded on the November 2020 bathymetry, alongside the visible differences observed by the divers in July 2021, PA recommends an urgent repeat MBES survey to record the changes. This is essential to fully understand the current extent of the exposure of the wreck and to quantitative the rate of change since the previous survey but also to track the

migration of the subaqueous dune, which was protecting the site. The survey results will inform future archaeological investigations and management strategies. A current MBES survey will greatly aid and direct an excavation proposal and potential Project Design by identifying areas of the site that are either most at risk or more achievable for intrusive investigations.

4.4.2. The *Northumberland* up to now is an excellent case study to demonstrate the successful management of a protected wreck in an extremely dynamic environment, such as the Goodwin Sands. This has been possible through funding from Historic England and a programme of work led by Pascoe Archaeology, following the series of management policies laid out in the current Conservation Statement and Management Plan (CSMP) (PA and HE 2020). Site monitoring through regular MBES surveys -- which is essential when sand dune movement is decameters each year -- have established the site is under immediate threat from complete exposure; sub-bottom surveys have identified a mouthwatering depth of stratigraphy that will be impacted by the loss of surrounding seabed sediments; and diver observations have already recorded a diverse and vulnerable mix of exposed archaeological features. Past experiences learned from the wreck of the *Stirling Castle* have shown that when a site becomes exposed on the Goodwin Sands, archaeological features appear and often deteriorate faster than they can be recorded (WightWright 2020). As both the high archaeological potential of the *Northumberland* and the immediate threat to it have been established, the next rational step following management policy 8 of the current CSMP is a strategic and targeted threat and research led excavation. PA therefore, recommends drafting an excavation proposal to submit to Historic England.

4.4.3. Recent underwater investigations on the site have identified that there has been and potentially still is a problem with fishing over the site. The evidence for this is the vast quantity of fishing gear of all types wrapped over most exposed features of the wreck. PA recommends a discussion with HE to establish what can be done to prevent the site being fished over. One possible idea might be the placing of a large wreck buoy on site, which would provide a physical marker to the wreck and hopefully deter trawling and other types of commercial scale fishing

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